FISCAL POLICY AND THE ENERGY CRISIS

HEARINGS

BEFORE THE

SUBCOMMITTEE ON ENERGY

OF THE

COMMITTEE ON FINANCE

UNITED STATES SENATE

NINETY-THIRD CONGRESS

FIRST AND SECOND SESSIONS

ON

S. 2806

ENERGY REVENUE AND DEVELOPMENT ACT OF 1973

NOVEMBER 27, 28, AND 29, 1973; JANUARY 23, 24, 25, 28, AND 29, 1974

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FISCAL POLICY AND THE ENERGY CRISIS

FRIDAY, JANUARY 25, 1974

U.S. SENATE,
SUBCOMMITTEE ON ENERGY
OF THE COMMITTEE ON FINANCE,
Washington, D.C.

The subcommittee met, pursuant to recess, at 9:40 a.m., in room 2221, Dirksen Senate Office Building, Senator Mike Gravel (chairman of the subcommittee) presiding.

Present: Senators Gravel and Dole.

Senator GRAVEL. The hearings will come to order.

Again we have a continuation of the hearings on S. 2806 and related areas of the energy crisis with the hope of developing policy options to be undertaken by the Finance Committee in meeting its responsibilities to the Senate.

We have a distinguished panel of witnesses today. I would anticipate that we would probably get through three or four of them this morning and go on this afternoon. We will probably adjourn around 12 o'clock and come back at 1:30 or 2 o'clock.

We are fortunate that the Senate is not in session as we should have no interruptions and can concentrate on the task at hand.

Our first witness is Hon. Dixy Lee Ray, chairman of the U.S. Atomic Energy Commission.

Dr. Ray, would you please come forward and bring anyone that you wish to sit with you to assist in your testimony. I must say I am an admirer of yours. As you know, I have been a critic at times of the AEC, yet I think I have the distinction of being one of the few Senators that has pushed for an increase in the AEC budget on the floor of the Senate, and been successful, independent of committee action. My criticism I hope has been constructive, and certainly on my side it has not been an effort to decrease your budget but to increase it because of the important task that your organization has set for itself in the total spectrum of satisfying human needs.

Thus I am very happy to have you here. I think you have been a positive influence on the Commission. I think your leadership is recognized, and I am glad that you are the chairman of the AEC.

Doctor, it is a pleasure having you here, and the floor is yours. Proceed as you wish.

STATEMENT OF HON. DR. DIXY LEE RAY, CHAIRMAN, U.S. ATOMIC ENERGY COMMISSION; ACCOMPANIED BY L. MANNING MUNTZING, DIRECTOR OF REGULATION, ATOMIC ENERGY COMMISSION; AND MARCUS A. ROWDER, GENERAL COUNSEL, ATOMIC ENERGY COMMISSION

Dr. RAY. Thank you very much, Senator.

May I express my appreciation for your very kind words? We know that we have had lots of good discussions with respect to nuclear energy, and I think that one of the finest things that has emerged are the voices of responsible criticism. These voices help any agency in any new technology as nuclear energy is, to be responsive, and to stay on its toes. When you get imbued and very much involved in any technology, sometimes you cannot see the forest for the trees.

So I think it is a very important thing in the public interest for open discussion to take place. Responsible criticism such as you have provided has been good for the agency, and we know that we can and we will continue to be responsive.

I would like to introduce the two gentlemen with me at the table this morning. To my left, Mr. Manning Muntzing, who is Director of Regulation for the Atomic Energy Commission; and to my right Mr. Marcus Rowden, who is our general counsel.

We are pleased to be with you this morning, and we will be happy to respond to questions which you may have.

As you know, I have a prepared statement. I thought I would read from it but summarize it a bit since it might otherwise take longer than necessary.

We are here to testify on S. 2806, the Energy Revenue and Development Act of 1973. The task of achieving a capability for energy independence for this Nation, which is a primary goal of this bill, is a task which has consumed a major part of my own energies for the past several months. Therefore, I do appreciate this opportunity to express my views on this extremely important and timely subject.

The Atomic Energy Commission is very much interested in the underlying goal of S. 2806: To organize the energy efforts of the Federal Government in such a way as to assist the Nation in establishing a posture for achieving energy independence by the mid-1980's.

The energy shortages of today and those projected for future decades stem, in part, from the lack of a coordinated national program for energy research and development over the past 10 to 20 years. Today's shortages impart a long overdue sense of urgency to the effort being launched to meet not only immediate requirements but also the growing needs of the years ahead.

The energy challenge posed by the immediate future carries with it an unparalleled opportunity for the Nation to emerge better equipped than ever before to pursue the higher goals of domestic and international peace and well being.

S. 2806 includes a wide range of provisions relating to energy. These provisions involve taxes, research and development policies and organizations, technology assessment, price controls, import and export policies, and oil and gas production. I plan to confine my statement to those areas of greatest concern to the Atomic Energy Commission and expect that other witnesses from the executive branch and from industry will discuss the areas of greatest concern to them.

As you are aware, the establishment of a Federal Energy Administration was first proposed by the executive branch in draft legislation submitted to the Congress on December 4, 1973. That legislation, which proposed a considerably different Federal Energy Administration from the one now under consideration, was subsequently introduced in the Senate as S. 2776, underwent hearings by the Government Operations Committee, and passed the Senate on December 19, 1973. As described by Mr. Roy Ash, Director, Office of Management and Budget, in testimony on S. 2776 before the Government Operations Committee on December 6, the Federal Energy Administration would concentrate "on the immediate operational needs of minimizing the adverse impact of the fuel shortage, increasing our energy supplies and reducing our energy demands."

A separate organizational entity was proposed by the President to deal with the longer range goal of developing and improving technologies which can be called upon to yield new approaches to creating and using energy. I am referring, of course, to the Energy Research and Development Administration, commonly called ERDA, as proposed in S. 2744, upon which hearings were also conducted in December by a Subcommittee of the Senate Government Operations Committee. That bill would form a new energy R. & D. agency by bringing together some of our Nation's best talent in research and development. It would draw not only from the resources and extensive experience in technical management of the Atomic Energy Commission, but also from the professional talent in fossil fuel development of the Interior Department's Office of Coal Research and Bureau of Mines' Energy Research Centers. From the Environmental Protection Agency it would acquire expertise on the development of alternative automotive power systems and on developing technology for controlling emissions of air pollutants from stationary sources using fossil fuels. ERDA would also perform functions related to solar and geothermal energy development, which would be transferred from the National Science Foundation.

Returning now to the energy organizational proposals in S. 2806, there are several comments I would like to make regarding the proposed transfer under section 310(a) of AEC's functions which relate "primarily to the peaceful uses of atomic energy."

First and foremost, I am opposed to the transfer of these functions to the Federal Energy Administration. I remain firmly convinced that it is wise and sound to create two separate organizations to deal with energy matters as proposed by the President: the Federal Energy Administration, as envisioned in S. 2776, and the Energy Research and Development Administration as embodied in S. 2744. Both organizational arrangements have received considerable scrutiny; they have undergone hearings in both the Senate and the House of Representatives; and each of them has completed at least one major step on the way to full congressional approval. As I mentioned, S. 2776 passed the Senate on December 19, and H.R. 11510, the House counterpart of S. 2744, passed the House on the same day.

The two-agency approach will permit the President to have reporting to him separately two agencies with quite different but equally important missions. One of those, the FED, not only can take rapid and decisive action in response to developments resulting from the energy shortages facing the Nation, but also provide centralized direction and management of energy policy. The other, ERDA, can mobilize those efforts that are needed to generate and accelerate research and development activities on all sources and forms of energy so that fossil and nuclear fuels, advanced energy sources, conservation of energy, and environmental considerations will all receive full recognition and appropriate emphasis.

Energy research and development activities are designed to alter present energy dependency relationships by reducing energy requirements, developing new energy sources or substituting plentiful resources for scarce ones. In one sense, the purpose of research and development is to change the status quo with respect to energy technology. The FEA on the other hand would be an agency which must of necessity be concerned with available technology. It would be charged with insuring that the present energy system meets national needs now and in the near future. Like its predecessor agencies, FEA would inevitably be caught up in the concerns and problems of current fuel and technology interests. In such an environment, it is not reasonable to expect that the agency would launch and maintain vigorous research and development programs whose benefits would be realized only after many years of study.

Section 310 would apparently transfer all AEC functions, including research and development and licensing and regulatory functions, to the proposed Federal Energy Administration. We find this feature undesirable because we believe the time has come to treat energy R. & D. and the problems attendant to the licensing and regulation of nuclear powerplants separately. As the current energy crisis has deepened, we as a nation have come to realize that we are faced with a very serious challenge to find those solutions which will most quickly and effectively lead us toward energy self-sufficiency. The reorganization of energy R. & D. functions in the Federal Establishment as provided by S. 2744 and S. 2776 seems to be the most appropriate way of giving comprehensive and systematic direction to solving our energy problems. The solid growth of the nuclear power industry in recent years has greatly increased demands upon the AEC in the area of regulation of the peaceful uses of nuclear energy. The time has now come when the scope and the magnitude of the regulatory function requires the undivided attention of a single agency. The proposal in S. 2744 to provide for a separate Nuclear Energy Commission is another step in the evolution of governmental control of nuclear development and uses, and we strongly support it.

Another point regarding the transfer provisions of S. 2806 is that they do not make clear what would be transferred to the new Federal Energy Administration in addition to certain functions of AEC. Additional transfers of functions from other agencies would be permitted by section 311(a) but would require future Presidential decision and subsequent notification to and tacit acceptance by the Congress. It also gives no assurance of a unified Federal approach to energy R. & D. as called for in the statement of policy and purposes set forth in section 101(3).

Title IV of section 2806 would establish a Commission on Energy Technology Assessment, consisting of an Energy Technology Assessment Board, and a Commission. The Board would be composed of 22 members, including the Commissioner, with seven members each from the field of economics, the field of engineering, and the fields of the physical, biological, or social sciences. This is embodied in section 401(c). We believe that any effectively managed energy administration should develop its own capability to undertake continuing assessments of the value of its programs and provide effective research and development planning and execution. A separate Commission on energy technology assessment could have a potential for causing a diffusion of responsibility and conflicting orders of priorities. We consider its creation unwise.

With regard to the establishment of an energy trust fund and the other provisions of S. 2806, we defer to the views of other Government agencies having responsibility and greater expertise in these matters. As a general observation, we might comment that while the imposition of an energy tax is an accepted method of raising revenues, it seems preferable for energy R. & D. financing to compete with other demands on the tax dollar through the budget and appropriations process. However, this in no way lessens my conviction that we need a sustained and adequate commitment to research and development to meet the Nation's future energy needs.

If we are to achieve the capability of energy self-sufficiency by the mid-1980's, we must rapidly begin to demonstrate our determination to accelerate the development of technology in conservation, in the fossil and nuclear fuels area, and in the solar, geothermal, and fusion fields. We believe that we have made a beginning developing of the recommendations for an integrated energy R. & D. program for the Nation as contained in my December 1, 1973, report to the President.

To summarize, Mr. Chairman, I would like to reiterate my support for an independent Energy Research and Development Administration together with a separate Nuclear Energy Commission to perform the licensing and regulatory functions now performed by the Atomic Energy Commission. For this reason, we do not favor the establishment of a Federal Energy Administration as proposed in S. 2806.

This concludes my prepared testimony and I would be pleased to respond to your questions.

Senator GRAVEL. Thank you very much, Doctor.

To start from the beginning of your statement, apparently its thesis, and obviously a thesis of the administration, is to have a dual effort, one of R. & D. and one of immediate executive action to cope with the emergency. The Federal Energy Administration as proposed by the administration would be terminated when the short-range problem has been mitigated.

In your statement, you talked of the obvious problem of the lack of planning up to this time. We have not addressed ourselves to a coherent energy policy for the Nation.

Would not the ingredients of having a dual system or a tandem system, one with a lot of executive power sitting over here, worrying about the emergencies in the late afternoon, as one part, and the R. & D. guys sitting over there in their, what some would term "unrealistic" vacuum, doing the long-term research, would that not cause a duality of purpose and add to the incoherence rather than the approach taken here, which is to bring it all under one roof so that we have some accountability and an integral leadership pattern?

I know that the administration has taken these two separate acts. I am not married to any particular proposal, but it would seem more logical and efficient to have one integrated structure with the necessary power and ability to go ahead, because the shortrun problems are no different than the longrun problems. The only difference is, they are more immediate.

Dr. RAY. Well, that is a very good statement, I think, of the situation which does exist. What we have really in any area like this is a long spectrum of events, from the development of basic knowledge which requires a considerable effort in scientific research, even in areas where there does not appear to be an immediate payoff, through all of the aspects of energy utilization and development to the immediate transfer of a technology to the private sector, and the problems of getting, distributing, and using energy. There is also a question of whether that task should be considered in a total picture under a single agency, or whether it should be divided up into more manageable segments. At what point one should make such divisions is a question I think that can be discussed at great length.

From a philosophical point of view one can adopt a number of equally acceptable management schemes, but I think from a practical point of view what actually works out is that distinct areas of responsibility, where they are distinct, and limited, generally result in more effective action.

If we look over the structure of the Federal agencies at the present time, there are very few agencies without some research and development responsibility. Indeed, one of the problems today is the fact that various aspects of energy and fuels research are a portion of the responsibility of a large number of agencies.

Senator GRAVEL. Well, making the comparison with the space agency, when we decided we were going to put a man on the moon, we had NASA, and that was the aegis of it all.

Now, how would that program have worked if we had said, well, we have got an ego problem in competing with the Soviet Union since they have just launched Sputnik, and we will take care of that shortrun problem by setting up one agency with a lot of power, but then we will put the eggheads all over here somewhere in California or Florida and let them go off and do their number. I wonder how soon we would have gotten a man on the Moon that way. What would be your view to that?

Dr. RAY. Well, sir, I would consider NASA an egghead organization. That was a research and development program. It did not have anything to do with resolving any present-day problems of supplying of things to the civilian economy. That was a special task totally assigned for a research and development program.

The basic scientific principles were understood, but there was a great deal of research that had to be done to find the right technologies that would work in an environment. We were not totally familiar with these technologies and there was an enormous amount of basic research that had to be a central component of the task. R. & D. was the name of the game so far as NASA was concerned.

Senator GRAVEL. I think that makes a compelling statement of comparison.

Dr. RAY. And whatever there has been, I think that history will show that where there has been a need to accomplish a task—when it was clearly something that had to be done but required the development of new knowledge, or the improvement of technologies, while principles were understood—the assignment of that to an independent agency has been the most effective way to accomplish it.

Senator GRAVEL. Well, in drawing it one step further—and I see the merit of that—if there are differences between the immediate policy with respect to the shortrun problem of shortages and the long term R. & D. policy, the only real place to arbitrate the difference is in the White House, because you have two agencies of Government.

Dr. RAY. That is correct.

Senator GRAVEL. Which creates a situation that Jack Kennedy was fond of describing as, "I think it is a good idea and someone should try to get the Government to go along with it." But with the climate that now exists in the White House, with problems besetting it from other areas, how much attention do you think you could get from the Office of the Presidency, to act as effective arbitor between possibly conflicting bureaucracies, personal ambitions and possibly conflicting goals, if you have two separate agencies going their merry way?

Dr. RAY. Well, I think then the situation described in general, Senator, will probably always exist. But if I can speak from the standpoint of the Atomic Energy Commission, which is my responsibility: Regardless of what conditions exist in the Federal Government, we have had no problems in getting the attention of the White House when we needed it on a particular problem, nor in arbitrating any question of interrelationships with other agencies. And I think I can say with complete justification and with evidence to back it up that the Atomic Energy Commission is continuing to perform effectively its role in its research development and in its regulatory functions, whatever the political climate may be.

Indeed, I think that the effectiveness of the manageable independent agency approach to performing tasks of importance, will depend very much upon the leadership. There will always be, I think, healthy interaction between agencies with similar or overlapping responsibilities; but this is in my opinion, sir, a good way to administer the necessary work of the Government.

There have been, as you know, many proposals in the past to create a Department of Science, which would be a large umbrella organization to accomplish all aspects of the scientific work in which the Federal Government has obvious responsibility and concern. But whenever the discussion comes up in the Congress and hearings are held and attention is focused upon it, it is recognized that, however pleasing such an overall philosophical concept is, in practical matters it just does not tend to work out very well. It is too all-encompassing.

Senator GRAVEL. Well, you know, Doctor, I think we should commend you, because it just dawned on me where our differences are in this regard. I set up a Commission on Energy Technology Assessment, which in your statement you disagree with because you have built in already the automatic check and balance by separating the R. & D. and the more executive and mundane activities that would obviously be a check against each other, as you view it. But the way I structured the bill was to have the whole thing under one energy administration but with a commission that would act as adversary, and I think there is no cognizance of that adversary role in your statement except as you are explaining it now.

Do you see the need for an adversary role within the operation of Government and its bureaucracies? So let me just commend to your thinking and the administration, that what you as a person are offering, and your leadership and advice within the administration, have begun to appreciate the need for an adversary system, be it inside or outside of Government.

This is a matter of personal preference, but let me just suggest that the Commission on Energy Technology Assessment would not bear the responsibility for policy as you infer in your statement. In my mind it would bear the responsibility of doing what many public constituencies are doing to the AEC now, that is, assaulting them from afar. Now this assault is publicly financed through the largesse of generous individuals, whereas I would like to see that process be financed by Government.

It may appear inefficient, but in our system where we are all sort of "vectored" and all vested interests, it is very difficult to break through.

I want to commend you and your leadership right now because when you are sitting here before me saying that you think that the licensing procedure should be taken away or separated from present AEC activities, I am reminded this is a proposal that I suggested in May 1969. I was roundly excoriated by the AEC leadership at that time, and by the administration.

Dr. RAY. You were a prophet without honor.

Senator GRAVEL. Well, the whole thought then was the same as now. We all need discipline, you need discipline, and I need discipline, and the best hope of discipline is not one which I engineer but which other people engineer upon us.

And so I would just commend to your assessment, within your counsels, just an analysis of this parallel. I think you see the check and balance system within two agencies operating in the total energy field. What I have structured is a total administration to handle energy, but then a separate, outside-of-Government group of people who can be properly funded to do their job on the Government or on the private sector, wherever the chips fall. And as they get information, since we are all honest people looking for the truth, I guess we can take it sometimes, even if it hurts a little bit.

Dr. RAY. I think that is very true. Anyway, we are both striving toward the same goals with perhaps a different organizational proposal or way to get there. But it is quite clear that the objective is the same.

Senator GRAVEL. Thank you, Doctor.

In another area in your presentation, you make mention of your report to the President. I was cognizant of that at the time, and felt that it was just throwing money at the problem. A lot of times money solves problems, but you can take a sackful and just throw it, and I was hoping that we could see a more imaginative approach to broadening the spectrum of possible activities. I noted later on in your proposal the study that ensued, the Cornell Workshops, and your analysis of that workshop which identified five tasks.

I wonder if we could get the detailed study so that we may include it in the record, because the AEC is probably the only area of Government that has done that type of detailed thinking with any specificity on the spectrum of possibilities.

Dr. RAY. I would be very happy to provide that. I brought a copy of the main report with me this morning. I would be happy to leave it with you. We will provide more copies for your committee, if you would like, and we will send in the full published results of the Cornell Workshops, which are the backup material.

Senator GRAVEL. The main report is in summarized form?

Dr. RAY. Yes.

Senator GRAVEL. Very good.

I would like one copy personally, one for the record, and then we will have the full report.

Very good.

Dr. RAY. We will be happy to do that.

[The "Report of the Cornell Workshops on the Major Issues of a National Energy Research and Development Program," was made a part of the official files of the committee.]

Senator GRAVEL. After reviewing that, I would be more capable of going into other areas with you at a later date, but let me just ask whether, and it is not in the legislation right now, you think it is possible to put in some time frames which in themselves would act as disciplines on the various technological possibilities that could take place?

Let us say, would it make any sense to say we shall have on line—and these are policy guidelines, obviously—x kilowatt-hours of windpower; we shall have on line x kilowatt-hours of sea thermal power; x kilowatt-hours of solar cell power, so that we have some guidelines to force the situation.

Do you think this would be too hazardous from a legislative point of view?

Dr. RAY. One can always set target dates, and from the standpoint of developing the knowledge and doing the engineering, to get the technology operating, I think some reasonable guesses can be made so that those target dates have some validity.

But then the picture becomes complicated by two facts. Would these target dates be set for a government program which would be organized and directed, say, by an administrator utilizing Government laboratories and personnel so that you have all of the parts of the picture in place to make certain that the work does get done and the target dates are met as close as possible? Or is it to be done by cooperative work with private industry, by providing various sorts of incentives for scientists and engineers and organizations outside of the Government to perform that work, in which case the control of the pace of the program is very much less?

The second factor which impinges upon being able to meet target dates are very practical things such as the availability of basic materials and component parts for engineering development. I will come back to that point in a moment. We must also remember the sorts of constraints that are on the technology, particularly where the technology is in the private industry in the terms of tax controls, in terms of price controls, in terms of a number of economic and environmental considerations that will have some impact upon the ability to reach that target date.

For example, purely from a technology point of view, we can start right now extracting oil from the shale lands of the Western United States. It might be rather inefficient and be more expensive than if we targeted production of so many barrels per day at a date further into the future so as to develop step by step a series of pilot plants of increasing size, each one incorporating the improvements that were in the previous plant.

Senator GRAVEL. I appreciate that, but if we talk in terms of a timeframe within which we want to reach some point, you can reach that goal technologically let us say in 5 years, 10 years, or 15 years, and obviously the longer you take the more "efficient" in terms of expenditures of dollars you can be. But if you say at that date, we want *x* capacity of energy production then we may not be able to go the normal route; smaller prototype to larger prototype to working model. Maybe we should take it right from the drawing boards and go to the full scale operational model and pay the extra cost involved; and at the same time get the extra production earlier and work the bugs out. It will cost us in the long run, but then again so will it cost us to continue to delay.

Dr. RAY. Yes, sir.

Let me use coal gasification as an example. If we say we want to have so many Btu's or so many cubic feet of gas produced from coal by such and such a date, we have to mine more coal. The coal is going to have to be used for other things, too. We can either deep mine it or we can strip mine it. There are other kinds of constraints to determine how fast one is going to be able to get the coal out of the ground: environmental laws, the problems of mine health and safety, the question of people who are already trained, capable, skilled, able to work as miners, or how fast one has to train new people to do that kind of job. We must also consider the development of mining machinery so that you just do not send a bunch of men down a mine with picks and shovels, but rather acquire the complicated machinery required, particularly in the deep mining. It takes time and allocation of materials actually to construct the machinery to do that.

Presently we are mining something over 600 million tons of coal per year. I think my figure is correct. And, just as an example, if the existing electrical energy generating stations which are now burning oil and could convert to coal actually did convert this year, we would have to mine more coal. Given the existing amount of machinery and amount of manpower, it is not likely we could mine a sufficient increase of coal in the next year or so to accomplish that goal of converting those powerplants to coal burning, much less adding on a new program that will require coal for gasification purposes.

What I am saying is that the technology may exist.

Senator GRAVEL. I see very clearly.

Dr. RAY. But there are lots of other considerations that may make the targeting date itself unrealistic.

Senator GRAVEL. Well, that is borne out very clearly when you look at our system where the dollar is quite a disciplinarian, and realize that the profits on steel have risen last year by 100 percent, denoting the amount of pressure the industry in receiving from various areas to satisfy the need for steel for drilling or for oil rigs or coal digging equipment, or the other areas we are talking about.

Dr. RAY. Let me just mention the enormous coal deposits in your own State of Alaska. Around Cook Inlet, for example, there is very high quality coal, but we must think about how long it will take to develop a mining industry in that area and actually have coal brought to the surface and how long will it take to build the refining capacity, the kind of chemical engineering plant required, even using the existing technology.

Senator GRAVEL. Well, do you share my view, then, that the private sector probably cannot do that prototyping because the economics may not be there to make it profitable in a short timeframe, even ignoring the problem we will have in the apportionment of resources in order to get the basic tools.

Dr. RAY. That is right.

Senator GRAVEL. But assuming that will translate itself out and that our productive capacity could react as rapidly as probably any in the world, the problem then comes to, not so much as to who is going to get the resource first, but whether the economics at the other end may not justify large costs initially.

Dr. RAY. That is right, and we cannot ask private industry to take that risk unless it can have some kind of better guarantee than it now has.

The system where there is a guarantee of purchase of the product——

Senator GRAVEL. Well, then, that leads me into the figure that the administration hangs on to somewhat religiously, and that is that $2 billion a year will do the job.

We are presently spending about a billion dollars a year, so that is just about doubling our effort. OK, so we double our effort. It is $2 billion a year, and as you point out here, we can probably get that through the normal appropriation process, competing with education funds and others which will mean a few more vetoes in some of these areas. We will try to get some money into this area, but have you considered in your recommendations to the President, the enormous cost of prototyping that we were just discussing now? We will have a gentleman from the Gulf Oil Corp. on the panel a little later. Gulf is one of the companies that just went into the oil shale business, and I will be asking them a question about where will they get the money to do it if the economics are not there.

My question to you is, when you put together the inventory of moneys that would be needed, in that $2 billion a year, in order to get the goals within 10 years, did you add in $1 billion for a shale plant and $3,300,000 a copy for three possible liquefaction plants? That is $2 billion right there, with not even a dime for your fusion, or your fission programs.

Dr. RAY. That is right, and as you see when you have the chance to look through the details of the program yourself, the $10 billion figure was a constraint right from the beginning. The President asked for a report in the framework of a $10 billion 5-year program and that is what we worked with then.

But what we have to——

Senator GRAVEL. Wait a second, Doctor, what you are telling me is that the President said we are going to spend $10 billion, now you get us self-sufficiency within 10 years for $10 billion. That is not going to work.

Dr. RAY. Yes, sir. But remember that the request for this report was made on June 29.

Senator GRAVEL. Oh, prior to the 10 year?

Dr. RAY. That is correct.

Senator GRAVEL. So now we come down to another point.

And that is, Doctor, we are all using, in conference right now, this magic figure of $10 billion.

Dr. RAY. Before anybody was even thinking about self-sufficiency.

Senator GRAVEL. So this is just something that somebody reached into the air and brought down and said this is what we think we need. Whether it came through the Interior Committee or whether it came through the administration, it is a capricious, arbitrary figure, and my question to you is, does it have any relation to the reality of what it would really cost us to get to our goal within a decade?

Dr. RAY. Yes, sir. I think it does have some relationship to reality, and let me try to take a moment to point that out.

First of all, the research and development budget as proposed within this $10 billion framework, proposes a program that I believe this Nation should undertake whether there is any emergency or crisis or not. And the study was made during the months of July, August, September, and October before the real fuel crisis emerged as a result of the Middle East situation.

So that what is being focused on now in most people's minds, is the actual fuel shortage which we have. But the report itself focuses really on the much bigger, long-term problem that has been recognized by thoughtful people for some time, that we in this Nation and the world as a whole for that matter, face. But we can only resolve our own problems. We face a real, long-term situation in terms of fossil fuels.

The fossil fuels will give out, no matter how big our deposits are at the rate at which we are using them. And this will happen faster if we try very hard to satisfy all of our fossil fuel requirements from supplies in U.S. territories alone. We will run out of them in what, a decade, two, three, four decades, 100 years? But at the most, the fossil fuel supplies will last only for a very short time measured against the history of our country, of our society, or certainly of mankind's living on this Earth.

Other alternatives have to be found to provide energy than burning fossil fuels. And it was this longer-term problem of starting now to do the research and development that will lead eventually to that, which was the initial requirement for the R. & D. report that was due on December 1. We must recognize that we have to start right away.

But as the study was going on, the problem became very much worse, and the crisis which was anticipated to come within a few years, actually arrived because of the embargo. So that we are having to deal with it at the present time.

Senator GRAVEL. But in the time frame that you are giving me—and I agree wholeheartedly and accept what you are saying—but if I put a time frame on that, we are talking about the crunch period of the year 2000?

Dr. RAY. That is right, because one can only plan——

Senator GRAVEL. But that is the thinking for $10 billion. Now the President has charted a course of self-sufficiency within a decade. Now, what is the price tag for shortening that projected period by 20 years? What is 20 years really going to cost us?

Dr. RAY. The price tag is very much larger. And in the report itself we recognize that there are only certain things that the Federal Government can and should do with Federal dollars. And those are the things that are outlined within this $10 billion recommendation. We recognize that that job cannot be done, even to go as far toward self-sufficiency by 1980 as is indicated there, without a considerable input from the private sector. The report indicates that to reach the goals which we set for 1980 will take not $10 billion, but $22.5 billion. And we outline——

Senator GRAVEL. Is that just for the public sector? Or for the private sector?

Dr. RAY. That is for the combination, the public and private sector, of what we feel can be done given the time constraints or the time it takes to construct things, and the availability of materials and so on, within the next 5-year period.

There are some additional things which were not included in the report that can also be done. And that is the construction of demonstration plants. The report is an R. & D. report.

Senator GRAVEL. Who pays for that, in your report, the prototyping?

Dr. RAY. Oh, the prototyping, the building of full-scale demonstration plants is not included in the R. & D. report because one——

Senator GRAVEL. But where would that money come from?

I mean if it is not in that $22 billion, then we are all kidding ourselves, because it has got to come from somewhere.

Dr. RAY. We approached that through a program which is recommended. It is called a pioneer synthetic fuels development program. And it is anticipated that there would be Federal Government involvement through a variety of kinds of incentives, but without very much financial input.

That kind of thing is the development of what will be very soon a commercial activity and should be primarily in the private sector, and our discussions with people from industry indicated industry wants to do the job. They have the capability and can do it provided they get some help, either in the frontend loading of costs and incentives which would guarantee the purchase of product, or tax relief, or a variety of kinds of things that the Federal Government might do which would not involve actual appropriations from the budget.

Senator GRAVEL. Very good. Let us underscore what you were saying because I think it is pretty important for the American public to recognize it; and that is, in point of fact, to attain the goal that we are talking about, that the Government—there are only two parts in our society, the private sector, and the Government—the Government budget does not cover the job to attain the goal.

Dr. RAY. That is right.

Senator GRAVEL. But that you feel the private sector will carry its share.

OK, so now the private sector—correct me if you disagree with my statement—the private sector can only get money from two areas. Either it can get incentives from Government, or it will turn around and charge the proper price for its products so that it can make enough profits to go ahead and self-finance or debt finance these developments.

Dr. RAY. That is right.

Senator GRAVEL. So if governmental policy, at the same time, does not try to provide the incentives and perhaps thereby does not permit the proper price to be reached, then there is a hoax being perpetrated on the American people. We are not going to reach any goal because the administration has not projected that money in its budget. It is just passing the buck to the private sector.

And if the private sector does not get the money through these devices I have enumerated, price or incentive, then nothing will take place and the American people are going to wait for the train to come in that has not even been put on the track.

Dr. RAY. Unless there is either Federal input of funds or incentives placed so that there will be a profit——

Senator GRAVEL. Well, you know as well as I what the thinking of Congress is right now, and that is that the prices are too high, and the oil companies and the oil industry has been ripping it off, and therefore we are not going to provide incentives. In fact, the President wants to cut back on depletion allowances. I will not comment on that, but that is the policy of the administration.

So they are going to cut back on incentives, and they are coming forward with a budget that does not include the enormous costs of prototyping. All we have is this $10 billion figure which is unrealistic because that was when we were thinking in terms of 30 years.

Am I correct, or am I exaggerating?

Dr. RAY. Well, I think it is a very general statement. I cannot agree with all of it because the situation in oil is quite different from the situation in coal which is quite different from the situation in, say, geothermal.

Senator GRAVEL. Well, do you agree they all take money?

Dr. RAY. All of them take money. It has to come from some place.

Senator GRAVEL. OK, so that we agree that the money has to come from somewhere?

Dr. RAY. That is right.

Senator GRAVEL. And under your proposal, of which you will give me a detailed study, you are not covering a good portion of that cost?

Dr. RAY. We can take a definition of research and development as being all the way from the original idea to the actual selling of the product; or we can say research and development covers only that part of it from the idea to showing that it can be done. The implementation or commercialization is something which is a step beyond research and development, and that is a position that we took as a practical matter.

Senator GRAVEL. So all it is, is that the Federal Government, for $22 billion, is going to do just the R. & D.? And then the prototyping which will prove the R. & D., or which will make it an economic feasibility, is really unpaid for?

That is what you look to for development from the private sector. Is that correct?

Dr. RAY. In the context of the $10 billion, 5-year program——

Senator GRAVEL. $10, or $22 billion? You mentioned $22 billion.

Dr. RAY. Yes, with $12½ billion involvement of the private sector. That is to the pilot stage, but not the full-scale demonstration and commercialization.

Senator GRAVEL. Well, I look to your study very avidly because according to testimony we have received from the private sector, not even talking about the prototyping that you have mentioned, that $12 billion to satisfy the private needs is really somewhere between $500 billion and $1 trillion, depending on where you draw the line.

Dr. RAY. As soon as you talk about full-scale commercial demonstration plants, yes, I agree.

Senator GRAVEL. I am talking about the fact that this Nation needs 40 refineries, needs all of the pipe to go with it, needs to do all the drilling, build all the tankers, and everything else, and it is going to take the private sector somewhere between $500 billion and $1 trillion?

Dr. RAY. I would think that would be in the right order of magnitude.

Senator GRAVEL. That is not even getting into the areas you described in your report?

Dr. RAY. That is right, that is not R. & D.

Senator GRAVEL. Then the Government is not putting up a cent under your projected program. This money has got to come from somewhere, and I think the American people, if they are going to expect results, and if politicians are going to make speeches about doing things, somebody had better seriously talk in terms of getting the money to do the job, and not just talk about doing it.

Otherwise, it is empty rhetoric.

Dr. RAY. Right.

Senator GRAVEL. Thank you very much, Doctor.

I would like to pursue one more thing; it is very brief.

It is not entirely germane, but it has been something that has been on my conscience for a long time and I think since we have an opportunity to get your wisdom and counsel on this, let me just give you the thesis and if you can comment on it, I think it would be very good. I will not explore it very deeply because I think time is pressing us.

The thesis is, that as we move into a nuclear economy, we spot the land with atomic plants, and there is great concern over the danger, possible danger, of these atomic plants.

I think I understand these atomic plants as well as most lay people, and probably a little better than most, and realized the danger they present and the nature of the danger.

The area—because the AEC has an unusual record—that I am most concerned with is something where regardless of what we do as human beings, we suffer a threat. And that is the danger of sabotage. You could have a deranged person who has enough knowledge of physics, realizing the power that he could have with a small amount of plastique in a key area of a nuclear reactor, and knowing that we treat nuclear reactors essentially as normal, commercial installations for the generation of power, causing a very great deal of harm. We had an example occur the year before last with the threat of crashing a hijacked plane into a reactor in Tennessee. This was a possibility that I had talked of, unfortunately, a year or so before, and still talk of because it is still a very real possibility.

This is something that I do not know if we can provide against. This does not address the defense problem if we went to war. The idea of somebody being able to rapidly sabotage nuclear plants and the impact that would have on the community without even dropping any ICBM's or ULMS, or what have you. Just take the commercial powerplants that we have and wreck havoc with them in a war situation.

I am thinking about a peacetime situation like; for example, in our air travel industry, where because of the threat of sabotage or hijacking, I have had to undergo a search just as a violation of my human rights goes far beyond what I would have thought possible a few years ago, yet I gladly go through it because I do not want to get some deranged person on the plane with me and have my life in danger.

I am willing, at a price, to give up those human rights, those freedoms, in order to travel safely and rapidly. Now, what will happen to our society as we go nuclear? Where we are suffering the possibility of sabotage that is a far greater threat than a single aircraft, which could cause a loss of human life in the dimension of 100, 500, or maybe 1,000 if you hit a school or populated area with a 747? What would happen when now the threat exists to annihilate millions of people, or wreck such havoc on a community that you will not be able to go back in for a thousand years or more?

What will that threat cause us to do in the way of police powers to control all of the human beings in our society? So that we can make sure that we have got a handle on all of the deranged people and be sure there is not even one who can sneak into a nuclear powerplant anywhere?

I am concerned as to what will happen to the freedom, as we understand it, of representative government which will take place as we change sociologically to respond to a new technological basis of threat that might exist.

Has there been any thought of what this will mean to our system within the councils of the AEC?

Now I realize this is not a technical question. This is a sociological, philosophical, human question. But then again that is what it is all about, if we change our system of Government and our attitudes toward human freedom because we need electric power and we have to go to atomic generation to get the electricity, then what we have done is we have given up our freedom in order to have light.

And we have succeeded through atomic efforts where the Communists have failed through their semantics or economic efforts.

Could you comment on that thesis?

Dr. RAY. In a word, I would be happy to.

What you have commented on, sir, is a very, very large and complex problem and I think that we in the Atomic Energy Commission are as keenly aware and keenly concerned as anyone about the possibilities for sabotage and the introduction into the system of stringent controls. Because of the hazardous nature of the material that we deal with we are probably as keenly aware of that as any people can be.

There has begun to be considerable discussion that acts of terrorism present a serious threat to part of our economy.

As a result, we have recently been reviewing all of the procedures and operational controls and rules which we have in place for guarding not only this special nuclear material that goes into the weapons program, but also for taking the precautions to see that this sort of thing is not a credible act with respect to nuclear powerplants.

Later this spring, the Joint Committee on Atomic Energy will be holding open hearings on the whole question of sabotage, diversion of materials, security measures, and so on. And I think this will be a good occasion to get much of the detailed information on the public record about the problems to which you have referred.

It is a situation which I think is easy to think about in terms of problems and to imagine a scenario that poses great hazards and enormous impact upon the minds of people.

While recognizing that the problems exist, and recognizing that it is necessary to control hazardous materials, and recognizing our responsibility as an agency to be alert to this, we do not feel that the proposals of, or the scenarios that some people imagine, are really credible ones at all.

On the other hand, I think it is very necessary for us to take advantage of every opportunity to indicate the nature of some of the controls and the security measures that are taken and to explain more carefully why it is not likely that a saboteur could rush into a nuclear powerplant and grab some radioactive material and run away with it, or something like that. It just cannot be done.

And why that cannot be done, what the precautions are and the hazards involved, and so on, could be made quite clear.

We will be happy to provide for the record if you like, because the time right now I know is short, some comment on the points which you just made.

Senator GRAVEL. Well, Doctor, I would be most appreciative of that. And as a product of what you provide, I will study it and let us counsel. I will go down to the AEC and maybe have lunch with you, or sit and have a full-scale briefing on it, and maybe you can discuss the matter in your offices and proceed from that point.

Dr. RAY. We would like to very much, but I would like to take a moment if it is agreeable with you and ask Mr. Muntzing in whose area much of this responsibility lies, if he would comment.

Senator GRAVEL. Certainly.

Mr. MUNTZING. Senator, Dr. Ray has enumerated very carefully the protective concepts and philosophy that we do employ.

We should keep in mind several things with regard to the way the plants are built in the very first instance. They are built with extreme protective features to control the fission process, these being redundant backup features, protective features which assume that others will fail, and will back them up several times.

In fact, we usually talk about three lines of defense. The way the plants are built, the way they are designed, is of course a very important protection against sabotage.

Secondly, all of the people who are authorized to be within the facility must be licensed by the AEC, and pass careful scrutiny, testing, physical testing, et cetera, and this gives us a confidence with regard to the people who are authorized.

With regard to people who would come to the premises, we have protective devices that again use the concept of multiple defenses, starting with the fences and armed guard, controlled access areas, communication links, TV monitors, and requirements that they be escorted whenever they are on the premises.

Finally, turning to the possibility of a very overt sabotage attempt which we must be alert to—and that can lead anywhere from a small band of people up to a foreign nation. That speculation obviously had to be considered if we consider some of the types of terrorism that we see today.

We have recently changed our regulations to enhance the physical protective features of the plants. And while we do not like to give people the key to the front door by describing how they all work, in great detail, I think it is important for you to know that the various features which lead us to believe that a determined group can be deterred so that the reactor can be controlled, and so that backup people from outside the plant, law enforcement officers, and facilities can be brought to bear on the problem, have and are being put in place at this moment.

The potential from that kind of a sabotage approach can be reduced to the very possible minimum. I think you have put your finger on an extremely important problem and that is one that we are determined to be responsive to. It is going to take money on the part of the industry to put in the protective features that we are requring, but we think it is necessary in the interest of the public.

Senator GRAVEL. Good. I want to thank you very much.

[The following additional material relative to points raised by Senator Gravel was provided for the record by the Atomic Energy Commission. An additional report entitled "An Appraisal of the Potential Hazard of Industrial Sabotage in Nuclear Power Plants," C. Rogers McCullough, Stanley E. Turner, and Ray L. Lyerly, was made a part of the official files of the committee. Hearing continues on page 1376.]

[From U.S. Atomic Energy Commission Regulatory Guide, June 1973]

PROTECTION OF NUCLEAR POWER PLANTS AGAINST INDUSTRIAL SABOTAGE

A. INTRODUCTION

On February 1, 1973, the Atomic Energy Commission had published in the *Federal Register* proposed amendments to its regulation in 10 CFR Part 50, "Licensing of Production and Utilization Facilities." Proposed § 50.55c would require each licensee authorized to operate a nuclear reactor to provide appropriate protection against industrial sabotage. Proposed paragraph (c), "Physical Security Plan," of § 50.34 would require each application for an operating license to include a physical security plan. Proposed paragraph (p) of § 50.34 would require existing licensees who have not submitted a physical security plan to submit such a plan to the Commission for approval within 60 days after the publication of these amendments in effective form. Furthermore, § 50.34 requires that an application for a construction permit include the principal design criteria to be satisfied in meeting the requirements for structures, systems, and components essential to safety. This regulatory guide describes physical security criteria that are generally acceptable for the protection of nuclear power plants against acts of industrial sabotage which could lead to a threat to the health and safety of the public. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

B. DISCUSSION

Subcommittee ANS-3 of the American Nuclear Society Standards Committee has developed a standard that provides criteria for industrial security programs to protect operational nuclear power plants from acts of industrial sabotage which could lead to a threat to the health and safety of the public. This standard, to be designated ANSI N18.17, "Industrial Security for Nuclear Power Plants," has been revised by American National Standards Committee N18 and is in final review by the American National Standards Institute (ANSI) Board of Standards Review.

In addition to the procedural measures described in ANSI N18.17, the design of structures, systems, and components important to safety (e.g., such features as redundancy, automation, independence, diversity, protection against common-mode failures, and the placement of facilities and equipment) can also provide protection against acts of industrial sabotage. Therefore, it is considered prudent to enhance this form of protection by protecting the vital equipment against surreptitious acts of industrial sabotage that could impair the performance of its intended safety functions. It is important that such protection be considered early in the design stage and that protective measures be described in the application for a construction permit. At a later stage, these measures would be described in greater detail in the applicant's security plan identified in proposed paragraphs (c) and (p) of § 50.34.

C. REGULATORY POSITION

The requirements and recommendations contained in the proposed ANSI Standard N18.17, "Industrial Security for Nuclear Power Plants," dated March 23, 1973, are generally acceptable and, with due consideration for the unique characteristics of the plant and its owner organization, provide an adequate basis for a physical security plan for the protection of nuclear power plants against industrial sabotage, as supplemented by the following:

1. Security Systems

a. The plant security forces should have onsite, armed, and uniformed individuals whose primary duties are the protection of facilities from acts that could endanger the health and safety of the public.

b. All security alarms should annunciate in a continuously manned, onsite central alarm station and in at least one other continuously manned station not necessarily onsite. All alarms should be self-checking and tamper indicating. The annunciation of an alarm at the onsite central alarm station should indicate the type of alarm (e.g., intrusion alarm, emergency exit alarm) and location. The annunciation at the other alarm station should, as a minimum, provide indications that an intrusion or illegal entry has occurred. The affected annunciator should be reset only after satisfactory communications have taken place between alarm stations. All intrusion alarms, emergency exit alarms, alarm systems, and line supervisory systems should, as a minimum, meet the level of performance and reliability indicated by GSA Interim Federal Specification W-A-00450 A (GSA-FSS).

2. Equipment Testing

a. Security-related equipment, except for communication equipment, should be functionally tested for operability at the commencement and completion of each interval during which such equipment is used for security, but no less frequently than once each seven days.

b. Communication equipment used for security should be tested with a minimum frequency of once at the beginning of each security force work shift.

3. Protection of Vital Equipment

Appropriate design features and equipment arrangements should be provided and be consistent with other safety requirements to reduce the opportunity for successful industrial sabotage of vital equipment. To the extent feasible, these features should include measures to protect against undetected intentional acts that could impair equipment performance, such as automatic indication of inoperability.

Detailed security measures for the physical protection of the facility against industrial sabotage will be withheld from public disclosure as provided in § 2.790 of the Commission's regulations in 10 CFR Part 2.

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SAFETY GUIDE 17—PROTECTION AGAINST INDUSTRIAL SABOTAGE

A. INTRODUCTION

In its Memorandum and Order dated February 20, 1967, in the Florida Power and Light case, the Commission noted that it would expect the staff to assure at the operating license stage that appropriate industrial security measures are provided by an applicant to protect against industrial sabotage in a nuclear power plant. This guide describes a suitable program for protecting against industrial sabotage.

B. DISCUSSION

The following means can be employed to reduce the probability and effects of industrial sabotage: (1) control of access of personnel and material to the plant and plant site, (2) selection of plant operating personnel, (3) monitoring of plant equipment, and (4) design and arrangement of plant features.

1. Control of Access.—A program for protection against industrial sabotage includes security measures to prevent access of unauthorized personnel to the plant site, control room, reactor building, other vital buildings, and to equipment within these areas. Control of the extent of access to the plant by the general public, utility employees not part of the regular plant staff, contractor personnel, and unauthorized persons is necessary to reduce the opportunity for sabotage. The control may be achieved by erecting a physical barrier, such as a fence, around the facility and by stationing guards at each point of access. A program for surveillance of the physical barrier (e.g., by roving patrols, closed-circuit television, or intrusion alarms) will assure the continued effectiveness of the barrier.

Adequate control of individuals within the plant site also is important for protection against industrial sabotage. The conduct of persons or groups that are not part of the operating staff should be monitored while they are at the plant site. These measures should include provisions for detecting the unauthorized presence of individuals in certain areas whether or not these individuals are part of the plant operating staff. For example, it may be prudent for control room personnel to challenge anyone attempting to enter who is not "known by sight" as a person authorized for that area. Procedures for monitoring and controlling the access to the plant and movement of persons within the plant may include badging of employees, signing in and out of visitors, providing escorts for "uncleared" visitors, and challenging the entry of persons attempting to enter vital areas.

Precautions also are necessary to control the passage of unauthorized material to and from the plant site. Procedures which include appropriate searching of packages and briefcases of visitors, and either forbidding the entry of or requiring the inspection of vehicles other than those associated with plant operation are effective means in controlling the flow of unauthorized material to and from the plant.

Persons responsible for physical security at the plant site and at higher management levels should be identified. It should be made clear, for example, whether the ultimate responsibility for security at the plant rests with the plant superintendent or with the senior security officer. In addition, procedures are needed to assure proper coordination between the operating and security staffs. The security measures appropriate for emergency conditions may be significantly different from those for normal operation; therefore, it is important that security procedures be made consistent with the plan appropriate for the plant condition (e.g., emergency security procedures should be consistent with the emergency plan).

The opportunity for industrial sabotage also may be reduced by providing locks on vital equipment. In determining the acceptability of using equipment locks, all relevant safety considerations in addition to sabotage must be evaluated to assure that overall safety is enhanced by their use.

The availability of a pre-planned course of action in the event of an actual or potential danger is important to controlling access to the plant. Procedures should be developed for dealing with potential dangers, such as bomb threats and civil disturbances, including provisions for timely notification of the proper authorities. To assure an effective physical security program requires continued vigilance. Procedures should be developed for investigation of security incidents and for auditing the security program.

2. Selection of Personnel.—It is important that utility management select and maintain reliable personnel to protect against industrial sabotage. Management and supervisory attention to the competence and demeanor of engineering and operating staffs is important throughout the lifetime of the plant. To this end, employment standards and practices for selection of competent, well-balanced individuals and procedures for review of employee performance should be established.

An alert staff, cognizant of its responsibility for protection against industrial sabotage, is necessary. Personnel should be trained with regard to plant security, and procedures should be implemented to aid in early detection of unusual behavioral patterns of employees, such as may result from drug abuse.

3. Monitoring of Equipment.—A program for protection against industrial sabotage includes means for detecting physical changes of the status of critical plant components on a periodic basis during reactor operation. Procedures should be developed and personnel trained to identify equipment that has been disabled or whose status has undergone an unauthorized change. This may be accomplished by use of check lists to ascertain, for example, vital valve positions. Such a procedure would help to assure that unauthorized changes in the positions of a significant number of valves would not remain undetected for long periods of time.

4. Design and Arrangement of Equipment.—Nuclear reactor power plants should be designed to provide a reasonable assurance that deliberate acts of sabotage will not lead to consequences that could cause undue risk to the health and safety of the public. Design and arrangement of features included to provide safety in depth, redundancy, independence, diversity, and protection against common mode failure also provide protection against industrial sabotage. In addition, the many automatic protection features that provide assurance that operator error or inattention will not result in a dangerous situation also reduce the probability that acts of industrial sabotage will lead to significant fission product releases. Protection against industrial sabotage that is provided over and above that included for other purposes, such as physical separation of redundant components, must be consistent with other safety requirements.

C. REGULATORY POSITIONS

Means should be provided in nuclear plants, and procedures should be developed and implemented to reduce the opportunity for and mitigate the effects of successful industrial sabotage. Particular consideration should be given to control of access, selection of personnel, monitoring of vital equipment, and design and arrangement of equipment.

1. Control of Access.—The means provided to control access by unauthorized persons to the plant site and to vital areas, buildings, and equipment within the nuclear power plant should include:

(a) A physical barrier, such as a fence, around the facility;

(b) Surveillance of this barrier, such as by roving patrols, closed-circuit television, or intrusion alarms;

(c) Guards at each point of access;

(d) Locks on vital equipment where consistent with other safety requirements;

(e) An organization plan that identifies the persons having line responsibility for security matters;

(f) Procedures for monitoring and controlling the access to and from the plant and the movement of persons within the plant by means, such as badging of employees, signing in and out of visitors, providing escorts for visitors, and challenging the entry of unauthorized persons attempting to enter vital areas;

(g) Procedures for appropriate searching of visitors;

(h) Procedures for forbidding the entry of unauthorized vehicles and for searching vehicles entering site;

(i) Procedures associated with physical security to deal with emergencies at the plant;

(j) Procedures for dealing with potential dangers, such as bomb threats and civil disturbances, including provisions for timely notification of the proper authorities;

(k) Procedures for investigation of security incidents and for auditing of the security program.

2. *Selection of Personnel.*—The means provided to assure a staff of reliable plant personnel should include:

(a) Establishment of employment standards and practices that provide for selection of competent, well-balanced individuals;

(b) Procedures for review of employee performance;

(c) Procedures for early detection of unusual behavioral patterns of employees, such as may result from drug abuse;

(d) Training of personnel with regard to plant security.

3. *Monitoring of Vital Equipment.*—Means should be provided to monitor the status of vital equipment. Procedures should be developed and personnel trained to identify equipment that may have been disabled or whose status may have undergone unauthorized changes (e.g., a valve closed when it should be open).

4. *Design and Arrangment of Equipment.*—Appropriate design features and equipment arrangements should be provided and be consistent with other safety requirements to reduce the opportunity for successful industrial sabotage.

Detailed security measures for the physical protection of the facility against industrial sabotage will be withheld from public disclosure as provided in § 2.790 of the Commission's regulations in 10 CFR Part 2.

[From the Federal Register, Vol. 38, No. 213, Nov. 6, 1973]

Title 10—Atomic Energy

CHAPTER I—ATOMIC ENERGY COMMISSION

PART 70—SPECIAL NUCLEAR MATERIAL

PART 73—PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIAL

Amended Requirements for Material in Transit

On February 1, 1973, the Atomic Energy Commission published in the Federal Register (38 FR 3080) proposed amendments to its regulations in 10 CFR Part 73 which would, in the interest of the common defense and security, strengthen existing requirements for physical protection of special nuclear material while in transit. Interested persons were invited to submit comments and suggestions for consideration in connection with the proposed amendments within 30 days after publication in the FEDERAL REGISTER. The comment period was subsequently extended another 30 days. Upon consideration of the comments received and other factors involved, the Commission has adopted the proposed amendments, with certain modifications as set forth below.

Significant differences from the amendments published for comment are: (1) The text has been reorganized to present the general requirements for the protection of special nuclear material in one section, and to group into sections requirements for particular transportation modes and monitoring methods; (2) the concept and definition of "dual occupancy protection" has been replaced with a "continuous visual surveillance" concept and definition; (3) requirements for fingerprint seals have been replaced by requirements for tamper-indicating type seals; (4) call-in times for road and rail movements have been extended from two to five hours when radiotelephone coverage or conventional telephone coverage along the planned route is not available; (5) only one driver is required in the cargo vehicle when escorts are used for motor vehicle movements which last less than one hour and during which continuous radiotelephone or radio communication with the shipper is maintained; (6) criteria for protection of special nuclear material in shipments by sea have been added; (7) monitoring requirements have been further clarified, and requirements for arming monitors have been added; (8) export requirements have been clarified; (9) the requirement that direct routes be taken in motor shipments has been eliminated; and (10) licensees and applicants for a license are required to submit a plan outlining the procedures that will be used to meet the requirements of Part 73 applicable to transportation. Editorial changes were also made.

The following discussions pertain to items (1) through (10) respectively:

(1) The text of the rule as set forth below has been reorganized to present in one section requirements that apply generally to all modes of transportation. Requirements pertaining to particular modes of transportation are specified in individual sections. Requirements for monitoring during transfers and other criteria have been put into separate sections.

(2) The concept and definition of "continuous visual surveillance" has been substituted for the concept and definition of "dual occupancy protection" since it is a more widely used term. Requirements for dual occupancy protection are still retained in conjunction with "continuous visual surveillance" for shipments by road (§ 73.31(c)) of one hour or more and for shipments by road of less than an hour where continuous communication with the shipper is not available. The requirement that a driver or other authorized individual be within 10 feet of the access door leading to the special nuclear material has been replaced by a requirement that all access to storage areas or cargo compartments be kept within unobstructed view at all times.

(3) Since, under the regulations that follow, special nuclear material in transit will be under continuous surveillance during road movements, and at all stops during air, rail and sea movements, the requirement for fingerprint-type seals has been changed to a requirement for tamper-indicating type seals. Tamper-indicating type seals are also required in 10 CFR Part 70 to provide an indication that material is intact.

(4) Where no radiotelephone coverage is available, a requirement that the driver of a motor shipment of special nuclear material call in every two hours could necessitate frequent detours from the planned route.

Such detours would increase transit time and hence vulnerability to diversion. Accordingly, calls shall be made by either radiotelephone or conventional telephone (if available along the preplanned route) at least every two hours. In cases where radiotelephone coverage or a conventional telephone has not been available along the preplanned route for 5 hours, a conventional telephone call shall be made.

(5) In order to reduce costs between local plant transfers or local plant to airport transfers which take less than an hour, the need for two drivers in the cargo vehicle has been eliminated when escorts are used provided continuous communication to the licensee or his agent is available.

(6) Requirements for shipment by sea have been included in the amendments that follow to cover all possible modes of transportation. The requirements are for: (a) Armed guards at all scheduled stops at domestic seaports; (b) no ship-to-ship transfers; (c) minimization of ports of calls; (d) ship-to-shore communication every 24 hours.

(7) The monitoring requirements at terminal points have been combined into one section and made applicable to shipments by all modes of transportation. Consistent with the protection required for land shipments while a vehicle is in motion, monitors are required to be armed. This will assure that a shipment is adequately protected at points where shipments are subject to possible theft or misrouting.

(8) Requirements applicable to export by air or sea have been clarified by a provision that licensees assure that an unarmed escort accompany a shipment from the last port or terminal in the United States up to the terminal at which the special nuclear material is unloaded from the vehicle that left the United States. From that point to the final destination an exchange of hand-to-hand receipts is required at all points en route where there is a transfer of custody.

(9) The requirement that direct routes be taken in motor shipments has been eliminated because of the possible need to "interline," which may result in transportation through points which do not necessarily lie along the most direct route. The need to minimize transit times, however, has been retained.

(10) The requirement that a plan be submitted by certain licensees for use of either specially designed trucks or escorts has been expanded to require that licensees submit a plan outlining the procedures that will be used to meet the transportation requirements of Part 73. Part 70 has also been revised to reflect this requirement for license applicants.

On or before January 7, 1974, licensees are required to submit a plan outlining the procedures that will be used to meet the requirements of these amendments, including a plan for the selection, qualification, and training of armed escorts, or the specification and design of a specially designed truck or trailer, as appropriate. This plan must be followed as of March 8, 1973.

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Each applicant for a license to import, export, transport, deliver to a carrier in a single shipment, or take delivery of a single shipment as specified in § 73.1(b) of this chapter is also required to include in his application filed pursuant to Part 70 a plan outlining the procedures that will be used to meet the requirements of these amendments, including a plan for the selection, qualification, and training of armed escorts, or the specification and design of a specially designed truck or trailer, as appropriate.

Pursuant to the Atomic Energy Act of 1954, as amended, and sections 552 and 553 of Title 5 of the United States Code, the following amendments to Title 10, Chapter 1, Code of Federal Regulations, Parts 70 and 73 are published as a document subject to codification.[1]

1. Section 70.22 is amended by adding a new paragraph (g) to read as follows:

§ 70.22 Contents of applications.

* * * * * * *

(g) Each application for a license which would authorize the transport or delivery to a carrier for transport of special nuclear material in an amount specified in § 73.1(b) of this chapter shall include a description of the plan for physical protection of special nuclear material in transit in accordance with §§ 73.30 through 73.36 and 73.41(c) of this chapter, including a plan for the selection, qualification and training of armed escorts, or the specification and design of a specially designed truck or trailer as appropriate.

2. The prefatory language of § 70.23(a) is amended and a new paragraph (a)(9) is added to § 70.23 to read as follows:

§ 70.23 Requirements for the approval of applications.

(a) An application for a license, other than a license for export, will be approved if the Commission determines that:

* * * * * * *

(9) Where the applicant is required to submit a plan for physical protection of special nuclear material in transit pursuant to § 70.22(g), of this chapter, the applicant's plan is adequate.

* * * * * * *

3. A new paragraph (d) is added to § 70.32 to read as follows:

§ 70.32 Conditions of licenses.

* * * * * * *

(d) The licensee shall make no change which would decrease the effectiveness of the plan for physical protection of special nuclear material in transit prepared pursuant to § 70.22(g) or 73.30(c) of this chapter without the prior approval of the Commission. A licensee desiring to make such changes shall submit an application for a change in the technical specifications incorporated in his license, if any, or for an amendment to his license pursuant to § 50.90 or § 70.34 of this chapter, as appropriate. The licensee may make changes to the plan for physical protection of special nuclear material without prior Commission approval if these changes do not decrease the effectiveness of the plan. A report containing a description of each change shall be furnished the Commission within two months after the change.

4. Paragraph (b) of § 73.1 is amended and a new paragraph (c) is added to read as follows:

§ 73.1 Purpose and scope.

* * * * * * *

(b) This part prescribes requirements for the physical protection of special nuclear material in transportation by any person who is licensed pursuant to the regulations in Part 70 of this chapter who imports, exports, transports, delivers to a carrier for transport in a single shipment, or takes delivery of a single shipment free on board at the point where it is delivered to a carrier, either uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope), uranium-233, or plutonium, or any combination of these materials, which is 5,000 grams or more computed by the formula grams = (grams contained U-235) + 2.5 (grams U-233 + grams Pu).

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[1] Concurrently with publication of this notice, the Atomic Energy Commission is publishing further amendments of Parts 70 and 73 which appear on pages 30537-30546.

(c) This part also applies to shipments by air of special nuclear material in quantities exceeding (1) 20 grams or 20 curies, whichever is less, of plutonium or uranium-233, or (2) 350 grams of uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope).

5. In § 73.3, a new paragraph (n) is added to read as follows:

§ 73.3 Definitions.

* * * * * * *

(n) "Continuous visual surveillance" means unobstructed view at all times of a shipment of special nuclear material, and of all access points to a temporary storage area or cargo compartment containing the shipment.

6. The undesignated center head following § 73.13 is amended to read as follows:

PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIAL IN TRANSIT

7. Section 73.30 is amended to read as follows:

§ 73.30 General requirements.

(a) Except as specified in paragraph § 73.36(a) or as otherwise authorized pursuant to § 73.30(f), each licensee who transports or who delivers to a carrier for transport either uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope), uranium-233, or plutonium, or any combination of these materials, which is 5,000 grams or more. Computed by the formula grams = (grams contained U-235) + 2.5 (grams U-233 + grams Pu), shall make arrangements to assure that such special nuclear material will, if a common or contract carrier is used, be transported under the established procedures of a carrier which provides a system for the physical protection of valuable material in transit and requires an exchange of hand-to-hand receipts at origin and destination and at all points enroute where there is a transfer of custody.

(b) Transit times of shipments other than those specified in § 73.1(c) shall be minimized and routes shall be selected to avoid areas of natural disaster or civil disorders. Such shipments shall be preplanned to assure that deliveries occur at a time when the receiver at the final delivery point is present to accept receipt of shipment.

(c) Special nuclear material shall be shipped in containers which are sealed by tamper indicating type seals. The container shall also be locked if it is not in another container or vehicle which is locked. If inspection of the container or vehicle is not required by State or local authorities before final destination, the outermost container or vehicle shall also be sealed by tamper indicating type seals. No container weighing 500 pounds or less shall be shipped in open trucks, railroad flat cars or box cars and ships. This paragraph does not apply to shipments of quantities specified in § 73.1(c).

(d) When guards are used pursuant to §§ 73.31(c)(1), 73.31(c)(2), 73.33 and 73.35. the licensee shall not permit an individual to act as a guard unless there is documentation that the individual has been qualified by demonstrating an understanding of his duties and responsibilities. The licensee or his agent shall have documentation that guards have been requalified annually.

(e) By January 7, 1974, each licensee shall submit a plan outlining the procedures that will be used to meet the requirements of §§ 73.30 through 73.36 and 73.41(c) including a plan for the selection, qualification, and training of armed escorts, or the specification and design of a specially designed truck or trailer as appropriate. This plan shall be followed by the licensee after March 6, 1974.

(f) A licensee or applicant for a license may apply to the Commission for approval of proposed procedures for transport of special nuclear material in a manner not otherwise authorized by the regulations of this part. Such application shall include a description and quantity of the special nuclear material involved, the origin and destination, the carriers to be used, the expected time in transit, the number of transfer points, the communications to be used, the vehicle visual identification, and the cargo security and surveillance measures to be used.

8. Section 73.31 is amended to read as follows:

§ 73.31 Shipment by road.

(a) All shipments by road shall be made without any scheduled intermediate stops to transfer special nuclear material or other cargo between the facility from which it is shipped and the facility of the receiver.

(b) All motor vehicles used to transport special nuclear material shall be equipped with a radiotelephone which can communicate with a licensee or his agent. The licensee or agent with whom communications shall be maintained for different segments of the shipment shall be predesignated before a shipment is made. Calls to such licensee or agent shall be made at least every 2 hours when radiotelephone or conventional telephone coverage along the route is available to relay position and projected route. Call frequency may extend up to 5 hours when radiotelephone or conventional telephone coverage is not available along the preplanned route, at which time a conventional telephone call shall be made. In the event no call is received in accordance with these requirements, the licensee or his agent shall immediately notify an appropriate law enforcement authority and the appropriate Atomic Energy Commission Regulatory Operations Regional Office listed in Appendix A of this part.

(c) A shipment shall be accompanied by at least two people in the vehicle containing the shipment, which may be two drivers or one driver and an authorized individual. The vehicle containing the shipment shall be under continuous visual surveillance, or one of the drivers or authorized individuals shall be in the cab of the vehicle, awake, and not in a sleeper berth. The shipment shall be further protected by one of the following methods:

(1) An armed escort consisting of at least two guards shall accompany the shipment in a separate escort vehicle. Escorts shall maintain continuous vigilance for the presence of conditions or situations which might threaten the security of the shipment, take such action as circumstances might require to avoid interference with continuous safe passage of the cargo vehicle, provide assistance to, or summon aid for crew of cargo vehicles in case of emergency, check seals and locks at each stop where time permits, and observe the cargo vehicle and adjacent areas during stops or layovers. Continuous radio communication capability shall be provided between the cargo vehicle and the escort vehicle. Escort vehicles shall also be equipped with a radiotelephone. The licensee may use his own employees as armed escorts or he may use an agent. Only the driver is required in the vehicle containing special nuclear material for shipments involving an average of less than an hour in transportation, if continuous radiotelephone or radio communication is maintained during the course of the shipment with the licensee or agent monitoring the shipment.

(2) The shipment shall be made in a specially designed truck or trailer which reduces the vulnerability to diversion. Design features of the truck or trailer shall permit immobilization of the van and provide barriers or deterrents to physical penetration of the cargo compartment unless armed guards are also used in which case immobilization of the vehicle is not required.

(d) Transfers to and from other modes of transportation shall be in accordance with § 73.35.

(e) Vehicles shall be marked on top with identifying letters or numbers which will permit identification of the vehicle under daylight conditions from the air in clear weather at 1,000 feet above ground level. The same code of letters and numbers as those used on the top shall also be marked on the sides and rear of the vehicle to permit identification from the ground.

§ 73.60 [Redesignated]

9. Former § 73.60 is deleted; § 73.32 is redesignated as § 73.60, and a new § 73.32 is added to read as follows:

§ 73.32 Shipments by air.

(a) Except as specifically approved by the Atomic Energy Commission, no shipment of special nuclear material shall be made in passenger aircraft in excess of (1) 20 grams or 20 curies whichever is less, of plutonium or uranium-233, or (2) 350 grams of uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope).

(b) In shipments on cargo aircraft of either uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope), uranium-233 or plutonium, or any combination of these materials which is 5,000 grams or more computed by the formula grams= (grams contained U-235) + 2.5 (grams U-233 + grams Pu), transfers shall be in accordance with § 73.35. Transfers shall be minimized.

(c) Export shipments shall be escorted by an unarmed authorized individual, who may be a crew member, from the last terminal in the United States until the shipment is unloaded at a foreign terminal. He shall perform monitoring duties at foreign terminals as described in § 73.35.

10. Section 73.33 is redesignated paragraph (d) of the new § 73.60 and is amended to read as follows:

§ 73.60 Physical protection of special nuclear material in use or storage.

* * * * * * *

(d) Each licensee shall test and maintain intrusion alarms, security containers, and protected areas utilized by the licensee pursuant to the requirements of this part as follows:

(1) Intrusion alarms and security containers shall be maintained in operable and effective condition.

(2) Intrusion alarms shall be inspected and tested for operability and required functional performance at intervals not exceeding seven (7) days.

11. A new § 73.33 is added to read as follows:

§ 73.33 Shipment by rail.

(a) A shipment by rail shall be escorted by two guards, in the shipment car or an escort car of the train, who shall keep the shipment cars under observation and who shall detrain at stops when practicable and time permits to guard the shipment cars under observation, and check car or container locks and seals. Radiotelephone communication shall be maintained with a licensee or his agent to relay position every 2 hours or less, and at scheduled stops in the event that radiotelephone coverage was not available in the last 5 hours before the stop. The licensee or agent with whom communications shall be maintained for different segments of the shipment shall be predesignated before a shipment is made. In the event no call is received in accordance with these requirements, the licensee or his agent shall immediately notify an appropriate law enforcement authority and the appropriate Atomic Energy Commission Regulatory Operations Regional Office listed in Appendix A of this part.

(b) Transfers shall be in accordance with § 73.35.

12. A new § 73.34 is added to read as follows:

§ 73.34 Shipment by sea.

(a) Shipments shall be made on vessels making the minimum ports of call. Transfers to and from other modes of transportation shall be in accordance with § 73.35. There shall be no scheduled transfers to other ships. At domestic ports of call where other cargo is transferred, the shipment shall be protected in accordance with § 73.35(a).

(b) The shipment shall be placed in a secure compartment which is locked and sealed. Locks and seals shall be periodically inspected in transit, if accessible, by an escort or crew member.

(c) Export shipments shall be escorted by an unarmed authorized individual, who may be a crew member, from the last port in the United States until the shipment is unloaded at a foreign port. He shall perform monitoring duties at foreign ports as described in § 73.35.

(d) Ship-to-shore communications shall be available, and a ship-to-shore contact shall be made every twenty-four hours to relay position information, and the status of the shipment, which shall be determined by a daily inspection where possible. This information shall be sent, as often as it is available, to the licensee or his agent who makes the arrangements for the protection of the shipment.

13. A new § 73.35 is added to read as follows:

§ 73.35 Transfer of special nuclear material.

All transfers shall be monitored by a guard. An alternate guard shall be designated at all transfer points to substitute, if necessary. Monitoring of special nuclear material transfers shall be conducted as follows:

(a) At scheduled intermediate stops where special nuclear material is not scheduled for transfer, the guard shall observe the opening of the cargo compartment and assure that the shipment is not removed. The guard shall maintain continuous visual surveillance of the cargo compartment. Continuous visual surveillance of the cargo compartment shall be maintained up to the time the vehicle is ready to depart. The guard shall observe the vehicle until it has departed, and shall notify the licensee or his agent of the latest status immediately thereafter.

(b) At points where special nuclear material is transferred from a vehicle to storage, from one vehicle to another, or from storage to a vehicle, the guard shall keep the shipment under continuous visual surveillance by observing the opening of the cargo compartment of the incoming vehicle and assuring that the shipment is complete by checking locks and/or seals. Continuous visual surveillance of a shipment shall be maintained at all times it is in the terminal or in storage. Shipments shall be preplanned in order to avoid storage times in excess of 24 hours. Continuous visual surveillance of the cargo compartment shall be maintained up to the time the vehicle is ready to depart from the terminal. The guard shall observe the vehicle until it has departed, and shall notify the licensee or his agent of the latest status immediately thereafter.

(c) The guard shall be required to immediately notify the carrier and the licensee who made the arrangements for protection of special nuclear material of any deviation from or attempted interference with schedule or routing.

14. A new § 73.36 is added to read as follows:

§ 73.36 Miscellaneous requirements.

(a) Each licensee who takes delivery of special nuclear material free on board (f.o.b.) the point at which it is delivered to a carrier for transport shall make the arrangements to assure that such special nuclear material will be protected in transit as prescribed in §§ 73.30 through 73.35, rather than the person who delivers such shipment to the carrier for transport.

(b) Each licensee who imports special nuclear material shall make arrangements to assure that such material will be protected in transit as follows:

(1) An individual designated by the licensee or his agent, or as specified by a contract of carriage, shall confirm the container count and examine locks and/or seals for evidence of tampering, at the first place in the United States at which the shipment is discharged from the arriving carrier.

(2) The shipment shall be protected at the first terminal at which it arrives in the United States and all subsequent terminals as provided in §§ 73.30 through 73.35 and paragraphs (c) and (f) of this section.

(c)(1) Each licensee who delivers special nuclear material to a carrier for transport shall immediately notify the consignee by telephone, telegraph, or teletype, of the time of departure of the shipment, and shall notify or confirm with the consignee the method of transportation, including the names of carriers, and the estimated time of arrival of the shipment at its destination. (2) In the case of a shipment free on board (f.o.b.) the point where it is delivered to a carrier for transport, each licensee shall, before the shipment is delivered to the carrier, obtain written certification from the licensee who is to take delivery of the shipment at the f.o.b. point that the physical protection arrangements required by §§ 73.30 through 73.35 for licensed shipments have been made. When an AEC license-exempt contractor is the consignee of a shipment, the licensee shall, before the shipment is delivered to the carrier, obtain written certification from the contractor who is to take delivery of the shipment at the f.o.b. point that the physical protection arrangements required by AEC Manual Chapters 2401 or 2405 have been made. (3) Each licensee who delivers special nuclear material to a carrier for transport shall also make arrangements with the consignee to be notified immediately by telephone, telegraph, or teletype, of the arrival of the shipment at its destination.

(d) In addition to complying with the requirements specified in paragraphs (c) and (f) of this section, each licensee who exports special nuclear material shall comply with the requirements specified in §§ 73.30 through 73.35, as applicable, up to the first point where the shipment is taken off the vehicle outside the United States. The licensee shall also make arrangements with the consignee to be notified immediately by telephone and telegraph, teletype, or cable, of the arrival of the shipment at its destination, or of any such shipment that is lost or unaccounted for after the estimated time of arrival at its destination.

(e) Each licensee who receives a shipment of special nuclear material shall immediately notify the person who delivered the material to a carrier for transport of the arrival of the shipment at its destination. In the event such a shipment fails to arrive at its destination at the estimated time, the consignee, if a licensee, or in the case of an export shipment, the licensee who exported the shipment, shall immediately notify by telephone and telegraph, or teletype, the Director of the appropriate Atomic Energy Commission Regulatory Operations Regional Office listed in Appendix A of this part, and the licensee or other person who delivered the material to a carrier for transport. The licensee who made the physical protection arrangements shall also immediately notify by telephone and telegraph, or teletype the Director of the appropriate Atomic Energy Commission Regulatory Operations Regional office listed in Appendix A of the action being taken to trace the shipment.

(f) Each licensee who makes arrangements for physical protection of a shipment of special nuclear material as required by §§ 73.30 through 73.36 shall immediately conduct a trace investigation of any shipment that is lost or unaccounted for after the estimated arrival time and file a report with the Commission as specified in § 73.71. If the licensee who conducts the trace investigation is not the consignee, he shall also immediately report the results of his investigation by telephone and telegraph, or teletype to the consignee.

15. An undesignated center head is added after § 73.36 to read as follows:

PHYSICAL PROTECTION REQUIREMENTS AT FIXED SITES

16. Section 73.41(c) is amended to read as follows:

§ 73.41 Records.

* * * * * * *

(c) Shipments of special nuclear material subject to the requirements of this part, including names of carriers, major roads to be used, flight numbers in the case of air shipments, dates and expected times of departure and arrival of shipments, names and addresses of the monitor and one alternate monitor at each transfer point, verification of communication equipment on board the transfer vehicle, names of individuals who are to communicate with the transport vehicle, container seal descriptions and identification, and any other information to confirm the means utilized to comply with §§ 73.30 through 73.36. Such information shall be recorded prior to shipment. Information obtained during the course of the shipment such as reports of all communications, change of shipping plan including monitor changes, trace investigations and others shall also be recorded.

§ 73.71 [Redesignated]

17. § 73.42 is redesignated § 73.71.

Effective date. The foregoing amendments are effective on March 6, 1974, except for §§ 70.22(g), 70.23(a)(9), and 73.30(e), which will become effective on December 6, 1973.

(Sec. 161, Pub. Law 83-703, 68 Stat. 948; (42 U.S.C. 2201).)

Dated at Germantown, Maryland this 31st day of October 1973.

For the Atomic Energy Commission.

PAUL C. BENDER,
Secretary of the Commission.

[FR Doc. 73-2351 Filed 11-5-73; 8:45 a.m.]

PHYSICAL PROTECTION OF PLANTS AND MATERIALS

On February 1, 1973, the Atomic Energy Commission published in the Federal Register (38 FR 3073, 3075, and 3082), proposed amendments to its regulations in 10 CFR Parts 50, 70, and 73 which would, in the interests of the common defense and security and in the interests of public health and safety, strengthen the physical protection of licensee plants and of special nuclear materials (SNM) located at licensed facilities.

Interested parties were invited to submit comments and suggestions for consideration pertaining to the proposed amendments within 30 days after the publication in the Federal Register. The comment period was subsequently extended 30 days. Upon consideration of the comments received, and other factors involved, the Commission has adopted the proposed amendments, with certain modifications, as set forth below.

Significant differences from the amendments published for comment are the following: (1) Inclusion of all physical protection requirements into Part 73 and the subsequent expansion of the scope of that part; (2) removal of the requirement to search vehicles prior to entry into the protected area of a licensee's plant and clarification of the requirement that all drivers of such vehicles be escorted; (3) exemption of employees who possess an AEC clearance from a routine search at the protected area boundary; and (4) specification of the maximum amount of fissile material per volume of material (e.g., scrap) which can be stored outside a material access area. In addition, several editorial and clarifying changes were made.

The following discussions pertain to the items (1) through (4) above.

(1) The rule set forth below consolidates all the fixed-site physical protection requirements into a single part of the Commission's regulations in Title 10 of the Code of Federal Regulations, Part 73. The scope of that part is expanded accordingly. The purpose of the consolidation is to increase clarity and assure consistency.

(2) The rule set forth below does not require a search prior to entry into a protected area of a licensee's plant of either vehicles or of all packages. A thorough search of vehicles and packages on vehicles would take considerable time and effort and could necessitate dismantling the vehicles and the opening of each package to inspect the contents. Instead, drivers of trucks and delivery and service vehicles shall be escorted within the protected area. Packages being transported into the protected area shall be checked on a random basis. As in the proposed rule, hand-carried packages must be searched prior to entry into a protected area. Further, all persons, packages, and vehicles must be searched upon exit from a material access area.

(3) In the rule set forth below, employees possessing an AEC security clearance are exempted from a routine search but are required to be searched on a random basis prior to entry into the protected area. The exemption is based upon the belief that an AEC clearance in conjunction with a random search provides adequate assurance that such individuals will not carry materials which could be used for sabotage into the facility.

(4) In the rule set forth below, enriched uranium scrap which contains no more than 0.25 grams of uranium-235 per liter of scrap material may be stored in 30-gallon or larger containers outside a building, within an area separately fenced within the protected areas. Uranium scrap so stored would require theft of approximately 160 30-gallon containers to accumulate a strategic quantity (5,000 grams) of uranium-235.

The purpose of these amendments is to impose requirements for the protection of plants of licensees against acts of industrial sabotage and for the protection of SNM in the possession of licensees against theft by establishing and maintaining a physical protection system of (i) protective barriers and intrusion detection devices at fixed sites to provide early detection of an attack, (ii) deterrence to attack by means of armed guards, and (iii) liaison and communication with law enforcement authorities capable of rendering assistance to counter such attacks.

Pursuant to the Atomic Energy Act of 1954, as amended, and Sections 552 and 553 of Title 5 of the United States Code, the following amendments of Title 10, Chapter I, Code of Federal Regulations, Parts 50, 70, and 73 are published as a document subject to codification.[1]

PART 50—LICENSING OF PRODUCTION AND UTILIZATION FACILITIES

1. A new paragraph (c) is added to § 50.34 of 10 CFR Part 50 to read as follows:

§ 50.34 Contents of applications: technical information.

* * * * * * *

(c) Physical security plan. Each application for a license to operate a production or utilization facility shall include a physical security plan. The plan shall consist of two parts. Part I shall address vital equipment, vital areas and isolation zones, and shall demonstrate how the applicant plans to comply with the requirements of Part 73 of this chapter, if applicable, at the proposed facility.[2] Part II shall list tests, inspections, and other means to be used to demonstrate compliance with such requirements, if applicable.

2. New paragraphs (p) and (q) are added to § 50.54 of 10 CFR Part 50 to read as follows:

§ 50.54 Condition of licenses.

* * * * * * *

(p) The licensee shall make no change which would decrease the effectiveness of a security plan prepared pursuant to § 50.34(c) or paragraph (q) of this section without the prior approval of the Commission. A licensee desiring to make such a change shall submit an application for a change in the technical specifications incorporated in his license or for an amendment to his license pursuant to § 50.90, as appropriate. The licensee shall maintain records of changes to the plan made

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[1] These amendments include further amendments of certain sections of Parts 70 and 73 which appear on pages 30533 and 30542.

[2] Regulatory Guide 1.17 dated June 1973 describes physical security criteria generally acceptable for the protection of nuclear power reactors against acts of industrial sabotage.

without prior Commission approval, and shall furnish to the Commission a report containing a description of each change within two months after the change is made.

(q) Each licensee who is authorized to operate a production or utilization facility and who has not submitted a physical security plan, as described in § 50.34(c) by November 6, 1973 shall submit such a plan to the Commission for approval by January 7, 1974.

PART 70—SPECIAL NUCLEAR MATERIAL

3. Section 70.22(g) of 10 CFR is amended and a new paragraph (h) is added to read as follows:

§ 70.22 Contents of applications.

* * * * * * *

(g) Each application for a license which would authorize the transport or delivery to a carrier for transport of special nuclear material in an amount specified in § 73.1(b)(2) of this chapter shall include a description of the plan for physical protection of special nuclear material in transit in accordance with §§ 73.30 through 73.36 and 73.41(c) of this chapter, including a plan for the selection, qualification and training of armed escorts, or the specification and design of a specially designed truck or trailer as appropriate.

(h) Each application for a license to possess or use at any site or contiguous sites subject to control by the licensee uranium-235 (contained in uranium enriched to 20 percent or more in the uranium-235 isotope), uranium-233, or plutonium alone or in any combination in a quantity of 5,000 grams or more computed by the formula, grams=(grams contained U-235)+2.5 (grams U-233+grams plutonium), other than a license for possession or use of such material in the operation of a nuclear reactor licensed pursuant to Part 50 of this chapter, shall include a physical security plan, consisting of two parts. Part I shall address vital equipment, vital areas, and isolation zones, and shall demonstrate how the applicant plans to meet the physical protection requirements of Part 73 of this chapter in the conduct of the activity to be licensed. Part II shall list tests, inspections, and other means to demonstrate compliance with such requirements.

4. In § 70.23 paragraph (a) is revised and a new paragraph (a)(10) is added to read as follows:

§ 70.23 Requirements for the approval of applications.

(a) An application for a license, other than a license for export, will be approved if the Commission determines that:

* * * * * * *

(10) Where the applicant is required to submit a physical security plan pursuant to § 70.22(h), the applicant's proposed plan is adequate.

* * * * * * *

5. New paragraphs (e) and (f) are added to § 70.32 to read as follows:

§ 70.32 Conditions of licenses.

* * * * * * *

(e) The licensee shall make no change which would decrease the effectiveness of a security plan prepared pursuant to § 70.22(h) or paragraph (f) of this section without the prior approval of the Commission. A licensee desiring to make such a change shall submit an application for an amendment to his license pursuant to § 70.34. The licensee shall maintain records of changes to the plan made without prior Commission approval, and shall furnish to the Commission a report containing a description of each change within two months after the change is made.

(f) Each license who is authorized to possess or use at any site or contiguous site subject to control by the licensee uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope) uranium 233, or plutonium alone or in any combination in a quantity of 5,000 grams or more computed by the formula, grams=(grams contained U-235)+2.5 (grams U-235+grams plutonium), other than possession or use involved in the operation of a nuclear reactor licensed pursuant to Part 50 of this chapter, and who has not submitted a physical security plan as described in § 70.22(h), shall submit a physical security plan to the AEC for approval by January 7, 1974.

6. The title of Part 73 is revised to read as follows:

7. Paragraphs (a) through (c) of § 73.1 are amended and redesignated as paragraphs (b)(1), (b)(2), and (b)(3), respectively, and new paragraphs (a) and (b)(4) are added to read as follows:

§ 73.1 Purpose and scope.

(a) *Purpose.* This part prescribes requirements for physical protection of special nuclear material at fixed sites and in transit and of plants in which special nuclear material is used for the purpose of protection against acts of industrial sabotage and protection of special nuclear material against theft by establishment and maintenance of a physical protection system of: (1) Protective barriers and intrusion detection devices at fixed sites to provide early detection of an attack, (2) deterrence to attack by means of armed guards and escorts, and (3) liaison and communication with law enforcement authorities capable of rendering assistance to counter such attacks.

(b) *Scope.* (1) This part prescribes requirements for (i) the physical protection of production and utilization facilities licensed pursuant to Part 50 of this chapter; (ii) the physical protection of plants in which activities licensed pursuant to Part 70 of this chapter are conducted, and the physical protection of special nuclear material by any person who pursuant to the regulations in Part 70 of this chapter possesses or uses at any site or contiguous sites subject to control by the licensee, uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope), uranium-233, or plutonium alone or in any combination in a quantity of 5,000 grams or more computed by the formula, grams=(grams contained U-235)+2.5 (grams U-235+grams plutonium).

(2) This part prescribes requirements for the physical protection of special nuclear material in transportation by any person who is licensed pursuant to the regulations in Part 70 of this chapter who imports, exports, transports, delivers to a carrier for transport in a single shipment, or takes delivery of a single shipment free on board at the point where it is delivered to a carrier, either uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope), uranium-233, or plutonium, or any combination of these materials, which is 5,000 grams or more computed by the formula grams=(grams contained U-235)+2.5 (grams U-233+grams plutonium).

(3) This part also applies to shipments by air of special nuclear material in quantities exceeding (1) 20 grams or 20 curies, whichever is less, of plutonium or uranium-233, or (2) 350 grams of uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope).

(4) Special nuclear material subject to this part may also be protected pursuant to security procedures, prescribed by the Commission or another Government agency for the protection of classified materials. The provisions and requirements of this part are in addition to, and not in substitution for, any such security procedures. Compliance with the requirements of this part does not relieve any licensee from any requirement or obligation to protect special nuclear material pursuant to security procedures prescribed by the Commission or other Government agency for the protection of classified materials.

8. Existing § 73.2 is deleted and § 73.3 is redesignated as § 73.2; paragraphs (h), (i), and (j) are deleted; paragraph (n) is redesignated paragraph (e), new paragraphs (h), (i), (j), (k), and (p) are added, and paragraphs (a), (c), (d), (e), (f), (k), (l), and (m) are amended to read as follows:

§ 73.2 Definitions.

As used in this part:

(a) Terms defined in Parts 50 and 70 of this chapter have the same meaning when used in this part.

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(c) "Guard" means a uniformed individual armed with a firearm whose primary duty is the protection of special nuclear material against theft and/or the protection of a plant against industrial sabotage.

(d) "Watchman" means an individual, not necessarily uniformed or armed with a firearm, who provides protection for a plant and the special nuclear material therein in the course of performing other duties.

(e) "Continuous visual surveillance" means unobstructed view at all times of a shipment of special nuclear material, and of all access to a temporary storage area or cargo compartment containing the shipment.

(f) "Physical barrier" means

(1) Fences constructed of No. 11 American wire guage, or heavier wire fabric, topped by three strands or more of barbed wire or similar material on brackets angled outward between 30° and 45° from the vertical, with an overall height of not less than eight feet, including the barbed topping.

(2) Building walls constructed of stone, brick, cinder block, concrete, steel or comparable materials (openings in which are secured by grates, doors, or covers of construction and fastening of sufficient strength such that the integrity of the wall is not lessened by any opening), or walls of similar construction; not part of a building, provided with a barbed topping described in paragraph (f)(1) of this section of a height of not less than 8 feet.

(3) Ceilings and floors constructed to offer equivalent resistance to penetration equivalent to that of building walls described in paragraph (f)(2) of this section.

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(h) "Vital area" means any area which contains vital equipment within a structure, the walls, roof, and floor of which constitute physical barriers of construction at least as substantial as walls as described in paragraph (f)(2) of this section.

(i) "Vital equipment" means any equipment, system, device, or material, the failure, destruction, or release of which could directly or indirectly endanger the public health and safety by exposure to radiation. Equipment or systems which would be required to function to protect public health and safety following such failure, destruction, or release are also considered to be vital.

(j) "Material access area" means any location which contains special nuclear material, within a vault or a building, the roof, walls, and floor of which each constitute a physical barrier.

(k) "Isolation zone" means any area, clear of all objects which could conceal or shield an individual, adjacent to a physical barrier, which is monitored to detect the presence of individuals or vehicles within that area.

(l) "Intrusion alarm" means a tamper indicating electrical, electro-mechanical, electro-optical, electronic or similar device which will detect intrusion by an individual into a building, protected area, vital area, or material access area, and alert guards or watchmen by means of actuated visible and audible signals.

(m) "Locks" in the case of vaults or vault type rooms means a three-position, manipulation resistant, dial type, built-in combination lock or combination padlock and in the case of fences, walls and buildings, means an integral door lock or padlock which provides protection equivalent to a six-tumbler cylinder lock. "Lock" in the case of a vault or vault type room also means any manipulation resistant, electromechanical device which provides the same function as a built-in combination lock or combination padlock which can be operated remotely or by the "reading" or insertion of information which can be uniquely characterized and which allows operation of the device. "Locked" means protected by an operable lock.

(n) "Vault" means a burglar-resistant windowless enclosure with walls, floor and roof of: (1) Steel at least one-half inch thick, (2) reinforced concrete or stone at least 8 inches thick, (3) nonreinforced concrete or stone at least 12 inches thick, or (4) monolithic floor or roof construction of equivalent resistance to entry, with a built-in lock in a steel door at least 1 inch thick, exclusive of the locking mechanism.

(o) "Vault-type room" means a room with one or more doors, all capable of being locked, protected by an intrusion alarm which creates an alarm upon the entry of a person anywhere into the room and upon exit from the room or upon movement of an individual within the room.

(p) "Industrial sabotage" means any deliberate act directed against a plant in which an activity licensed pursuant to the regulations in this chapter is conducted, or to any component of such a plant, which could directly or indirectly endanger the public health and safety by exposure to radiation, other than such acts by an enemy of the United States, whether foreign government or other person.

§ 73.3 [Redesignated]

10. Section 73.4 is redesignated as § 73.3.

11. Section 73.5 is redesignated § 73.4 and amended to read as follows:

§ 73.4 Communications.

Except where otherwise specified, all communications and reports concerning the regulations in this part should be addressed to the Director of Licensing, U.S.

Atomic Energy Commission, Washington, D.C. 20545, or may be delivered in person at the Commission's offices at 1717 H Street NW., Washington, D.C.; at 7920 Norfolk Avenue, Bethesda, Maryland; or at Germantown, Maryland.

§ 73.5 [Redesignated]

12. Section 73.12 is redesignated § 73.5.

§ 73.13 [Redesignated]

13. Section 73.13 is redesignated § 73.6 and amended to read as follows:

§ 73.6 Exemptions for certain quantities and kinds of special nuclear material.

A licensee is exempt from the requirements of §§ 73.30 through 73.36 and of §§ 73.60 and 73.70 of this part, with respect to the following special nuclear material:

(a) Uranium-235 contained in uranium enriched to less than 20 percent in the U-235 isotope;

(b) Special nuclear material which is not readily separable from other radioactive material and which has a total external radiation dose rate in excess of 100 rems per hour at a distance of 3 feet from any accessible surface without intervening shielding; and

(c) Special nuclear material in a quantity not exceeding 350 grams of uranium-235, uranium-233, plutonium, or a combination thereof, possessed in any analytical, research, quality control, metallurgical or electronic laboratory.

14. Paragraphs (b) and (c) of § 73.30 are amended to read as follows:

§ 73.30 General requirements.

* * * * * * *

(b) Transit times of shipments other than those specified in § 73.1(b)(3) shall be minimized and routes shall be selected to avoid areas of natural disaster or civil disorders. Such shipments shall be preplanned to assure that deliveries occur at a time when the receiver at the final delivery point is present to accept receipt of shipment.

(c) Special nuclear material shall be shipped in containers which are sealed by tamper indicating type seals. The containers shall also be locked if it is not in another container or vehicle which is locked. If inspection of the container or vehicle is not required by State or local authorities before final destination, the outermost container or vehicle shall also be sealed by tamper indicating type seals. No container weighing 500 pounds or less shall be shipped in open trucks, railroad flat cars or box cars and ships. This paragraph does not apply to shipments of quantities specified in § 73.1(b)(3).

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15. A new § 73.40 and center head are added to read as follows:

PHYSICAL PROTECTION REQUIREMENTS AT FIXED SITES

§ 73.40 Physical protection: General requirements at fixed sites.

Each licensee shall provide physical protection against industrial sabotage and against theft of special nuclear material at the fixed sites where licensed activities are conducted. Security plans submitted to the Commission for approval shall be followed by the licensee after March 6, 1974.

16. A new § 73.50 is added to read as follows:

§ 73.50 Requirements for physical protection of licensed activities, other than the operation of nuclear reactors, against industrial sabotage.

In addition to any other requirements of this part, each licensee who is authorized to operate a fuel reprocessing plant pursuant to Part 50 of this chapter or who possesses or uses uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope), uranium-233, or plutonium alone or in any combination in a quantity of 5000 grams or more computed by the formula, grams = (grams contained U-235) + 2.5 (grams U-233 + grams plutonium), other than in the operation of a nuclear reactor licensed pursuant to Part 50 of this chapter, shall comply with the following after March 6, 1974.

(a) *Physical security organization.* (1) The licensee shall establish a security organization, including guards, to protect his facility against industrial sabotage and the special nuclear material in his possession against theft.

(2) At least one supervisor of the security organization shall be on site at all times.

(3) The licensee shall establish, maintain and follow written security procedures which document the structure of the security organization and which detail the duties of guards, watchmen, and other individuals responsible for security.

(4) The licensee shall not permit an individual to act as a guard or watchman unless such individual has been properly trained and equipped and has qualified by demonstrating: (i) an understanding of the licensee's security procedures, and (ii) the ability to execute all duties required of him by such procedures. Each guard and watchman shall be requalified at least annually. Such requalification shall be documented.

(b) *Physical barriers.* (1) The licensee shall locate vital equipment only within a vital area, which, in turn, shall be located within a protected area such that access through at least two physical barriers. More than one vital area may be within a single protected area.

(2) The licensee shall locate material access areas only within protected areas such that access to the material access area requires passage through at least two physical barriers. More than one material access area may be within a single protected area.

(3) The physical barrier at the perimeter of the protected area shall be separated from any other barrier designated as a physical barrier within the protected area, and the intervening space monitored or periodically checked to detect the presence of persons or vehicles so that the facility security organization can respond to suspicious activity or to the breaching of any physical barrier.

(4) An isolation zone shall be maintained around the physical barrier at the perimeter of the protected area and any part of a building used as part of that physical barrier. The isolation zone shall be monitored to detect the presence of individuals or vehicles within the zone so as to allow response by armed members of the licensee security organization to be initiated at the time of penetration of the protected area. Parking facilities, both for employees and visitors, shall be located outside the isolation zone.

(5) Isolation zones and clear areas between barriers shall be provided with illumination sufficient for the monitoring required by paragraphs (b) (3) and (4), but not less than 0.2 foot candles.

(c) *Access requirements.* The licensee shall control all points of personnel and vehicle access into a protected area including shipping or receiving areas, and into each vital area. Identification of personnel and vehicles shall be made and authorization shall be checked at such points.

(1) At the point of personnel and vehicle access into a protected area, all individuals, except employees who possess an AEC personnel security clearance, and all hand-carried packages shall be searched for devices such as firearms, explosives, and incendiary devices, or other items which could be used for industrial sabotage. The search shall be conducted either by a physical search or by the use of equipment capable of detecting such devices. Employees who possess an AEC personnel security clearance shall be searched at random intervals. Subsequent to search, drivers of delivery and service vehicles shall be escorted at all times while within the protected area.

(2) All packages being delivered into the protected area shall be checked for proper identification and authorization. Packages other than hand-carried packages shall be searched at random intervals.

(3) A picture badge identification system shall be used for all individuals who are authorized access to protected areas without escort.

(4) Access to vital areas and material access areas shall be limited to individuals who are authorized access to vital equipment or special nuclear material and who require such access to perform their duties. Authorization for such individuals shall be provided by the issuance of specially coded numbered badges indicating vital areas and material access areas to which access is authorized. Unoccupied vital areas and material access areas shall be protected by an active intrusion alarm system.

(5) Individuals not employed by the licensee shall be escorted by a watchman, or other individual designated by the licensee, while in a protected area and shall be badged to indicate that an escort is required. In addition, each individual not employed by the licensee shall be required to register his name, date, time, purpose of visit, employment affiliation, citizenship, name and badge number of the escort, and name of the individual to be visited. Except for a driver of a delivery or service vehicle an individual not employed by the licensee, who requires frequent and extended access to a protected area or a vital area need not be escorted provided such individual is provided with a picture badge, which he must receive upon entrance into the protected area and which he must return

each time he leaves the protected area, which indicates (i) nonemployee—no escort required; (ii) areas to which access is authorized, and (iii) the period for which access has been authorized.

(6) No vehicles used primarily for the conveyance of individuals shall be permitted within a protected area except under emergency conditions.

(7) Keys, locks, combinations, and related equipment shall be controlled to minimize the possibility of compromise and promptly changed whenever there is evidence that they have been compromised. Upon termination of employment of any employee, keys, locks, combinations, and related equipment to which that employee had access shall be changed.

(d) *Detection aids.* (1) All alarms required pursuant to this part shall annunciate in a continuously manned central alarm station located within the protected area and in at least one other continuously manned station, not necessarily within the protected area, such that a single act cannot remove the capability of calling for assistance or otherwise responding to an alarm. All alarms shall be self-checking and tamper indicating. The annunciation of an alarm at the onsite central alarm station shall indicate the type of alarm (e.g., intrusion alarm, emergency exit alarm, etc.) and location. All intrusion alarms, emergency exit alarms, alarm systems, and line supervisory systems shall at minimum meet the performance and reliability levels indicated by GSA Interim Federal Specification W-A-00450 B (GSA-FSS).

(2) All emergency exits in each protected area and each vital area shall be alarmed.

(e) *Communication requirements.* (1) Each guard or watchman on duty shall be capable of maintaining continuous communication with an individual in a continuously manned central alarm station within the protected area, who shall be capable of calling for assistance from other guards and watchmen and from local law enforcement authorities.

(2) The alarm stations required by paragraph (d)(1) of this section shall have conventional telephone service for communication with the law enforcement authorities as described in paragraph (e)(1) of this section.

(3) To provide the capability of continuous communication, two-way radio voice communication shall be established in addition to conventional telephone service, between local law enforcement authorities and the facility and shall terminate at the facility in a continuously manned central alarm station within the protected area.

(4) All communications equipment, including offsite equipment, shall remain operable from independent power sources in the event of loss of primary power.

(f) *Testing and maintenance.* Each licensee shall test and maintain intrusion alarms, emergency alarms, communications equipment, physical barriers, and other security related devises or equipment utilized pursuant to this section as follows:

(1) All alarms, communications equipment, physical barriers, and other security related devices or equipment shall be maintained in operable and effective condition.

(2) Each intrusion alarm shall be functionally tested for operability and required performance at the beginning and end of each interval during which it is used for security, but not less frequently than once every seven (7) days.

(3) Communications equipment shall be tested for operability and performance not less frequently than once at the beginning of each security personnel work shift.

(g) *Response requirement.* (1) The licensee shall establish liaison with local law enforcement authorities. In developing his physical security plan, the licensee shall take account of the probable size and response time of the local law enforcement authority assistance.

(2) Upon detection of abnormal presence or activity of persons or vehicles within an isolation zone, a protected area, or a vital area, or upon evidence of intrusion into a protected area or a vital area, the facility security organization shall (i) determine whether or not a threat exists, (ii) assess the extent of the threat, if any, and (iii) take immediate measures to neutralize the threat, either by appropriate action by facility guards or by calling for assistance from local law enforcement authorities, or both.

17. Section 73.60 is added to read as follows:

§ 73.60 Physical protection of special nuclear material at fixed sites.

Each licensee who pursuant to the regulations in Part 70 of this chapter possesses at any site or contiguous sites subject to control by the licensee uranium-

235 (contained in uranium enriched to 20 percent or more in the U-235 isotope), uranium-233, or plutonium alone or in any combination in a quantity of 5,000 grams or more computed by the formula, grams = (grams contained U-235) + 2.5 (grams U-233 + grams plutonium) shall, by March 6, 1974 protect the special nuclear material from theft or diversion as follows:

(a) *Access requirements.* (1) Special nuclear material shall be stored or processed only in a material access area. No activities other than those which require access to special nuclear material or equipment employed in the process, use, or storage of special nuclear material, shall be permitted within a material access area.

(2) Material access areas shall be located only within a protected area to which access is controlled.

(3) Special nuclear material not in process shall be stored in a vault equipped with an intrusion alarm or in a vault-type room and each such vault or vault-type room shall be controlled as a separate material access area.

(4) Enriched uranium scrap in the form of small pieces, cuttings, chips, solutions or in other forms which result from a manufacturing process, contained in 30-gallon or larger containers, with a uranium-235 content of less than 0.25 grams per liter, may be stored within a locked and separately fenced area which is within a larger protected area provided that the storage area is no closer than 25 feet to the perimeter of the protected area. The storage area when unoccupied shall be protected by a guard or watchman who shall patrol at intervals not exceeding 4 hours, or by intrusion alarms.

(5) Admittance to a material access area shall be under the control of authorized individuals and limited to individuals who require such access to perform their duties.

(6) Prior to entry into a material access area, packages shall be searched for devices such as firearms, explosives, incendiary devices, or counterfeit substitute items which could be used for theft or diversion of special nuclear material.

(7) Methods to observe individuals within material access areas to assure that special nuclear material is not diverted shall be provided and used on a continuing basis.

(b) *Exit requirement.* Each individual, package, and vehicle shall be searched for concealed special nuclear material before exiting from a material access area unless exit is into a contiguous material access area. The search may be carried out by a physical search or by use of equipment capable of detecting the presence of concealed special nuclear material.

(c) *Detection aid requirement.* Each unoccupied material access area shall be locked and protected by an intrusion alarm on active status. All emergency exits shall be continuously alarmed.

(d) *Testing and maintenance.* Each licensee shall test and maintain intrusion alarms, physical barriers, and other devices utilized pursuant to the requirements of this section as follows:

(1) Intrusion alarms, physical barriers, and other devices used for material protection shall be maintained in operable condition.

(2) Each intrusion alarm shall be inspected and tested for operability and required functional performance at the beginning and end of each interval during which it is used for material protection, but not less frequently than once every seven (7) days.

18. Section 73.41 is redesignated as § 73.70 and amended to read as follows:

Records and Reports

§ 73.70 Records.

Each licensee subject to the provisions of §§ 73.30 through 73.36 and/or § 73.50 and/or § 73.60 shall keep the following records:

(a) Names and addresses of all individuals who have been designated as authorized individuals.

(b) Names, addresses, and badge numbers of all individuals authorized to have access to vital equipment or special nuclear material, and the vital areas and material access areas to which authorization is granted.

(c) A register of visitors, vendors, and other individuals not employed by the licensee recorded pursuant to § 73.50(c)(5).

(d) A log indicating name, badge number, time of entry, reason for entry, and time of exit of all individuals granted access to a normally unoccupied vital area.

(e) Documentation of all routine security tours and inspections, and of all tests, inspections, and maintenance performed on physical barriers, intrusion alarms, communications equipment, and other security related equipment used pursuant to the requirements of this part.

(f) A record at each onsite alarm annunciation location of each alarm, false alarm, alarm check, and tamper indication that identifies the type of alarm, location, alarm circuit, date, and time. In addition, details of response by facility guards and watchmen to each alarm, intrusion, or other security incident shall be recorded.

(g) Shipments of special nuclear material subject to the requirements of this part, including names of carriers, major roads to be used, flight numbers in the case of air shipments, dates and expected times of departure and arrival of shipments, names and addresses of the monitor and one alternate monitor at each transfer point, verification of communication equipment on board the transfer vehicle, names of individuals who are to communicate with the transport vehicle, container seal descriptions and identification; and any other information to confirm the means utilized to comply with §§ 73.30 through 73.36. Such information shall be recorded prior to shipment. Information obtained during the course of the shipment such as reports of all communications, change of shipping plan including monitor changes, trace investigations and others shall also be recorded.

(h) Procedures for controlling access to protected areas and for controlling access to keys for locks used to protect special nuclear material.

19. Section 73.71 is amended to read as follows:

§ 73.71 Reports of unaccounted for shipments, suspected theft, unlawful diversion, or industrial sabotage.

(a) Each licensee who conducts a trace investigation of a lost or unaccounted for shipment pursuant to § 73.36(f) shall immediately report to the Director of the appropriate Atomic Energy Commission Regulatory Operations Regional Office listed in Appendix A, by telephone, telegram, or teletype, the details and results of his trace investigation and shall file within a period of fifteen (15) days a written report to the Director of the appropriate Regulatory Operations Regional Office with a copy to the Director of Regulatory Operations, U.S. Atomic Energy Commission, Washington, D.C. 20545, setting forth the details and results of the trace investigation.

(b) Each licensee shall report immediately to the Director of the appropriate Atomic Energy Commission Regulatory Operations Regional Office listed in Appendix A, by telephone, telegram, or teletype, any incident in wihch an attempt has been made, or is believed to have been made, to commit a theft or unlawful diversion of special nuclear material which he is licensed to possess, or to commit an act of industrial sabotage against his plant. The initial report shall be followed within a period of fifteen (15) days by a written report submitted to the Director of the appropriate Regulatory Operations Regional Office, with a copy to the Director of Regulatory Operations, U.S. Atomic Energy Commission, Washington, D.C. 20545, setting forth the details of the incident. Subsequent to the submission of the written report required by this paragraph a licensee shall immediately inform the Director of the appropriate Regulatory Operations Regional Office by means of a written report of any substantive additional information, which becomes available to the licensee, concerning the incident.

§ 73.80 [Redesignated]

20. Section 73.51 is redesignated as § 73.80.

Effective date. The foregoing amendments become effective on December 6, 1973.
(Sec. 161, Public Law 83-703, 68 Stat. 948, 42 U.S.C. 2201.)

Dated at Germantown, Maryland this 31st day of October 1973.

For the Atomic Energy Commission.

PAUL C. BENDER,
Secretary of the Commission.

[FR Doc. 73-2355 Filed 11-5-73; 8:45 am]

PART 70—SPECIAL NUCLEAR MATERIAL

Revised Control and Accounting Requirements

On February 1, 1973, the Atomic Energy Commission published in the Federal Register (38 FR 3077) proposed amendments to its regulations in 10 CFR Part 70 which would revise the materials control and accounting requirements for special nuclear material.

Interested parties were invited to submit comments and suggestions for consideration in connection with the proposed amendments within 60 days after publication in the Federal Register. Upon consideration of the comments received, and other factors involved, the Commission has adopted the proposed amendments, with certain modifications as set forth below.

Significant differences from the proposed amendments published for comment are: (1) A change in the detailed control and accounting requirements for plutonium containing 80 percent or more by weight of the isotope Pu-238; (2) addition of a requirement for tamper-safing procedures to include control of the tamper-safing devices and records of the date and time of tamper-safing; (3) addition of requirements for the identification and control of in-process items containing special nuclear material; (4) changes in the date of the first inventory required under the amended regulation and the date by which the licensee's description of his program to meet the amended regulations must be submitted to the Commission have been made; (5) a change in the required frequency of plutonium inventories has been made from one to two months; (6) clarification of the description of that portion of a fuel reprocessing plant requiring only 6-month inventories; (7) addition of a five-year retention period for material balance and inventory records; (8) provision for licensees to apply for a license or amendment authorizing alternate limits of error (LE) for material unaccounted for (MUF) than specified in the proposed amendments and deletion of the limit of error of MUF requirements to be effective after January 1, 1976; (9) modification of LEMUF requirements to specify that they apply to a total plant balance for inprocess material of each type; (10) modification of the absolute minimum quantity limits for LEMUF to reflect a less stringent requirement for low enriched uranium; (11) modification of the material balance requirements to require accounting for plutonium only on the element basis; (12) deletion of specific remeasurement criteria for material inventory that has not been tamper-safed to permit the licensee flexibility in this remeasurement of SNM; and (13) addition of a footnote to clarify that the regulations do not require plant shutdown and cleanout for physical inventory. In addition, editorial changes were made.

The following discussion pertains to the respective items (1) through (13) above:

(1) The rule set forth below requires that the control and accounting requirements for plutonium containing 80 percent or more by weight of the isotope Pu-238 be the same as those for low-enriched uranium. This isotope of plutonium, because of the heat generated within the material, is, like low-enriched uranium, an improbable fissile material for use in nuclear weapons and does not require the controls specified in Part 70 for strategic material such as high-enriched uranium and plutonium having higher Pu-239 isotopic content. This isotope at these concentrations, i.e., greater than 80 percent, does not exist in quantity because it is produced only by special irradiation programs and not ordinarily as a product from power reactors.

(2) The rule set forth below specifies that tamper-safing devices must be controlled and that the date and time of application of the devices be recorded. Unless it can be assured that the tamper-safing devices are available only to authorized persons and that there is documented evidence that the devices were applied at a time appropriate to ensure the integrity of the measurement of the material, tamper-safing cannot be an effective control mechanism.

(3) The proposed rule required item identification and control for items containing special nuclear material that had been tamper-safed and were not in process. It is equally as important to identify and control items in process that contain special nuclear material. The rule set forth below requires identification and control of items containing special nuclear material whether in process or not in process.

(4) Section 70.51(e)(2) of the proposed amendments would have required the licensee to perform the first inventory under the amended rule within 90 days after the effective date of the rule. However, § 70.51(g) would not have required the licensee to submit a description of his procedures to be used to comply with the requirements of amended rule until 120 days after the effective date. Based on comments received, the Commission believes the licensee whould develop and submit a description of his inventory procedures prior to taking an inventory following the amended rule. Accordingly, the rule set forth below provides effective dates such that the additional material control and accounting requirements will become effective 6 months after publication of these amendments, the first inventory under the revised rule must be taken within 6 months after publication of these amendments, and the licensee's program description must be submitted to the Commission within 4 months after publication of these amendments. Until

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the submittals have been reviewed and their acceptability determined, licensees will be expected to follow the material control and inventory program described in their submittals.

(5) After evaluating comments, it was determined not to be feasible for licensees to meet the 0.5 percent limit on the limit of error of material unaccounted for (LEMUF) on a monthly balance for plutonium as specified in the proposed amendments. To meet the 0.5 percent limit licensees indicated that plant shutdown and clean-out would be required. Even then there were some questions whether the 0.5 percent limit would be met. To have a higher throughput factor for the LEMUF limit, the rule set forth below requires conduct of plutonium inventories every two months instead of every month as required by the proposed amendment. The two-month inventory interval for plutonium (other than in a reprocessing facility) makes the limits and inventory interval for plutonium the same as for high enriched uranium.

(6) The proposed rule identified that part of a fuel reprocessing plant which would have required physical inventory at only 6-month intervals. Comments indicated that the intent of this requirement was not clear. The rule set forth below more specifically identifies that portion of the fuel reprocessing process that is inaccessible and not as susceptible to diversion of special nuclear material and therefore does not require as frequent inventories as more accessible processes and materials.

(7) The rule set forth below specifies a five-year retention time for material balance and inventory records. This requirement is consistent with International Atomic Energy Agency records retention requirements and will make the U.S. records retention requirements compatible with IAEA safeguards for purpose of the Treaty on the Nonproliferation of Nuclear Weapons.

(8) At the time that the proposed rules were formulated, it was recognized that some types of processes and operations initially could not meet the proposed regulations and provision was made for application for exception to the specified requirements. Based upon comments received and upon reconsideration, the Commission has determined that specific provision should be made in the regulations for consideration of alternative LEMUF limits. The regulation has been revised accordingly. If a licensee has demonstrated through actual experience that he cannot meet the specified LEMUF limits, he may apply to the Commission for imposition of limits that can be met. These alternate limits will be approved if the licensee demonstrates that he has made reasonable efforts and cannot meet the prescribed limits and he has or will initiate a program to enable him to meet the prescribed limits. In view of this alternate provision and in consideration of the many uncertainties in the developing technology, prediction of firm LEMUF limits two to three years in the future was not considered feasible. Licensee performance and technological developments will be evaluated on a continuing basis and more stringent LEMUF limits established as the need is indicated and as the state-of-the-art permits.

(9) The proposed amendments were not clear as to which material balance the LEMUF limits applied. The rule set forth below specifies that the LEMUF limits apply to the total plant in-process material balance for a given material type. While balances still will be needed for material balance areas and limits of error calculated for such balances to permit MUF evaluation, the LEMUF limits specified in the rule set forth below do not apply for such balances unless they consist of the total plant in-process balance for a given material type.

(10) The proposed amendments specified absolute quantities for the LEMUF limits below which the relative percentage limits would not apply. The proposed limits for low enriched uranium were more stringent at the 3–4 percent enrichment level on an effective kilogram basis than the limits for plutonium, U–233, and high enriched uranium. To provide proper gradation of requirements the limits for low enriched uranium have been modified.

(11) The proposed amendments would have required calculation of an in-process material balance, MUF, and LEMUF for both element and isotope for plutonium. Adequate control can be maintained for plutonium using only the element balance. The rule set forth below requires calculation of an in-process material balance, MUF and LEMUF for plutonium element only.

(12) The proposed amendments specified confidence levels for statistical sampling plans to be used for verification of previous measurements for inventory purposes. Comments indicated that these statistical sampling plan statements were interpreted to mean specific requirements for the use of the specified plans. There also appeared to be some confusion as to the interpretation of the confidence levels

being required. The rule set forth below specifies only that measurements of SNM on inventory whose integrity is not ensured by tamper-safing shall be vertified by remeasurement. The licensee may select appropriate remeasurement procedures and sampling plans. These plans will be included in the description of his program which will be submitted to the Commission.

(13) Comments indicated that the inventory criteria in the proposed amendments were interpreted as requiring plant shutdown and cleanout for physical inventory. Such is not required so long as process inventory measurements can be made on a dynamic basis to sufficient precision and accuracy to meet the LEMUF limits specified in § 70.51(e)(5)(ii). The rule set forth below contains a footnote to this effect. Many comments indicated that the license should be given flexibility to develop "innovative" inventory techniques to preclude costly plant shutdown. Such flexibility had always been the intent of the proposed amendments.

Pursuant to the Atomic Energy Act of 1954, as amended, and sections 552 and 553 of Title 5 of the United States Code, the following amendments of Title 10, Chapter I, Code of Federal Regulations, Part 70 are published as a document subject to codification.

1. Section 70.4 is amended by adding a new paragraph (t) to read as follows:

§ 70.4 Definitions.

* * * * * * *

(t) "Effective kilograms of special nuclear material" means: (1) For plutonium and uranium-233 their weight in kilograms; (2) For uranium with an enrichment in the isotope U-235 of 0.01 (1%) and above, its element weight in kilograms multiplied by the square of its enrichment expressed as a decimal weight fraction; and (3) For uranium with an enrichment in the isotope U-235 below 0.01 (1%), by its element weight in kilograms multiplied by 0.0001.

2. Paragraph (b) of § 70.22 is revised to read as follows:

§ 70.22 Content of applications.

* * * * * * *

(b) Each application for a license to possess at any one time special nuclear material in a quantity exceeding one effective kilogram of special nuclear material and to use such special nuclear material for activities other then those involved in the operation of a nuclear reactor licensed pursuant to Part 50 of this chapter or those involved in a waste disposal operation, or as sealed sources, shall also contain:

(1) A full description of the applicant's program for control of and accounting for special nuclear material which will be in his possession under license, including:

(i) Procedures used in receiving, storing and shipping special nuclear material;

(ii) Procedures for controlling special nuclear material during its processing or use in the facility, if appropriate;

(iii) Procedures by which process losses are determined;

(iv) Special nuclear material records and reporting procedures;

(v) Physical inventory procedures showing how the requirements of paragraphs (e) and (f) of § 70.51 will be satisfied;

(vi) Measurement and statistical control procedures; and

(vii) Administrative controls (organization and management) for assuring appropriate implementation of the procedures described in paragraph (b)(1) (i) through (vi) of this section.[1]

(2) An identification of the fundamental material controls provided in the procedures described in paragraphs (b)(1) (i) through (vii) of this section, which the applicant considers essential for assuring that special nuclear material in his possession under license will be adequately safeguarded. Such proposed controls will be considered by the Commission in determining the conditions to be incorporated in the license pursuant to § 70.32(c).

* * * * * * *

3. Paragraph (c) of § 70.32 is revised to read as follows:

[1] For guidance in preparing the required descriptions, an applicant may consult "Guide for Preparation of Fundamental Material Controls and Nuclear Materials Safeguards Procedures," and "Regulatory Guide 5.3 Statistical Terminology and Notation For Special Nuclear Materials Controls and Accountability" which are available for inspection at the Commission's Public Document Room, 1717 H Street, NW., Washington, D.C. Copies of these guides may be obtained by addressing a request to the Director of Regulatory Standards, U.S. Atomic Energy Commission, Washington, D.C. 20545.

§ 70.32 Conditions of licenses.

* * * * * * *

(c) Each license authorizing the possession at any one time and location of special nuclear material in a quantity exceeding one effective kilogram of special nuclear material and the use of such special nuclear material except those uses involved in the operation of a nuclear reactor licensed pursuant to Part 50 of this chapter or those involved in a waste disposal operation, or in sealed sources, shall contain and be subject to a condition requiring the licensee to maintain and follow (1) the program for control and accounting for special nuclear material and fundamental material controls described pursuant to § 70.22(b) (2) and (2) such other material control procedures as the Commission determines to be essential for the safeguarding of special nuclear material. The licensee shall make no change which would decrease the effectiveness of the material control and accounting program prepared pursuant to § 70.22(b)(1) or § 70.51(g) without the prior approval of the Commission. A licensee desiring to make such changes shall submit an application for amendment to his license pursuant to § 70.34. The licensee shall maintain records of changes to the material control and accounting program made without prior Commission approval, and shall furnish to the Commission a report containing a description of each change within:

(1) Two months of the change if it pertains to plutonium, uranium-233 or uranium-235 contained in uranium enriched 20% or more in the uranium-235 isotope, and

(2) Six months of the change if it pertains to uranium enriched less than 20 percent in the uranium-235 isotope.

4. Section 70.51 is revised to read as follows:

§ 70.51 Material balance, inventory, and records requirements.

(a) As used in this section:

(1) "Additions to material in process" means receipts that are opened except for receipts opened only for sampling and subsequently maintained under tamper-safing, and opened sealed sources.

(2) "Enrichment category" for uranium 235 means high-enriched uranium—that uranium whose isotope content is 20 percent or more uranium 235 by weight, and low-enriched uranium—that uranium whose isotope content is less than 20 percent uranium 235 by weight.

(3) "Element" means uranium or plutonium.

(4) "Fissile isotope" means (i) uranium-233 or (ii) uranium-235 by enrichment category.

(5) "Limit of error" means the uncertainty component used in constructing a 95 percent confidence interval associated with a quantity after any recognized bias has been eliminated or its effect accounted for.

(6) "Material balance" means a determination of material unaccounted for (MUF) by subtracting ending inventory (EI) plus removals (R) from beginning inventory (BI) plus additions to inventory (A). Mathematically,

$$MUF = BI + A - EI - R$$

(7) "Material in process" means any special nuclear material possessed by the licensee except in unopened receipts, sealed sources, and ultimate product maintained under tamper-safing.

(8) "Physical inventory" means determination on a measured basis of the quantity of special nuclear material on hand at a given time. The methods of physical inventory and associated measurements will vary depending on the material to be inventoried and the process involved.[2]

(9) "Removals from material in process" includes measured quantities of special nuclear material disposed of as discards, encapsulated as a sealed source, or in other ultimate product paced under tamper-safing or shipped offsite.

(10) "Tamper-safing" means the use of devices on containers or vaults in a manner and at a time that ensures a clear indication of any violation of the integrity of previously made measurements of special nuclear material within the container or vault.

(11) "Ultimate product" means any special nuclear material in the form of a product that would not be further processed at that licensed location.

(12) "Unopened receipts" means receipts not opened by the licensee, including receipts of sealed sources, and receipts opened only for sampling and subsequently maintained under tamper-safing.

[2] Criteria for physical inventories are set out in paragraph (f) of this section.

(b) Each licensee shall keep records showing the receipt, inventory (including location), disposal, acquisition, import, export, and transfer of all special nuclear material in his possession regardless of its origin or method of acquisition.

(c) Each licensee who is authorized to possess at any one time special nuclear material in a quantity exceeding one effective kilogram of special nuclear material shall establish, maintain, and follow written material control and accounting procedures which are sufficient to enable the licensee to account for the special nuclear material in his possession under license.

(d) Except as required by paragraph (e) of this section, each licensee who is authorized to possess at any one time and location special nuclear material in a quantity totaling more than 350 grams of contained uranium 235, uranium 233, or plutonium, or any combination thereof, shall conduct a physical inventory of all special nuclear material in his possession under license at intervals not to exceed twelve months.

(e) Effective May 6, 1974, each licensee who is authorized to possess at any one time special nuclear material in a quantity exceeding one effective kilogram of special nuclear material and to use such special nuclear material for activities other than those involved in the operation of a nuclear reactor licensed pursuant to Part 50 of this chapter or those involved in a waste disposal operation; as sealed sources; or as reactor irradiated fuels involved in research, development, and evaluation programs in facilities other than irradiated fuel reprocessing plants, shall:

(1) Maintain procedures which shall include:

(i) Procedures for tamper-safing containers or vaults containing nuclear material not in process, which include control of access to the devices and records of the date and time of application of each device to a container or vault; unique identification of each such item; inventory records showing the identity, location, and quantity of special nuclear material for all such items; and records of the source and disposition of all such items;

(ii) Records of the quantities of special nuclear material added to or removed from the process;

(iii) Inventory records for the quantity of special nuclear material in process;

(iv) Unique identification of items or containers containing special nuclear material in process; inventory records showing the identity, location, and quantity of special nuclear material for all such items; and records of the source and disposition of all such items;

(v) Documentation of all transfers of special nuclear material between material balance areas to show identity and quantity of special nuclear material transferred;

(vi) Requirements for authorized signatures on each document for transfer of special nuclear material between material balance areas; and

(vii) Means for control of and accounting for internal transfer documents.

(2) On or before May 6, 1974, and thereafter as necessary to comply with the requirements of paragraph (e)(3) of this section, perform a physical inventory of all special nuclear material in his possession in compliance with the criteria for physical inventories set forth in paragraph (f) of this section.

(3) Conduct physical inventories made in accordance with the criteria for physical inventories set forth in paragraph (f) of this section at intervals determined from the start of the beginning inventory to the start of the ending inventory not to exceed:

(i) 2 calendar months for plutonium except for plutonium containing 80 percent or more by weight of the isotope Pu-238, uranium 233 and for uranium enriched 20 percent or more in the isotope uranium 235 (except as provided in paragraph (e)(3)(ii) of this section); and

(ii) 6 calendar months for uranium enriched less than 20 percent in the isotope uranium 235; for plutonium, U-233 and high-enriched uranium in that portion of an irradiated-fuel reprocessing plant from the dissolver to the first vessel outside of the radiation shielded portion of the process: and for plutonium containing 80 percent or more by weight of the isotope Pu-238;

(4) Within 30 calendar days after the start of each ending physical intentory required by paragraph (e)(3) of this section:

(i) Calculate, for the material balance interval terminated by that inventory, the material unaccounted for (MUF) and its associated limit of error for each element and the fissile isotope for uranium contained in material in process:

(ii) Reconcile and adjust the book record of quantity of element and fissile isotope, as appropriate, to the results of the physical inventory;

(iii) Complete and maintain for a period of five years material balance records for each material balance showing the quantity of element and fissile isotope, as appropriate, in each component of the material balance, with the associated limit of error for the material unaccounted for both in terms of absolute quantity element and fissile isotope and relative to additions to or removals from material in process for the interval, where results of limit of error calculations are recorded in sufficient detail to permit an evaluation of sources of error.

(iv) Complete and maintain for a period of five years a record summarizing the quantities of element and fissile isotope, as appropriate, for ending inventory of material in process, additions to material in process during the material balance interval and removals from the material in process during the material balance interval; and

(v) Complete and maintain for a period of five years a record summarizing the quantities of element and fissile isotope, as appropriate, in unopened receipts (including receipts opened only for sampling and subsequently maintained under tamper-safing), and ultimate products maintained under tamper-safing, or in the form of sealed sources;

(5) Establish and maintain a system of control and accountability such that the limits of error for any material unaccounted for (MUF) ascertained as a result of the material balances made pursuant to paragraph (c)(3) of this section do not exceed (i) 200 grams of plutonium or uranium 233, 300 grams of high enriched uranium or uranium 235 contained in high enriched uranium, or 9,000 grams of uranium 235 contained in low enriched uranium, (ii) those limits specified in the following table, or (ii) other limits authorized by the Commission pursuant to paragraph (c)(6) of this section:

Material type:	*Limit of error of MUF on any total plant inprocess material balance* [3] *percent*
Plutonium element or uranium 233 in a chemical reprocessing plant	1. 0
Uranium element and fissile isotope in a reprocessing plant	0. 7
Plutonium element, uranium 233, or high enriched uranium element and fissle isotope—all other	0. 5
Low-enriched uranium element and fissile isotope—all other	0. 5

[3] As a percentage of additions to or removals from material in process, whichever is greater.

Any licensee subject to this paragraph on December 6, 1973, who requests higher limits pursuant to paragraph (c)(6) of this section at the time he submits his program description under the provisions of paragraph (g) of this section is hereby authorized to operate at the higher limits until the application for license or amendment has been finally determined by the Commission;

(6) An applicant or a licensee subject to the requirements of paragraph (c) of this section may request limits higher than those specified in paragraph (c)(5) of this section. The requested higher limits shall be passed on considerations such as the type and complexity of process, the number of unit operations, process throughput quantities, process recycle quantities, and the technology available an applicable to the control and accounting of the material in the process. The Commission will approve higher limits if the applicant demonstrates:

(i) That he has made reasonable efforts and cannot meet the limits of error of MUF specified in paragraph (c)(5) of this section; and

(ii) That he has initiated or will initiate a program to achieve improvements in his material control system so as to meet the limits specified in paragraph (c)(5) of this section.

(f) Each licensee subject to the requirements of paragraph (c) of this section shall:

(1) Establish physical inventory procedures to assure that:

(i) The quantity of special nuclear material associated with each item on inventory is a measured value;

(ii) Each item on inventory is listed and identified to assure that all items are listed and that no item is listed more than once;

(iii) Cutoff procedures for transfers and processing are established so that all quantities are inventoried and none are inventoried more than once;

(iv) Cutoff procedures for records and reports are established so that all transfers for the inventory and material balance interval and no others are included in the records; and

(v) Upon completion of the inventory, all book and inventory records, both total plant and material balance area, are reconciled with and adjusted to the physical inventory.

(2) Establish inventory procedures for sealed sources and containers or vaults containing special nuclear material that provide for:

(i) Identification and location of all such items;

(ii) Verification of the integrity of the tamper-safing devices for such items;

(iii) Reverification of identity and quantity of contained special nuclear material for each item not tamper-safed, or whose tamper-safing is found to have been compromised;

(iv) Verification of the correctness of the inventory records of identity and location for all such items; and

(v) Documentation in compliance with the requirements of paragraphs (f)(2) (i), (ii), (iii), and (iv) of this section.

(3) Establish inventory procedures for special nuclear material in process that provide for:

(i) Measurement of all quantities not previously measured by the licensee for element and fissile isotope; and

(ii) For all material whose content of element and fissile isotope has been previously measured by the licensee but for which the validity of such previously made measurements has not been assured by tamper-safing, verification of the quantity of contained element and fissile isotope by remeasurement.

(4) Conduct physical inventories according to written inventory instructions for each inventory which shall:

(i) Assign inventory duties and responsibilities;

(ii) Specify the extent to which each material balance area and process is to be shut down, cleaned out, and/or remain static;[4]

(iii) Identify the basis for accepting previously made measurements and their limits of error;

(iv) Designate measurements to be made for inventory purposes and the procedures for making such measurements; and

(v) Identify the means by which material on inventory will be listed to assure that each item is inventoried and that there is no duplication.

(g) Each licensee subject to the requirements of paragraph (e) of this section shall submit to the Commission for approval by March 6, 1974, a full description of the program intended to be used to enable the licensee to comply with that paragraph and the requirements set forth in paragraph (f) of this section. This program shall be followed by the licensee after May 6, 1974.

(h) Each licensee who determines that the requirements of paragraph (e) of this section will require modifications of his plant or equipment costing $500,000 or more may, by March 6, 1974, apply to the Commission for an extension of time, not to exceed six additional months, for compliance with those requirements. Each application for extension shall include a description of the modifications to be made, a statement of estimated associated costs with substantiating evidence, and a schedule of the dates when the modifications will be commenced and completed.

5. Section 70.53 is revised to read as follows:

§ 70.53 Material status reports.

(a) Each licensee who is authorized to possess at any one time and location special nuclear material in a quantity totaling more than 350 grams of contained uranium 235, uranium 233, or plutonium or any combination thereof, shall complete and submit to the Commission Material Status Reports on Form AEC-742, in accordance with printed instructions for completing the form, concerning special nuclear material received, produced, possessed, transferred, consumed, disposed of or lost by the licensee. All such reports shall be made as of June 30 and December 31 of each year and shall be filed with the Commission within thirty (30) days after the end of the period covered by the report. The Commission may permit a licensee to submit Material Status Reports at other times when good cause is shown.

(b) Each licensee subject to the requirements of § 70.51(e) shall submit to the appropriate Regional Office of the AEC Directorate of Regulatory Opera-

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[4] No process shutdown and/or cleanout for inventory is required if requirements with respect to MUF and the limit of error of MUF as specified in paragraph (e)(5)(ii) of this section are met using other inventory methods.

tions listed in Appendix A of Part 73 of this chapter within 30 calendar days after the start of each ending physical inventory required by § 70.51(e)(3):

(1) If the material unaccounted for exceeded both (i) its associated limit of error and (ii) 200 grams of plutonium or U-233, 300 grams of high enriched uranium or uranium U-235 contained in high enriched uranium, or 9,000 grams of U-235 contained in low enriched uranium, a statement of the probable reasons for the material unaccounted for and actions taken or planned with respect to the material unaccounted for; and

(2) If for any material the limit of error of the material unaccounted for balance exceeds any applicable limits specified in § 70.51(e)(5) or approved pursuant to § 70.51(e)(6), a statement of the probable reasons for the limit of error and actions taken or planned with respect to the limit of error.

Effective date. The foregoing amendments become effective on December 6, 1973.

(Secs. 53b, 161, Pub. L. 83-703, 68 Stat. 930, 948 (42 U.S.C. 2073(b), 2201))

Dated at Germantown, Maryland this 31st day of October 1973.

For the Atomic Energy Commission.

PAUL C. BENDER,
Secretary of the Commission.

[FR Doc.73-23552 Filed 11-5-73; 8:45 am]

Senator GRAVEL. Senator Dole, do you have any questions that you would like to ask?

Senator DOLE. No, I have no questions.

I have read your statement, Dr. Ray, and I have also watched you recently, on "Meet the Press". I thought you did an excellent job.

Dr. RAY. Thank you very much.

Senator DOLE. In the fall, I went to Kansas where they are about to build the first nuclear plant, I learned there that it is quite controversial.

Dr. RAY. Yes, sir.

Senator DOLE. Particularly with reference, not to anything you have done, but with the—I think the same thing Senator Gravel has raised—the great mass of misinformation and lack of information and of course above all the safety of a plant in any area, this disposal of wastes and all of the questions that you are asked 100 times a day probably.

Dr. RAY. It makes us recognize that we have got to do a much better job in laying the facts before the people. And we have been trying to think of better ways to do it.

We can speak in the public forum, we can talk with newspaper reporters, and so on. We intend to do all of those but I would like to call attention to one program we have that you might find useful, if you would like to request it.

We have organized something called citizens workshops that can be requested. These are held in the community, in the public library or a school building with some technical people from AEC laboratories, and with demonstration materials that will be responsive to any question any citizen wants to ask. These workshops provide a 2- or 3-day program covering everything from how a nuclear plant works, to how you can get information about what the precautions are and what the radiation picture is.

We think the workshops are responsive to the sorts of questions that the public raises. We are not trying to sell the idea of foisting a nuclear plant on any community, but to provide the information that will help to answer some of the people's questions so that they can make up their own minds.

And if in the area of your State, there are questions being raised, if they would like to have the citizens workshop program there, we would be most happy to respond.

Senator DOLE. I could have used it last week, and I think I can probably use it a little later on, but as Walt Rogers knows, I can understand the people who would lose their land having a very direct interest in it, and I am completely sympathetic because sometimes you cannot place a value on it because it goes back and back and back into the family.

But, I think, overriding that is this sort of unknown, even though there have been no radiation injuries that I know of—I do not think there have, precisely none as I understand?

Dr. RAY. That is correct, yes.

Senator DOLE. So that might be helpful, and I appreciate it very much.

Senator GRAVEL. Well, thank you very much, Doctor.

I appreciate it and we will be in touch.

Dr. RAY. Thank you.

[The prepared statement of Dr. Ray follows:]

PREPARED STATEMENT BY DR. DIXY LEE RAY, CHAIRMAN, U.S. ATOMIC ENERGY COMMISSION

Mr. Chairman, members of the Subcommittee, I am pleased to appear before you today to testify on S. 2806, the Energy Revenue and Development Act of 1973. The task of achieving a capability for energy independence for this Nation, a primary goal of S. 2806, is a task which has consumed a major part of my own energies for the past several months. Therefore, I do appreciate the opportunity to express my views on this extremely important and timely sub'ect.

Let me say first that I am pleased that Congress and the Executive Branch are developing proposals designed to meet the energy problems. The process of considering various forms of legislgtion will aid both the Government and the public in understading the magnitude of the problem and devising the most appropriate solutions.

The Atomic Energy Commission is very much interested in the underlying goal of S. 2806: to organize the energy efforts of the Federal Government in such a way as to assist the Nation in establishing a posture for achieving energy independence by the mid-1980's.

The energy shortages of today and those projected for future decades stem, in part, from the lack of a coordinated national program for energy research and development over the past 10 to 20 years. Today's shortages impart a long overdue sense of urgency to the effort being launched to meet not only immediate requirements but also the growing needs of the years ahead.

The energy challenge posed by the immediate future carries with it an unparalleled opportunity for the Nation to emerge better equipped than ever before to pursue the higher goals of domestic and international peace and well being.

S. 2806 includes a wide range of provisions relating to energy. These provisions involve taxes, research and development policies and organizations, technology assessment, price controls, import and export policies, and oil and gas production. I plan to confine my statement to those areas of greatest concern to the Atomic Energy Commission, and expect that other witnesses from the Executive Branch and industry to discuss the areas of greatest concern to them.

FEDERAL ENERGY ADMINISTRATION

Title III, Sec. 301, would establish a Federal Energy Administration, headed by an Administrator who would be appointed by the President, by and with the advice and consent of the Senate. This proposed Administration would be empowered to "develop, direct, and carry out a national energy program involving energy research, demonstration, development, utilization, and conservation in order to meet the present and future energy needs of the United States."

Many of its functions are set forth in Sec. 302(b), including the pursuit of research, demonstration, and development programs in a wide variety of energy technologies. The Administrator would undertake the assessment and direction of the energy R&D activities of the Federal Government and the formulation and carrying out of a comprehensive energy research, development, and demonstration program in the use of fossil fuels, nuclear fuels, geothermal energy, solar power, tidal power, and other unconventional sources of power.

Sec. 310 provides for the transfer to the Administration of "all functions (including powers, duties, activities, facilities, and parts of functions) which were carried out . . . by the Atomic Energy Commission and which relate primarily to the peaceful uses of atomic energy."

As you are aware, the establishment of a Federal Energy Administration was first proposed by the Executive Branch in draft legislation submitted to the Congress on December 4, 1973. That legislation, which proposed a considerably different Federal Energy Administration from the one now under consideration, was subsequently introduced in the Senate as S. 2776, underwent hearings by the Government Operations Committee, and passed the Senate on December 19, 1973. As described by Mr. Ash, Director, Office of Management and Budget, in testimony on S. 2776 before the Government Operations Committee on December 6, the Federal Energy Administration would concentrate "on the immediate operational needs of minimizing the adverse impact of the fuel shortage, increasing our energy supplies and reducing our energy demands."

A separate organizational entity was proposed by the President to deal with the longer range goal of developing and improving technologies which can be called upon to yield new approaches to creating and using energy. I am referring, of course, to the Energy Research and Development Administration (ERDA) as proposed in S. 2744, upon which hearings were also counducted in December by a Subcommittee of the Senate Government Operations Committee. That bill would form a new energy R&D agency by bringing together some of our Nation's best talent in research and development. It would draw not only from the resources and extensive experience in technical management of the Atomic Energy Commission, but also from the professional talent in fossil fuel development of the Interior Department's Office of Coal Research and Bureau of Mines' Energy Research Centers. From the Environmental Protection Agency, it would acquire expertise on the development of alternative automotive power systems and on developing technology for controlling emissions of air pollutants from stationary sources using fossil fuels. ERDQ would also perform functions related to solar and geothermal energy development transferred from the National Science Foundation.

The need for reorganization of Federal energy research and development into a single agency was most recently expressed in the President's January 23 Energy Message. Without such a consolidation it would be extremely difficult to develop to full potential the variety of energy generation sources: fossil, nuclear, solar, geothermal, hydro, and others required to meet our growing energy needs. During the last several months I have had an exceptional opportunity to assess the scope and magnitude of our research and development requirements for all of these energy systems in formulating recommendations to the President for a five-year, $10 billion program for Federal energy research and development. I would like to make some comments on this subject later in my testimony.

TRANSFER OF AEC FUNCTIONS

Returning now to the energy organizational proposals in S. 2806, there are several comments I would like to make regarding the proposed transfer under Section 310(a) of AEC's functions which relate "primarily to the peaceful uses of atomic energy."

First, and foremost, I am opposed to the transfer of these functions to the Federal Energy Administration. I remain firmly convinced that it is wise and sound to create two separate organizations to deal with energy matters as proposed by the President, the Federal Energy Administration (S. 2776) and the Energy Research and Development Administration (S. 2744). Both organizational arrangements have received considerable scrutiny; they have undergone hearings in both the Senate and the House of Representatives; and each of them has completed at least one major step on the way to full Congressional approval. S. 2776 passed the Senate on December 19 and H.R. 11510, the House counterpart of S. 2744, passed the House on the same day.

The two-agency approach will permit the President to have reporting to him separately two agencies with quite different but equally important missions. One of these, the FEA, cannot only take rapid and decisive action in response to developments resulting from the energy shortages facing the Nation, but also provide centralized direction and management of energy policy. The other, ERDA, can mobilize those efforts needed to generate and accelerate research and development activities on all sources and forms of energy so that fossil and nuclear fuels, advanced energy sources, conservation of energy, and environmental considerations will receive full recognition and appropriate emphasis.

Energy research and development activities are designed to alter present energy dependency relationships by reducing energy requirements, developing new energy sources or substituting plentiful resources for scarce ones. In one sense the purpose of R&D is to change the status quo with respect to energy technology. The FEA on the other hand would would be an agency which must of necessity be concerned with available technology. It would be charged with ensuring that the present energy system meets national needs now and in the near future. Like its predecessor agencies, FEA would inevitably be caught up in the concerns and problems of current fuel and technology interests. In such an environment, it is not reasonable to expect that the agency would launch and maintain vigorous R&D programs whose benefits would be realized only after many years of study.

Section 310 would apparently transfer all AEC functions, including research and development and licensing and regulatory functions, to the proposed Federal Energy Administration. We find this feature undesirable because we believe the time has come to treat energy R&D and the problems attendant to the licensing and regulation of nuclear power plants separately. As the current energy crisis has deepened, we as a Nation have come to realize that we are faced with a very serious challenge to find those solutions which will most quickly and effectively lead us toward energy self-sufficiency. The reorganization of energy R&D functions in the Federal establishment as provided by S. 2744 and S. 2776 seems to be the most appropriate way of giving comprehensive and systematic direction to solving our energy problems. The solid growth of the nuclear power industry in recent years has greatly increased demands upon the AEC in the area of regulation of the peaceful uses of nuclear energy. The time has now come when the scope and magnitude of the regulatory function requires the undivided attention of a single agency. The proposal in S. 2744 to provide for a separate Nuclear Energy Commission is another step in the evolution of governmental control of nuclear development and uses, and we strongly support it.

Another point regarding the transfer provisions of S. 2806 is that they do not make clear what would be transferred to the new Federal Energy Administration in addition to certain functions of AEC. Additional transfers of functions from other agencies would be permitted by Sec. 311(a) but would require future Presidential and subsequent notification to and tacit acceptance by the Congress. It also gives no assurance of a unified Federal approach to energy R&D as called for in the Statement of Policy and purposes set forth in Sec. 102(3).

COMMISSION ON ENERGY TECHNOLOGY ASSESSMENT

Title IV of S. 2806 would establish a Commission on Energy Technology Assessment, consisting of an Energy Technology Assessment Board and a Commissioner. The Board would be composed of 22 members, including the Commissioner, with seven members each from the field of economics, the field of engineering, and the fields of the physical, biological or social sciences (Sec. 401(c)). We believe that any effectively managed energy administration should develop its own capability to undertake continuing assessments of the value of its programs and provide effective research and development planning and execution. A separate Commission on Energy Technology Assessment could have a potential for causing a diffusion of responsibility and conflicting orders of priorities. We consider its creation unwise.

ENERGY TRUST FUND; PRICE CONTROLS; TAX ENFORCEMENT

With regard to the establishment of an Energy Trust Fund and the other provisions of S. 2806, we defer to the views of other Government agencies having responsibility and greater expertise in these matters. As a general observation, we might comment that while the imposition of an energy tax is an accepted method of raising revenues, it seems preferable for energy R&D financnig to compete with other demands on the tax dollar through the budget and appropriations process. However, this in no way lessens my conviction that we need a sustained and adequate commitment to research and development to meet the Nation's future energy needs.

If we are to achieve the capability of energy self-sufficiency by the mid-1980's, we must rapidly begin to demonstrate our determination to accelerate the development of technology in conservation, in the fossil and nuclear fuels area, and in the solar, geothermal and fusion fields. We believe that we have made that beginning in the course of the effort which went into the development of the recommendations for an integrated energy R&D program for the Nation as contained in my December 1, 1973, Report to the President.

DECEMBER 1 REPORT TO THE PRESIDENT

Let me take just a few moments to comment on that report and note its major conclusions. First of all, our task was three-fold, to recommend:

A national energy research and development program needed to regain and maintain energy self-sufficiency;

A five-year, $10 billion Federal energy research and development program to supplement research and development expenditures expected from the private sector; and

Proposals for inclusion in the Fiscal Year 1975 Federal energy research and development budget.

To accomplish this task, a series of four workshops on the major issues of the national energy research and development program was organized under the sponsorship of the College of Engineering of Cornell University. Each workshop brought together leading authorities from industry, the academic community, and government, to treat topics that were considered to be of major importance in the development of a coherent energy R&D program.

Concurrent with the workshop effort a procedure was set in motion to ensure that we had available, from all potential sources, nominations for specific individual research and development efforts that should be carried on as part of the recommended program. We solicited nominations last August for individual research and development programs from government and industry that in their judgment the Nation needed to pursue over the period in question. The response to this solicitation provided eleven hundred and fifty-two specific and detailed proposals. The task of evaluating this formidable compilation of proposals was conducted by a series of 16 technical review panels, made up of 121 Federal employees from 36 departments, agencies and bureaus of the Federal Government.

The job of trying to pull together these two diverse efforts—the broad policy overview of the Cornell Workshops and the detailed program recommendations of the technical review panels—was undertaken by an Overview Panel charied by Mr. Stephen A. Wakefield, the Assistant Secretary for Energy and Minerals of the Department of the Interior.

The principal findings of the study were as follows:

Present energy problems stem, in large part, from the lack of a coordinated national energy research and development program over the last 20 years. Only nuclear power has received sustained support at adequate levels.

The requirement to regain and maintain energy self-sufficiency stems from conditions more fundamental than the current crisis. Worldwide energy shortages impend as energy-intensive industrial growth spreads and accelerates. The United States has the resources and technological base to regain self-sufficiency.

Five tasks are required to regain and sustain self-sufficiency, and simultaneous effort is urgently required on all five. Their contributions to self-sufficiency will begin to materialize in the order listed:

Task 1. Conserve energy by reducing consumption and conserve energy resources by increasing the technical efficiency of conversion processes.

Task 2. Increase domestic production of oil and natural gas as rapidly as possible.

Task 3. Increase the use of coal, first to supplement and later to replace oil and natural gas.

Task 4. Expand the production of nuclear energy as rapidly as possible, first to supplement and later to replace fossil energy.

Task 5. Promote, to the maximum extent feasible, the use of alternative energy sources (hydro, geothermal, solar) and pursue the promise of fusion and central station solar power.

The recommended program, based on what is now known, is both necessary and sufficient to maximize energy research and development's contribution to the Nation's energy goals. Even so, 1985 is the earliest date by which self-sufficiency can reasonably be expected with this program.

Mr. Chairman, I believe that the Report demonstrates the determination of all of us involved in energy research and development planning to accelerate the development of technology in all available fields—conservation, oil and natural gas, many uses of coal, nuclear fission plants, and solar, geothermal, and fusion work. The emphasis is on the period up to 1985, with the expectation that the capability for self-sufficiency can be regained by that time. The President emphasized the need for expanded energy R&D efforts in his January 23 message to the Congress, message that reflected the December 1 Report recommendations.

SUMMARY

To summarize, Mr. Chairman, I would like to reiterate my support for an independent Energy Research and Development Administration together with a separate Nuclear Energy Commission to perform the licensing and regulatory functions now performed by the Atomic Energy Commission. For this reason we do not favor the establishment of a Federal Energy Administration as proposed in S. 2806.

This concludes my testimony; I will be pleased to respond to any questions the Subcommittee members might have.

Senator GRAVEL. Our next witness is Hon. Walter E. Rogers, the president of the Interstate Natural Gas Association.

STATEMENT OF WALTER E. ROGERS, PRESIDENT, INTERSTATE NATURAL GAS ASSOCIATION OF AMERICA, ACCOMPANIED BY WILBER MACK, CHIEF EXECUTIVE OFFICER

Mr. ROGERS. Thank you, Mr. Chairman.

I have with me Mr. Wilber Mack, who is chairman of the American Natural Gas Co. out of Detroit, and he is chief executive officer of our association. I would like to have him join me.

Senator GRAVEL. We would be happy to have him join you Mr. Rogers. I welcome you back as a former colleague in Congress for 15 years and as chairman of the Subcommittee on Communications and Power of the House Commerce Committee.

So we welcome you here, sir, as a colleague. It is a pleasure to have you here; and proceed as you will. And, Mr. Mack, we welcome you also.

Senator DOLE. Let me add, too, that having served in the House with Mr. Rogers, I can advise the chairman that he is totally fair and objective and also an expert in this matter, and should be very helpful to the committee.

Senator GRAVEL. I had that opinion before my colleague said that.

Mr. ROGERS. Thank you, Mr. Chairman. I hope I can live up to that.

Mr. Chairman, in the interest of time—and I appreciate your time limitations—I have undertaken to reduce the statement to several pertinent points; and I would ask that the full statement be included as if it had been read.

Senator GRAVEL. It shall be included in the record, and your recognition of that is testimony to your own tenure as a public servant on this side of the bench.

Mr. ROGERS. INGAA is a nonprofit industry organization whose membership includes virtually all the major interstate natural gas pipeline companies in the United States. Our pipeline members today serve all of the lower 48 States, with the exception of Vermont, through an underground pipeline network now totaling more than 150,000 miles of transmission lines alone. They account for 90 percent of the total interstate sales of natural gas and provide the vital transportation link between the gas producer at the wellhead and the distributor who makes final delivery of gas to the consumer.

Now, the principal points I want to make, Mr. Chairman, I do not want to oversimplify, and I want to say that each of these points is treated more fully in the full statement.

To begin with, the target problem with relation to natural gas is supply. The curtailment proceedings that have been instituted by 15 interstate pipeline companies this year evidence that. It appears that during this winter heating season the customers of interstate pipelines will suffer curtailments approximating 509 billion cubic feet of gas, which is an increase of 20 percent over last year's winter curtailments.

But in that respect let me say this. That in view of the very moderate winter we have had that these statistics may be off to some extent.

Senator GRAVEL. Do you mean by curtailment that last year they had to cut back because they did not have the product, and that this year there has been a 20 percent increase in the cutback over last year?

Mr. ROGERS. Yes. If the winter for which these figures were worked out had been as bad as we had expected, it would have been about, a 20 percent increase. However, I think it will be less than that if the weather does not get worse.

Senator GRAVEL. So it was projected that it would have been 20 percent.

Mr. ROGERS. Twenty percent. That is right.

Senator GRAVEL. And sheer nonavailability of product is what it is, because nobody has got any gas to sell you?

Mr. ROGERS. That is right. That is exactly right.

Now, No. 2, I think a mention of the historical background of the pipeline industry and Federal regulation would be appropriate. This business has experienced its major expansion since World War II, and it serves every major population center. And it provides one-third of the energy requirements of the Nation.

It is limited primarily to the transportation of natural gas from producers' wells to the city gates. It is a capital intensive industry with a high proportion of fixed, immobile assets; and it must remain in service for a long period for obvious economic reasons, and also for the vital service it performs.

It must be able to produce gas itself or to have access to a market from which it can purchase gas if it is going to fulfill its responsibility.

Of course, the best supply would be from the lower 48 States because it would be more readily accessible. By that I do not mean to downgrade Alaskan gas or arctic gas or Canadian gas or any other kind of gas, because we are going to need it all, and the sooner the better.

The pipeline industry has been regulated since 1938 by the Federal Power Commission under the Natural Gas Act. The producers, as the chairman knows, were brought under jurisdiction of this act in 1954 by the U.S. Supreme Court decision in the *Phillips'* case. This created many, many problems, and the regulation has never been successful and it should never have been brought into being in the first place.

Overregulation, we feel, has been the cause in large part of our shortages. Our reserves-to-production ratio decreased between 1966 and 1972 from 16 to 10 years.

Pipeline companies, in view of this and looking to the future, have intensified their acquisition efforts and are seeking alternative sources—coal, oil, naphtha, and other light hydrocarbons, and also importation of Canadian gas and liquefied gas from other world sources.

There are many reasons discouraging producers in the dedication of gas to interstate markets. Four important ones are: the utility-type standard applied in the rate fixing of the Natural Gas Act in disallowing contractual price adjustments and in evaluating the lawfulness of existing rate levels.

Virtually all producer sales in interstate commerce are required to be made at prices substantially less than the true commodity value of the gas.

The prospects of future rate reduction orders is another reason; delay or disallowance of contractual price adjustments.

Delay in obtaining authorization for producer sales and connections; aggravated by delays in regulatory approval of the pipeline aspects of the project.

Economic disincentives applicable to producers are equally present and applicable in the case of pipeline production and in producing affiliates.

Now, No. 5 is the impact of the intrastate market. It should be recognized that the present gas shortage, although nationwide in scope, is not spread evenly among gas consumers. Its adverse effects are concentrated on the large populous areas which depend on interstate lines for their gas. The reason being that the intrastate market for gas in producing States has a pronounced advantage over the nonproducing States. The simple reason being that the intrastate market brings a higher price than the regulated interstate market. The interstate pipelines are therefore blocked from obtaining their share of the new production offerings.

We feel that the natural gas pipeline should be afforded an equal position in bidding for these new supplies.

No. 6, the punitive regulations of the pipeline industry. Statutory and regulatory obstacles threaten the ability of the interstate pipelines to acquire new supplies of domestic gas without assuming intolerable risks. This is especially true with relation to supplies of synthetic gas from coal and light hydrocarbons, foreign LNG, and imported gas from frontier areas.

The FPC has refused to give pipelines assurance of the recoupment of the cost of such projects including a reasonable return on invested capital, largely because the facilities involved were held to be nonjurisdictional.

We strongly recommend that the FPC's jurisdiction be extended to include domestic plants for the production or manufacture of synthetic gas for transportation or sale for resale in interstate commerce by natural gas companies.

Senator GRAVEL. Mr. Rogers, would you expand upon this a little bit. This is new ground for us—on the jurisdiction of the FPC. I was under the impression that all gas activities were under the FPC, and that some of their orders, like the order they have now for a 6-month increase to 51 cents, which is being challenged in court, is what is holding it up.

Mr. ROGERS. You mean the emergency sales?

Senator GRAVEL. Right.

Mr. ROGERS. Now, Senator, with your permission, I would like for Mr. Mack to address himself to this, because he has just been through this; and I think he can give you a much clearer picture of the facts.

Senator GRAVEL. Very good. If it does not disrupt you for me to interrupt like this, because I think that is a very germane point.

Mr. ROGERS. I think it is a quite important point.

Mr. MACK. Well, I think the point that Mr. Rogers is making, Senator, is that the Federal Power Commission to date has said that under the Natural Gas Act they have no jurisdiction over the facilities involved, let us say in the case of coal gassification over the plant itself that would gassify the coal. They have said that once a product from a coal plant becomes mingled with natural gas in the pipeline, then they have jurisdiction. But they do not go back of that point, you see.

Now, the problem that is created as a result is that while they have jurisdiction over your rates, the rates of the pipeline, there is no assurance that the cost that the pipeline has incurred in building that plant and building facilities related to that plant will be recouped in its rates. The pipeline has to go forward, of course, and advance the moneys for building the plant. And as I say, there is no assurance that the Federal Power Commission down the road will allow the pipeline to recoup the money that has been spent, as is the case normally.

Now, in the normal case where we put in facilities—let us say we have put in a facility, pipeline facility, offshore to bring gas to the pipeline system. Then the Federal Power Commission authorizes in a certificate proceding the construction of those facilities, and once they have certificated it, then, of course, it goes without saying that you will get a full recoupment of what you spent, plus a reasonable return on your investment, you see.

Senator GRAVEL. Well, I appreciate that. But why should they then guarantee something like District Gas, or the other gas deals that have been made with respect to Algeria, and permit that to be brought into the rate structure, but not permit a domestic gas production plant be brought into the process?

Mr. MACK. Well, there are the problems with District Gas and these Algerian projects that we are talking about. To date, there have been difficulties from the standpoint of the pipelines recovering those costs, too, you see. There has been no—in some of these situations that have occurred——

Senator GRAVEL. You mean there is no guarantee that the District Gas Co., and the other companies in Boston and elsewhere that are presently negotiating deals which may have on a docket before the Federal Power Commission; there is no guarantee that they are going to be able to get those costs out of a fair return?

Mr. MACK. Well, I am not too familiar with those cases, sir, but my understanding is that there is a problem with respect to these synthetic gas projects; and, indeed, all of the synthetic gas projects from the standpoint of how far the FPC is willing to go in asserting jurisdiction and in recognizing the costs, you see, of the project, in the rates of the people who are building the projects.

Now, we have got, for instance, in my case—I say in my case. My company is building a plant, as are a great many companies, to gasify coal. We are building a plant in North Dakota. We have something like 3½ billion tons of coal there. We are in the early stages of constructing a plant.

Now, each one of these plants is going to cost somewhere in the neighborhood of one-half billion dollars. The plant will produce maybe 250 million cubic feet of gas a day. We will have a great many plants before we are through, hopefully.

The 3½ billion—just to give you a little idea of what is involved here—the 3½ billion cubic feet of gas will eventually give us something like—a pool will give us something like 28 trillion cubic feet of gas.

Now, this, of course, is going to be a tremendous aid to ourselves. Other people have comparable quantities. But in order to go forward on these deals you have got to see recoupment of your rates, indeed, in order to finance these projects, in order to self-see your debt.

Senator GRAVEL. Is your company moving ahead on this without having——

Mr. MACK. We are moving ahead so far; and of course, as we go forward the tab becomes increasingly heavier.

Senator GRAVEL. Now, when is the point when you are going to stop spending money?

Mr. MACK. Well, this is a point; this is a point, Senator. Somewhere down the road you have to take a good look and determine whether you go forward from the standpoint of protection of your stockholder in seeing the money that is being spent recouped in your rates.

Now, FPC feels that under the Natural Gas Act they do not have the jurisdiction, and presumably they are right. What I think Mr. Rogers is suggesting is that the Natural Gas Act be amended to provide jurisdiction over the facilities we are talking about.

Senator GRAVEL. Well, let me just underscore and compliment you on your courage for going forward, realizing the need, in the face of the recalcitrance that is before us. I am just astounded that you would have the courage to put the money on the line when you do not know if you are going to get a return on it.

Mr. MACK. Thank you, sir. And of course, we are very hopeful that we can get this legislation.

Senator GRAVEL. Good luck. I will help you as much as I can, but I think the American people should realize that, that you are willing to make that kind of a risk.

Please continue.

Mr. ROGERS. Senator, in my prime statement there are some citations that I am sure the staff would be interested in on this particular problem; and I think it would be most helpful. But it is a very difficult problem.

Senator GRAVEL. Could I ask Mr. Mack if it is not an invasion of the sanctity of your own corporation in competitive advantage, would you furnish for the committee if you can a detailed breakdown as to what you have done thus far in the South Dakota plant, how much

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money you have spent, and what you think the economics would be? You obviously have some in-house projections and all that.

And if you feel you can do that without unfair disadvantage to yourselves, I think it would be valuable for us to have it so we can get a full taste of the dimension of the risk you are undertaking.

Mr. MACK. We will be very happy to do that, Senator.

[The following was subsequently supplied for the record:]

AMERICAN NATURAL GAS COMPANY,
New York, N.Y., February 1, 1974.

Hon. MIKE GRAVEL,
Chairman, Senate Finance Energy Subcommittee,
Dirksen Senate Office Building, Washington, D.C.

DEAR MR. CHAIRMAN: On January 25, 1974 when Mr. Rogers and I testified in a hearing before you on the Energy Revenue and Development Act (S. 2806), you requested that I submit for the record a memorandum regarding the problems in coal gasification projects confronting the gas industry, with particular reference to those created by the absence of Federal Power Commission jurisdiction under the Natural Gas Act over synthetic gas plants and related facilities. This memorandum is enclosed herewith.

In addition, you requested that I supply for the record a statement as to the economics of the gasification project of Michigan Wisconsin Pipe Line Company, our transmission subsidiary, including the estimated costs of the gasification plant, related facilities and pipeline, and the estimated delivery costs to the ultimate consumer. This tabulation is also enclosed herewith and I respectfully request that this letter and the enclosed two documents be made a part of the record on S. 2806.

Respectfully yours,

WILBER H. MACK.

MEMORANDUM REGARDING DEVELOPMENT OF COAL GASIFICATION PROJECTS BY THE U.S. GAS INDUSTRY

PRELIMINARY STATEMENT

In virtually every projection by Federal Government departments and agencies of methods by which the nation's energy requirements can be met in the 1980's, the utilization of coal plays a prominent role. The production of gas and syncrude from coal is taken for granted as providing significant quantities of energy beginning in about 1980. In announcing "Project Independence" which is aimed at gaining energy resource independence from foreign countries by 1980, President Nixon referred specifically to full utilization of the nation's coal and natural gas potential as essential to achieving that goal.

The fact is, however, that the Federal government is not yet addressing itself to the difficult practical problems that confront the companies which are attempting to plan coal gasification projects and, in some respects, is actually obstructing or impeding those projects. What is required is an aggressive, coordinated Government effort to *assist* energy companies in expediting these very expensive, innovative projects and to help overcome some of the obstacles. This memorandum will indicate some of the areas where the Federal Government could provide material assistance in the development of coal gasification projects and some of the difficulties that must be overcome.

A. The Present Status of Coal Gasification—Projects and Government Participation

Many of the major natural gas pipeline systems in the United States have acquired sizeable coal reserves and are actively attempting to develop coal gasification projects. While only two such projects (those of El Paso Natural Gas Company and Transwestern Pipeline in the Four Corners area of New Mexico) are before the Federal Power Commission, a number of other projects have been announced, and still others are in the process of formulation.[1]

It should be noted that, without exception, the projects so far announced all propose to utilize the Lurgi pressure gasification process developed by Lurgi Mineraloltechnik GMBH of Frankfurt, Germany. While a number of other processes are presently in the experimental stage,[2] the Lurgi process is the only

[1] See Appendix A attached.
[2] See Appendix B attached.

commercially proven process presently available for large-scale gas production. Since none of the experimental processes is likely to reach the stage of commercial production prior to the early 1980's, wide-scale adoption of one or more of these processes cannot be expected until the mid-1980's or thereafter.

It should be recognized, therefore, that the Federal Government's efforts in the coal gasification field, which are devoted largely to funding the experimental processes, can have little effect on the development of coal gasification projects for a number of years to come. Furthermore, while proponents of the experimental processes claim advantages of up to 15 percent in efficiency over the Lurgi process, it is obvious that this claimed advantage, even if it eventuates, will be more than outweighed by escalations in costs by the time the processes are perfected as compared with Lurgi-type plants constructed during the intervening period.

Thus, while most gas companies support the R & D expenditures of the Federal Government and the American Gas Association in attempting to develop new coal gasification processes, a number of companies believe that evolutionary improvements in the Lurgi process as new plants are designed and constructed are likely to be more productive than entirely new processes that have yet to be perfected.

While there has been much talk of a "Manhattan Project" approach for the development of new coal gasification processes—and we are not opposed to the allocation of substantial additional funds for research and development of such processes—we are concerned that the emphasis placed on this activity will obscure the need for a major effort by the Federal Government and the gas and coal industries to meet the very real problems associated with the current development of coal gasification projects using presently available technology. We are also concerned as to whether the requisite experitse can be assembled and the required allocation of resources can be made for a Manhattan Project approach without interfering seriously with ongoing projects to design and construct Lurgi-type plants.

The point of this discussion is that the Federal Government's efforts and funds are being directed almost entirely toward the development of processes that are of no use to the gas industry at the present time and cannot have any material impact on the production of gas from coal until the late 1980's. Meanwhile, the gas industry is running into a great many problems in planning current projects (i.e., those projected to come on-stream between 1978 and 1985) where Federal Government support and assistance would be effective and significant.

B. Problem Areas Where Affirmative Federal Government Participation Would be of Material Assistance

We will indicate below a number of problem areas where affirmative Federal Government participation would be of material assistance to gas companies attempting to develop coal gasification projects. Before dealing with specifics, however, we should emphasize that if *any* coal gasification projects are to be constructed, the states where the projects would be located must be convinced that such projects are required by the national public interest. A significant number of people in each of these states are firmly opposed to coal gasification projects, and their views of course have a significant impact on state and local government agencies which must issue permits and licenses of various kinds.

It is essential, in our view, that the Federal Government take the lead in convincing the states that utilization of their coal reserves for production of synthetic gas and oil is absolutely necessary if the nation is to achieve the independence from foreign energy sources that has been declared to be national policy. It is difficult for the gas company sponsors of coal gasification projects to get the message across because of suspicions of self-interest and the fact that, in most cases, most of the energy is to be transported to other states for use and consumption.

With this general preliminary, the following are problem areas where Federal Government help is necessary:

1. *Obtaining mineral rights in Federal lands and leases.*—It is obvious that the coal deposit areas of the western states are blanketed with Federal lands and mineral leases. The so-called "Mansfield Amendment" to S. 425 (Sec. 612(b)), which would withdraw all coal deposits, title to which is in the United States, from all forms of surface mining if the United States is not also the surface owner, would make coal gasification impossible throughout virtually all of the western states. There is no practical or economic way by which most of the western lignite and sub-bituminous coal can be mined except by surface mining, and the environmental consequences of underground mining would in many cases be far more undesirable than the environmental effects of surface mining. Since the Federal Government owns the mineral rights to vast areas of land throughout the mining

areas, the Mansfield Amendment would effectively preclude the utilization of coal for any energy use.

2. *Obtaining rights to water.*—All processes by which coal and oil shale are converted into useable forms of energy require relatively large quantities of water. One of the major contributions the Federal Government could make toward advancing coal gasification projects would be to assist sponsors of the projects to obtain commitments of water.

While the division of authority over the allocation of water from rivers as between the states and the Federal Government is not entirely clear, it appears that the states have primary authority to allocate water from rivers flowing within their boundaries. However, both the Corps of Engineers of the Department of the Army and the Bureau of Reclamation of the Department of the Interior have some authority over the withdrawal and utilization of water from navigable streams and bodies of water stored behind dams constructed for flood control and irrigation purposes.

To date the Corps of Engineers and the Bureau of Recalamation have not been able to arrive at any common approach to water use proposals, and the question of the respective rights of the states and the Federal Government has not yet been resolved.

It is therefore essential that the Federal Government coordinate its actions with respect to the allocation of water for energy projects. And if the Government really wants the projects built, it must exercise some leadership in ensuring that water rights are granted rather than deferred and delayed, as is presently the case.

3. *Obtaining Federal assistance in the funding of coal gasification projects.*—As was indicated earlier, the modest amounts of money presently being provided by the Federal Government for coal gasification R & D is being spent on new processes that cannot contribute materially toward meeting the energy shortage until the mid-1980's or later. Nor do we believe that massive amounts of R & D funds for a "Manhattan Project" type approach would be a wise investment. There are areas, however, in which the Federal Government could provide material assistance for coal gasification projects and would be fully justified in doing so.

It should be emphasized in this connection that, while the Lurgi process has been proven commercially, there are a number of "unknowns" with respect to the operation of the plant, its efficiency, down-time, etc. Moreover, because the technology is constantly changing, each plant will be different in some respects from its predecessors. All of these factors of course increase the risks of the project.

In addition, the capital costs of a single Lurgi coal gasification plant capable of producing 250,000 Mcf per day amount to approximately $500 million in 1973 dollars—a huge investment for any of the pipeline companies planning to construct such projects. Thus, the sheer size of the investment and the attendant risks make some one or more forms of Government assistance a practical necessity.

Such Government assistance might be manifested in one or more of the following forms:

(a) An investment tax credit in addition to the 7% job development tax credit.

(b) Federal Government guarantee of securities issued to finance coal gasification plants similar to that provided for domestic ship construction (or permit local or state government units to issue tax free revenue bonds to finance such projects, as is now the case with securities issued to finance pollution control equipment).

(c) The adoption of tax depreciation policies that would reduce tax payments in the early years of operation.

The reduced cost of financing these projects would reduce the cost of gas to consumers and would not redound to the financial benefit of the owning company.

4. *Obtaining Federal assistance in other critical areas.*—There are a number of areas other than those relating directly to the financing of coal gasification projects where Federal assistance would be most helpful and warranted. The following are some examples:

(a) A Lurgi-type coal gasifier is needed to test samples of coal from various areas before desinging commercial-size gasification plants. At present such samples must be sent to either Westfield, Scotland, or Sasolburg, South Africa. Such a plant would be a practical and immediately useful R & D facility if funded by the Federal Government.

(b) Each coal gasification plant will employ about 1,000 persons. All must be trained, and there are no present training facilities or operating facilities where such employees can be trained. The Federal Government could provide a vital service by establishing or funding an employee training program for coal gasification plant employees.

(c) Most of the coal gasification plants will be constructed in areas of sparse population. The influx of approximately 1,000 employees and their families into these areas will obviously have an important impact, including an increase in the need for schools, roads, police, hospitals and other government services and facilities. The need to provide these facilities will arise at or before the time construction begins and long before the plant is completed and goes onto the tax rolls. The Federal Government could assist by helping to finance and plan these local facilities prior to the time the plant is completed and added to the property tax rolls.

(d) We are seriously concerned about the availability of trained manpower and materials for construction of the projects presently planned (in addition to oil refineries, chemical plants, etc.). We urgently suggest, therefore, that the Federal Government undertake an immediate assessment of the number and skills of (1) engineers, draftsmen, etc., and (2) construction workers required for the various energy projects now in the planning stage, together with an assessment of the availability of materials, fabrication equipment, etc. for such projects. If, as we anticipate, such a survey will disclose significant shortages of both trained manpower and material, prompt measures must be taken to overcome the shortages. In the case of manpower shortages, subsidized training programs, scholarships for engineering students, etc. may be necessary. In the case of material, allocations of steel and fabrication facilities may be necessary.

(e) One of the critical problems so far as reclamation of land is concerned after surface mining has been completed is the restoration of productivity to pre-existing levels. The Federal Government could assist materially in meeting the environmental problems by research and experiments designed to establish the best procedures for restoring productivity to reclaimed land once the overburden had been restored and the land had been graded to its original contour. Some work of this kind is going on, but a much more intensified program is required in order to meet environmental concerns being raised by farm and ranch interests in the western states.

C. The Natural Gas Act Must be Broadened to Cover Synthetic Gas Projects

In *Algonquin Gas Transmission Company*, Opinion No. 637, issued December 7, 1972 at Docket No. CP72-35, *et al.*, the Federal Power Commission held that the Natural Gas Act does not confer jurisdiction on the Commission over the manufacture of synthetic gas or its transportation prior to the time it is commingled with natural gas. In *El Paso Natural Gas Company* and *Transwestern Pipeline Company*, this rationale was applied specifically to gas manufactured from coal. While appeals have been taken from these holdings, it must be recognized that the Commission may be sustained ultimately and, in any event, the position of the Commission has had an immediate adverse impact on the gas pipeline industry. For the reasons discussed below, prompt steps should be taken to amend the Natural Gas Act to extend Commission jurisdiction to the manufacture and transportation of synthetic gas.

1. *FPC rate treatment of gas from synthetic gas projects imposes unwarranted risks on sponsors of the projects.*—Lack of Federal Power Commission jurisdiction subjects pipelines to the unwarranted additional risk that they will not be able to recover costs prudently incurred in an effort to maintain adequate service. Regulation cannot insulate pipelines from many of the financial risks attendant upon these enormously expensive gas supply projects, but it should not aggravate them. A case involving *Algonquin Gas Transmission Company*, an interstate gas pipeline company, presents a classic case in point as to what can happen to a pipeline embarking on an SNG project.

At Docket No. CP72-35, *et al.*, a subsidiary of Algonquin formed to construct and operate a synthetic gas plant requested certificate authorization under the Natural Gas Act to construct and operate a SNG manufacturing plant, pipelines and related facilities to transport the gas to Algonquin's line, and to sell the gas to Algonquin. Algonquin requested authorization to buy, transport and sell the synthetic gas. In dismissing the application of Algonquin's SNG subsidiary for want of jurisdiction under the Natural Gas Act, the Commission said:

"As a necessary consequence of our jurisdictional holdings, it is beyond our reach to explore the economic feasibility of the Algonquin SNG project. We do not reach those areas of Staff concern with the soundness of the basic engineering process, the rate at which SNG will be sold,[3] or whether the construction and operation of the synthetic gas plant, the service to be provided therefrom, and the proposed cost of service rate for such service is in the public interest.

In short, while disclaiming jurisdiction over the synthetic gas project itself, the Commission reserved full rights to consider the reasonableness of the rates at which the synthetic gas was introduced into the natural gas pipeline system, noting particularly that "a transaction between affiliates is involved."

In considering the latter question, the Commission conditioned its certificate approving Algonquin's transportation and sale of the synthetic gas on Algonquin's selling the SNG at an initial maximum rate of $1.80 per Mcf, which was the cost of such service based upon the estimated cost of construction of the synthetic gas plant and of the plant feedstock. Subsequent to the time of the proceedings before the Federal Power Commission, however, the cost of construction of the plant and the cost of liquid hydrocarbon feedstocks had both increased very materially, with the result that when the plant was completed the cost of synthetic gas was approximately $2.50. Algonquin therefore filed for permission to charge the higher rate and also proposed a revision which would have permitted automatic adjustment of the rate based upon changes in the cost of feedstock.

Without discussion the Federal Power Commission suspended the rate filing for the full statutory period of six months. This meant that minimum, Algonquin would be forced to absorb the difference between $2.50 and $1.80 for each Mcf of synthetic gas produced and sold during that period. The Commission rejected Algonquin's request that the higher rate be suspended for only one day, which would have permitted the company to place that rate in effect after one day subject to refund of any charges found not to be just and reasonable. Upon request for rehearing by Algonquin, supported by the entire pipeline industry, the Commission reversed its position and permitted the one day suspension but reiterated its previous statements concerning the burden on the company to justify the higher rates, notwithstanding the fact that they reflected actually experienced costs, because the synthetic gas facilities were nonjurisdictional.

It is quite true that Algonquin would not have been fully protected even if the Commission had asserted jurisdiction over the SNG facility. However, if the Commission had done so and had approved construction of the facilities and the cost of service contract between Algonquin and its SNG subsidiary, the Commission would certainly have to assume some responsibility for the cost of SNG to Algonquin. Indeed, unless it could have been shown that construction of the SNG facilities was not carried out in accordance with the certificate of public convenience and necessity or was improperly and imprudently managed, the Commission would have no basis upon which to deny Algonquin's right to include the full cost of service of producing the SNG in its rates.

2. *Financing of synthetic gas projects will be much more difficult absent FPC jurisdiction.*—Closely associated with the matter of rate protection is the problem of financing very costly SNG projects. Regulation can never guarantee that a pipeline will be able to recoup its full cost of service through its rates. However, where one source of a pipeline's gas supply is not subject to regulation, a new element of uncertainty is injected, and particularly is this true when the unregulated supply source is an affiliate of the pipeline.

In the case of jurisdictional facilities, the Federal Power Commission must make a determination that construction and operation of the facilities is required by the public convenience and necessity before issuing a certificate authorizing construction. This involves the Commission's review of engineering design, cost estimates, economic feasibility, financeability and other factors. Since the Commission is an expert body, and the proposal is carefully reviewed by its technical staff, financing institutions are accustomed to rely upon a certificate of public convenience and necessity as establishing, at least *prima facie*, the technical and economic feasibility of the project.

As noted above, the Commission has taken the position in the *Algonquin* case that "it is beyond our reach to explore the economic feasibility of the Algonquin SNG project" and has refused to consider "the soundness of the basic engineering process, the rate at which the SNG will be sold, or whether the construction and operation of the synthetic gas plant, the service to be provided therefrom, and the

[3] Although the sale by Algonquin SNG is nonjurisdictional it will still be incumbent upon us to adjudge the reasonableness and necessity of Algonquin Gas's purchase of SNG as a component of the jurisdictional commodity, i.e., the mixture of natural and artificial gas, and the rate treatment to be accorded such purchases. This examination will occur in any Algonquin Gas rate case in which SNG purchases are offered as a constituent element of Algonquin Gas's cost of purchased gas. We note also that a transaction between affiliates is involved.

proposed cost of service rate for such service is in the public interest." Thus, the Commission has refused to consider any of the questions or make any of the findings upon which financial institutions place reliance in purchasing securities for the financing of gas pipeline projects. The absence of such finding would unquestionably add significantly to the already difficult problem of raising the massive amounts of capital required by supplemental supply projects.

In addition, doubts and uncertainties as to the rate treatment of synthetic gas delivered into jurisdictional pipeline facilities, as exemplified by the *Algonquin* case, would further exacerbate the problems of financing synthetic gas facilities. While it might be contended that the jurisdictional pipeline is not precluded from paying its affiliated synthetic gas producing company the full cost of the gas, the strong possibility that the Federal Power Commission might not permit the jurisdictional entity to recover such costs in its own rates would both (2) substantially increase the risks to investors in the natural gas pipeline facilities, and (b) create doubts as to the jurisdictional pipeline's ability to meet its contractual obligations to its affiliated sythetic gas producing company.

These considerations have led a major financial institution in the natural gas pipeline field, to conclude in the attached memorandum: [3]

"For a company whose primary business is in the regulated sector of the natural gas industry the exercise of jurisdiction by the FPC should have an important favorable effect on its ability to attract investors in senior debt securities issued to finance the cost of the facilities. This consideration could be critical in view of the reliance the natural gas industry has placed on senior debt investors in the past, and the high cost of equity capital for the industry today."

3. *FPC jurisdiction is necessary to provide eminent domain power for synthetic gas and related pipeline facilities.*—The Commission squarely held in *Algonquin* (gas produced from naphtha) and in *El Paso* and *Transwestern* (gas produced from coal) that the Natural Gas Act did not confer jurisdiction on it with respect to the construction and operation of the pipeline required to transport SNG from the SNG plant to the pipeline company's jurisdictional pipeline system. It held that its jurisdiction did not attach until the SNG was commingled in the pipeline with natural gas. The power to condemn for right-of-way is available under Section 7(h) of the Natural Gas Act only to the "holder of a certificate of public convenience and necessity." In view of the Commission's interpretation of the scope of its jurisdiction, it follows that, unless the Commission is reversed or the Natural Gas Act is appropriately amended, there is no power to condemn right-of-way for a pipeline transporting SNG unmixed with natural gas.

Presumably there is considerable flexibility in the siting of a plant for the conversion of liquid hydrocarbon feedstocks into SNG. Such a plant often could be located in sufficiently close proximity to jurisdictional facilities without materially adverse economic consequences so that the acquisition of right-of-way by purchase may not be critical. However, this is not true in locating a coal gasification plant. Economics dictate that such a plant must be located in close proximity to both coal and water which may be many miles distant from a jurisdictional facility. Without the power to condemn, right-of-way acquisition would become more difficult and time-consuming, and certainly much more expensive. These projects are expensive without this additional cost which can be avoided through an amendment of the Natural Gas Act.

4. *Absence of FPC jurisdiction presents problems of overlapping federal and state regulation of synthetic gas.*—Absent Federal Power Commission jurisdiction over SNG facilities, it can be argued with considerable force that such facilities are subject to state regulatory jurisdiction, at least to the extent that the SNG is sold within the state where the plant is located and depending on the breadth of the state statute. At least one state has given some indication that it may take this position, including the right to require that a portion of the output of the plant must be allocated for local consumption. If this position is found to be valid, the pipeline company in effect would be subject to dual regulation—once by the state before the gas is commingled with natural gas and thereafter by the Federal Power Commission. The disadvantages to the public of overlapping and potentially conflicting regulation are obvious.

CONCLUSION

The gas industry is ready and willing to proceed promptly with plans for major supplemental supply projects, including gasification of coal. However, significant problems must be overcome before these projects can be constructed, and the cooperation and assistance of the Federal government is urgently required.

[3] See Appendix C attached.

APPENDIX A

SUMMARY OF HIGH-Btu COAL GASIFICATION PROCESSES AND PROJECTS

COMMERCIAL PROCESSES AND VENTURES

Name of process	Owner(s) or contractor and site	Plant output (million cubic feet per day)	Status and funding
Lurgi Pressure Gasification (Lurgi Gesellschaft fur Warme and Chemotechnik m.b.H.).	El Paso Natural Gas Co. (Four Corners area, New Mexico).	250	El Paso plans to construct and operate the Burnham coal gasification complex Indian on the Navajo Reservation. In the initial announcement, capital costs were estimated at $353,200,000 for the gasification plant and $65,300,000 for the associated mine. Initial gas production was scheduled for June 1976, and the estimated 1977 cost of gas at the plant outlet was $1.20 per 1,000 SCF.
Lurgi pressure gasification	Transwestern Coal Gasification Co., Pacific Coal Gasification Co., and Western Gasification Co. (Four Corners area, New Mexico).	250	The firms plan to construct and operate a $405,900,000 coal gasification plant on the Navajo Indian Reservation near Farmington, N. Mex. Utah International will supply the coal and water. Plant operation is scheduled for 1976.
Do	Panhandle Eastern Pipe Line Co. and Peabody Coal Co. (eastern Wyoming).	250	Plant operation anticipated in the 1978–80 period, assuming timely receipt of all required governmental authorizations. Plant investment will be about $400,000,000.
Do	Michigan Wisconsin Pipe Line Co. (central North Dakota).	250	Michigan Wisconsin has acquired options to 3,500,000,000 tons of North Dakota lignite and has entered into agreements with Lurgi and with Lummus Corporation for preliminary design of a 250,000,000 cubic feet per day plant.
Do	Northern Natural Gas Co. and Cities Service Gas Co. (Powder River Basin, Mont.).	250	Northern Natural and Cities Service are considering construction of four 250,000,000 cubic feet per day coal gasification plants. Peabody Coal has agreed to supply about 500,000,000 tons of coal, and the gas companies are negotiating for another like amount. $10,000,000 will be spent for preliminary development through 1975. Construction of the 1st plant could start in 1976, with operation in 1979.
Do	Natural Gas Pipeline Co. of America (Dunn County, N. Dak..	250	Rights to 2,000,000,000 tons of lignite have been obtained from Star Drilling Inc. The lignite will be reserved for possible future use in a coal gasification project.
	Colorado Interstate Gas Co. and Westmoreland Resources (southeast Montana).		Colorado Interstate has an option on 300,000,000 tons of coal and 10,000 acre-feet per year of water to be supplied by Westmoreland for development of a coal gasification project.
	Columbia Gas System, Inc		Core drilling program in West Virginia to identify possible sites for coal gasification facilities. 233,000,000 tons of recoverable coal reserves have been proved on part of land to which the company has coal rights.
	Texas Gas Transmission Corp. and Consolidation Coal Co.		Texas Gas Transmission Corp. has acquired ½ interest in a large block of Illinois Basin coal reserves controlled by Consolidation Coal Co. The largest parcel will be held for 10 years for possible use in a coal gasification project.
	Eastern Gas & Fuel Associates and Texas Eastern Transmission Corp.		The companies have acquired coal mining and prospecting rights to about 40,000 acres of Federal and State leases in northwestern New Mexico. If the reserves are developed, Eastern Gas would conduct the mining and Texas Eastern would build and operate the gasification plant.
Do	Transcontinental Gas Pipe Line Corp. (Powder River Basin, northeast Wyoming).	250	Transco has acquired joint rights from Tipperary Corp. and Stoltz, Wagner & Brown to evaluate coal under more than 20,000 acres in Wyoming for a coal gasification project.
	Consolidated Natural Gas Co. (southwest Pennsylvania)		Consolidated has a 70-percent interest in southwestern Pennsylvania acreage containing over 300,000,000 tons of coal and is negotiating for more reserves. The company expects to make a commitment on its 1st gasification plant in 18 to 24 months.

APPENDIX B

SUMMARY OF HIGH-BRITISH THERMAL UNIT COAL GASIFICATION PROCESSES AND PROJECTS

PRINCIPAL RESEARCH AND DEVELOPMENT PROJECTS

Name of process	Owner(s) or contractor and site	Plant output (million cubic feet per day)	Status and funding
COGAS	COGAS Development Co. (FMC Corp., Panhandle Eastern Pipe Line Co., Tenneco Inc., Consolidated Natural Gas Service Co., Republic Steel Corp., Rocky Mountain Energy Co.) (Princeton, N.J.).		The 1st stage of the COGAS Process is based on results from the COED pilot plant in Princeton, N.J., which was designed to produce oil, char, and a relatively small amount of gas. The COED pilot plant was funded by OCR and completed in 1970 at a cost of $4,500,000. COGAS Development Co. will invest $7,000,000 in the COGAS pilot plant over an 18- to 24-mo. period. The pilot plant has been in operation for over a year.
HYGAS	Institute of Gas Technology (Chicago, Ill.)	1.5	Pilot plant in operation. Preliminary demonstration, plant design complete. Original cost of pilot plant was approximately $9,500,000.
CO_2 acceptor	Consolidation Coal Co. (Pilot plant constructed and operated by Stearns-Roger Corp.) (Rabid City, S. Dak.).	[1]	Pilot plant in operation. A methanation stage is not incorporated, but may be added at a later date. The original pilot plant cost was about $9,300,000.
BI-GAS	Bituminous Coal Research, Inc. (Homer City, Pa.)	2.3	Construction contract has been awarded to Stearns-Roger Corp. Plant cost will be about $18,000,000, and construction will take 18- to 24-mo. Initial startup is scheduled for late 1974.
Kellogg molten salt process	M. W. Kellogg Co		OCR funded a bench-scale program from 1964 to 1967. Total expenditures were $1,700,000. Major difficulties were experienced with materials of construction. OCR ceased sponsorship because of this problem, budgetary restrictions, and assignment of higher priorities to other coal gasification processes. M. W. Kellogg has carried out additional development work since 1967, but support has not yet been obtained for construction of a large-scale pilot plant.
SYNTHANE	U.S. Bureau of Mines (Bruceton, Pa.)	1.4	Construction contract has been awarded to Rust Engineering Co. Estimated cost is $10,000,000. Operation is expected by mid-1974.
Hydrane	U.S. Bureau of Mines (Pittsburgh, Pa.)		A 10-lb per hour integrated pilot plant is in operation. Scale-up to a 24-ton per day pilot plant is planned
	Exxon Corp. (Baytown, Tex.)		Exxon has spent $20,000,000 on coal gasification and liquefaction since 1966 and is committing $10,000,000 for additional R. & D. 1st phase of gasification experiments to be finished in 1974. If justified, next phase will be construction of $75,000,000 to $80,000,000 pilot plant charging 500 tons per day of coal.
	Battelle Columbus Laboratories (West Jefferson, Ohio)	[2] .8	Battelle has been granted a 30-mo, $4,100,000 contract under the joint OCR/AGA program.

[1] Up to 2 (no heating value specified).
[2] Synthesis gas.

APPENDIX C

Memorandum re the effect of Federal Power Commission jurisdiction on the financing of coal gasification plants and attendant facilities

AMERICAN NATURAL GAS COMPANY

INTRODUCTION

In discussing coal gasification plants and attendant facilities, we are referring to facilities required to manufacture the gas and transport it in unmixed form. The question for discussion is if the Federal Power Commission ("FPC") should take jurisdiction of these facilities, would this decision make it easier to finance their cost given the magnitudes currently comtemplated (approximately $400 million).

CONCLUSION

For a company whose primary business is in the regulated sector of the natural gas transmission industry and which is not in a position to commit significant amounts of equity capital, the exercise of jurisdiction by the FPC should have an important favorable effect on its ability to attract investors in senior debt securities issued to finance the cost of coal gasification facilities. This opinion is based on the historical economic environment FPC jurisdiction has helped to create in which natural gas transmission companies have always been allowed to charge rates sufficient to cover all operating costs and to provide for the repayment of all debt securities and a reasonable return on capital. This type of environment has minimized risks to debt investors. The amount of senior debt capital investors will commit to coal gasification facilities and the leverage they will accept will depend on the degree to which they anticipate that the historical economic environment will continue to exist in the future.

Background of FPC Jurisdiction

In the past the economics of the natural gas transmission industry have been very favorable. In addition, the FPC, by the exercise of jurisdiction and certification of pipeline construction, has assumed a degree of responsibility for the economic viability of facilities and always allowed rates sufficient to cover costs and provide a return on capital. This factor, in combination with the economic circumstances present in the past, has minimized the risk that increases in the cost of facilities or the cost of purchased gas would adversely affect the ability of a natural gas company to service its debt or provide a fair return to its stockholders.

As a result financing was able to be undertaken on a basis of highly leveraged capitalization ratios and substantially reduced overall capital costs.

Furthermore, by increasing the proportion of debt in the capital structure the industry was able to reduce its reliance on the equity market, a much smaller and more volatile market than the debt market.

Applicability of FPC Jurisdiction to Coal Gasification Plants and Attendant Facilities

The economics of coal gasification have not been tested and it should be recognized that the basic economic characteristics of this new technology are not affected through the exercise of jurisdiction by the FPC. Such characteristics include:

(*a*) The technological risk that the process will not perform according to specifications;

(*b*) The difficulty in predicting the final cost of the facilities;

(*c*) The timely availability of an adequate supply of raw material;

(*d*) The marketability of the high cost gas produced by the facilities particularly if the FPC does not permit its cost to be rolled in with the cost of gas from other sources.

If the FPC should take jurisdiction of coal gasification plants and attendant facilities as a result of court action or amendments to the Natural Gas Act, it would, in approving the application for construction of the facilities, certify that such facilities were to be constructed for the public convenience and necessity.[1]

[1] In exercising jurisdiction, it is assumed that such jurisdiction would not extend to the coal reserves or mining activities. However, it would not be illogical to assume that the FPC would approve or disapprove the price at which the coal was to be bought.

Thus, the FPC would assume some responsibility for the economic viability of the facilities and in accordance with past practice be obligated to allow rates for the output sufficient to meet all costs and provide a return on capital. In this respect the risk associated with the coal facilities should be reduced and the ability of a natural gas transmission company to raise senior debt to finance the facilities should improve, particularly a natural gas transmission company which was not able to support substantial additional senior debt on the basis of its own equity base. It should be recognized, however, that the size of the commitment by debt investors and the amount of leverage they will accept will depend on the applicability and the implementation of past FPC rate making practice in view of the uncertainties currently surrounding the economics of coal gasification

For example, through the recent adoption of incremental pricing the FPC has in effect fragmented the market. It has created a market risk by isolating the high cost gas which then becomes a vulnerable target for cheaper alternative sources. Thus, revenues based on incremental pricing could be expected to have far less predictability than revenues based on "rolled-in" pricing, and provide a less attractive basis on which to raise senior debt capital. However, even if the FPC through its rate-making policy undertook to provide a reasonable rate of return on facilities which proved to be uneconomic, it is questionable as to how much protection they could provide if cheaper alternative fuels were available.

Therefore, it is not reasonable to assume that the FPC, by exercising jurisdiction, will assume ultimate responsibility for coal gasification facilities which become uneconomic for competitive reasons. To the extent the risks cannot be minimized, the result will probably be that the initial facilities will have to be financed with lower debt to equity ratios and substantially higher overall returns on capital than normally have been associated with natural gas pipeline operations. Natural gas companies have not been allowed to earn returns on equity in the past sufficient to build a base to absorb the risks currently associated with the new technology of coal gasification facilities. Therefore, higher returns, not only to build a base but to attract new equity capital, will be required.

Projected investment cost and annual cost of service of coal gasification project

Coal gasification plant:	
Process units (gas production)	$175, 000, 000
Utility plants (power, oxygen, etc.)	125, 000, 000
Ash and water systems	20, 000, 000
General facilities	35, 000, 000
Initial catalyst and chemicals	5, 000, 000
Total direct cost of plant	396, 000, 000
Contingency (10 percent)	36, 000, 000
Allowance for funds during construction	70, 000, 000
General overheads	12, 000, 000
Other	4, 000, 000
Total property, plant and equipment	482, 000, 000
Working capital	12, 000, 000
Total gross investment	494, 000, 000
Coal mine plant (first 5 years of operation):	
Direct costs and contingencies	60, 000, 000
Retirements and replacements	4, 000, 000
Total costs	64, 000, 000
Total gasification and mine plant investment	558, 000, 000

Projected investment cost and annual cost of service of coal gasification project—Con.

Estimated costs:	
Operation and maintenance expenses	$100,000,000
Depreciation and amortization expenses	20,000,000
Return on common equity	19,000,000
Income taxes	19,000,000
Byproduct revenues	(16,000,000)
Total estimated costs	142,000,000
Synthetic gas delivered (annually, Mcf)	96,000,000
Cost per 1000 cubic feet (Mcf)	1.48

NOTE.—These figures are necessarily tentative estimates. If is is assumed that the plant is constructed over the period 1976–1979, an annual escalation factor in the neighborhood of 5% must be applied to the direct capital costs referred to, which are stated at 1973 levels. In addition, a cost of transportation through a gas pipeline from the coal gasification plant to the market area must be included. In total, therefore, the delivered cost of gas manufactured from coal in 1980 will probably be in the range of $1.75 to $2.00 per Mcf delivered at the city gate in the major market areas.

Senator GRAVEL. Very good. Thank you.

Please continue.

Mr. ROGERS. Thank you.

Now, the sixth point, Senator, is the question of deregulation of wellhead sales of natural gas, section 502 in your bill. We feel that section 502 of the bill is definitely a step in the right direction but should have some amendments.

We recommend that Congress enact legislation providing for the establishment of an index, formula or procedure designed to establish the commodity value of gas in relation to the prevailing price of other fuels, and that gas be allowed to be sold at that level.

It is essential that any legislation changing the present method of regulating wellhead sales of natural gas contain four additional provisions.

First, that the modification apply only to contracts with a minimum term of 15 years or the life of the dedicated reserves, whichever is the lesser. Otherwise, the pipeline industry would not be able to finance or construct the expensive facilities required in the pipeline business.

Second, the legislation should place interstate buyers on a parity with intrastate buyers so that they may compete on equal terms for the purchase of domestic gas supplies. Otherwise, intrastate purchasers would capture the bulk of new gas from non-Federal supply areas.

Third, the provisions of all gas purchase contracts should be sanctified once those contracts have been finally approved by the Commission.

Fourth, it is essential that pipelines be allowed to reflect in their rates the cost of both new and flowing gas as presently provided in section 502(e) of S. 2806.

No. 7, the energy trust fund, tax on energy sources and administration. The creation of a trust fund is generally accepted as an appropriate and reasonable way of developing a national energy program involving energy research, demonstration, development, utilization, and conservation to meet the present and future needs of the United States.

There should be adequate assurance that all funds collected through the imposition of tax be used for the purposes indicated and not otherwise, and that the trust fund be administered by the Federal Energy Administration within general guidelines.

Should Congress retain the power to appropriate funds, we would urge that direct authority for the funding of specific projects be lodged in the Federal Energy Administration and that funding of the same over a period of years be permitted. Annual funding of long-range projects would not be practical.

We do not see the need for a separate Commission on Energy Technology Assessment and would respectfully suggest that the functions contemplated by title IV would be better carried out under the direction of the Federal Energy Administration itself.

And I listened with interest to your discussion with Dr. Ray on this subject.

Senator GRAVEL. You can appreciate what I was trying to do then—I do not view it as a duplicative activity, but look at it as a disciplinary activity. And that was one of the great geniuses of our Founding Fathers that they pitted one against the other. It makes for inefficiency, but then again, that is democracy, and it is not inefficient in the long run.

I can appreciate your position also.

Mr. ROGERS. I think your point is well taken. What we are looking forward to here, Senator, more or less is a matter of expedition. And of course, we feel that perhaps the wording of the law could be worked out to where this Commission within the Federal Energy Administration could sort of be the overseers and the disciplinary force.

Senator GRAVEL. Of course, the record has been that when that happens, they usually get co-opted. Let me just rely on a cliche, and that is that there is only one way to get to a goal, and that is the right way, whatever that may be. And that is a subjective thing from your point of view, my point of view, and any other human being's point of view.

Mr. ROGERS. No. 8, excise tax on uninvested profits from energy sources. INGAA members are presently reviewing in detail the provisions of this section and would request permission to submit additional comments if appropriate.

We note that under section 601(a)——

Senator GRAVEL. Please, Mr. Rogers, would you submit additional material on that? Let me make a request at the same time. If you would submit a regional breakdown of the curtailments that took place last year, those you project this year and may project next year, however far you were going into it on a regional basis.

Mr. ROGERS. We will.

Senator GRAVEL. Good.

[Mr. Rogers subsequently supplied the following information:]

EXHIBIT C (PT. 1)

FEDERAL POWER COMMISSION,
Washington, D.C., September 17, 1973.

NEWS RELEASE NO. 19640

FPC RELEASES REVISED STAFF REPORT ON INTERSTATE NATURAL GAS PIPELINE CURTAILMENTS

The Federal Power Commission today released a revised staff report which indicates that interstate natural gas pipeline companies are continuing to experience difficulties in meeting their customers' firm requirements. The report updates an earlier staff report issued July 16, 1973.

The report, by the FPC's Bureau of Natural Gas, states that 12 companies reported actual curtailments during the period April–July of this year which total more than 515.4 billion cubic feet, a 77 percent increase over last year. During April–July 1972, 9 companies reported firm volume curtailments totaling nearly 290.9 billion cubic feet.

Total actual and estimated curtailments of 966.3 billion cubic feet for the 1973 summer period (April–October) indicate an increase of 74 percent over the actual 1972 summer curtailment of 555.4 billion cubic feet. Summer curtailments are used in large part to fill storage.

Last winter, firm volume curtailments by 15 interstate piepline companies amounted to about 565.6 billion cubic feet. For next winter. 14 companies are estimating curtailments of more than 679.7 billion cubic feet, 20 percent more than last year.

The complete text of the staff report, by Frank C. Allen, Acting Chief of the FPC's Bureau of Natural Gas, accompanies this release.

FEDERAL POWER COMMISSION,
Washington, D.C., September 1973.

BUREAU OF NATURAL GAS REVISED STAFF REPORT

FIRM REQUIREMENTS AND CURTAILMENTS OF MAJOR INTERSTATE PIPELINE COMPANIES

As a result of the recently completed meetings with various groups of interstate natural gas piepline companies, staff has obtained additional information which has enabled it to update its earlier report of Firm Requirements and Firm Requirement Deficiencies of Major Interstate Pipeline Companies issued on July 16, 1973. Significant changes include a reduction of projected 1973–74 heating season curtailments of 14,360,000 Mcf by Transcontinental Gas Pipe Line Company and increased curtailments by Trunkline Gas Company to reflect Commission denial of a limited term sale of 75,000 Mcf per day by Atlantic Richfield Company for the months August–December, 1973. Commission denial of limited term sales are not reflected unless specifically included in a company's estimate. However, other companies have revised their estimates to include small volume emergency purchases which have not yet been authorized. In addition, staff has added 18,802,000 Mcf to El Paso Natural Gas Company's estimated 1973–74 heating season curtailment. This volume was inadvertently omitted from the July, 1973 report. This revised report more accurately reflects the estimated gas supply and firm requirements of the major interstate pipeline companies for the projected 12-month period ending March 31, 1974.

A summary of the reported information is given in the attached Schedules I and II. Schedule I is based upon actual operations for the 12-month period ended March 31, 1973; whereas, Schedule II consists of actual and estimated requirements and deficiencies of the 12-month period ending March 31, 1974. Both schedules show the firm requirements and firm requirement deficiencies of the 33 reporting companies in four parts for each of the aforementioned periods. These parts are the month April–October (summer season) and November–March (heating season) for each 12-month period. The summer season is further broken down into two periods, April–July and August–October, in order to compare actual requirements and deficiencies for both reporting periods. Four companies did not report in sufficient detail to be included in the summary. However, it was indicated that curtailments would be in small volumes with very little change over last year.[2]

During the period April–July, 1972, 9 companies reported firm volume curtailments aggregating 290,869,457 Mcf. For the same period of 1973, 12 companies reported actual curtailments totaling 515,412,370 Mcf, an increase of 77 percent. Firm volume curtailment for the period August–Octobr, 1972, was reported by 10 companies to be 264,519,467 Mcf; whereas, 12 companies estimate curtailments amounting to 450,908,100 Mcf for this period in 1973. This is an increase of 70 percent. Total actual and estimated curtailments of 966,320,470 Mcf [3] for the period April–October, 1973, indicate an increase of 74 percent over the actual curtailment of 555,388,924 Mcf reported for the corresponding period in 1972. For the 1972–73 heating season, 15 companies reported a firm volume curtailment of 565,603,890 Mcf. There are 14 companies estimating curtailment of 679,747,700 Mcf for the 1973–74 heating season. This represents an increase of approximately 20 percent. It should be noted that companies experiencing curtailment are not necessarily the same in the two seasons or from year to year.

Volumes curtailed in intercompany transactions [4] which were included in the total volume curtailed for the April–July and August–October, 1972, periods and the 1972–73 heating season are 84,617,387 Mcf, 69,039,596 Mcf and 142,446,011 Mcf, respectively. Volumes curtailed in intercompany transactions for the 1973 April–July period were reported to be 126,963,729 Mcf. Based upon 1972 data, staff estimates that volumes curtailed in intercompany transactions will be approximately 98,550,000 Mcf and 170,990,000 Mcf for the 1973 August–October period and 1973–74 heating season, respectively.

The Commission will continue to review the supply and requirements situation of all the reporting pipeline companies and will update its reports in order to reflect the latest data available to it.

FRANK C. ALLEN,
Acting Chief, Bureau of Natural Gas.

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[2] Alabama-Tennessee Natural Gas Company, Arkansas-Missouri Power Company, Lone Star. Gas Company and Southwest Gas Corporation.

[3] Summer curtailments are used in large part to fill storage.

[4] Intercompany transactions were not reported in the BNG request but have been compiled from information submitted in FPC Form 17.

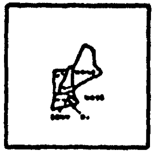
Schedule III

PIPELINE COMPANIES SERVICING FUTURE REQUIREMENTS COMMITTEE REGIONS

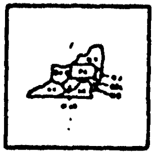
Reporting Company	Region Serviced by Company									
	1	2	3	4	5	6	7	8	9	10
Algonquin	X	X								
Arkansas Louisiana Gas Company						X	X			
Cities Service Gas Company					X	X	X			
Colorado Interstate Gas Company						X	X	X		
Columbia Gas Systems, Inc.		X								
Consolidated Gas Supply Corporation		X					X			
East Tennessee Natural Gas Company		X	X							
Eastern Shore Natural Gas Company		X								
El Paso Natural Gas Company						X	X	X	X	X
Florida Gas Transmission Company			X				X			
Granite State Gas Transmission, Inc.	X									
Great Lakes Gas Transmission Company				X	X					
Kansas-Nebraska Natural Gas Company, Inc.					X	X	X	X		
Louisiana-Nevada Transit Company							X			
Michigan Wisconsin Pipeline Company		X	X	X	X	X	X			
Midwestern Gas Transmission Corporation		X	X	X	X					
Mid Louisiana Gas Company							X			
Mississippi River Transmission Corporation				X		X	X			
Montana-Dakota Utilities Company					X			X		
Mountain Fuel Supply Company								X		X
Natural Gas Pipeline Company of America				X	X	X	X		X	
Northern Natural Gas Company				X	X	X	X	X	X	
Pacific Gas Transmission Company									X	X
Panhandle Eastern Pipeline Company		X		X		X	X			
South Georgia Natural Gas Company			X							
Southern Natural Gas Company			X				X			
Tennessee Gas Pipeline Company	X	X	X				X			
Texas Eastern Transmission Corporation		X	X	X		X	X			
Texas Gas Transmission Corporation		X	X	X			X			
Transcontinental Gas Pipe Line Corporation		X	X				X			
Transwestern Pipeline Company						X	X		X	
Trunkline Gas Company			X	X			X			
United Gas Pipe Line Company			X				X			

Note: Some companies may have minor service in some areas not designated in this schedule.

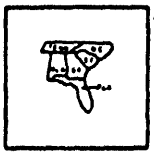
Regions by FRC



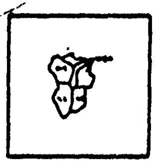
REGION 1
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont



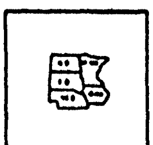
REGION 2
Delaware, Kentucky, Maryland, New Jersey, New York, Virginia, West Virginia
Ohio, Pennsylvania.



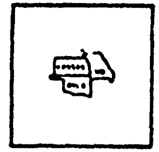
REGION 3
Alabama, Florida, Georgia, North Carolina, South Carolina, Tennessee



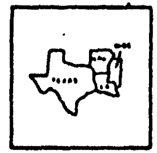
REGION 4
Illinois, Indiana, Michigan, Wisconsin



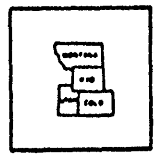
REGION 5
Iowa, Minnesota, Nebraska, North Dakota, South Dakota



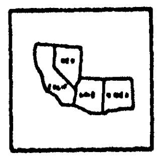
REGION 6
Kansas, Missouri, Oklahoma



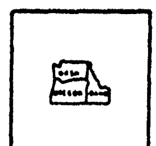
REGION 7
Arkansas, Louisiana, Mississippi, Texas



REGION 8
Colorado, Montana, Utah, Wyoming



REGION 9
Arizona, California, Nevada, New Mexico



REGION 10.
Idaho, Oregon, Washington

Schedule I
(Revised)

Revised
Firm Requirements and Firm Requirement Deficiencies
Reported to FPC by Major Pipeline Companies
(MCF)

Reporting Company	1972 - Actual 1/ APRIL-JULY Firm Requirement	Volume Curtailed	Percentage Curtailed	AUGUST-OCTOBER Firm Requirement	Volume Curtailed	Percentage Curtailed	APRIL-OCTOBER Firm Requirement	Volume Curtailed	Percentage Curtailed	1972-1973 - Actual 1/ NOVEMBER-MARCH Firm Requirement	Volume Curtailed	Percentage Curtailed
Algonquin Gas Transmission Company	43,730,600	320,100	0.7	30,368,000	-0-	0.0	74,098,300	320,100	0.4	65,066,700	6,606,967	1.0
Arkansas Louisiana Gas Company	148,363,000	28,651,299	19.3	122,029,000	32,679,930	26.8	270,392,000	61,331,229	22.7	344,610,000	76,236,832	20.7
Cities Service Gas Company	155,043,000	-0-	0.0	117,066,000	31,300 2/	0.0	272,051,000	31,000 2/	0.0	303,716,000	43,000,000 2/	14.2
Colorado Interstate Gas Company	115,873,300	-0-	0.0	90,048,400	-0-	0.0	205,711,700	-0-	0.0	207,630,300	-0-	0.0
Columbia Gas System, Inc. (Columbia Gas Trans. Corp.)	370,956,000	-0-	0.0	254,521,000	-0-	0.0	625,477,000	-0-	0.0	833,417,000	-0-	0.0
Consolidated Gas Supply Corporation	201,310,000	-0-	0.0	164,437,000	-0-	0.0	365,747,000	-0-	0.0	536,043,000	-0-	0.0
East Tennessee Natural Gas Company	28,961,000	-0-	0.0	22,336,000	-0-	0.0	51,299,000	-0-	0.0	65,663,000	-0-	0.0
Eastern Shore Natural Gas Company	3,766,100	-0-	0.0	2,616,603	-0-	0.0	6,360,700	-0-	0.0	5,068,300	3,303	0.1
El Paso Natural Gas Company	587,652,000	83,303	0.0	446,418,000	470,000	0.1	1,034,070,000	553,303	0.1	839,930,000	66,067,332	8.1
Florida Gas Transmission Company	7,101,000	-0-	0.0	5,132,060	-0-	0.0	12,233,000	-0-	0.0	15,670,000	-0-	0.0
Granite State Gas Transmission, Inc.	1,160,100	-0-	0.0	875,400	-0-	0.0	2,035,500	-0-	0.0	2,366,300	-0-	0.0
Great Lakes Gas Transmission Company	125,352,000	-0-	0.0	98,315,000	-0-	0.0	223,667,000	-0-	0.0	180,663,000	-0-	0.0
Kansas-Nebraska Natural Gas Company, Inc.	37,230,000	-0-	0.0	29,650,000	-0-	0.0	66,880,000	-0-	0.0	65,365,000	-0-	0.0
Louisiana-Nevada Transit Company	43,960,436	32,500	0.1	33,933,475	26,300	0.1	77,893,911	58,800	0.1	64,614,902	432,000	0.7
Michigan Wisconsin Pipe Line Company	238,161,000	-0-	0.0	169,562,000	-0-	0.0	407,723,000	-0-	0.0	640,934,000	-0-	0.0
Midwestern Gas Transmission Corporation	113,836,000	-0-	0.0	85,501,000	-0-	0.0	199,337,000	-0-	0.0	120,048,300	386,300	0.3
Mid Louisiana Gas Company	11,716,000	-0-	0.0	8,329,000	-0-	0.0	20,245,000	-0-	0.0	17,802,000	-0-	0.0
Mississippi River Transmission Corporation	65,575,000	-0-	0.0	35,793,000	-0-	0.0	101,368,000	-0-	0.0	122,659,000	9,217,355	7.5
Montana-Dakota Utilities Company	6,391,000	-0-	0.0	5,333,060	-0-	0.0	11,724,000	-0-	0.0	23,316,000	-0-	0.0
Mountain Fuel Supply Company	13,619,000	-0-	0.0	6,154,400	-0-	0.0	19,773,300	-0-	0.0	62,730,000	-0-	0.0
Natural Gas Pipeline Company of America	399,460,800	74,552,397	18.7	301,020,500	70,956,061	23.6	700,481,300	145,409,410	20.8	385,197,900	-0-	0.0
Northern Natural Gas Company	263,117,000	-0-	0.0	192,718,000	1,776,957	0.9	455,835,000	1,776,957	0.4	630,690,000	6,760,557	1.1
Pacific Gas Transmission Company	130,420,000	-0-	0.0	100,220,000	-0-	0.0	230,640,000	-0-	0.0	180,181,000	-0-	0.0
Panhandle Eastern Pipeline Company	355,357,600	-0-	0.0	287,496,100	-0-	0.0	642,853,700	-0-	0.0	393,055,700	16,306,737	3.9
South Georgia Natural Gas Company	8,396,390	-0-	0.0	6,308,065	-0-	0.0	14,704,044	-0-	0.0	10,437,300	-0-	0.0
Southern Natural Gas Company	174,753,000	-0-	0.0	134,688,000	-0-	0.0	309,441,000	-0-	0.0	287,463,000	-0-	0.0
Tennessee Gas Pipeline Company	415,296,000	-0-	0.0	311,901,000	-0-	0.0	727,207,000	-0-	0.0	501,326,000	-0-	0.0
Texas Eastern Transmission Corporation	313,306,000	26,708,257	8.5	231,430,000	11,751,606	5.1	544,736,000	38,460,061	7.1	427,118,000	61,663,736	14.4
Texas Gas Transmission Corporation	231,876,000	-0-	0.0	173,254,000	-0-	0.0	405,120,000	-0-	0.0	327,604,000	-0-	0.0
Transcontinental Gas Pipe Line Corporation	344,929,000	25,183,144	6.9	291,754,000	21,566,348	7.9	636,683,000	46,739,492	7.3	649,540,000	30,508,322	4.6
Transwestern Pipeline Company	111,711,700	-0-	0.0	86,783,300	-0-	0.0	198,497,000	-0-	0.0	144,336,900	1,063,770	0.7
Trunkline Gas Company	197,057,000	14,399,630	7.3	148,735,000	13,133,417	8.8	345,792,000	27,533,053	8.0	143,566,000	33,335,552	23.3
United Gas Pipeline Company	355,041,100	120,333,977	34.0	300,776,000	112,109,110	38.0	655,817,000	232,443,087	36.2	499,321,000	152,172,029	27.9
TOTAL	5,049,578,035	290,060,637	5.1	4,242,030,020	264,319,667	6.2	9,292,308,055	555,380,306	5.6	8,339,953,100	363,003,070	4.3
Less Intercompany Transactions		94,637,367 3/			92,839,366 3/			153,636,903 3/			36,466,011 3/	
Net Curtailment		196,423,270			171,479,621			401,743,593			323,157,873	

1/ Firm Requirements as reported in Gas Supply-Requirements Balance. Volume Curtailed (Deficiencies) as reported in Form 17.

2/ Cities Service States, "our entire contractual demands for gas on our system----although some volumes of gas sold and delivered to distributors for resale and to direct customers are interruptible".

3/ Intercompany Transactions as obtained from FPC Form 17.

Schedule II
(Revised)

Revised
Firm Requirements and Firm Requirements Deficiencies
Reported to FPC by Major Pipeline Companies
(Mcf)

Reporting Company	1973 - Actual and Estimated 1/									1973-1974 - Estimated 1/		
	April-July - Actual			August-October - Estimated			April-October - Actual and Estimated			November-March - Estimated		
	Firm Requirement	Volume Curtailed	Percentage Curtailed	Firm Requirement	Volume Curtailed	Percentage Curtailed	Firm Requirement	Volume Curtailed	Percentage Curtailed	Firm Requirement	Volume Curtailed	Percentage Curtailed
Algonquin Gas Transmission Company	42,065,900	-0-	0.0	32,092,000	6,955,100 2/	21.2	74,958,700	6,955,100	9.3	102,977,300	10,476,400	10.2
Arkansas Louisiana Gas Company	151,123,000	43,687,965	28.9	113,015,000	33,092,000	29.3	264,138,000	76,779,965	29.1	231,610,000	43,090,000	18.6
Cities Service Gas Company 3/	162,126,000	4,856,000	3.0	117,936,000	3,000,000	2.5	280,062,000	7,856,000	2.8	295,102,000	22,000,000	7.6
Colorado Interstate Gas Company	124,165,100	-0-	0.0	87,705,800	-0-	0.0	211,870,900	-0-	0.0	280,234,300	-0-	0.0
Columbia Gas System, Inc. (Columbia Gas Trans. Corp.)	361,755,000	-0-	0.0	276,780,000	-0-	0.0	638,535,000	-0-	0.0	876,030,000	12,376,000	1.4
Consolidated Gas Supply Corporation	200,070,000	-0-	0.0	142,856,000	-0-	0.0	342,926,000	-0-	0.0	366,323,000	[illegible]	0.0
East Tennessee Natural Gas Company	30,700,000	-0-	0.0	22,761,000	-0-	0.0	53,461,000	-0-	0.0	44,620,000	[illegible]	0.0
Eastern Shore Natural Gas Company	3,744,300	-0-	0.0	2,616,400	-0-	0.0	6,360,700	-0-	0.0	5,158,200	233,0[illegible]	4.5
El Paso Natural Gas Company	617,147,000	28,326,637	4.6	462,173,000	33,498,000	7.2	1,079,320,000	61,824,637	5.7	817,417,000	85,030,[illegible]	10.4
Florida Gas Transmission Company	7,801,600	-0-	0.0	5,736,400	-0-	0.0	13,537,000	-0-	0.0	19,094,000		0.0
Granite State Gas Transmission, Inc.	1,268,400	-0-	0.0	920,600	-0-	0.0	2,188,000	-0-	0.0	2,548,700	-0-	0.0
Great Lakes Gas Transmission Company	140,025,000	-0-	0.0	105,195,000	-0-	0.0	245,220,000	-0-	0.0	180,749,000	-0-	0.0
Kansas-Nebraska Natural Gas Company, Inc.	39,215,000	-0-	0.0	31,790,000	-0-	0.0	71,005,000	-0-	0.0	66,790,000	-0-	0.0
Louisiana-Nevada Transit Company	45,168,595	36,700	0.1	32,547,263	-0-	0.0	77,715,858	36,700	0.1	69,535,456		0.0
Michigan Wisconsin Pipe Line Company	249,844,000	-0-	0.0	183,302,000	-0-	0.0	433,146,000	-0-	0.0	698,082,000		0.0
Midwestern Gas Transmission Corporation	114,250,000	-0-	0.0	85,350,000	-0-	0.0	199,600,000	-0-	0.0	150,637,000		0.0
Mid Louisiana Gas Company	10,345,000	-0-	0.0	6,626,000	-0-	0.0	16,971,000	-0-	0.0	17,438,000		0.0
Mississippi River Transmission Corporation	48,943,000	175,118	0.4	37,532,000	-0-	0.0	86,475,000	175,118	0.2	122,021,000	7,[illegible]	0.4
Montana-Dakota Utilities Company	7,040,000	-0-	0.0	5,121,000	-0-	0.0	12,161,000	-0-	0.0	25,390,000	[illegible]	0.0
Mountain Fuel Supply Company	15,296,000	-0-	0.0	6,877,000	-0-	0.0	22,173,000	-0-	0.0	42,867,000	[illegible]	0.0
Natural Gas Pipeline Company of America 6/	399,227,000	117,960,178	29.6	299,703,900	110,900,000	37.0	698,930,900	228,860,178	32.7	900,200,100	[illegible]	0.0
Northern Natural Gas Company 6/	206,678,000	-0-	0.0	202,368,000	5,800,000	2.9	409,046,000	5,800,000	1.2	666,934,000	[illegible]	.5
Pacific Gas Transmission Company	136,319,000	-0-	0.0	102,735,000	-0-	0.0	239,054,000	-0-	0.0	176,791,000	[illegible]	[illegible]
Panhandle Eastern Pipeline Company 6/	250,080,000	3,063,300	0.8	188,759,000	3,300,000	1.6	438,839,000	3,063,300	1.2	386,840,000	[illegible]	.6
South Georgia Natural Gas Company	8,339,990	-0-	0.0	6,640,000	-0-	0.0	14,979,990	-0-	0.0	18,370,000	[illegible]	0.0
Southern Natural Gas Company	186,134,000	-0-	0.0	136,915,000	-0-	0.0	323,049,600	-0-	0.0	292,914,000	[illegible]	0.0
Tennessee Gas Pipeline Company	431,573,000	-0-	0.0	326,713,000	-0-	0.0	758,286,000	-0-	0.0	614,238,000	[illegible]	0.0
Texas Eastern Transmission Corporation 6/	339,726,000	48,084,700	14.1	251,471,000	48,046,000	19.3	591,197,000	97,130,700	16.4	490,617,000	67,373,000	13.7
Texas Gas Transmission Corporation	236,156,000	-0-	0.0	175,967,000	-0-	0.0	412,121,000	-0-	0.0	347,049,000	-0-	0.0
Transcontinental Gas Pipe Line Corporation 6/	366,758,000	46,118,748	12.5	276,903,000	37,219,000	13.4	643,661,000	83,337,748	12.9	451,491,000	57,601,000	12.8
Transwestern Pipeline Company 6/	117,435,300	421,057	0.4	90,781,700	919,000	1.0	208,216,000	1,340,057	0.6	153,315,200	19,419,300	12.7
Trunkline Gas Company	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 7/	26.8	345,792,000	86,628,429 7/	25.3	232,196,000	80,975,000 7/	32.1
United Gas Pipe Line Company 6/	512,819,029	179,135,852	34.9	387,801,000	122,367,300	32.0	900,620,000	301,502,852	34.0	782,125,000	233,525,000 8/	33.3
TOTAL	5,863,293,193	515,612,370	8.8	4,354,204,463	430,900,100	10.4	10,217,497,876	946,320,670	9.3	9,166,770,256	679,367,700	7.4
Less Intercompany Transactions		125,962,729 4/			98,350,040 5/			223,313,[illegible]			130,000,000 5/	
Net Curtailment		389,648,641			332,549,120			640,806,[illegible]			548,757,700	

1/ Firm Requirements, both actual and estimated are as reported in Gas Supply-Requirements Balance. Actual volume curtailed (Deficiencies) are as reported in Form 17. Estimated volume curtailed are as reported in the Supply-Requirements Balance.

2/ Volumes purchased under firm contracts but sold under Interruptible schedules.

3/ Cities Service states, "our entire contractual demands for gas on our system---although some volumes of gas sold and delivered to distributors for resale and to direct customers are interruptible".

4/ Obtained from FPC Form 17.

5/ Estimated intercompany transactions.

6/ Estimated curtailments of these companies assume the attachment of emergency supplies under applications presently pending before the Commission.

7/ Volume curtailed has been increased to reflect Commission denial of limited term sale by Atlantic Richfield Company issued August 30, 1973, at Docket No. CI73-691.

8/ United had revised its original estimate to reflect a reduction of 12,250,000 Mcf in its projected curtailment assuming approval of Sea Robin Pipeline Company's application at Docket No. CP73-87, et al. However, in view of the fact that Sea Robin's proposal may not be completed in time for the 1973-74 winter season, staff has re-inserted the 12,250,000 Mcf.

FEDERAL POWER COMMISSION,
Washington, D.C., January 31, 1974.

NEWS RELEASE NO. 20019

FPC RELEASES REPORT ON MAJOR INTERSTATE NATURAL GAS PIPELINE REQUIREMENTS AND CURTAILMENTS

The Federal Power Commission today released a staff report which shows that major interstate natural gas pipelines' supply deficiencies are expected to be more than 53 percent higher during the September 1973–August 1974 period than they were a year earlier.

The report, by the FPC's Bureau of Natural Gas (based on information in the companies' Form 16 filing), indicates that a net actual total curtailment of 1,031,254, 000, 000 cubic feet of firm requirements was experienced during the year September 1972 through August 1973.

For the following 12 months, net supply deficiencies totaling 1,579,195,000,000 cubic feet were projected.

Thus, anticipated supply deficiencies for the September 1973 through August 1974 period exceed curtailments for the preceding year by 547,941,000,000 cubic feet, or 53.13 percent.

Curtailments, actual and projected, were reported by 18 of 36 reporting major pipeline companies. The largest actual curtailment, 492,337,000,000 cubic feet, or 30.82 percent of its firm requirements, was reported by United Gas Pipe Line Company for the 1972–1973 period. United expects still larger curtailments, amounting to 34.9 percent, for the 1973–1974 period.

The report shows that anticipated net supply deficiencies for November 1973 through March 1974 total 583,882,000,000 cubic feet. Actual net curtailments for the preceding heating season were reported as 418,674,000,000 cubic feet. This increase, 165,208,000,000 cubic feet, amounts to 39.46 percent. The largest curtailments and anticipated supply deficiencies for the two winters also were reported by United Gas Pipe Line Company.

The complete text of the report accompanies this release.

FEDERAL POWER COMMISSION,
Washington, D.C., January 1974.

BUREAU OF NATURAL GAS STAFF REPORT

REQUIREMENTS AND CURTAILMENTS OF MAJOR INTERSTATE PIPELINE COMPANIES BASED ON FORM 16 REPORTS

On August 24, 1973, the Commission issued Order No. 489 in Docket No. R–472 establishing Form No. 16, Report of Gas Supply and Requirements. The report is to be filed twice each year on April 30 and September 30 by pipeline companies making sales of natural gas for resale in interstate commerce. The April 30 filings will present supply and requirements data on a monthly basis for the past year, April through March, and projected data for the following one year period, April through March. The September 30 filings will present actual data for the past year, September through August, and projected data for the following year, September through August.

This report summarizes the data in the first Form 16 filings, which were due on September 30, 1973, filed by 36 major pipelines (Class A and B) and one small pipeline company, Western Gas Interstate Company (Class C).

A number of small pipeline companies did not file Form 16 reports or filed too late to be included in the attached compilations. These companies, in total, had natural gas sales in 1972 of less than 2% of the total sales of all Commission regulated pipeline companies. We do not believe that failure to include information covering their operations significantly affects the totals presented here.[1]

A number of the filing companies, being inexperienced with this new form, were late in filing and in many cases the staff had to send follow-up letters to obtain the filing. Two companies (Consolidated and Transco) requested extensions of time because they did not have the required information. In the future, the

[1] In addition, eight companies were exempted from filing Form 16 by Commission order issued November 7, 1973, and thirteen other companies have requested exemption or indicated they are not required to file because they make no interstate sales or resale.

staff expects that the pipeline companies will be able to file more timely and our report will be prepared more timely and more comprehensively.

Based on the September 30, 1973, filings made by the 37 pipelines, this report provides requirements and curtailment data for the period September 1972 through August 1973 and projected requirements and supply deficiency data for the period September 1973 through August 1974. It is noted that requirements less curtailments constitute the available supply.

Curtailment of Firm Requirements

Schedule I attached shows the actual firm requirements and percent of such requirements curtailed for the year September 1972 through August 1973 for each of the 37 companies listed in the schedule. For comparison, their projected firm requirements, projected supply deficiency, and percent deficiency for the following year (September 1973-August 1974) are also shown. After elimination of the curtailments of reporting pipelines to other reporting pipelines, a net actual total curtailment of 1,031,254,000 Mcf of firm requirements is shown for the year September 1972 through August 1973. For the following year, net supply deficiencies totalling 1,579,195,000 Mcf were projected. Thus, the anticipated supply deficiencies for September 1973 through August 1974 exceed the curtailments for the preceding year by 547,941,000 Mcf or 53.13%. Curtailments, actual and projected, were reported by 18 of the 37 companies. The largest actual curtailment (492,337,000 Mcf or 30.82% of its firm requirements) was reported by United Gas Pipe Line Company. This company expects still larger curtailments (34.9%) during the following year.

Schedule II shows the requirements and curtailment information for the heating seasons, November 1972 through March 1973, and projections for November 1973 through March 1974. Anticipated net supply deficiencies for November 1973 through March 1974 total 583,882,000 Mcf. Actual net curtailments for the preceeding heating season 1972–1973 were 418,674,000 Mcf. The increase in curtailments from 1972–1973 to 1973–1974 is 165,208,000 Mcf or 39.46%. Here, also, the largest curtailments and anticipated supply deficiencies were reported by United Gas Pipe Line Company.

A comparison of projected supply deficiencies for the November 1973–March 1974 heating season as reported in response to the Commission's letter request of April 10, 1973 [2] and as reportèd later on Form 16 reveals that several pipelines (Cities Service, El Paso, Panhandle Eastern and Trunkline) now anticipate larger supply deficiencies than they did earlier.

Schedule III shows peak day firm requirements and curtailments and projected supply deficiencies. As with the annual and heating season data, it shows anticipated deficiencies increasing during the November 1973–March 1974 season from those encountered during the preceeding heating season. It also shows United Gas Pipe Line Company having the largest actual peak day curtailment for 1972–1973 (1,657,000 Mcf, about 30% of its firm requirement) and projected peak day deficiency for 1973–74 (1,859,000 Mcf, about 33% of its firm requirement).

Curtailment of Interruptible Sales

Schedule IV shows data on interruptible sales as reported by fifteen pipelines. Nine companies reported that interruptible curtailments [3] were made for the period September 1972–August 1973 and are anticipated for September 1973–August 1974. One (Texas Gas Transmission Corp) made no curtailments of interruptible sales in the year ended August 1973 but expects to make interruptible curtailments during the year ending August 1974. The fifteen pipelines had total curtailments of 44.62% of their interruptible load for the year ended August 1973 and anticipated increases to 51.75% for the following year. For the heating seasons, the curtailment of interruptible sales was 52.54% for November 1972 through March 1973 and 57.37% anticipated for the following season, November 1973 through March 1974.

[2] Requirements and deficiencies for the 1972–1973 and 1973–1974 heating seasons for major pipelines were reported by the Commission staff in public reports issued on July 16 and September 17, 1973. Information for these reports was obtained through an informal letter request of April 10, 1973.

[3] Form 16 requires reporting of curtailment of interruptible market "based on reduction in normal deliveries to the attached interruptible load of the reporting pipelines."

Cities Service Gas Company advised that it did not report its interruptible data on Form 16 because it used the same approach as it used in reporting its curtailments as shown in the Commission's September 17, 1973, report on interstate pipeline curtailments (Press Release No. 19640) wherein it was noted that Cities reported only its curtailments of firm contractual demands.

Areas Affected by Curtailments

Schedules V and VI show the areas serviced by the reporting pipelines and provide an indication of the regions affected by the curtailments.

Comparison of Actual Firm Requirements and Curtailments For Heating Season November 1972-March 1973 With Projections For Heating Season November 1973-March 1974

Schedule II

Pipeline	Heating Season - Nov. 1972-March 1973: Firm Requirements (Mcf)	Heating Season - Nov. 1972-March 1973: Actual Volume Curtailed (Mcf)	Heating Season - Nov. 1972-March 1973: Percent Curtailed	Heating Season - Nov. 1973-March 1974: Firm Requirements (Mcf)	Heating Season - Nov. 1973-March 1974: Projected Deficiency (Mcf)	Heating Season - Nov. 1973-March 1974: Percent Deficient
Algonquin Gas Transmission Company	84,388,000	8,486,000	10.06	92,334,000	10,005,000	10.84
Arkansas Louisiana Gas Company	280,763,000	76,257,000	27.16	252,915,000	77,361,000	30.59
Cities Service Gas Company	302,224,000	41,888,000	13.86	296,004,000	35,074,000	11.85
Colorado Interstate Gas Company	207,333,000	-0-	-0-	208,763,000	-0-	-0-
Columbia Gas Transmission Corporation	823,785,000	-0-	-0-	874,038,000	12,573,000	1.44
Consolidated Gas Supply Corporation	389,293,000	-0-	-0-	417,338,000	-0-	-0-
East Tennessee Natural Gas Company	37,271,000	-0-	-0-	40,005,000	-0-	-0-
El Paso Natural Gas Company - So. Div.	622,437,000	66,848,000	10.75	611,355,000	87,586,000	14.33
N.W. Div.	207,521,000	446,000	.21	216,171,000	13,428,000	6.21
Florida Gas Transmission Company	15,478,000	-0-	-0-	20,786,000	-0-	-0-
Great Lakes Gas Transmission Company	180,683,000	-0-	-0-	181,653,000	-0-	-0-
Kansas-Nebreaska Natural Gas Company	42,818,000	-0-	-0-	42,153,000	-0-	-0-
Kentucky-West Virginia Gas Company	10,934,000	-0-	-0-	10,336,000	-0-	-0-
Lawrenceburg Gas Transmission Corp.	2,265,000	-0-	-0-	2,265,000	-0-	-0-
Michigan Wisconsin Pipe Line Company	480,954,000	-0-	-0-	497,115,000	-0-	-0-
Mid Louisiana Gas Company	18,134,000	321,000	1.77	16,647,000	-0-	-0-
Midwestern Gas Transmission Company	150,048,000	-0-	-0-	150,747,000	-0-	-0-
Mississippi River Transmission Corporation	122,659,000	7,277,000	5.93	123,151,000	10,018,000	8.13
Montana-Dakota Utilities Company	23,322,000	-0-	-0-	24,802,000	-0-	-0-
Natural Gas Pipeline Company of America	502,481,000	-0-	-0-	505,448,000	-0-	-0-
North Penn Gas Company	16,880,000	-0-	-0-	17,231,000	-0-	-0-
Northern Natural Gas Company	410,490,000	4,769,000	1.16	407,820,000	3,193,000	0.78
Pacific Gas Transmission Company	180,181,000	-0-	-0-	176,791,000	-0-	-0-
Panhandle Eastern Pipe Line Company	393,056,000	14,532,000	3.70	388,103,000	36,048,000	9.29
South Georgia Natural Gas Company	6,798,000	-0-	-0-	6,933,000	-0-	-0-
Southern Natural Gas Company	287,826,000	-0-	-0-	291,605,000	-0-	-0-
Tennessee Gas Pipeline Company, A Division of Tenneco, Inc.	602,155,000	-0-	-0-	617,141,000	-0-	-0-
Texas Eastern Transmission Corporation	494,945,000	61,641,000	12.45	500,459,000	68,732,000	13.73
Texas Gas Pipe Line Corporation	2,022,000	-0-	-0-	1,362,000	-0-	-0-
Texas Gas Transmission Corporation	342,407,000	-0-	-0-	352,853,000	-0-	-0-
Transcontinental Gas Pipe Line Corporation	497,617,000	30,589,000	6.15	513,988,000	69,481,000	13.52
Transwestern Pipeline Company	148,111,000	5,471,000	3.69	150,589,000	10,553,000	7.01
Trunkline Gas Company	243,285,000	51,565,000	21.20	247,262,000	84,115,000	34.02
United Gas Pipe Line Company	699,821,000	194,564,000	27.80	705,664,000	234,761,000	33.27
United Natural Gas Company	62,076,000	-0-	-0-	62,207,000	-0-	-0-
The Union Light, Heat and Power Company	11,364,000	-0-	-0-	12,168,000	-0-	-0-
West Texas Gathering Company	40,257,000	-0-	-0-	40,257,000	-0-	-0-
Western Gas Interstate Company	2,603,000	-0-	-0-	2,678,000	-0-	-0-
Totals	8,946,685,000	564,654,000	6.31	9,079,137,000	752,928,000	8.29
Less: Pipeline to pipeline curtailments		145,980,000			169,046,000	
Net curtailments		418,674,000			583,882,000	

Comparison of Actual Firm Requirements and Firm Curtailments
For Year September 1972 Through August 1973 With Projections
For Year September 1973 Through August 1974

Schedule I

Pipeline	Total For Year Sept. 1972-Aug. 1973 Firm Requirements (Mcf)	Actual Volume Curtailed (Mcf)	Percent Curtailed	Total For Year Sept. 1973-Aug. 1974 Firm Requirement (Mcf)	Projected Deficiency (Mcf)	Percent Deficient
Algonquin Gas Transmission Company	149,179,000	8,486,000	5.69	176,736,000	11,815,000	6.69
Arkansas Louisiana Gas Company	591,240,000	155,522,000	26.30	540,182,000	149,622,000	27.70
Cities Service Gas Company	579,891,000	47,748,000	8.23	581,139,000	52,849,000	9.09
Colorado Interstate Gas Company	401,872,000	-0-	-0-	401,606,000	-0-	-0-
Columbia Gas Transmission Corporation	1,455,473,000	-0-	-0-	1,520,473,000	59,509,000	3.91
Consolidated Gas Supply Corporation	719,108,000	-0-	-0-	746,752,000	29,875,000	4.00
East Tennessee Natural Gas Company	76,096,000	-0-	-0-	83,807,000	-0-	-0-
El Paso Natural Gas Company - So. Div.	1,444,651,000	103,153,000	7.14	1,461,970,000	223,121,000	15.25
- N.W. Div.	440,643,000	475,000	.11	465,259,000	20,843,000	4.48
Florida Gas Transmission Company	28,895,000	-0-	-0-	36,739,000	-0-	-0-
Great Lakes Gas Transmission Company	426,248,000	-0-	-0-	438,622,000	-0-	-0-
Kansas-Nebraska Natural Gas Company	86,046,000	-0-	-0-	85,011,000	-0-	-0-
Kentucky-West Virginia Gas Company	26,011,000	-0-	-0-	25,478,000	-0-	-0-
Lawrenceburg Gas Transmission Company	5,300,000	-0-	-0-	5,523,000	-0-	-0-
Michigan Wisconsin Pipe Line Company	907,081,000	-0-	-0-	930,321,000	-0-	-0-
Mid Louisiana Gas Company	36,145,000	321,000	.89	32,907,000	-0-	-0-
Midwestern Gas Transmission Company	348,707,000	-0-	-0-	351,099,000	-0-	-0-
Mississippi River Transmission Corporation	210,040,000	7,412,000	3.53	214,168,000	11,248,000	5.25
Montana-Dakota Utilities Company	35,383,000	-0-	-0-	36,802,000	-0-	-0-
Natural Gas Pipeline Company of America	1,194,295,000	191,408,000	16.03	1,201,477,000	210,195,000	17.49
North Penn Gas Company	29,287,000	-0-	-0-	29,158,000	-0-	-0-
Northern Natural Gas Company	892,908,000	7,445,000	.83	872,332,000	6,163,000	.71
Pacific Gas Transmission Company	418,282,000	-0-	-0-	415,845,000	-0-	-0-
Panhandle Eastern Pipe Line Company	833,683,000	16,533,000	1.98	817,214,000	56,909,000	6.97
South Georgia Natural Gas Company	11,826,000	-0-	-0-	12,062,000	-0-	-0-
Southern Natural Gas Company	606,374,000	-0-	-0-	615,230,000	-0-	-0-
Tennessee Gas Pipeline Company, A Division of Tenneco, Inc.	1,351,210,000	-0-	-0-	1,383,525,000	-0-	-0-
Texas Eastern Transmission Corporation	1,086,447,000	130,465,000	12.01	1,094,217,000	181,169,000	16.56
Texas Gas Pipe Line Corporation	5,009,000	-0-	-0-	3,232,000	-0-	-0-
Texas Gas Transmission Corporation	749,518,000	-0-	-0-	753,090,000	16,412,000	2.18
Transcontinental Gas Pipe Line Corporation	1,086,203,000	104,504,000	9.62	1,098,062,000	189,077,000	17.22
Transwestern Pipeline Company	352,449,000	6,173,000	1.75	363,377,000	27,298,000	7.51
Trunkline Gas Company	583,454,000	116,892,000	20.03	591,772,000	194,190,000	32.82
United Gas Pipe Line Company	1,597,206,000	492,337,000	30.82	1,608,694,000	561,456,000	34.90
United Natural Gas Company	100,271,000	-0-	-0-	101,201,000	-0-	-0-
The Union Light, Heat and Power Company	17,553,000	-0-	-0-	18,475,000	-0-	-0-
West Texas Gathering Company	93,923,000	-0-	-0-	93,923,000	-0-	-0-
Western Gas Interstate Company	6,637,000	-0-	-0-	7,550,000	-0-	-0-
Totals	18,984,544,000	1,388,874,000	7.32	19,215,030,000	2,001,751,000	10.42
Less: Pipeline to pipeline curtailments		357,620,000			422,556,000	
Net curtailments		1,031,254,000			1,579,195,000	

Comparison of Actual Firm Requirements and Curtailments For
Peak-Day-November 1972-March 1973 Heating Season With
Projections For November 1973-March 1974 Heating Season

Schedule III

Pipeline	Actual-Peak Day-Heating Season Nov. 1972 - March 1973			Projected-Peak Day-Heating Season Nov. 1973 - March 1974		
	Firm Requirement (Mcf)	Volume Curtailed (Mcf)	Percent Curtailed	Firm Requirement (Mcf)	Volume Deficiency (Mcf)	Percent Deficient
Algonquin Gas Transmission Company	697,000	81,000	11.62	836,000	69,000	8.25
Arkansas Louisiana Gas Company	2,316,000	791,000	34.15	2,253,000	680,000	30.18
Cities Service Gas Company	2,826,000	758,000	26.82	3,300,000	887,000	26.88
Colorado Interstate Gas Company	1,624,000	-0-	-0-	1,762,000	-0-	-0-
Columbia Gas Transmission Corporation	7,848,000	-0-	-0-	7,660,000	-0-	-0-
Consolidated Gas Supply Corporation	4,286,000	-0-	-0-	4,323,000	-0-	-0-
East Tennessee Natural Gas Company	343,000	62,000	18.08	345,000	62,000	17.97
El Paso Natural Gas Company - So. Div.	4,387,000	657,000	14.98	4,071,000	494,000	12.13
N.W. Div.	1,515,000	-0-	-0-	1,662,000	140,000	8.42
Florida Gas Transmission Company	199,000	-0-	-0-	250,000	-0-	-0-
Kansas-Nebraska Natural Gas Company	452,000	74,000	16.37	459,000	-0-	-0-
Kentucky-West Virginia Gas Company	81,000	-0-	-0-	81,000	-0-	-0-
Lawrenceburg Gas Transmission Corp.	16,000	-0-	-0-	15,000	-0-	-0-
Michigan Wisconsin Pipe Line Company	3,882,000	-0-	-0-	4,184,000	-0-	-0-
Mid Louisiana Gas Company	170,000	24,000	14.12	194,000	-0-	-0-
Midwestern Gas Transmission Company	1,037,000	-0-	-0-	1,025,000	-0-	-0-
Mississippi River Transmission Corporation	868,000	-0-	-0-	900,000	94,000	10.44
Montana-Dakota Utilities Company	263,000	-0-	-0-	270,000	-0-	-0-
Natural Gas Pipeline Company of America	3,360,000	-0-	-0-	3,369,000	-0-	-0-
North Penn Gas Company	174,000	-0-	-0-	205,000	-0-	-0-
Northern Natural Gas Company	2,972,000	-0-	-0-	3,036,000	-0-	-0-
Pacific Gas Transmission Company	1,327,000	-0-	-0-	1,256,000	-0-	-0-
Panhandle Eastern Pipe Line Company	2,811,000	117,000	4.16	2,811,000	252,000	8.96
South Georgia Natural Gas Company	74,000	-0-	-0-	75,000	-0-	-0-
Southern Natural Gas Company	2,161,000	-0-	-0-	2,226,000	-0-	-0-
Tennessee Gas Pipeline Company, A Division of Tenneco, Inc.	4,190,000	-0-	-0-	4,315,000	-0-	-0-
Texas Eastern Transmission Corporation	3,827,000	510,000	13.33	3,929,000	501,000	12.75
Texas Gas Pipe Line Corporation	17,000	-0-	-0-	12,000	-0-	-0-
Texas Gas Transmission Corporation	2,474,000	-0-	-0-	2,609,000	-0-	-0-
Transcontinental Gas Pipe Line Corporation	4,378,000	-0-	-0-	4,458,000	-0-	-0-
Transwestern Pipeline Company	1,008,000	5,000	.05	1,021,000	87,000	8.52
Trunkline Gas Company	1,646,000	-0-	-0-	1,675,000	-0-	-0-
United Gas Pipe Line Company	5,549,000	1,657,000	29.86	5,610,000	1,859,000	33.14
United Natural Gas Company	553,000	-0-	-0-	605,000	-0-	-0-
The Union Light, Heat and Power Company	119,000	-0-	-0-	144,000	-0-	-0-
West Texas Gathering Company	300,000	-0-	-0-	300,000	-0-	-0-
Totals	69,750,000	4,736,000	6.79	71,246,000	5,125,000	7.19
Less: Pipeline to pipeline curtailments		880,000			884,000	
Net curtailment		3,856,000			4,241,000	

Comparison of Actual Interruptible Sales and Curtailments For
Year September 1972-August 1973 With Projected Requirements
and Deficiencies For Year September 1973-August 1974

Schedule IV
Page 1

	Actual - Year September 1972 - August 1973			Projected - Year September 1973 - August 1974		
	Interruptible Requirement (Mcf)	Volume Curtailed (Mcf)	Percent Curtailed	Interruptible Requirement (Mcf)	Volume Deficiency (Mcf)	Percent Deficient
Algonquin Gas Transmission Company	8,097,000	8,097,000	100.00	11,815,000	11,815,000	100.00
Arkansas Louisiana Gas Company	7,425,000	7,425,000	100.00	23,183,000	23,183,000	100.00
East Tennessee Natural Gas Company	23,368,000	-0-	-0-	24,303,000	-0-	-0-
El Paso Natural Gas Company	45,174,000	29,992,000	66.39	42,739,000	37,427,000	87.57
Florida Gas Transmission Company	123,581,000	23,425,000	18.95	155,438,000	46,038,000	29.68
Kansas-Nebraska Natural Gas Company	34,853,000	-0-	-0-	34,615,000	-0-	-0-
Mississippi River Transmission Corp.	85,098,000	77,000,000	90.48	84,680,000	84,680,000	100.00
Montana-Dakota Utilities Company	20,059,000	90,000	.04	20,243,000	120,000	.06
Panhandle Eastern Pipe Line Company	72,050,000	8,639,000	11.99	71,801,000	17,391,000	24.22
South Georgia Natural Gas Company	20,371,000	6,192,000	30.40	20,371,000	6,661,000	32.70
Southern Natural Gas Company	182,392,000	134,104,000	73.53	171,576,000	131,813,000	76.82
Texas Gas Transmission Corp.	5,312,000	-0-	-0-	6,202,000	1,349,000	21.75
Transwestern Pipeline Company	1,206,000	-0-	-0-	1,107,000	-0-	-0-
Colorado Interstate Gas Company	28,077,000	-0-	-0-	26,514,000	-0-	-0-
Northern Natural Gas Company	3,928,000	-0-	-0-	2,009,000	-0-	-0-
Totals	660,991,000	294,964,000	44.62	696,596,000	360,477,000	51.75
Less: Pipeline to Pipeline Curtailments		10,023,000			26,442,000	
Net Curtailments		284,941,000			334,035,000	

Comparison of Actual Interruptible Sales and Curtailments For November 1972-March 1973 Heating Season With Projected Requirements and Deficiencies For November 1973-March 1974 Heating Season

Schedule IV
Page 2

	Actual - Heating Season - November 1972-March 1973			Projected - Heating Season -November 1973-March 1974		
	Interruptible Requirement (Mcf)	Volume Curtailed (Mcf)	Percent Curtailed	Interruptible Requirement (Mcf)	Volume Deficiency (Mcf)	Percent Deficient
Algonquin Gas Transmission Company	671,000	671,000	100.00	227,000	227,000	100.00
Arkansas Louisiana Gas Company	4,885,000	4,885,000	100.00	11,476,000	11,476,000	100.00
East Tennessee Natural Gas Company	8,174,000	-0-	-0-	8,707,000	-0-	-0-
El Paso Natural Gas Company	36,588,000	28,600,000	78.17	29,260,000	29,260,000	100.00
Florida Gas Transmission Company	50,874,000	14,783,000	29.06	62,611,000	21,635,000	34.55
Kansas-Nebraska Natural Gas Company	16,626,000	-0-	-0-	16,659,000	-0-	-0-
Mississippi River Transmission Corp.	35,329,000	34,941,000	98.90	35,032,000	35,032,000	100.00
Montana-Dakota Utilities Company	10,679,000	90,000	0.84	11,120,000	120,000	1.08
Panhandle Eastern Pipe Line Company	28,696,000	7,640,000	26.62	28,216,000	10,777,000	38.19
South Georgia Natural Gas Company	7,634,000	3,578,000	46.87	7,634,000	3,773,000	49.42
Southern Natural Gas Company	47,786,000	39,517,000	82.70	43,585,000	37,057,000	85.02
Texas Gas Transmission Corp.	1,757,000	-0-	-0-	1,918,000	-0-	-0-
Transwestern Pipeline Company	414,000	-0-	-0-	412,000	-0-	-0-
Colorado Interstate Gas Company	3,617,000	-0-	-0-	2,089,000	-0-	-0-
Northern Natural Gas Company	2,674,000	-0-	-0-	1,404,000	-0-	-0-
Totals	256,404,000	134,705,000	52.54	260,350,000	149,357,000	57.37
Less: Pipeline to Pipeline Curtailments		5,878,000			12,986,000	
Net Curtailments		128,827,000			136,371,000	

Schedule V

Pipeline Companies Servicing Future Requirements Regions

	1	2	3	4	5	6	7	8	9	10
Algonquin Gas Transmission Company	X	X								
Arkansas Louisiana Gas Company						X	X			
Cities Service Gas Company					X	X	X			
Colorado Interstate Gas Co., A Division of Colorado Interstate Corporation						X	X	X		
Columbia Gas Transmission Corporation		X								
Consolidated Gas Supply Corporation		X					X			
East Tennessee Natural Gas Company		X	X							
El Paso Natural Gas Company						X	X	X	X	X
Florida Gas Transmission Company			X				X			
Great Lakes Gas Transmission Company				X	X					
Kansas-Nebraska Natural Gas Company					X	X	X	X		
Kentucky-West Virginia Gas Company		X								
Lawrenceburg Gas Transmission Company		X		X						
Michigan Wisconsin Pipe Line Company		X	X	X	X	X	X			
Mid Louisiana Gas Company							X			
Midwestern Gas Transmission Company				X	X	X				
Mississippi River Transmission Corporation				X		X	X			
Montana-Dakota Utilities Company					X			X		
Natural Gas Pipeline Company of America				X	X	X	X		X	
North Penn Gas Company		X								
Northern Natural Gas Company				X	X	X	X	X	X	
Pacific Gas Transmission Company									X	X
Panhandle Eastern Pipe Line Company		X		X		X	X			
South Georgia Natural Gas Company			X							
Southern Natural Gas Company			X				X			
Tennessee Gas Pipeline Company	X	X	X				X			
Texas Eastern Transmission Corporation		X	X	X		X	X			
Texas Gas Pipe Line Corporation							X			
Texas Gas Transmission Corporation		X	X	X			X			
Transcontinental Gas Pipe Line Corporation		X	X				X			
Transwestern Pipeline Company						X	X		X	
Trunkline Gas Company		X	X	X			X			
United Gas Pipe Line Company			X				X			
United Natural Gas Company		X								
Union Light, Heat and Power Company		X								
West Texas Gathering Company							X			
Western Gas Interstate Company						X	X		X	

Note: Some companies may have minor service in some areas not designated in this schedule.

Future Requirements Regions are those defined by the Future Requirements Committee of the gas industry as shown on Schedule VI.

Mr. ROGERS. We note that under section 601(a) the tax does not apply to a public utility as defined in section 247(b)(1), relating to the dividends paid deduction for public utilities. Section 247(b) of the code exempts pipeline companies subject to the Federal Power Commission regulation. Such exemption is clearly necessary because the return on investment of regulated pipelines is already limited to a just and reasonable level.

Senator GRAVEL. I would imagine—you probably have studied it more than I have in relationship to this case—that because of the regulation that they are not even close to 20-percent profitability. And since they are not even close, there is no way they are going to get taxed under this proposal.

Mr. ROGERS. Yes, sir. We——

Senator GRAVEL. And if utilities are making 20-percent, I am very surprised.

Mr. ROGERS. As a matter of fact, after looking at that law I hesitate to mention that; but I thought it would be better to nail it down for the purposes of the record.

Senator GRAVEL. Properly stated.

Mr. ROGERS. Now, No. 9, the loan guarantees and tax incentives for energy projects. We particularly support the concept of assistance through loan guarantees of the projects named in the bill. However, we feel that the language listing the type of project eligible for loans should be extended to include projects for the transportation or transmission of energy, especially projects relating to remote Arctic areas, undersea depths, and new or novel techniques in unique environments.

We generally support the tax incentive proposals, especially the investment tax credit. We urge that the investment tax credit be broadened to apply to continental as well as domestic projects to the extent such projects would provide energy for U.S. consumption. We would also suggest that tax credits should be extended sufficiently to permit utilization of the full credit.

No. 10, export and import policies. We would first point out that U.S. pipelines——

Senator GRAVEL. Excuse me again. Excuse me again, sir.

Mr. ROGERS. Sure.

Senator GRAVEL. Is that last sentence amplified in your full testimony?

Mr. ROGERS. Yes, sir. It is.

Senator GRAVEL. OK. Good.

Mr. ROGERS. We would first point out—well, let me say this in that regard. It may not be as fully pointed out—I mean, treated—as you would like; and with your permission we will furnish you some additional advice on that.

Senator GRAVEL. Right. Because I think we need your counsel as to what you mean by "extended sufficiently." We thought that what we had done had extended it. And if you could spot areas where it does not do that, I would like to know it, and I appreciate your taking care of Alaska in your prior paragraph. We did not intentionally omit it, I can assure you.

Mr. ROGERS. We would first point out that U.S. pipelines purchase large quantities of Canadian gas under licenses that do not expire until after 1985. We would suggest that the possible renewal of these licenses not be jeopardized.

We would suggest that the level of imports be determined by the President, who can balance the exigencies or need to the risks of dependence upon foreign sources. We also object to the issuance of licenses to the highest bidder, as it would prevent negotiations by U.S. energy companies with foreign producers associated with the gas import projects. Also, we believe that the President should be given the authority to regulate export of energy products, but the provisions of title VIII appear to be unduly rigid and could be harmful.

Now, we do treat that sentence a little more in the full statement; but it has to do, Senator, with relation to drilling and mining equipment, that some problems could arise.

Senator GRAVEL. And as a matter of fact, are in existence right now.

Mr. ROGERS. No. 11, changes in the Natural Gas Act. And this is repetition. Again, we strongly urge that the Natural Gas Act be amended to extend FPC jurisdiction under the act to the certification of proposed domestic plants for the manufacture or production of artificial or synthetic gas for transportation or sale for resale in interstate commerce by the natural gas companies.

We believe that the Federal Power Commission should continue to have jurisdiction over the importation and exportation of natural gas. It is better equipped than any other agency for this function.

We would recommend repealing section 3 of the Natural Gas Act with an appropriate grandfather provision granting the Commission authorization to certificate exports and imports under section 7 of this act. This would remove a cloud of uncertainty now present under section 3 whereby the Commission can, by supplemental order, revoke or modify permits previously granted.

Senator GRAVEL. Well, thank you very much, Mr. Rogers.

I think I used up my time, and you were kind enough to permit me to interrupt you, and so I feel that I have covered the areas that I have thought were necessary. I wonder if—and I only ask this, and you can respond to this not necessarily now but maybe provide it for the record—if you have a paper that discusses why gas got regulated and oil did not, from an historical point of view, or if you might have a bibliography of that subject, because I think from an historical point of view it would have some interest to the whole process.

Mr. ROGERS. We will try to brief that. As a matter of fact, we have all the hearings of the old 1956 Gas Act that was finally passed by the Congress and vetoed by the President.

[Mr. Rogers subsequently supplied the following material:]

This is a question that has caused grave concern for a number of years because both oil and gas are commodities developed by mining processes. It has been argued many times that it is unfair to treat natural gas as an integral part of a public service and to subject it to regulation, although admitting that it is a commodity similar to oil and other mined products such as coal, iron, copper, etc. Nevertheless, right or wrong, natural gas has been stuck with regulation and I will attempt to briefly treat the question and its development.

Before the discovery of natural gas, activities associated with the use of gas related to manufactured or artificial gas used in the close vicinity of its source. It was distributed by the use of pipes laid in the city streets or public thoroughfares and in accordance with rights obtained under franchises. Hence, it was developed as a public service or public utility and therefore regulated at local or state levels. On the other hand, oil was a bulk commodity that could be transported in a number of different ways and sold in different forms. Activities with relation to it did not require a franchise or any unusual use of public property or thoroughfares. It was considered a product, the marketing of which was highly competitive.

Whereas, on the other hand, since gas could only be transported by pipe and there was need for the use of the public thoroughfares, it was considered more the subject of a monopolistic control. Since natural gas became available, it was used generally in the areas in which it was naturally deposited. Its distribution and sale to the ultimate consumer was regulated under public utility laws and practices. The product itself was treated as a commodity and the wellhead price was not subject to direct regulation. When substantial advancements were made in the ability to transport natural gas over long distances, the interstate nature of such transmission became the subject of federal jurisdiction. At that time fears arose as to the possibility of monopolistic practices developing over huge sections of the country. Hence, the Federal Trade Commission in 1936 submitted a report to Congress on the subject matter and suggested legislation at the Federal level. The report, among other things, contained the following statement:

> ". . . A few large holding companies controlling the greater part of the business soon found it to their mutual advantage to recognize territorial rights, and to allocate territory to the end that each should monopolize the business in certain areas and stay out of the territory occupied or claimed by another. Without the competition of any rival line, such an organization to be completely successful need only take steps to preserve its rate structure before public service commissions and the courts. . . ."

Largely due to the Federal Trade Commission study, the Congress passed the Natural Gas Act in 1938 without a dissenting vote in either House. Since that time the interstate transmission lines have operated under the jurisdiction and regulation of the Federal Power Commission.

The Federal Power Commission had consistently held that it did not have jurisdiction over, among other things, the production and gathering of natural gas. However, in the Phillips Petroleum case of 1954, the Supreme Court reversed the Federal Power Commission and held that the Natural Gas Act applies to sales of natural gas in interstate commerce which are made during the producing and gathering phases of production or resale. The Court held that such control of field sales was necessary under the primary aim of the Act—to protect consumers from exploitation at the hands of the natural gas companies.

Hence, since 1954 the Federal Power Commission jurisdiction has extended from the wellhead to the city gate, at which point regulation is taken up by either the state or local regulatory authorities.

Senator GRAVEL. Maybe we could have a summary as to why this phenomenon occurred in our society, and is here again. Finally, and if you could back this up with some data, though you need not respond to the question if you choose not to right now, and that is concerning the nature of the gas producers in this country today; if you could identify their association, does it come primarily from the majors or do we have the minors that provide most of the gas, looking to the issue of competition?

Mr. ROGERS. Well, let me say this at the present time, and I do not know whether it is in the full statement or not, but our association at one time was composed of interstate pipelines, producers, and distributors. Since January 1 of this year it is now confined to interstate pipelines, as voting members, distributors and producers may be, associate members (nonvoting).

Senator GRAVEL. Only?

Mr. ROGERS. Only, that is right, except as pointed out. Now, you have several other associations, some independent producers, some major.

Senator GRAVEL. All right, then, let me not ask you to go out of your area, and if you could furnish us a breakdown on a percentage basis or identification basis as to the majors that are involved in pipeline ownership so that we could have some idea as to whether there is validity to the charge that the cartel is in the United States.

Mr. ROGERS. You mean the major oil companies?

Senator GRAVEL. Right; as to what their involvement is in the various gas pipelines in this country, if you have anything that could demonstrate that.

Mr. ROGERS. Any involvement; I would be glad to furnish it. I do not know of any involvement at all unless they are buying the stock on the open market.

Senator GRAVEL. That is fine, but I think documentation of that would be a very valuable asset in the record that we are making.

Mr. ROGERS. Good.

[Mr. Rogers subsequently supplied the following additional material:]

MAJOR OIL PRODUCERS WITH PIPELINE OWNERSHIP

Cities Service Company:
  Pipeline: Cities Service Gas Company
Tenneco, Inc.
  Pipeline: Tennessee Gas Transmission Company
Pennzoil Pipeline Company:
  Pipeline: United Gas Pipe Line Company
Coastal States Gas Producing Company
  Pipeline: Colorado Interstate Corporation

Senator GRAVEL. Very good.

I for one want to thank you again, and I turn it over to my colleague from Kansas.

Senator DOLE. Well, I only have a couple of questions.

One, I would be interested in exhibit A, which is mentioned in your full text, Walt; it is the producing areas, FPC producing areas.

Mr. ROGERS. Yes, we will furnish those. As a matter of fact, they should have been attached.

(Exhibit A referred to appears on the opposite page:)

Senator DOLE. I am particularly interested in the Hugoton-Anadarko Basin which covers part of Kansas, and we have a great reservoir of natural gas there that we would like to produce if we could deregulate the price of at least the new gas or somehow work out some compromise so that those who have great concern about consumers can be satisfied that we are not trying to jack up the price and drive away consumers, because I think they have had a bargain for a long time. We want them to continue to have that bargain, and it seems to me that we have got, even though the balance is fairly close in the Congress, there still, I think, needs to be more information available to consumer groups who have an open mind on the matter, and I am certain you are doing that. I think if we would have had deregulation we probably would not be in as much difficulty as we are now with reference to the total energy problem, but that is my opinion, and I am perhaps somewhat biased because I come from a gas-producing State, hopefully not.

But I do not think anyone quarrels with what—or anyone understands what is happening now. You have got all of the intrastate, and I do not know what the price—what is the price in Texas now for intrastate?

Mr. ROGERS. Well, there is some talk about $1, $1.25, an MCF, although most of it is probably in the area of 55 cents and 60 cents. It stays above the interstate rates, which is why the interstate market cannot get it.

Senator DOLE. So it is quite easy to determine what is going to happen, of course. Maybe some of these nonproducing States may understand the problems if it stays within the State. That has been suggested in our State. I do not totally agree with it, but if they are called in Topeka and New York City and you have got the gas in Hugoton and you represent that State, the choice is not too difficult, unless you want to commit political suicide, and I try not to do that on purpose.

Mr. ROGERS. I understand. I know what you mean.

Senator DOLE. But I had another question on curtailment. I am not the expert that either one of you are, but curtailment proceedings, you mentioned, have been instituted by 15 interstate pipeline companies.

Could you just inform me what that is, what does that really mean?

Mr. ROGERS. Now, the curtailment proceedings have to be approved by the Federal Power Commission.

Let me yield again to Mr. Mack on this because they are confronted with this as a daily situation.

Mr. MACK. Well, I should start by saying that my system is not involved in a curtailment proceeding. A great many are, though, Senator. I think the reference is to 15 major pipeline companies that are being curtailed, and you question what it is. It is a proceeding held before the Federal Power Commission to determine just how the available gas supply on that system shall be allocated in the light of the fact that they haven't enough to meet all of their requirements, you see, and you have in the hearing, you have various parties represented who take gas from that system, and each making his argument as to why he should be curtailed less than somebody else, for instance, or should not be curtailed at all.

Of course, the Federal Power Commission is looking at this from a standpoint of high end users. They, in their rules and regulations, are promoting high end users for the gas as opposed to, say, an inferior use such as putting gas under boilers for electric generation and so on. But that is generally what a curtailment proceeding is.

Now, in my system which serves—incidentally, we come through Kansas, one of our pipelines is Michigan-Wisconsin. You may have heard of it and I am sure Senator Gravel has heard of it from the standpoint of Prudhoe Bay and letting it across through Canada, and as I say, in our situation, we supply gas for the Midwest, notably Wisconsin and Michigan, and we have at the present moment an adequate gas supply by recent planning we have done, offshore and other areas, your Anadarko Basin. In Canada we take 330 million cubic feet a day from Canada, for instance. We are serving only high end users in our market areas.

In other words, while we are continuing to serve our requirements, we are on a program in our distribution areas approved by the individual State commissioners that restrict our distance to high end uses such as space heating, commercial heating, essential industry for which no other fuel does the job, and so on, you see.

Now, right alongside of us there is another area that is served by another system which is in curtailment. They have been cut something like a couple of hundred million cubic feet of gas a year because the supplier does not have the gas, as a great many do not have at the present time. I hope that gives you some idea.

Senator DOLE. That is helpful. I know in our own—oh, I guess you refer to your own areas, but Panhandle Eastern has had that problem, resulting in the Distributor Gas Service Co. being unable to provide natural gas to a couple of schools, and other institutions of that kind that are on interruptable contracts, and of course, converting to another fuel these days is expensive, not only the conversion, but the cost has increased so rapidly in propane and in other alternates that it has caused a great deal of anguish and concern, also a couple of cold days in school. And I have learned a little about that recently, that I had not understood.

But if the curtailment is—what do they say, 20 percent, an increase of 20 percent over last winter?

Mr. ROGERS. Approximately.

Mr. MACK. It was predicted to be by reason of the warmer than normal temperatures that they have encountered so far. I think Mr. Rogers said it perhaps did not reach that figure at this point.

Mr. ROGERS. Senator, that is the information from a report prepared by the FPC.

Senator DOLE. Oh, I see.

Mr. ROGERS. So any of that data can be obtained without any difficulty.

Senator DOLE. Well, do you agree that we have had some—well, a lesser crisis because of rather a mild winter so far?

Is that your view?

I mean, do you share that view expressed by others?

Mr. ROGERS. Yes; I think we have been very fortunate in the winter we have had so far and I hope that it stays this way.

Mr. MACK. I think this is exactly true, in our area, for instance. Let's talk about Michigan and Wisconsin, Senator. We have had in the last quarter of 1973, we had perhaps a 12 to 18 percent, depending upon the individual area, warmer than normal weather. Now, the first week or so of January we had colder than normal weather, but now, of course we are in another milder period, and of course this is very helpful from the standpoint of—particularly from the standpoint of the heating oil situation in our area.

Now, as I told you earlier, we have an adequate gas supply. We have not been forced to, what shall I say, to the same concerns that some other people have. We are conserving gas, as of course the Administration wants us to do, and we are making the gas that is available for conservation and also to the extent that we have any excess gas available to areas that do not have it.

You spoke of a system, and we have some people who are served by that system, notably Consumers Power. We perhaps sold them somewhat in the neighborhood of 20 billion cubic feet of gas in the last couple of months or so in order to alleviate their situation.

Senator DOLE. Well, is the Interstate Natural Gas Association of America convinced that we have an energy, maybe not crisis, but a severe problem?

Mr. ROGERS. I do not think there is any question. As a matter of fact, we have been warning about this for a number of years, but our voice has fallen on deaf ears.

Senator DOLE. The only reason I asked this, I have asked this question of every witness, because I think there is still a skepticism out there somewhere that the American people really cannot put a handle on. I mean, they are really not certain. Maybe it is lack of credibility with the President, maybe it is lack of credibility with the Congress. Maybe there is a feeling that the Government is ineffective, the policies are dictated by gas and oil producers, but there is that skepticism and it is rather widespread.

And I think it is important that the record show in every instance that at least those who have testified had a conviction that it is there, and that it has been growing or is growing. It has been there for some time.

Mr. ROGERS. Well, I think the reduction of the reserve to production ratio from 16 to 10 years is definite proof, and as a matter of fact, if the committee would like to have it, we have the most recent report from the Potential Gas Committee and from the Future Requirements Committee which reflects very clearly when you read it and understand it, the problem that you have in the gas industry as to present and future demands and supply.

Senator DOLE. You also have an information program designed for public consumption where—I mean an objective program aimed at, well, I guess convincing the people that it is real.

Mr. ROGERS. Yes. Well, actually, we have done this on not a large scale, because our association is not large in membership like a lot of associations. AGA, the American Gas Association, has addressed itself to this point and has done an admirable job.

Senator DOLE. Thank you very much.

Mr. MACK. I might, if I could say one word, Senator, along the lines of what you were talking about?

Senator DOLE. Certainly.

Mr. MACK. We all recognize, I think everyone in the industry recognizes, that there is a very acute shortage that is coming on apace, and that is why we are building projects that have been mentioned here and that are covered in Mr. Rogers' testimony. I refer to projects such as the synthetic gas plants, the Arctic gas project, if you will, and in Mr. Rogers' testimony, we have tried to expand the Senators' bill in some respects to aid in those projects, for instance, guarantees that would be extended to unusual projects such as the Arctic gas project on a midcontinental basis, not just a domestic basis, so long as the product of results, the gas, if you will, eventuates—it is coming to the United States, and of course, it is going to be necessary from a public interest standpoint, but those projects are simply tremendous. I have been on this Prudhoe Bay project since 1969 when we kicked it off, and we are looking at something like $8 billion in the way of costs for that project.

When you add to the costs of the project coming from Alaska through Canada and tie to it the cost of the facilities required in the Midwest, in the East and on the west coast to bring that gas to market, you are looking at $8 billion, and you have tremendous problems from the standpoint of engineering, from the standpoint of construction, and above all, from the standpoint of financing, and this is where we have made several suggestions with respect to the Senator's bill in order to aid in the fruition or coming into being of projects of that sort.

And so it is with gasification. Here we are talking about an individual plant costing $¼ billion, 250 million cubic feet of gas a day. These figures are not astronomical anymore. I worked on an economic survey, an economic portion of a natural gas survey for the Federal Power Commission, the industry worked on that, and I think that one showed that oh, as of a year or two ago, my recollection may be a little bit off—but we were shown that the industry had spent something like $25 billion up to that date, and here we are, to make the point at Prudhoe Bay, we are talking about a project that will cost $8 billion, one single project, and it will supply, when it comes into being, something like 5 percent of the gas that is being used that year, so you can see what a tremendous problem it is to finance those projects, and how essential it is that the Senator's bill recognize it, which it does. But we just have some additional ideas that we hope you would consider.

Senator GRAVEL. Thank you very much, gentlemen.

Mr. ROGERS. Thank you, sir.

Mr. MACK. Thank you, sir.

[The prepared statement of Mr. Rogers follows:]

PREPARED TESTIMONY OF WALTER E. ROGERS, PRESIDENT, INTERSTATE NATURAL GAS ASSOCIATION OF AMERICA

Mr. Chairman and Members of the Committee, I am Walter E. Rogers, President of the Interstate Natural Gas Association of America, referred to as INGAA. I am appearing here today on behalf of INGAA.

INGAA is a non-profit industry organization whose membership includes virtually all the major interstate natural gas pipeline companies in the United States. Our pipeline members today serve all of the lower 48 states, with the exception of Vermont, through an underground pipeline network now totaling more than 150,000 miles of transmission lines alone. They account for 90 percent of the total interstate sales of natural gas and provide the vital transportation link between the gas producer at the wellhead and the distributor who makes final delivery of gas to the consumer.

As the country's major transporters of natural gas we are acutely sensitive to the overall question of natural gas supply. Our customers now need and will require more gas than we can presently obtain for delivery. We, in turn, are expending every effort possible to guarantee future supply by the development of new reserves. However, despite these all out endeavors, fifteen of the interstate pipeline companies have found it necessary to institute curtailment programs and it is estimated that during the present winter heating season the customers of interstate pipelines will suffer curtailments aggregating approximately 509 billion cubic feet of gas, an increase of 20 percent over last year's winter curtailments.

In our opinion these curtailments will inevitably increase many fold unless prompt legislative action is taken to provide the necessary incentives and assurances to enable all segments of the gas industry to take the steps necessary to augment our Nation's diminishing gas supplies. Thus, I am pleased, Mr. Chairman, that you and the committee have provided the opportunity for us to appear and present our views at these hearings.

HISTORICAL BACKGROUND OF PIPELINE INDUSTRY AND FEDERAL REGULATION

The natural gas pipeline industry is a relatively young industry which has experienced its major expansion in the quarter-century since the end of World War II. The pipeline industry has grown impressively since then. Mileage of transmission pipe has increased from 77,000 in 1945 to in excess of 150,000 miles in 1971, the latest year for which data is presently available. Mr. Chairman, every major population center in the United States is served with natural gas, most of it supplied by our pipeline members. In all, natural gas pipelines now supply one-third of the energy requirements of the United States.

Gross utility plant of the pipeline companies has increased from $2.1 billion in 1946 to $22.1 billion in 1971, and sales revenues for the same period have jumped from $612 million to $6.4 billion annually. During this same period, annual marketed production of natural gas increased from 3.9 trillion cubic feet in 1945 to 22.5 trillion cubic feet in 1971 and in 1972.

Pipeline companies are commonly characterized as the middlemen in the natural gas industry. Although some pipeline companies own natural gas production, and others are affiliated with companies engaged in exploration for and production of natural gas, and some have distributor affiliates, the operations of most are limited predominantly to the transportation of natural gas from the gas field to the market. They deliver and sell natural gas to distributing companies for resale to residential, commercial and industrial customers. Pipelines are dependent upon their suppliers, the natural gas producers, for a continuous and adequate supply of gas.

The pipeline industry is a capital-intensive industry characterized by a high proportion of fixed, immobile assets. Consequently, a pipeline must remain in service for a relatively long period of time to pay off its debt and recoup the equity capital provided by its investors as well as to provide continuing natural gas service to the millions of consumers dependent on this service.

Gas supply is the lifeblood of the pipeline industry; if it cannot produce or buy and deliver gas, it has no function to perform and consumers would be deprived of the gas they need.

The most critical problem facing the pipeline industry at the present time is the unavailability of adequate gas supplies. It is imperative, therefore, that to the extent possible additional gas supplies be expeditiously discovered and developed in areas reasonably accessible to the pipeline systems. Unlike other enterprises dependent upon wasting assets, pipeline companies are tied to specific areas of production and distribution by their extensive investment in immobile facilities. Therefore, it is highly desirable to foster di covery and development of gas reserves within the lower 48 United States which are accessible to these pipeline systems, thereby enabling a continued efficient use of this vast network of underground pipelines supplying the Nation's gas consumers.

Since 1938, the pipeline industry has been comprehensively regulated by the Federal Power Commission under the provisions of the Natural Gas Act (15 USC 717, *et seq.*). The Act gives the Commission responsibility for regulating the rates for the transportation of natural gas in interstate commerce and the sale of natural gas in interstate commerce for resale; the certification of facilities for the transportation or sale of gas in interstate commerce and regulation of natural gas companies engaged in such transportation and sale. On June 7, 1954, the United States Supreme Court in the *Phillips* case [1] held in a 5-3 decision that the sale of natural gas by independent producers in interstate commerce for resale was subject to the jurisdiction of the Commission under the terms of the same Natural Gas Act that is applicable to interstate pipelines. Since that time, as this Committee well knows, the Commission and the courts have been struggling unsuccessfully with the problem of producer regulation.

Now, over 19 years later, it is abundantly clear that the effort to regulate producers under such Natural Gas Act has been a failure. We believe that part of the present crisis can be attributed directly to uncertainty and unresponsiveness of wellhead price regulation under the restrictions of current law as defined by the courts. Some means must be found to permit the long-term sale of new gas supplies at prices which reasonably reflect its commodity value from time to time as a premium fuel in relation to alternate energy supplies and thus encourage producers, pipelines and pipeline producing affiliates to make the tremendous expenditures required to search for and develop badly needed gas reserves. In addition, means should be provided to honor definite contract provisions for prices for flowing gas.

THE ENERGY CRISIS IN THE UNITED STATES

Because of its relatively pollution-free characteristics and low price, natural gas has been, and continues to be, a most desired fuel. Even by the most conservative of estimates, if we could be certain of unlimited supply, the use of natural gas could be expected to more than double in the next 20 years.

[1] *Phillips Petroleum Co.* v. *State of Wisconsin*, 347 U.S. 672, 74 S. Ct. 794 (1954).

The facts are, however, that unless we can bring about a dramatic reversal in the trend of gas reserves additions, we simply are not going to come near fulfilling present, much less future, demands for gas. Indeed, as I have noted, we are already experiencing a critical shortage of gas with resultant steadily increasing curtailments of present customers.

Much has been said about this growing shortage of gas supply and it is clear from the testimony before this Committee that the energy crisis is real and not contrived or imagined. This crisis promises to be with us for some time, if not indefinitely, unless innovative, remedial and realistic legislative steps are taken now. A 1972 Federal Power Commission staff study projects annual gas supply deficits in the United States of about 9 trillion cubic feet by 1980 and 17 trillion cubic feet by 1990. These are startling figures, Mr. Chairman, and should be a matter of great concern to the Congress and to every citizen of this country. I can assure you, they are of deep concern to the industry I represent.

With few exceptions, the reserve/production ratio in all of the major supply areas of the lower 48 states has experienced a steady downward movement and is approaching dangerous levels.[2] According to Federal Power Commission data, the reserve/production ratio of reserves connected to the interstate pipelines has dropped from 16.4 years in 1966 to 10.5 years in 1972.

The estimated proved reserves of natural gas for the United States, excluding Alaska, have declined sharply in the last six years as reported by the American Gas Association. Even with Alaskan reserves included there has been a sharp decrease in proved reserves for the last two years with production far exceeding new additions to reserves. Using AGA figures, the reserves to production ratio at the end of 1972, with Alaska included, is 11.8 years. If Alaska is dropped out the reserves to production ratio would be 10.5 years. In May of 1973, the Federal Power Commission Staff issued its own report on natural gas reserves and arrived at estimates that are approximately 10 percent below those projected by the American Gas Association.[3]

Certainly, the forecasting of natural gas reserves is not an exact science and various studies may reasonably derive different results from an analysis of the same or similar data. In any event, and whether you accept the AGA figures or the FPC study, it is abundantly clear that we are consuming natural gas at a far greater rate than we are discovering new reserves. Reserve additions simply are not keeping pace with demands.

The alarming decline in our traditional domestic reserves and the tremendous increase in consumer demand have combined to create a large imbalance between available supply and present and projected demand. The effect of this growing natural gas supply crisis on the interstate pipelines and the ultimate consumer of natural gas is easily discernible and knows no geographic boundary.

Because of diminishing gas reserves, the pipeline companies have intensified their own acquisition efforts in the attempt to supply consumers with the required service. Moreover, the worsening reserve picture and intense competitive situation for domestic reserves have also forced the interstate pipeline companies to seek alternative sources of supply such as the production of gas from coal, oil, naphtha and other light hydrocarbons, importation of Canadian gas, and importation of liquefied natural gas. All of these proposed alternatives, in conjunction with greatly intensified exploration for and development of our domestic supplies, will be required if we are to ameliorate the gas shortage.

The Commission has recognized the worsening gas supply situation and has taken several innovative steps in an attempt to make additional gas supplies available to the interstate market. While these moves have been of some help, principally as a "stopgap," they have not solved and will not solve the long-range or, indeed, near-term supply problem. Moreover, even these limited measures have come under attack in the courts, and recent decisions make it clear that meaningful steps to alleviate the gas shortage cannot be accomplished within the framework of the existing outmoded statute.

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[2] The reserve/production ratio is the ratio between proven or known reserves and the annual production rate. While a reserve/production ratio of 10 means that proven or known reserves are 10 times annual production, it does not mean that this full production rate can be maintained for 10 years or that a pipeline has a 10 year supply. As a matter of fact, the availability of gas to a pipeline may be much less than 10 years as the productive capability of wells to deliver the gas declines. It is inaccurate, therefore, to assume that an R/P ratio of 10 years means that reserves would be available for the full 10 year period.

[3] On October 15, 1973, the FPC released a revised staff report which shows that the nation's proven recoverable natural gas reserves totaled 258.6 trillion cubic feet at the end of 1970, about 1.2 percent lower than the 261.6 trillion cubic feet estimate contained in the original National Gas Reserves Study report released last May 17. The FPC also reported on October 3, 1973, that in 1972 for the fifth consecutive year, the natural gas reserves committed to interstate pipeline companies registered a decline, from 161.3 trillion cubic feet to 148.6 trillion cubic feet.

Under present conditions, the prospect of obtaining significant additional quantities of natural gas for the interstate market, over both the short and long term, remains bleak unless Congress acts promptly and meaningfully.

THE REASONS FOR THE SHORTAGE

In view of the critical gas shortage and the resulting adverse consequences already disrupting energy transmission, distribution and consumption, it is necessary to examine the basic causes of the problems in order to formulate paractical and useful solutions.

In general, the underlying causes are economic, statutory and governmental in nature. They are, therefore, susceptible of solution, or in any event, substantial improvement if the Congress has sufficient interest in helping to accomplish this.

More specifically, regulatory obstacles and restrictions upon producers and pipelines, environmental problems, as well as governmental policies withholding or restricting development of the sources of gas, especially federal leases, have been largely responsible for the difficulties with which we are confronted.

Our supply problems are greatly aggravated by the fact that intrastate purchasers are generally exempt from the governmental restrictions to which I have referred, and governmental obstacles progressively stifle those producers which supply interstate markets and discourage new entrants.

The ultimate irony of too restrictive a framework for price regulation has been that the underpricing of the gas has made it much more popular to use at the same time it became much less popular to search for and develop, thereby aggravating the gas shortage at both the market end and the supply end.

A. FPC Regulation of Producers and Pipelines

There would appear to be no need to particularize the various features of the Federal Power Commission's statutory charter, or the particular decisions which it has promulgated in the 19 years following its first excerise of jurisdiction over producers, mandated by the Supreme Court in the *Phillips* case. Only a few of the features of producer regulation need be mentioned here, although the total effect of all producer regulation is a major cause of the current supply problem.

Regardless of the make-up of the Commission at any particular time, and despite varying forms of efforts to apply novel and even non-utility standards to its regulation of producers at different points during the 19-year period, the plain fact is that the language of the Natural Gas Act will not stretch to the extent needed to obtain workable solutions. Upon most occasions when the Commission has undertaken to loosen the strictures, the courts have swiftly wiped out its efforts.

This is not intended as a general criticism of courts as they exercise their review function over Commission decision, nor even as to the Commission when it fails to decide a matter in the way best calculated to improve gas supply availability. Rather, it is intended to recognize that the source of most of the regulatory difficulty for all forms of supply is the statute in its present posture—ill-suited to the task at hand.

The precise impact upon the producers, discouraging the search for and dedication of gas to interstate markets, has been at least four-fold.

First, the utility-type standard which is applied in implementing the rate-fixing provisions of the Natural Gas Act—both in disallowing contractual price adjustments and in evaluating the lawfulness of existing rate levels—is an insurmountable obstacle to enlargement of the industry's search for new gas supplies or the commitment of those supplies to the interstate market.

Second, virtually all producer sales in interstate commerce are required to be made at prices substantially less than the true commodity value of the gas.

Third, there is always the prospect of future rate reduction orders; or in any event, delay or disallowance of contractual price adjustments, again largely because of the statutory interpretation of the Commission and the reviewing courts.

Fourth, there has been persistent delay in obtaining authorization for producer sales and necessary activities to connect the gas to interstate pipelines; aggravated in some instances by delays in regulatory approval of the pipeline aspects of the project. Commission efforts to reduce the wasteful delay have been partially successful, but under the present statute it will never be possible to eliminate all of the wasted motion and its economic consequences.

And finally, it should be recognized that the economic disincentives applicable to producer activities are present also in the case of production activities of the pipelines and their producing affiliates under the present statute, and the same obstacles to gas exploration and development exist in this sector as well. It is essential that pipeline producing affiliates be placed on a parity with independent producers.

To the considerable extent that these major statutory flaws have contributed to our gas shortage, their correction is likely to help solve the problem; and conversely, absent prompt correction of the statutory origin, a more pronounced shortage will inevitably result.

B. The Impact of the Intrastate Markets

It should be recognized that although the present shortage of gas is nationwide in scope it is not spread evenly among gas consumers. Rather in most instances its adverse effects are concentrated on the large and populous areas of the nation which depend upon interstate pipelines for their gas supplies.

The intrastate market for gas in states which produce more of this fuel than they consume presently has such a pronounced advantage over the vastly larger area dependent upon interstate supplies that any new volumes exposed to competition from the intrastate market are almost invariably lost to it. Unfortunately, the imbalance becomes more severe as the shortage increases.

With the exception of offshore areas from which gas production is interstate because of its location, the trend toward greater dedication for intrastate use is applicable in each of the major producing areas. Ninety percent of all gas produced in the United States originates in the five major producing areas which are located either wholly or partially within the States of Texas and Louisiana: 1. Texas Gulf Coast; 2. Permian Basin; 3. Hugoton-Anadarko; 4. Other Southwest; and 5. Southern Louisiana—state taxing jurisdiction.[4] In many of these key areas the intrastate market has been taking the bulk of the gas for several years.

Of even greater significance, perhaps, is the adverse experience of the interstate pipelines in acquiring gas from the two promising gas-prone areas in which exploration for gas has been relatively active during recent years, namely the Southern Louisiana and Permian Basin areas. With regard to Southern Louisiana, the major portion of its onshore gas was being committed to the interstate market from 1966 through 1969, but this pattern changed in 1970 and since then a significant portion of the gas which became available has been committed to intrastate purchasers. This adverse experience is even more pronounced in the Permian Basin area.

The principal features which in their combined effect have precluded the interstate pipelines from purchasing their share, or indeed virtually any, of the recent offerings of this new production are (i) the inability of the interstate pipelines to pay the going market price for the gas—indeed the interstate pipelines are not even able, if they are able to negotiate a purchase, to assure the seller that they will be able to pay the initial contract price under the statute and regulations governing interstate purchases; (ii) the uncertainty as to whether periodic fixed and other price adjustment features of the contract will be permitted to take effect, or even whether the price initially allowed will be protected against reduction; and (iii) the delay in attachment of the supplies and commencement of the deliveries due to statutory red tape and regulatory delav

It is these defects which must be overcome if the interstate purchasers are to be permitted to obtain any substantial volumes of new natural gas supplies to counteract the mounting shortages in their market areas. It is thus essential that interstate purchasers be placed on a parity with intrastate purchasers so that they may compete on equal terms for the purchase of new gas supplies.

C. Punitive Regulations of the Pipeline Industry

I have been discussing the reasons for the gas shortage in the context of the stifling effect the statute, regulations and court decisions have had upon the exploration and development of domestic natural gas supplies and the inability of the interstate pipelines to compete effectively with the intrastate market for the relatively smaller volumes of gas now available to meet the country's needs. The problems go deeper, however. Even when Congress cures the statutory and regulatory defects in this area, problems plaguing the interstate gas pipeline industry must be solved.

Statutory and regulatory obstacles threaten to block interstate pipeline company efforts to develop new supply sources such as synthetic gas from coal

[4] The FPC Production Areas are shown on the map facing page 1416.

and liquid hydrocarbons, foreign LNG and natural gas from frontier areas such as Alaska and the Canadian Arctic. Indeed, such obstacles even threaten the ability of the interstate pipelines to acquire new supplies of domestic gas without assuming intolerable risks.

For example, it is widely recognized that even with optimum exploration for and development of our domestic natural gas reserves, our nation's gas consumers will require substantial supplemental supplies such as synthetic gas from coal and liquid hydrocarbons, foreign LNG and imported gas from frontier areas. In the Federal Power Commission's Staff Report No. 2 on National Gas Supply and Demand 1971–1990, previously referred to, it is recognized that there will be "heavy reliance on imports and other supplemental supplies of gas which will account for about 40 percent of consumption by 1990." Yet despite the obvious need for supplemental supplies, the Federal Power Commission has steadfastly refused to give the pipeline industry any assurance that the recoupment of the costs of such projects, including a reasonable return on invested capital, will be allowed in future pipeline rate cases—largely because the facilities involved were held to be non-jurisdictional and the gas to be outside the scope of the Commission's jurisdiction under the Natural Gas Act until commingled with natural gas supplies. Indeed, the Commission has made it clear that if pipeline companies implement such projects, they do so at the risk of having the actual costs of such projects disallowed in future rate cases.[5] Obviously, these highly capital intensive supplemental fuels projects cannot be financed if industry is saddled with such intolerable risks.

Accordingly, we strongly recommend that the Natural Gas Act be amended to extend the Commission's jurisdiction under the Act to the certification of proposed domestic plants for the production or manufacture of artificial or synthetic gas for transportation or sale for resale in interstate commerce by natural gas companies. It should be made clear that, as in the case of other projects certificated by the Federal Power Commission, once certification is granted the costs of imported, artificial or synthetic gas projects prudently incurred by the applicant will be recoverable in its rates.

COMMENTS ON S. 2806

Within the limits of time available to us, we have given consideration to the provisions of S. 2806 and are prepared to comment on a number of provisions of the Bill. We will first address ourselves to the deregulation of producer sales, as contemplated by Section 502 of the Bill, after which we will comment on various other provisions of S. 2806 of particular interest to the pipeline industry.

A. Deregulation of Wellhead Sales of Natural Gas (Section 502)

We feel that Section 502 of the Bill is definitely a step in the right direction, but without amendment it could lead to inordinately higher prices and a decreasing supply of gas to interstate markets.

In our view the solution that would best serve the twin objectives of protecting the consumer while providing the necessary incentive to stimulate the exploration and development of new domestic gas supplies would be to permit new gas to be sold at prices up to a level reflecting the commodity value of gas in relation to the prevailing price of other fuels. We therefore recommend that Congress enact legislation providing for the establishment of an index, formula or procedure designed to establish the commodity value of gas from time to time, which would serve as a ceiling price for gas purchase contracts.

Since such a procedure would be self-executing, producer prices would be freed of the red tape and delay of regulatory control and the constant cloud of litigation, but at the same time the consumer would be protected by an automatic monitoring system which would prevent the wellhead price from rising above its commodity value in relation to other forms of energy. All segments of the industry and the consuming public would be protected from runaway prices on the one hand and assured adequate price levels on the other.

It is essential also that any legislation changing the present method of regulating wellhead sales of natural gas contain four additional provisions:

[5] See, *Re Columbia LNG Corp., et al.*, Docket No. CP71-88, *et al.*, Ops. 622 and 622-A, issued, respectively June 28, 1972, and October 5, 1972; *Algonquin SNG, Inc., et al.*, Docket Nos. CP72-35, *et al.*, Ops. 637 and 637-A, issued respectively, December 7, 1972, and February 6, 1973; see also, *re Algonquin Gas Transmission Company*, Docket No. RP73-98, Order Suspending Proposed Rate Increase and Denying Motion to Consolidate, issuee October 12, 1973, and Order Denying Motion for Oral Argument and Granting in Part Application for Rehearing and Reconsideration, issued November 23, 1973; *El Paso Natural Gas Co., et al.*, Docket No. CP73-131, *et al.*, Op. 663, issued September 4, 1973.

First, any modification of present regulation of new gas should apply only to sales under long term contracts, and by that I mean contracts with a minimum term of 15 years or the life of the dedicated reserves, whichever is the lesser, whether it be a new contract or a rededication of reserves under an old contract which has expired. The pipeline industry cannot finance or construct the expensive facilities required to transport gas from producing areas to market without the assurance of long-term supplies, and some assurance of the availability of the gas is therefore essential.

Second, it is equally essential, for reasons stated earlier, that the legislation should place interstate buyers on a parity with intrastate buyers so that they may compete on equal terms for the purchase of domestic gas supplies. If this is not done, intrastate purchasers will continue to capture the bulk of new gas found in non-Federal supply areas.

Third, we urge that any legislation adopted by the Congress establish the sanctity of the provisions of all gas purchase contracts and prohibit any change by the Commission in the terms or conditions of the sales as provided by the contracts once those contracts have been finally approved by the Commission.

Fourth, it is essential that pipeline purchasers of gas be allowed to reflect in their rates the costs of both new and flowing gas, as presently provided in Section 502(e) of S. 2806. Our concern in this connection stems from recent Federal Power Commission actions exempting certain producer sales from regulation on the theory that indirect price control can be achieved *by refusing to permit the pipelines to recover prices paid to the producers* if the Commission should later determine such prices to be unreasonable or imprudent under some as yet to be announced standards. We submit that the pipelines cannot continue to adequately serve the public if they are required to operate under such regulatory hindsight policies. As noted above, we advocate relief for the producers in the form of prices which reasonably reflect the commodity value of their gas but such relief cannot and should not be granted at the expense of the pipelines. The pipelines make no profit whatsoever out of the purchase and sale of gas. Instead they are limited solely to the opportunity to earn a reasonable return on their investment in pipeline transportation facilities. Thus, legislation permitting producers to obtain higher prices from the pipelines must likewise permit the pipelines to recover such prices. Otherwise, they will be denied the opportunity to realize a reasonable return on their invested capital with a resultant impairment of their financial integrity and ability to continue to render service to the public.

B. Energy Trust Fund, Tax on Energy Sources and Administration

Because of limitations of time, it has been difficult to arrive at a detailed and precise pipeline industry position regarding the proposal to establish a trust fund through imposition of a tax on energy sources, as provided in Title II of S. 2806. However, the establishment of a fund for the purpose of developing and carrying out "a national energy program involving energy research, demonstration, development, utilization and conservation to meet the present and future energy needs of the United States," as contemplated by Section 302(a) of the Bill, is clearly in the public interest. We have the following additional comments concerning this aspect of the Bill:

First, if a trust fund is established through imposition of a tax on energy sources, it is important (1) that *all* of the funds thus collected be used for the purposes indicated and for no other purposes, and (2) that the trust fund be administered by the Federal Energy Administration within general guidelines. In our view, the Federal Energy Administration should be empowered to enter into commitments to make grants, loans and guarantees from Trust Fund monies and should not be subject to the necessity of obtaining periodic and detailed appropriations to make such expenditures. In the event that Congress retains the power to appropriate funds, we strongly urge that such funds be made available in such way as (1) to lodge direct authority for the funding of specific projects in the Administration and (2) to permit the funding of projects extending over a period of years. Annual funding of long range projects, in our view, would not be practical.

Secondly, we do not see the need for a separate Commission on Energy Technology Assessment, as provided by Title IV of S. 2806. Such a divided responsibility for determining how funds should be expended for energy research and development, and the divorcement of the task of assessing the necessity, impact, costs, etc., of various energy programs from the actual administration of such programs would, in our view, create intolerable confusion and lack of direction.

We urge that the functions contemplated by Title IV be carried out under the direction of the Federal Energy Administration itself, not by a separate and co-equal commission.

C. Excise Tax on Uninvested Profits From Energy Sources

INGAA members are presently reviewing in detail the provisions of Section 601 of S. 2806 imposing an excise tax on uninvested profits from energy sources and would respectfully request permission to submit additional comments. However, we note that under Section 601(a) the tax "does not apply to a public utility as defined in Section 247(b)(1) (relating to the dividends paid deduction for public utilities)." Section 247(b)(1) of the Code exempts pipeline companies subject to Federal Power Commission regulation under the Natural Gas Act since it refers to corporations whose rates are subject to approval by an agency of the United States.

Such exemption is clearly necessary because the return on investment of regulated pipelines is already limited to a "just and reasonable" level. Since the test of "just and reasonable" rates is related to the earnings necessary to permit the company to raise capital to carry out its public service obligations, any tax on the earnings allowed by the regulatory agency would necessarily impinge on the company's ability to provide adequate service.

D. Loan Guarantees and Tax Incentives for Energy Projects

Section 304 of S. 2806 provides loan guarantees to persons or corporations with whom the Federal Energy Administration has entered into contracts pursuant to Section 303. We particularly support and endorse the concept of assistance, through loan guarantees, of projects to design, construct and operate commercial-size facilities to produce energy from oil shale, coal gasification, etc., as contemplated by Section 303(a)(6). Many of these projects would be difficult to finance at acceptable capital costs without government guarantees. As that section indicates, these are "unconventional sources of energy," and some assistance in the financing of the projects, which involve enormous sums of money, is therefore justified and required.

We wish to make two additional points with respect to the subject of loan guarantees under Sections 303 and 304.

First, we are concerned with the provision of Section 304(h) which authorizes the Administration to include a provision in the loan guarantee contract under which the Administration agrees to purchase any such energy so produced on a cost and reasonable profit basis. We would not object to such a provision provided the company is not *required*, as a condition of the loan guarantee, to sell the energy to the Administration. However, since each company has its own service obligations and must plan to meet particular requirements, we would object to any provision under which the Administration could, in effect, take over the role of marketing gas from the projects involved.

Second, there will undoubtedly be projects to transport or transmit energy which will involve new technology and unconventional engineering techniques equal in difficulty and risk to the kinds of projects contemplated by Section 303(a)(b), such as pipelines constructed in remote Arctic areas and at undersea depths requiring unconventional approaches. In addition, some pipeline or transportation projects may require such massive amounts of capital as to require Federal loan guarantees if the project is to be successfully financed. We therefore suggest that Section 303(a)(6) be broadened to extend to apply to projects for the transportation or transmission of energy by new or novel techniques or in unique environments.

With respect to the tax incentives provided by sections 901 and 902 of S. 2806, we generally support the proposals, particularly the increased investment tax credit for property used in the development, storage or transportation of oil, gas, coal or any other energy source as provided in Section 902(a). This would be of great assistance in meeting the enormous capital requirements faced by the energy industries in financing supplemental supply projects. In addition, we urge that the investment tax credit provided by section 902(a) of S. 2806 be broadened to apply to continental as well as domestic projects to the extent such projects would provide energy for United States consumption. Such extension of investment tax credit would be particularly helpful and justified in connection with projects such as the proposed pipeline to transport natural gas from Alaska to the lower 48 States which would be located principally in Canada. In order that the tax credits authorized by this section provide the maximum incentive for domestic exploration the carryover-carryback provisions and the 50% limitation provision of the existing tax laws should be extended sufficiently to permit utilization of the full tax credit.

E. Export and import policies

The gas pipeline industry supports the proposition that the development of domestic supplies of energy is a matter of first priority and that the nation's principal efforts should be in the direction of energy self-sufficiency. We are concerned, however, over some of the policy statements concerning energy self-sufficiency and the provisions of S. 2806 designed to implement that policy by regulating exports and imports.

First, Section 102(1) expressed the policy of the United States ". . . to achieve energy independence by 1985 and to reduce progressively the dependence of the United States on foreign sources of energy between now and that date."

This statement ignores the fact that United States pipelines purchase large quantities of gas from Canada under licenses that do not expire until after 1985; that these pipelines have extentsive facilities in place which would be rendered inoperative if current licenses are not renewed; that there is a vast interdependence between Canada and the United States in the electrical energy field; and that in order to meet immediate shortages in energy it will be essential to enter into 1985 (e.g., imports of foreign LNG and natural gas from the Canadian Arctic). In short, the policy statement, we believe, should speak in terms of efforts to move progressively toward energy independence without stating as national policy the achievement of complete independence by a particular date.

Second, we believe that the statutory limitation of imports from Arab countries under Section 702 to 5 percent of the estimated United States consumption is unduly rigid. We would suggest that the level of imports of energy products be determined by the President, who can balance the exigencies or need at any particular time to the risks of dependence upon such sources. We also object to the proposal in Section 702(e) that licenses for the importation of energy products would be issued by the Government to the highest bidder. This would be impractical in our view and wold prevent the negotiation by United States energy companies of agreements with foreign producers which are essential to the formulation of gas import projects.

Third, the provisions of Title VIII relating to exportation of energy producing commodities and essential drilling or mining articles appear to be far too broad. For example, this would prevent a contract drilling company from undertaking a contract to drill for oil and gas in a foreign country without obtaining a license from the Secretary upon the submission of bids. We believe that the President should be given authority to regulate exports of energy products, but the provisions of Title VIII appear to be unduly rigid, cumbersome and restrictive.

COMMENTS OF INGAA ON OTHER PROPOSED CHANGES IN THE NATURAL GAS ACT

As indicated earlier in my testimony, the member companies of INGAA urge that the Natural Gas Act be amended to extend the Federal Power Commission's jurisdiction under the Act to the certification of proposed domestic plants for the manufacture or production of artificial or synthetic gas for transportation or sale for resale in interstate commerce by natural gas companies.[6] As I indicated, if the vast sums of money required by these projects are to be raised, assurances must be provided that the costs incurred in the construction and operation of the facilities will be recovered in the company's rates. Certification of such facilities by the Federal Power Commission, necessarily accompanied by recognition of the costs prudently incurred in implementing the certificated project for rate-making purposes, would go far toward providing the necessary assurances.

Finally, we believe, contrary to Section 502(d) of S. 2806, that the Federal Power Commission should continue to have jurisdiction over the importation and exportation of natural gas since it is better equipped than any other Federal agency or instrumentality to exercise this function. However, in order to require the Commission to pass upon the issue of whether proposed export and import projects are required by the present or future public convenience and necessity and to "sanctify" import authorizations once approved by the Commission, we recommend repealing Section 3 of the Natural Gas Act with an appropriate grandfather provision and granting the Commission authorization to certificate exports and imports under Section 7 of the Act. We believe that such an amendment is necessary to remove a cloud of uncertainty which now exists under the present Section

[6] The Columbia Gas System, Inc., a member company, has requested INGAA to advise the Committee that it is not in agreement with this particular recommendation.

3 whereby the Commission could at some future time by "supplemental order" revoke or modify permits previously granted. The existing requirements for Executive permission for exports and imports as provided for in Executive Order 10485 would remain unchanged under this proposal.

CONCLUSION

We appreciate very much, Mr. Chairman, the opportunity to submit our views to the Committee on this important matter. We would be pleased to furnish any additional information or data available to us for your consideration if the Committee shou d so desire.

Senator GRAVEL. Our next witnesses are representing API. There are a couple of gentlemen, Mr. William L. Henry, executive vice president, Gulf Oil Co., and Mr. Annon M. Card, senior vice president of Texaco, on behalf of American Petroleum Institute.

Mr. Henry and Mr. Card, if you would take your seats in front, you can have anybody come forward that you might want to assist you. They can sit behind you, and just by way of introduction, Mr. Henry is known to me. I have known him as a very fine executive from a very fine company, and I am very happy to have you here.

So that gives him a little bit of an edge.

But let me say that by way of procedure, we will not swear you in or ask you to take an oath unless you feel that that might operate as a constraint.

I noticed my good friend Mr. Henry here has quite a statement. You can proceed as to however you want to handle that, Mr. Henry.

STATEMENT OF WILLIAM L. HENRY, EXECUTIVE VICE PRESIDENT, GULF OIL CO., ON BEHALF OF THE AMERICAN PETROLEUM INSTITUTE

Mr. HENRY. Thank you very much, Mr. Chairman, Senator Dole. We appreciate very much the opportunity to testify on behalf of the American Petroleum Institute. I appreciate very much your kind words, Mr. Chairman.

Let me just say, if I may be personal, I was obviously very impressed when I read in the Congressional Record of December 1973 your introductory remarks when you introduced the bill to the Senate, S. 2806, and I have never seen really a more cogent, clear, concise understanding and explanation of what created this problem in the United States of America for the energy crisis, and the reasons we should put forward to solve it than was in the preface to that bill which you introduced, and your particular remarks.

I am again particularly impressed today, Mr. Chairman, in your conversations with Dr. Ray of the Atomic Energy Commission with whom we are very familiar, and I think that you ought to be commended because I certainly respect and admire your leadership in this particular effort. It is indeed a refreshing contrast to those that are playing politics with a great national emergency which we have seen over the last 3 days, and which you know Gulf has been quite heavily involved in.

Namecalling of any kind is not going to solve this problem for us and it is not going to solve the energy crisis, and I do not believe it is going to fool the American people under any set of circumstances. We all need to work together on this program. We need to work together constructively. We need to work together honestly. It is the only way we are going to solve the problem which is facing us, and any hysterical and uninformed tax that you impose on the industry is not going to do this job for us. So I certainly do appreciate the remarks that you made.

This bill which you have introduced pulls together many parts of the energy puzzle, as we see it. It is an important stride forward in recognizing what must be done to bring our Nation back to balance in energy supply and demand.

We commend the Senator and the committee for this excellent initiative.

I have a long and detailed statement to submit, but we are not going to read that, for which I am sure you are very happy. But instead, I would like to emphasize that the energy problems of the United States are highly complex, but there are some pure and relatively simple objectives we must keep straight in our minds, and I would like to talk about those.

First, as Senator Dole asked, there is an energy shortage. There is no question about it in our mind. To solve it, we must increase production of all domestic energy and we must increase efficiency in the way we use our energy which is one of the principal reasons of this present problem.

Second, we have to think big. And not be afraid of bigness. The job that must be done is enormous. Enormous in terms of what the Federal Government must do and what the energy companies must do. It is enormous in terms of money, manpower, and brainpower.

The National Petroleum Council says it will take $200 billion through 1985 in domestic oil and gas facilities alone, and most of this must be supplied by the industry. Another $300 billion will be needed for the production of other fuels and of electric power. This total cost will be 20 times bigger than the whole Apollo program to date.

Senator GRAVEL. Excuse me. That is $200 billion for oil and gas? And then the other was——

Mr. HENRY. Other fuels and electric power, nonconventional sources and electric power.

Senator GRAVEL. Thank you.

Mr. HENRY. My third point is that we can make it. Obviously we can make it as an industry. We can make it as a country, but the Congress must write the bills that can make this happen. The energy companies must be allowed to make enough money to help generate the enormous capital that is going to take to do this job for us. And this is the awesome background we see when we evaluate bill S. 2806 which has been proposed by the chairman.

First, let me comment briefly on the Governmental organization provisions of the bill and then comment briefly on the tax provisions.

The bill established a Federal Energy Administration, and we do need an overall energy administrative group in the executive branch of the Government. But the API is concerned over the scope of the charter for this Federal Energy Administration in the bill. The bill has empowered the Administration to build and operate demonstration and commercial energy facilities, to explore for and produce coal, oil, and natural gas, and to market the output of these operations.

In short, the FEA is empowered to act almost as a national energy company, with the authority to preempt future developments.

Now, granted, the bill also provides the FEA the right to contract these activities out to industry, but no requirement to do so is specified.

Now, we're sure that the authors of the bill did not intend that the FEA preempt future energy activities. But the intent must be clearly specified and the separate roles of Government and industry be precisely spelled out. The role of Government should include establishment of policy, regulations, and standards, the provision of a favorable investment climate, and the monitoring of the industry's performance. Industry's role is the construction of commercial facilities, their operation, and the commercial production and distribution of energy.

We feel that the organization provisions can best be accomplished through the following program.

One, have a central body charged with studying in detail the national energy situation and proposing comprehensive long-range policy. Such a body has been provided for in bill S. 70, introduced in the Senate last year. This body would be comparable in a number of ways to the Council of Economic Advisers.

This group should be involved only with formulating policy. If it were to have the responsibility for administering authorized programs, it would become so involved that it would have an unacceptable bias toward demonstrating the merit of these programs. This could mean that programs would be continued past their day of usefulness.

The energy spectrum is going to be a changing thing, and it will have to be reappraised continuously. This takes objectivity that will only come through a separation of the policy and administrative functions.

Second point. The FEA should have transferred to it existing and new administrative functions. This includes the Energy Research and Development Administration and the Energy Trust Fund. It would also include energy functions of the Cost of Living Council, the Office of Energy Conservation, the Office of Petroleum Allocation and others.

Point three. There must be a coordinated energy research and development capability. Such a program has been provided in the modified version of bill S. 1283, as passed by the Senate last December, and we commend it. The bill specifies that the role of Government will be primarily to sponsor research projects to be carried out by the private sector.

Point four. A Federal funding mechanism, such as the Energy Trust Fund proposed by Senator Gravel's bill, will be important in stepping up development of new energy technology.

Projects eligible for Energy Trust Fund support seem to fall into two categories: First, pilot plant and demonstration plant, which is jointly funded and for which there would be no obligation on the non-Government participant to repay funds.

The second category is the construction and operation of prototype first-generation commercial scale projects. Here, the developer would arrange the financing and the trust fund would provide loan guarantees not to exceed 90 percent of the total. The developer will be putting up a portion of the capital and will benefit only if the project operates profitably. And therefore, he will have a strong incentive to be efficient and productive.

Senator GRAVEL. Excuse me, Mr. Henry.

Is that expanded upon in your text?

Mr. HENRY. Yes, it is, Mr. Chairman.

Senator GRAVEL. Very good.

Mr. HENRY. In regard to import controls, orderly decontrol of all energy prices, which is the phasing out of the price controls, and increased leasing, which means that we need more quickly and at a more rapid rate offshore Federal leasing land, all of these are most important, and they are in fact critical to an adequate domestic energy supply.

Some other features of the bill: It provides that the United States shall not import petroleum from Arab countries in an amount greater than 5 percent of our consumption and this provision we think should be eliminated. Without this oil, America will be colder, darker, than we now are.

The bill also contains provisions relating to the import and export of energy and energy related equipment, and provides that most favored nation treatment be denied any importing country that refuses to join a group to negotiate with the oil exporting countries.

These provisions we feel would be counterproductive.

A word about taxation.

First, Gulf and the API strongly support continuation of the present tax provisions, particularly percentage depletion, intangible drilling costs, IDC, and foreign tax credits.

Second, excess profits tax.

We do not have excess profits. Profits have increased, but they are nowhere in the range of what may be considered excessible, especially when compared with the very low earnings of recent years. For example, Gulf's profits represent only a 5-percent annual growth rate since 1968, not even enough to cover inflation. This is far short of the 18-percent rate which the Chase Manhattan Bank has said will be required of the industry if we are to develop adequate domestic energy supplies.

Senator DOLE. How do you combat the headlines, though, that like Exxon, 59-percent profits up. I agree with your first statement. I may not be able to stay for all of the testimony because I have another commitment, and I think it would be very realistic, of course, for the majors to become the whipping boy. There is more politics in kicking you around than Richard Nixon these days.

Senator GRAVEL. Almost as much.

Senator DOLE. No; there is much more, having had about 60 public meetings in my State, there is a feeling in a real sense that it is contrived and that because of oil contributions and politics that they run the Government, in essence, either both parties, one or both.

And there is that skepticism that I keep finding, and I think once people are convinced, there is going to be more voluntary conservation measures undertaken at a greater saving, but it must make the oil executives have, not sleepless nights, but troublesome times, and maybe without total justification.

Mr. HENRY. Yes, sir, Senator Dole. I could not agree more. We do have sleepless nights and troublesome nights, and I can personally guarantee that. But let me suggest what I tried to say earlier, about the chairman himself. I think with the leadership you are providing and what we are talking about today is what this country really needs today. We are in this kind of difficulty because we have the demagogs who are attacking us, for whatever particular reason they choose, whether they are running for office, or regardless. We do not need that kind of leadership, Senator. What we really need is leadership for the country to survive this particular crisis.

Whether we are capable of telling our own stories in industry, we are going to try to do more, but what we really need is the kind of leadership which I think the chairman showed today in his discussions with Dr. Ray.

Senator DOLE. Well, there is a fear, and it may reach even those in politics that we might be laying the groundwork to killing off an industry and I do not suggest what motivates some in politics. I think I have probably engaged in a little sparring with the oil companies when I was home, because we have independents, of course, and we try to put them in a different category, but if you read the excess profits provision, it applies even to the gas service station operator, whether it be Texaco or Gulf, if he has made an excess profit or a larger profit this last year than he made in the base period, then he has to pay an excess profits tax, and I think we are talking about jobs, and I do not suggest that there might not be some middle ground, but it does seem to me that—what does the latest poll show, that 27 percent of the people feel that it is contrived by the companies, and I do not know where you draw the line between a major and a minor oil company, or between a small and a large farmer, or lawyers or doctors or whatever.

Is there some magic line out there that indicates that these people made a lot of money and others did not?

Mr. HENRY. No, sir, not that I am aware of and I think it is something that we very often overlook, that the independent operator, as he is so-called, is out there and he needs our help as do the majors, and we must consider him all the time when we are talking about depletion, and intangible drilling costs and quotas and things of that kind are things that are very often overlooked in the governmental process. It is extremely important to the industry and to the country.

Senator DOLE. You think the foreign tax credit should not be changed?

Mr. HENRY. Yes, sir, Senator. I think it should not be changed, and I think really for the reasons that you are pointing out. Here we are in a situation of extreme difficulty and emergency, and our total effort seems to be to destroying the very industry that can possibly get us out of it. It does not make any sense to me. It never has. We need more help, not less help.

Senator DOLE. Well, I think the one portion of the foreign tax credit that troubles some of us is whether you are in effect paying to those countries taxes or royalties.

Mr. HENRY. Yes, sir.

Senator DOLE. And if there should be the offset, if it is a royalty, and I know the Treasury Department has been—this is not a new problem. It is one that has been around for a long time, and it was raised by Senator Ribicoff at an earlier full committee hearing, and it seems to be an area that would be considered carefully by the Finance Committee.

Mr. HENRY. I am sure it will be, Senator, and to draw a conclusion, basically what happens is that any sovereign government, as I see it, is entitled to pass whatever law it chooses. I do not think the United States either has the right or wants to tell people what kind of laws they should write, and if the foreign government decides that it has a tax levied on income, I think that is its privilege, and I am sure that we would object violently if Kuwait or Saudi Arabia or Ghana or Abu Dhabi, Bahrain, came over and told us, well, that is very nice but you cannot write a law that levies income tax on U.S. citizens. We have got to deny you that right.

So I really think they have got that privilege.

Senator DOLE. But it has even been suggested by some again in politics, that this was sort of a conspiracy between those who operate in Saudi Arabia and others, and the Government, so—well, you understand all those things.

Senator GRAVEL. Would you pursue that, Senator Dole? I think you are touching on the crux of one of the problem areas that the Finance Committee is going to have to handle in this area.

Senator DOLE. I think we were all sent home in December saying the recess was going to be a referendum on Richard Nixon.

Well, he ranked about seventh. He was below propane, bailing wire, fertilizer, Daylight Saving Time, and a host of other things. There is still a strong feeling there, but people are concerned about jobs, and they had their axes out for a lot of different people. Most politicians have fair antennas. Some are seeking the Presidency, some are just seeking reelection, some are just seeking safety, and so I think that may have generated this first week of showmanship, and if it is a three-network hearing, everybody shows up. Not today, though; Mike and I are alone, but if the cameras come, we would have a fuller attendance.

But in any event, you understand those things, and hopefully that, after this initial rash of—I do not say it is without some justification—but this initial rash of trying to capitalize on what some see as a real political asset, maybe we can sit down as the chairman is trying to do and look at the crisis, look at the foreign tax credit, the depletion allowance, and other matters more constructively.

Mr. HENRY. Well, Senator, obviously I think that is terrific, and I offer any help that we, as an industry, can offer and that I personally can offer, and I am obviously glad to do it.

Senator GRAVEL. Mr. Henry, could you touch upon what Senator Dole mentioned, the difference, or the impact financially, of whether it is considered a royalty or whether it is considered a tax? What is the impact from the foreign investment tax credit?

Maybe if you could chart us up with some numbers, or we will do it together, and that way we will really all put it in our minds.

Mr. HENRY. All right, Senator, we will try.

Let us presume for a minute we have $100 income in a foreign country and operating cost is what, $30, which means that there is a net income to be taxed of $70—that is $100 less the $30 operating cost.

Senator GRAVEL. Would the operating cost include royalty payments? Or do you lump that together?

Mr. HENRY. For practical purposes, they include royalty. It would be included as an operating cost in this particular calculation.

Senator GRAVEL. So that would be an expendable item? So, including royalties in your costs——

Mr. HENRY. Yes, that is basically correct. That gives us roughly $70 net income. And let us presume that the income tax rate effectively is 80 percent in a foreign country where it happens to be. That is, what, $56 tax that would be due to foreign government and that is the first calculation that is made.

We then come over and calculate the U.S. income tax which on the same $100, less the $30, the same net income of $70 at our effective tax rate of, let me say, 50 percent so I can multiply easily, would be $35.

Now we, theoretically, would owe the U.S. Government $35. But our tax laws permit us to credit against that $35 the $56 which we paid to the foreign producing country. And therefore effectively saying that our tax to the United States is zero, none. Zero on income earned in that foreign country. It is not effecting U.S. income.

If that credit were to be taken away from us, then obviously we would pay the $35 to the United States, or some portion of it, as well as the $56 to the foreign country, and we would be getting ourselves up to a 90-percent tax against the operation, and in the case I've just used, we would actually have a real loss of about $20.

Therefore, that foreign tax credit is extremely vital to any industry. And let me also point out on that point, that this is—the foreign tax credit is obviously not something that just the oil industry has. Any American company operating overseas under the tax structure has a foreign tax deduction. It is an attempt, and I think it is the right kind of attempt, to equate taxes paid in the United States and abroad so there is no double taxation so it is an important provision in our tax laws.

Senator GRAVEL. Would it change your computations, say if you took out within that $30 cost deduction of the $100, if you said $10 of that was royalty and you took that $10 and moved it down so you had only a $20 deduction, that would give you $80, and then took 80 percent of the $80, that will not change or alter what your financial benefit would be in these computations would it?

Mr. HENRY. If I understand you question correctly, Mr. Chairman, that then we have an $80 profit against——

Senator GRAVEL. Well, let us not consider royalty as a cost. Consider it as a tax. Does it make any difference?

Mr. HENRY. Under that sort of circumstances, no, because we have an excess credit even greater actually than we now have.

Senator GRAVEL. If you did not have an excess, what would be the impact then of treating the royalty as a tax rather than as a cost?

Mr. HENRY. It would increase the excess credit, but basically I think, Mr. Chairman, the problem is to treat it the other way, that the difficulty is that some, as I think Senator Dole pointed out, that somebody will consider the taxes as a royalty and the effect of this is to reduce the foreign tax credit which is available to us so that our credit of $56 in your illustration would be reduced and we would have to pay tax both to the United States and to the producing country.

Senator GRAVEL. Yes, I see.

Mr. HENRY. So actually, Mr. Chairman, it goes the other way. The effort is to try to get the taxes classified as royalties.

Senator GRAVEL. As royalty?

Mr. HENRY. Yes, sir.

[The additional comment was subsequently supplied for the record by the Gulf Oil Corp.:]

A U.S. oil company receives a credit for foreign taxes paid, but only up to the amount of U.S. tax that would otherwise be due. To the extent the foreign tax exceeds the U.S. tax, the excess cannot be used as a credit against U.S. taxes on U.S. income. Treasury has estimated that oil companies probably have \$500–\$700 million annually in unused foreign tax credits. Treating foreign royalties as taxes would only increase the amount of unused foreign tax credits, and thus, would have little if any financial effect.

On the other hand, treating the foreign taxes as royalties would have an adverse financial impact. Suppose a U.S. company earns \$100 in the foreign country and pays a foreign tax of \$60. With a U.S. tax of \$48 there would be no U.S. tax if the foreign tax of \$60 can be credited against the U.S. tax of \$48. However, if the foreign tax is treated as a royalty the \$60 would be deducted from the \$100 and U.S. tax of 48% of \$40 or \$19 would be due. Thus, the company's total tax burden would be increased from \$60 to \$79. We believe this would result in U.S. companies being fatally disadvantaged relative to their foreign competitors who pay no home country tax on foreign operations.

Senator GRAVEL. Very good. What do you do with your excess credit?

Mr. HENRY. Well, Senator, in summation, we eat them.

We do not spread them across the rest of the world.

We cannot take them against the United States, they are just there. We calculate them and that is the end of it.

Senator GRAVEL. Do all companies do that?

Senator DOLE. Can you spread them from one foreign country to another?

Mr. HENRY. No, sir, we do not in Gulf because we are on what we call a per-country limitation so if we have an excess tax in let us say Kuwait where our major operation is, we are not able to apply this in any other country in the world, United States or foreign.

There is another limitation called the overall limitation which does permit an averaging of all taxes, but again only at the effect of the U.S. income tax rate against income, earned regardless of source.

So effectively then you cannot take that tax credit which is at the averaged U.S. rate from country A and apply it to country B. And I know that there are some oil companies, and other industries, who do have the overall credit and who do have the ability to move the tax. I do point out, however, that you can never exceed on the average what is the effect of the U.S. income tax.

So basically it is an averaging factor and in addition as I remember the tax laws, there is a penalty to the company for that because it is not entitled to deduct their exploration costs in the calculation if they elect the overall credit.

Senator DOLE. What about the intangible drilling costs that have been suggested that that be taken away in foreign development?

Mr. HENRY. Senator, I think that the most important thing of all is for the oil industry, and therefore the United States, to have the use of all of the oil and the control of all of the oil that we can have. I just do not believe that under any set of circumstances should we consider reducing the incentives that are granted to any segment of the oil industry at this particular point in our history.

Senator DOLE. But does that not conflict with our goal of Project Independence, if we encourage you to spend it or drill it or find it, explore for it in a foreign country rather than domestically?

Mr. HENRY. Senator, we are going to look for it, basically, wherever we can find it, and I do not know that in the history of the Gulf Oil Co., we have ever not looked in the United States for a good commercial prospect of oil. The difficulties have been slow offshore leasing.

Senator DOLE. If it is the same for Texaco, I think we might just bring both in. It might save some time.

Mr. CARD. Well, I was not interrupting because I think some good points were being made, but certainly it is essential that the international oil companies be allowed to compete effectively in foreign markets and in foreign countries for production.

Some of the limitations or some of the restrictions that have been suggested would definitely put the American international oil companies at a disadvantage, a distinct disadvantage in these producing countries. Other countries, keep in mind, are anxious to be in production in many of these areas. Some are not. But if these restrictions were imposed, as have been suggested, I can assure you that the American oil company would be at a distinct disadvantage and the production would be handed to perhaps some others on a silver platter.

Now, this is a very grave danger of some of the suggestions and some of the bills that have been presented.

Senator DOLE. Is there—well, I think what we are suggesting—should there be a disincentive for foreign development and a further incentive for domestic development?

Mr. CARD. Sir, let me mention on this point, it is going to take all of a maximum effort, worldwide, to make energy available to supply the needs. Now, in the United States there are some who are fearful that because of that in foreign areas that it will lessen the effort in the United States. This is simply not true on behalf of the petroleum industry. The industry—and I speak for Texaco specifically—is doing its maximum, has done and is continuing to do its maximum to develop, explore for and produce crude oil and natural gas as well as other sources of energy in the United States.

As an example, we just had our results for 1973, and some 35 percent of our earnings came from the United States, whereas 55 percent of our expenditures are in the United States, and this is an indication of the efforts that are being made.

Senator GRAVEL. You mean capital expenditures?

Mr. CARD. Yes, sir.

Senator GRAVEL. Could you submit that for the record?

Mr. CARD. I would be glad to submit a copy of our press release that we put out yesterday, sir.

Senator GRAVEL. All right, very good. But it does regionalize your capital?

Mr. CARD. Outside the United States and inside the United States.

Senator GRAVEL. I wonder if you could, Mr. Henry, supply the same thing from Gulf?

Mr. HENRY. Yes, sir.

Senator GRAVEL. This would give us some indication as to where the English is being placed on the ball.

Mr. HENRY. Let me just point out dramatically that of the $2 million capital budget which Gulf is projecting for 1974, the major bulk of it is for resource acquisition in the United States.

[The following material was subsequently received for the record:]

NEWS FROM TEXACO, INC., NEW YORK, N.Y.

TEXACO REPORTS 1973 EARNINGS

FOR IMMEDIATE RELEASE: THURSDAY, JANUARY 24, 1974

NEW YORK, Jan. 24—"The full year 1973 produced the highest earnings for any year in Texaco's history, and the fourth quarter of 1973 similarly showed higher earnings than in any previous quarter," Maurice F. Granville, Chairman and Chief Executive Officer of Texaco, announced today. "While these results are gratifying, it must be recognized that these periods were highly unusual."

Consolidated net income of Texaco Inc. for the full year 1973 amounted to $1,292,403,000, or $4.75 a share, compared with $889,040,000, or $3.27 a share for 1972. This was an increase of 45.4%.

Net income for the fourth quarter of 1973 totalled $453,486,000, or $1.66 a share, compared with $266,637,000, or $.98 a share for the fourth quarter of 1972. This was an increase of 70.1%.

This strong upswing, especially in the letter part of 1973, followed a period of four years in which the Company's returns on both gross income and total assets had been lagging behind the average returns of the past ten years," Mr. Granville said. "The higher earnings reflected sharp increases in product prices that followed the imposition of the Arab oil cutbacks and embargoes in October as well as the continued high levels of worldwide operations. This strengthening of product prices over the previously unsatisfactory levels took place both in Western Europe and other overseas markets and in the United States within Cost of Living Council guidelines."

Approximately 35% of the 1973 earnings was attributable to United States operations, compared with 49% in 1972. The bulk of the earnings gain for 1973 came from other areas worldwide. The United States earnings amounted to $454,000,000 in 1973, an increase of 3.6% over the United States earnings of $438,000,000 in 1972, but did not reach the 1968 level of approximately $548,-000,000. Earnings attributable to other areas of the world amounted to $838,000,000 in 1973, an increase of 86% over such earnings of $451,000,000 in 1972.

"United States earnings failed to keep pace because of declines in United States crude oil and natural gas production and because of price controls on petroleum products and on existing production in the face of sharply rising costs," Mr. Granville said.

Consolidated gross income for the full year was approximately $11,834,000,000 in 1973 and $8,972,000,000 in 1972, an increase of 31.9%.

Gross income for the fourth quarter amounted to approximately $3,579,000,000 in 1973 and to $2,442,000,000 in 1972, an increase of 46.6%.

Mr. Granville stated that the Company's net income for 1973 averaged about 10.9 cents per dollar of total sales and other gross income, and thus showed a significant improvement over the return of 9.9 cents per dollar for 1972. However, the 1973 return on gross income was lower than Texaco's average return of 12.9 cents per dollar for the previous ten years, he noted, and lower than the return in every one of those years except 1972.

The Texaco Chairman also pointed out that the Company's earnings as a percentage of average total assets, including equity in total assets of non-subsidiaries, after being disappointingly low for some years, amounted to approximately 9.4% in 1973. This return, while somewhat improved over the ten-year average of 8.4% followed four years of below-average returns on assets.

When measured against sales of petroleum products and crude oil, net income in 1973 averaged only about 1.7 cents a gallon, Mr. Granville said.

"There is no assurance," the Texaco Chairman said, "that the 1973 earnings gains will be continued into 1974 in view of the numerous uncertainties throughout the world." He specifically cited the unprecedented level of current petroleum prices, and the increases in taxes and royalties of almost 10 cents a gallon in the oil-exporting countries, effective January 1, 1974, and other increases in costs and expenses.

Mr. Granville also estimated that approximately 30% of the increase in foreign earnings of $387,000,000 represents the effect of the higher net value, in terms of U.S. dollars, of the operating earning realized in the currencies of the countries in which operations outside the United States are conducted.

The Texaco Chairman pointed out that, "including Texaco's equity in non-subsidiary companies, its capital and exploratory expenditures reached a peak of about $1.6 billion in 1973 and could be close to $2 billion in 1974." Approximately 55% of these expenditures are allocated to United States operations.

"Texaco's improved level of earnings will help in meeting the tremendous capital requirements of the future, as well as significantly greater requirements for working capital resulting from higher receivables and higher-cost inventories of crude oil and refined products," Mr. Granville said. "If we are to provide the energy needed by this country, we must have adequate earnings and an investment climate that will support even higher levels of capital expenditures."

Mr. Granville noted that, "despite the tight supply situation throughout the year and especially during the last quarter, Texaco's marketing operations supplied slightly more product to U.S. customers during the full year 1973 than during the previous year."

Texaco's operational results for the full year 1973, compared with 1972, were reported by Mr. Granville as follows: Gross production of crude oil and natural gas liquids, 4,535,000 barrels a day, up 12.5%; refinery runs, 3,058,000 barrels a day, up 3.3%; petroleum product sales, 3,472,000 barrels a day, up 2.4%; and natural gas sales, 4,516,000,000 cubic feet a day, down 3.9%. These operational figures include interests in affiliated companies and purchases provided for under agreements with Saudi Arabia and Iran.

Texaco's results for the past 3 years are as follows:

	1973	1972	1971
Net income	$1,292,403,000	$889,040,000	$903,868,000
Net income per share	$4.75	$3.27	$3.32
Gross income	$11,834,000,000	$8,972,000,000	$7,757,000,000
Gross production of crude oil and natural gas liquids (bpd)	4,535,000	4,021,000	3,516,000
Refinery runs (bpd)	3,058,000	2,952,000	2,883,000
Petroleum product sales (bpd)	3,472,000	3,381,000	3,140,000
Natural gas sales (mcfd)	4,516,000	4,685,000	4,181,000

GULF OIL CO.

	1973	1972[1]	1971	1970	1969	1968	1976[1]	1966	1965	1964
Total corporate:										
Net income	800	447	561	550	611	626	568	505	427	395
Net assets	5,569	5,409	5,521	5,279	5,040	4,751	4,412	4,089	3,819	3,591
Rate of return net assets (percent)	(14.6)	(8.2)	(10.4)	(10.7)	(12.5)	(13.7)	(13.4)	(12.8)	(11.5)	(11.3)
United States:										
Net income	226	327	341	359	407	420	391	358	304	267
Net assets	3,029	3,303	3,123	3,270	3,222	2,999	2,753	2,641	2,550	2,420
Rate of return net assets (percent)	(7.1)	(10.2)	(10.7)	(11.0)	(13.1)	(14.6)	(14.5)	(13.8)	(12.2)	[2] (11.0)
Foreign:										
Net income	574	120	220	191	204	206	177	147	123	128
Net assets	2,540	2,106	2,398	2,009	1,818	1,752	1,659	1,448	1,269	1,171
Rate of return net assets (percent)	(24.7)	(5.3)	(10.0)	(10.0)	(11.4)	(12.1)	(11.4)	(10.8)	(10.1)	[2] (10.9)

[1] Before extraordinary write-off.

[2] Calculated on average net assets except for 1964 which is calculated on actual.

	1973	1972 [1]	1971	1970	1969	1968	1967	1966	1965	1964
Total corporate:										
Exploration expense	156	141	113	109	123	110	106	101	91	70
Capital investment	479	357	253	239	388	444	294	260	272	245
Total	635	498	366	348	511	554	400	361	363	315
Earnings (after taxes and dividends)	800	447	561	550	611	626	568	505	427	395
Exploration expense	156	141	113	109	123	110	106	101	91	70
Total	956	588	674	659	734	736	674	606	518	465
Total investment and exploration as percent of inc. and exp	(66)	(85)	(54)	(53)	(70)	(75)	(59)	(60)	(70)	(68)
Total United States:										
Exploration expense	57	53	39	46	52	46	59	51	58	53
Capital investment	375	277	113	130	251	254	177	180	180	170
Total	432	330	152	176	303	300	236	231	238	223
Earnings (after taxes and dividends)	226	321	341	359	407	420	391	358	304	267
Exploration expense	57	53	39	46	52	46	59	51	58	53
Total	283	374	380	405	459	466	450	409	362	320
Total investment and exploration as percent of inc. and exp	(153)	(88)	(40)	(43)	(66)	(64)	(52)	(56)	(66)	(70)
Total foreign:										
Exploration expense	99	88	74	63	71	64	47	50	33	17
Capital investment	104	70	140	109	137	190	117	80	92	25
Total	203	168	214	172	208	254	164	130	125	92
Earnings (after taxes and dividends)	574	126	220	191	204	206	177	147	123	128
Exploration expense	99	88	74	63	71	64	47	50	33	17
Total	673	214	294	254	275	270	224	197	156	145
Total investment and exploration as percent of inc. and exp	(30)	(79)	(73)	(68)	(76)	(94)	(73)	(65)	(80)	(63)

[1] 1972 capital investment as reported in the 1972 Annual Report was $349. It has been restated in 1973's Annual Report for comparative purposes.

Senator DOLE. I do not want to get away from the bill, but I do have to leave and I want to ask another general question that perhaps both could discuss. What do you see as far as further increases at the pump, the gas pump?

Have we reached the plateau or——

Mr. CARD. I will be glad to respond to that, and it will not be very responsive, but this is an area, sir, that I feel very sensitive about from the standpoint of trying to project what the prices will do. This is an area of antitrust that I have consistently asked, or respectfully asked that we not be called on to try to project what prices might do because this is a very sensitive area.

So I think it is very difficult to project under these circumstances, and this time, the rise in crude oil prices abroad. I think it is very difficult to even project it, and I would ask that I not be asked to do that.

Senator DOLE. Well, I understand that problem. It is just as difficult to project whether it might go down then, too, is it not?

Mr. CARD. You could make assumptions, I suppose, where you could expect it to, but I would have to say at this point it is not likely to.

Senator DOLE. Is that about the same?

Mr. HENRY. Yes, sir, I agree with that, Senator. I do not think it will go down.

Senator DOLE. Is there a conspiracy of the major oil companies to get together and decide what the price is going to be?

Mr. HENRY. Senator, may I just point out that I met Mr. Card for the first time yesterday?

Senator DOLE. I am not suggesting that you do, but—

Mr. CARD. For the record, sir, I would like to say there is absolutely no conspiracy such as has been alleged.

Senator DOLE. Have you met with Ralph Nader lately?

Mr. CARD. I have not—no, I have not, sir, but I might add I have been in the hearings for 3 days this week and I have testified to this effect previously, and I think there is absolutely—this is one of the things, sir, that we talked about—we talked about public confidence earlier, and this is one of the things that needs to be clarified, and the American people need to understand this, and the only way that we are going to get any degree of confidence in the efforts that are being made to overcome this energy shortage is for the American people to know the facts and for the people in Government to be willing to support the facts instead of trying to find some small inkling of error that has been made and make this the big headline, or make this the big thing to bring before the American people rather than the facts and the efforts that are going on to get this Nation out of this critical situation that it is in, and it is going to take a long time, even under the best of conditions, and whenever we see some of the things that are happening, it is only going to add to that time element in order to cure the energy shortage.

Senator DOLE. Well, I think it is very basic. There is no question about it. It is right out there, and right now the credibility of the industry is very low. I assume that everyone will be making an objective effort to change it. But you do have the problem of the headline hunter and others, and again, I do not absolve the companies from all fault, either. I think they all make mistakes. The Government makes enough.

I do not know the answer, but I think Senator Gravel's bill at least addresses itself to the problem rather than the headline. It is just going to take a while to convince, if that is the word, the American people that it is not the way they have been told the past 30, 60 days.

Mr. CARD. Senator Dole, I quite agree. We have a serious problem and it is going to take the combined effort of the industry people, the Government and the American people to overcome this critical problem that we are in today, and I would hope that there would be greater cooperation. I have certainly gone on record so far as Texaco is concerned, and offered to cooperate in every way that we possibly can, with Government to provide facts and information and to work jointly to give the facts to the American people and elicit their help. We must have the cooperation of the American people in conservation in order to cope with this situation.

I think we made good progress. It is encouraging. But we have only begun and it is going to require a tremendous amount over the next decade, not just this year or next year, but conservation is with us and it is going to be with us. It is a very important element, and I think the greater job we can do of educating and getting the confidence of the American people in this situation, the more they will be willing to cooperate in the areas of conservation, and I think this is an extremely important point.

Senator DOLE. Hopefully in some States across the country the American public is having an opportunity to question men like yourselves. in your corporations in a public forum setting where they can raise the questions that they raise with the guy who is running the gas station or the fellow who is the mayor or the Congressman or whatever. I do know there are some who are skeptical about the radio, TV and newspaper ads by Gulf and Texaco and other companies.

Mr. CARD. We are aware of that, sir, and it is a major effort, will continue to be a major effort, substantial amount of advertising funds, for example, now, newspaper, radio and TV, and so forth, is going into the effort, conservation as well as programs to inform the public of the facts, and we certainly carefully research before anything is presented to make sure that it is factual and can be backed up.

Mr. HENRY. I can only echo Mr. Card's sentiment, Senator.

Senator DOLE. Pardon me for that long interruption.

Senator GRAVEL. Could I just add something, pursuing the point where we were with royalty as opposed to net income; this would be a request for API to take the big eight and give us a breakdown in tabular form of, let us say, the profits from domestic activity from the last 10 years, and profits from foreign activity over the last 10 years, and for the foreign profits, break it out so that we could see if the tax were treated as royalty, what your foreign profit would be.

The only figures I have at hand, and I wish I had your statement, are Exxon's. They give 18 percent profitability for their integrated efforts in the world, and around 12 percent for domestic activity, which means that they have just reached the 18 percent profitability that Mr. John Winger of Chase Manhattan suggests as the figure needed if we are going to finance our needs in the private sector. So, if we cut back that profit level, then of course we are just denying you the capital to do the job, and I would like to see what a chart would show in that regard—when the chips fall where they may.

Mr. HENRY. Yes, sir, we would be pleased to do that.

Mr. Chairman, may I also say in your conversation this morning with Dr. Ray, she pointed out that the private industry is willing and able with Government to help to do the kind of job which we are now facing, which I found to be a very interesting statement.

Senator GRAVEL. But as you noted, and I pointed out too, that if the Congress is going the other way because of panic or what have you, and we do not provide for the money in the private sector, and if the administration's proposal does not include that money, then we have had a little bit of shell game going on. In point of fact, the American public must realize that the job is not being done at all. Either we do it through price or we do it through tax or provide incentive. It is not going to come from heaven. The capital has got to be created somewhere, you see, and the taxpayers will have to do it. What is not understood is that the taxpayer and the consumer is the same person, and he can do it through Government or through the free enterprise system.

And now is when we put that to the test. Do we really want a Socialist government or do we want a free enterprise system?

Mr. HENRY. Exactly correct.

Senator GRAVEL. If I could be furnished with that chart, that would be one chart that we would need, and the other would be a chart, let us say, for the past 10 years—the timeframe can be shortened if the figures are not readily available—showing the amount of money spent in exploration in other lands as opposed to the United States. That would address itself to a problem we have in the bill, the section where we cut our foreign depletion and intangibles, the section that we euphemistically call "come on home and drill, boys." Maybe it is not necessary, and maybe it is. I do not know.

I think those facts would give us an indication as to what it would take to get some extra effort domestically to make ourselves independent, and I think that there is merit in the point you made that since we consume a third of the world's energy and have 6 percent of the world's population, what with the rest of the world raising its level of consumption of energy in a more voracious fashion than we are, then by becoming independent, we service the world, because we are not out consuming what we could leave to the aspiring nations.

But as that activity increases, we certainly do not want to deny American corporate enterprise a good share of it, since it helps us in our financial balance of payments and in our position in world technology.

So I think there is merit on both sides, and where we have to strike a balance is one, in relationship of profitability to capital creation, and two, in relationship to displacement of capital into investment areas, so as to make sure that we are first taking care of our independence, at the same time also taking care of our world position as corporate entities.

I think I tried to describe what we are looking for, and if you could provide us with those charts, it would be very helpful.

Mr. HENRY. Mr. Chairman, we will provide them.*

*The Committee was subsequently informed the API was attempting to gather this data and it would be submitted when available.

Senator GRAVEL. Do you wish to continue with your statement? I think we interrupted you, and then we did not give Mr. Card a chance. I would like to, if you do not mind, stay right through as long as it takes to do it and then we will back up the afternoon entry coming back at 2 or 2:30, whatever is necessary.

Mr. HENRY. Thank you. Fine.

I will conclude very quickly, Mr. Chairman. That is basically that the industry and the country have an enormous and obviously unprecedented job which we have to do. In order to do it, we need to define clearly the separate roles of government and industry. We need an energy council which will propose energy policy. We need a Federal Energy Administration. We need an Energy Research and Development Administration. We need an Energy Trust Fund, to promote new energy technology. We need the accelerated leasing of Federal lands to improve our supply. We need an orderly and phased decontrol of all energy prices. We need continuing oil import controls. We need to maintain the present tax provisions and we need to increase profits, exactly as you pointed out.

What we do not need is an excess or windfall profits tax, limitations on Arab oil imports, export controls over fuels and energy production equipment and sanctions against oil importing nations which refuse to negotiate jointly on oil. And we would like to suggest that perhaps there may be other and alternate ways to fund the Energy Trust Fund rather than the British thermal unit tax, for example, the use of bonuses paid on offshore accelerated leasing to fund the particular effort.

And that, Mr. Chairman, concludes my remarks.

[The prepared statement of Mr. Henry follows. Hearing continues on page 1464.]

PREPARED STATEMENT OF W. L. HENRY, EXECUTIVE VICE PRESIDENT, GULF OIL CO., IN BEHALF OF THE AMERICAN PETROLEUM INSTITUTE

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SUMMARY

1. Overall comment.—S. 2806 merits commendation for recognizing many key factors in the energy crisis and measures needed to achieve adequate domestic supplies.

2. Scope of problem.—The scale of effort and costs required to solve the energy problem far surpasses the Apollo Project, the Manhattan Project, and the World War II synthetic rubber program.

3. Roles of government and industry.—The respective roles of government and private industry in dealing with energy supply problems should be clearly delineated. Government's role should be defined as including establishment of policy, regulations and standards, the provision of incentives and disincentives, and the monitoring of industry's performance. The functions of industry should include the construction and operation of commercial facilities for the production and distribution of energy.

4. *Federal organizations for energy.*—The purposes of the organizational provisions of the bill can be effectively accomplished through:

(*a*) The Federal Energy Administration, which should be assigned the governmental administrative and regulatory functions.

(*b*) A central body comparable to the Council of Economic Advisors should be responsible for appraising the national energy situation and proposing long-range energy policies.

(*c*) A comprehensive and coordinated Energy Research and Development Administration is needed to augment the Federal Energy Administration. The role of government should be to sponsor research projects that will be carried out by the private sector.

(*d*) A mechanism such as the Energy Trust Fund proposed in S. 2806 could play a vital role in accelerating the development and utilization of new energy technology. However, the BTU tax contemplated in this legislation would provide funds far greater than needed for an adequate program of energy research and development. A promising alternative would be to fund the Trust with the proceeds from bonus bidding and royalties the government receives from energy leases.

5. *Price decontrol.*—The orderly decontrol of prices is strongly supported including deregulation of natural gas.

6 *Tax incentives.*—The API supports present tax incentives—particularly percentage depletion and the expensing of intangible drilling costs—for both foreign and domestic operations.

7. "*Excessive profits*" *in perspective.*—API members condemn profiteering. However, an increase in profits does not necessarily mean that profits are excessive. Petroleum company earnings have risen from a level that was much too low. As the industry's costs increase, the absolute level of profits must rise correspondingly.

Removing capital from the industry through an "excess profits" tax will not help to solve the energy problem. It will needlessly prolong the energy shortage.

8. *Excess profits tax proposals.*—If the oil industry is singled out for an excess profits tax, a provision that gives credit for reinvestment is of critical importance. At least three proposals have been made:

(*a*) S. 2806 includes a tax based on current taxable income to the extent such income exceeds a profit allowance and the funds reinvested in energy projects. This proposal has the merit of a reinvestment feature, permitting profits to increase with additional investment. However, the 20 percent rate of return allowed in this bill may be nadequate because it relates to the smaller tax basis rather than the usual book basis used for computing rates of return.

(*b*) The McGovern-Aspin proposals would base the tax either on historic profit levels (perpetuating low profits from the chosen base period) or on a profit allowance substantially less than 6 percent of investment on a tax basis. Such a profit allowance would be grossly inadequate. The reinvestment provision is also inadequate.

(*c*) The Administration proposal would impose a graduated tax on the difference between the selling price of crude oil and the ceiling price as of December 1, 1973. The tax rate would be reduced over a three-year period. This tax should be imposed, if at all, only on prices well in excess of the long-run supply price, i.e., the price that will ultimately balance supply and demand. A reinvestment provision would be essential if this proposal is to stimulate new supplies.

STATEMENT

Gentlemen, I welcome the opportunity to testify before you today on behalf of the American Petroleum Institute. The nation does have an energy shortage, and, in the long run, its solution requires both increased production of all domestic energy sources and increased efficiency in the consumption of energy. Bill S. 2806, proposed by Senator Gravel, represents a significant step in recognizing many of the key factors relating to the energy crisis, their complex interrelationships, and, most importantly, measures needed to achieve adequate domestic energy supplies. We commend the Senator and the Committee for this excellent initiative.

Introduction

If there is a terse definition of our energy situation it is that the United States and the world have developed the capability to consume energy at faster rates than they can produce energy. To rectify this situation domestically will take a number of years, extensive and efficient organization, and huge capital investments. These factors are recognized in Bill S. 2806. But there is one central factor that is not adquately understood. A clear appreciation of this factor is critical if we are to resolve our energy imbalance. This central factor is the enormous magnitude of the task before us. It is unprecedented in scope.

The task of providing adequate domestic supplies has been compared to the Apollo Project, or the World War II synthetic rubber program, or the Manhattan Project. None of these comparisons is valid.

The entire cost of the Apollo project through the last moon landing is reported to be in the range of $25 billion. The National Petroleum Council has estimated that the United States energy program will involve the expenditure of $34 billion *per year* over the next 15 years . . . an amount comparable to one and one-half *total* Apollo projects every year for 15 years.

The World War II synthetic rubber project was outstandingly successful in translating essentially laboratory technology to full-scale commercial operation in a matter of months, and in providing adequate rubber supplies for the war effort. Yet, at the end of the war the total output of synthetic rubber was in the range of 800,000 tons per year. This is equivalent to 1/10th of the output of one reasonably sized refinery—and we will need some 50 such refineries between now and 1985, to say nothing of the expanded coal, nuclear, shale oil and synthetic fuel facilities.

The Manhattan Project was another historic achievement in the crash development of remarkable new energy technology under unusual and demanding conditions. Yet the total cost, including capital and operating expense, for the entire period 1940–1946 was less than $2.5 billion. Through 1973, the total cost of the Manhattan and A.E.C. programs combined, and including the weapons program, has been $60 billion—or only one-eighth of the capital expenditure we will need in domestic energy facilities through 1985.

Thus, the task before us is greater than these projects by several orders of magnitude. This task is so large that if it is to be accomplished it will require the full and effective utilization of government capabilities, of all facets of the energy industries, and of the supporting industries such as engineering, metals production and fabrication, construction, and transportation. No lesser measures will suffice. The capital required, and which must predominantly be supplied by industry, is estimated by the National Petroleum Council to be $200 billion through 1985 in domestic petroleum facilities alone. An additional $300 billion will be needed for the production of other fuels and electric power. Estimates by Government experts and the financial community range up to figures as high as $1.3 trillion, including expenditures abroad.

It is in this perspective that we must structure legislation to provide the means for solving our energy problem. It is against such a background that we must evaluate Bill S. 2806, and to which I will now turn:

First, I will comment on the organizational provisions. I will then review the tax provisions of the bill.

Federal organizations for energy

A significant provision in Bill S. 2806 is the establishment of the Federal Energy Administration—headed by an administrator, and charged with "developing, directing and carrying out a national energy program involving energy research, demonstration, development, utilization, and conservation, in order to meet the present and future energy needs of the United States." We are puzzled by the breadth of this charter. In reading the bill it appears that a major thrust is to provide for effective and timely development of needed energy technology. In other words, an energy research and development program. Yet, the section which I have just quoted clearly grants the Federal Energy Administration jurisdiction over every phase of the nation's energy activities. This includes building and operating commercial energy facilities, marketing, end-use controls, and rationing—as well as the development of technology. The Federal Energy Administration is empowered to build and operate demonstration and commercial energy facilities (Section 303(a)(6)), explore for and produce oil and natural gas (Section 303(a)(7)), and market the output of these operations (Section 304(h)). In short, based on a literal interpretation of the bill, the Federal Energy Administration is empowered to act as a national energy company, encompassing all aspects of the energy field, and with the authority to preempt future developments. Through the proposed trust fund it would have available to it approximately $4.5 billion per year for expenditures in the energy field. This is an impressive sum, particularly when compared to the combined 1972 capital expenditures of $6.8 billion in all domestic oil and gas facilities by the 30 largest U.S. oil companies.

Granted, the bill also clearly provides the Federal Energy Administration with the right to contract these activities out to industry, but no requirement to do so is specified.

We are confident that it is not the intent of the authors of the bill that the Federal Energy Administration preempt even a nominal portion of future energy activities. Nevertheless, it is most important that the intent be clearly specified and that the separate roles of the Government and of industry be precisely delineated. Judges in future court cases will necessarily base their decision on the literal phrasing of the bill and not on the presumed intent of its authors.

In any energy legislation it is important that the relative functions of the Government and of industry be defined. The role of the Government should include the establishment of policy, regulations and standards, the provision of incentive and disincentives, and the monitoring of industry's performance. The construction of commercial facilities, their operation, and the commercial production and distribution of energy are functions to be performed by industry. The reasons for this separation of activities are basic:

First, the task of achieving adequate domestic energy supplies is so vast that no single organizational element can accomplish it. It will be realized only by the effective utilization of every facet of industry working withon a comprehensive national energy program.

Second, should the energy policy, regulatory and commercial production functions be embodied in one organization, there would result irresolvable conflicts of interest. Once specific programs are initiated, the effort used to justify them will insure their continuance long after they have ceased to be of merit, and will inhibit development of competing operations. As Dr. Chauncey Starr observed in testimony before the Senate Interior and Insular Affairs Committee last year, the major shortcoming of Government research programs is that there is no effective mechanism for terminating, on a timely basis, unsuccessful projects. The structure of the Atomic Energy Commission has long been criticized for embodying under a single management both promotional and regulatory functions.

Third, there can be no competitive stimuli in the face of an all-pervasive Government operation.

Fourth, the expenditure by a single Government organization of the huge sums of money required would result in constant political pressure as to where and how the money is to be spent. Delays would be interminable.

As I mentioned initially, the purposes of the organizational provisions of the bill are necessary and commendable. They can be effectively accomplished through the following program:

1. There must be a central body charged with the responsibility of appraising in detail the national energy situation and of proposing comprehensive and long-range policy on energy matters. Such a body has been provided for in Bill S. 70, introduced to the Senate last year. This body would be comparable in a number of respects to the Council of Economic Advisors. It would report to the President, consist of perhaps three full-time members, one of whom would be appointed a chairman by the President. It would be charged with reviewing the nation's long-term energy supply and use trends, with developing a long-term national energy plan to be issued annually, with proposing energy programs by which the plan could be achieve, and with monitoring actual performance against the plan.

It is important that this energy policy council be charged only with the formulation of policy. It should include no administrative or regulatory functions. Only through this separation of responsibilities can the policy council maintain the mpartial objectivity which it must have.

If such a group were to have the responsibility for administering authorized programs which it had initiated, it would become so involved with these programs that it would have an unacceptable bias toward demonstrating their merit and in continuing them past the time when they could make an effective contribution. There have been, and will continue to be, rapid changes in the energy spectrum, and there will have to be continuing reappraisals of our energy programs. The necessary objectivity in making such reappraisals can be obtained only through a separation of the policy and administrative functions. A classic example is the year-long delay in restructuring the Oil Import Quota program, which became archaic in early 1972 when U.S. petroleum production reached capacity levels, but was not restructured until April 1973. We have all learned the hard way that any organization, whether it be in government, industry or other sector, which is involved in the press of day-to-day administration, can find neither the time nor the perspective needed for effective planning. Energy is much too important to permit less than a fully effective planning effort.

2. The Federal Energy Administration is a vital component of the national energy structure. The administration should be charged with seeing that the energy programs, proposed by the Energy Policy Council and established by the Congress, are properly carried out by industry. The charter of the Federal Energy Administration should be to provide the necessary environment which will enable the nation's industry to produce adequate domestic energy supplies on a basis which is both economically and environmentally acceptable. There should be transferred to the Federal Energy Administration existing and new administrative functions needed to carry out the energy programs established by Congress. This would include the Energy Research and Development Administration and the Energy Trust Fund, both of which I will discuss in a monemt. It would also include functions such as the Office of Oil and Gas, energy related functions of the Cost of Living Council, the Office of Energy Conservation, the Office of Petroleum Allocation, and such others as may be determined by the President, subject to Congressional approval. Again, there must be a clear separation of the Governmental administrative and regulatory functions on the one hand, and the commercial functions required for the production of energy by industry on the other hand.

There have been proposals that Federal oil companies or Federal energy companies be established. Proponents of such moves point to government-owned oil companies in other countries as valid justification for such a step. A review of the record and performance of such companies clearly demonstrates that they compound the problems which they are established to solve. Their costs are high, their ability to innovate is low, and they reduce or eliminate competition. No national oil company has made a significant contribution to the exploration for oil or gas. Once established there is no effective mechanism for monitoring or correcting unwise programs. The resolution of the U.S. energy supply problem lies not in the formation of national energy companies but in providing industry with the necessary energy programs, and in creating the climate which will permit the full and expeditious use of the nation's extensive and resourceful industrial capabilities.

3. One of these programs will be a comprehensive and coordinated energy research and development capability. Such a program has been provided in the modified version of Bill S. 1283, as passed by the Senate on December 7, 1973, and which we commend. That bill provides for the establishment of an energy research and development administration, and a funding level judged by most experts to be adequate. The bill also specifies that the role of the Government will be primarily to sponsor desired research projects to be carried out by the private sector rather than to conduct research projects completely through Government organizations.

Because the nature of research is creative, it is most important that a Research Advisory Council be established. This council should be comprised of qualified experts from industry, universities and the public, as well as from the Government. The Advisory Council should provide recommendations on research programs and priorities to the Research and Development Management Group, and its review and comments on the annual research programs and budgets should be required and published. Through this advisory capacity, a wide range of expert counsel would be available to the Research and Development Management Group to provide that the R&D program continually appraises and evaluates all new scientific and technological developments. Yet, by virtue of the advisory capacity there will be no conflict in the decision-making process within the Research and Development Management Group. The Advisory Council should be comprised of experts who serve on a part-time basis. This will provide the maximum opportunity for them to maintain a wide exposure to technical developments throughout the country and to funnel promptly such developments to the Research and Development Management Group. The Research Advisory Council would be established in lieu of the Commission on Energy Technology Assessment, as proposed in Bill S. 2806.

4. A Federal funding mechanism, such as the Energy Trust Fund proposed in Bill S. 2806, will play a vital role in accelerating the development and utilization

of new energy technology. The enabling legislation through which the Trust Fund is established should provide the Fund with the following characteristics:

Projects eligible for support from the Trust Fund fall into two categories: (1) the development of new technology through the pilot plant and demonstration plant stages, and (2) the construction and operation of prototype and first generation commercial scale projects.

In the first category, projects would be established through contractual arrangements between the Research and Development Management Group and a private, industrial or university entity and would be jointly funded. The government funding would be provided from the Energy Trust Fund. Such projects would be of a developmental nature, would not be economically viable, and there would be no obligation on the non-government participant to repay any funds to the Energy Trust.

The second category would include commercial scale projects utilizing new and commercially untried technology. Such projects will involve both unusual technical and economic risks, and will not be competitive with more efficient second generation plants. For such projects, if approved for Trust Fund support, the developer would arrange the financing, and the Trust Fund would provide loan *guarantees* in an amount not to exceed 90 percent of the total capital required. The security and contingent liability required from the developer should be limited solely to the assets of the project. Since the developer will be responsible for contributing a portion of the capital and for raising the balance and will only benefit if the project operates profitably, he will have a strong incentive to establish an efficient and productive project. The government, by using its credit through loan guarantees rather than by issuing direct loans, will minimize the amount of funds actually disbursed. Since the developer will have invested his own funds in the project, and since the out-of-pocket manufacturing costs are generally small in relation to total cost, the likelihood of defaults in loan servicing will be low.

The Trust Fund, as outlined in Bill S. 2806, should also be authorized to provide loans under specified conditions, fuels price guarantees for prototype and first-generation commercial energy projects, and reinsurance of risks from environmental hazards.

On the above basis, an annual budget of two to three billion dollars should be adequate, particularly in the early years of operation. As pointed out above, the loan guarantee program would not involve large or continuing cash outlays. The Bill proposes that the Fund be financed through revenues from an energy Btu tax. The tax, as proposed, would provide funds in excess of the needs projected for energy research and development and would further increase prices. A promising alternative would be to fund the Trust with the proceeds which the Federal Government receives from bonus bidding and from royalties on Federal energy leases. Since these leasing programs have been providing revenues in the range of $1.5 billion per offshore lease sale, the amount of funding from this source should be adequate.

Import/Export policies

I would now like to turn to some specific provisions included in Bill S. 2806 relating to energy trade. They are: the provision of variable tariffs in regard to oil imports, the limitation of imports from Arab countries, the limitation of energy and energy equipment exports, the decontrol of prices, and the program for government-to-government negotiations.

The concept of a tariff program to offset any future price advantage for lower priced imported crude oil, as compared to the price of domestic crude oil, is important and its need has been well established. The present oil embargo by the Arab countries is stark evidence of the fact that oil imports will be used for political purposes. Such purposes could well include a deliberate reduction in crude oil import prices at some future date in order to affect the U.S. energy producing industry adversely or to alter domestic energy consumption patterns. To avoid such problems a workable mechanism is needed to offset any price advantages which might develop for imports. However, the legislative provisions for such a mechanism should include sufficient flexibility that the Administration can adjust it to future and unforeseen conditions. In regard to the specific provisions of Bill S. 2806, we question whether it will be practical to calculate on a monthly basis an average crude price for the nation. Further, all domestic crude prices higher than the average would be at a competitive disadvantage versus imports. This would normally involve half of the domestic crude production. Differences in crude quality would provide an additional complication. In short, the legislative provisions must avoid overspecification of the mechanism for controlling imports. Otherwise the measure could be self-defeating.

Bill S. 2806 (Section 702) provides that the United States shall not import petroleum from Arab countries in an amount greater than 5 percent of its domestic consumption. We believe that this provision should be eliminated. For the next several years it will be physically impossible for the United States to increase its domestic petroleum production in an amount equivalent to the oil imports which we anticipate to be available from the Arab countries. Thus, the proposed provision would limit the amount of Arab oil which could be imported even at times when it would be needed to augment domestic supply. This would not only create unnecessary hardship, but could encourage non-Arab producers to toughen their trading terms. Further, it is impossible to foresee the future political situation in each of the Arab countries, or in non-Arab exporting countries. There could well be times when it would be in the nation's political or economic interest to import larger volumes of oil from certain Arab countries, or when our political relations would be more strained with a non-Arab exporting country. Rather than providing such an inflexible limitation, we recommend that the Federal Energy Administration be empowered to set import quotas by country of origin, if and when circumstances warrant. Such quotas—if they exceed specified levels or time periods—could be subject to the approval of Congress.

Bill S. 2806 also contains other provisions relating to the import and export of energy and energy related equipment. It contains a useful provision that the President be requested to negotiate with countries which have accepted voluntary restrictions on steel exports to the U.S. for removal of restraints of exports to the U.S. of energy equipment in short supply here. But at the same time, the Bill provides for a very elaborated system of export controls for energy supplies and equipment from the U.S. This system is at odds with the provision for increased imports of needed energy equipment. It would also serve as an invitation to other countries, on whose raw and manufactured materials we are vitally dependent, to invoke similar export restrictions. We do not believe that Project Independence should be a signal that we are pulling away from world trade, but rather that we are moving toward the resolution of a world problem. If attractive opportunities for domestic energy development are greatly expanded as intended by this Bill, and prices are deregulated as also proposed in this Bill, then the U.S. productive capacity for energy equipment will expand rapidly and the resulting exports will benefit U.S. employment and trade. At the most, a monitoring system such as that now being initiated for petroleum products might be considered for equipment exports as well.

Bill S. 2806 also provides in Section 704 that the United States develop with foreign oil importing countries an organization to negotiate with the oil exporting countries. The Bill further provides that any importing country which refuses to enter into such an arrangement be denied its most favored nation treatment in regard to its trade with the United States. The establishment of a community of interest on the part of the oil importing nations is necessary, and some institutional framework is certainly needed for this purpose. However, the complexity and difficulty of the problems involved are such that it is simply not practical to establish such an organization through legislation on the part of the Congress. Such an arrangement can only work if it is agreeable to all participants, and this can only be arrived at through give-and-take negotiation. The threat of withdrawing favored nation treatment could be counterproductive, and contrary to the interests of the United States. For instance, Canada is a major source of oil, nickel, wood, and other goods for the U.S., and it would be a matter of serious concern if we should have to remove them from favored nation trading status. The law should specify the goals to be achieved through a community of interest on the part of the oil importing nations. The programs for achieving these goals must necessarily be left to negotiation.

Price decontrol

It is clear from this discussion that we strongly support the position that an orderly decontrol of prices will make an important, and indeed an essential, contribution to the resolution of energy problems (on both the demand and supply sides of the equation). Relevant tax aspects will be touched upon shortly. One particular comment with respect to natural gas: under the provisions of the Bill as now drafted, gas under existing interstate contracts would not be deregulated. This is a shortcoming which should be rectified.

Leasing of Federal lands

We have emphasized the necessity of providing opportunities for domestic energy development. The provisions of this Bill which direct the Secretary of the Interior to proceed to full and expeditious development of Federal lands, including the Outer Continental Shelf, are vital in providing an early contribution to the nation's energy supply. About 97 percent of the U.S. Continental Shelf is yet to be explored, and in this, we lag far behind other major producing areas of the world. We welcome the Bill's initiative in this area.

Section 1104 of the Bill authorizes and directs the Secretary of the Interior to require under certain conditions that domestic oil and gas fields be produced in excess of their maximum efficient rate of production. This authority cannot be exercised for periods exceeding 180 days in cases where production at such rates may create excessive risk of loss in the ultimate recovery of crude oil. The authority for requiring production at rates in excess of the maximum efficient rate should be limited to *that period* which will avoid loss in ultimate crude recovery. This period will vary with each different producing formation and in many cases will be much less than 180 days. We simply cannot run the risk of leaving recoverable crude in the ground for the sake of nominal production increases for a six-month period.

Domestic tax policy

Before offering our analysis and comments on the specific tax proposals contained in Senate bill 2806, I would like to present our views on the justification for continuing the percentage depletion allowance and the option to expense intangible drilling costs.

From the very earliest days of our Federal income tax structure, tax incentives to encourage the development of our country's petroleum resources have been wisely provided. The need for such incentives is as great as, or greater than, any time in the past if the United States is ever to return to a level of near self-sufficiency in its oil and gas supply.

Percentage depletion and the intangible option are essential elements of such incentives. They have attracted into the high-risk search for petroleum a greater amount of capital than would otherwise have been available. As a result, our available domestic supply of petroleum has been greater than it would have been because the industry has spent the funds—and much more—generated by depletion in search for new petroleum deposits. The industry's expenditures in its exploration and drilling effort in recent years have been at a level twice the amount of the statutory depletion allowance.

Budgeted capital expenditure figures released by several petroleum companies for 1974 indicate that their level of exploration and development effort will increase substantially. These increases are part of the response of our industry to the need projected by the National Petroleum Council for exploration and development expenditures at an average level of at least $12 billion annually during the 1970's. Non-financial factors will also have to be present as part of a successful national energy program to achieve such expenditure levels, but in the face of our current critical energy shortages, it would not make economic sense now to remove established tax incentives which have worked effectively and fairly to attract and retain risk capital in this industry's vital effort to develop additional producing capacity. The reduction by the Revenue Act of 1969 in the rate of the percentage depletion allowance and subjecting it to the 10 percent preference tax added over $500 million annually to the petroleum industry's tax burden. There is no doubt that these changes had a negative effect on efforts to become less dependent on foreign oil and to become self-sufficient in energy. For example, in 1970 following the additional taxes resulting from the 1969 Act, there was a decline of more than 20 percent in exploratory wells and new fields discovered representing an acceleration of the long term decline in exploratory activity.[1]

There is another aspect of this issue on which I would like to present our views. Prices of crude oil and petroleum products are subject to control by the Cost of Living Council. Whether price controls continue on domestic petroleum or the prices are allowed to move to the price of imported oil, there is little or no possibility—politically or economically—that for the foreseeable future domestic prices could respond in the manner or the magnitude required to pass on additional tax costs. The Administration has announced an objective of establishing a free market which would permit all U.S. crude oil prices to reach world parity. Thus, the

[1] Richard J. Gonzalez, "Declining Trends in Exploration for Oil and Gas", Statement before Senate Interior and Insular Affairs Committee, August 9, 1972, pages 12-13.

domestic price would be set by prices of imported oil regardless of the level of U.S. taxation. Under these conditions, there would be no way to shift any U.S. petroleum tax increases on to consumers. It is a basic principle of international trade that a government cannot, in the absence of import barriers, increase taxes on domestic producers without reducing their profits and discouraging them from making domestic investments. With or without percentage depletion, the U.S. producer could receive no more than the import price. If depletion and the option to expense intangibles were eliminated, the adverse effect on the industry's energy efforts should be apparent. These provisions, therefore, remain essential parts of a national energy policy. Their incentive effects are as important today as ever before.

In the context of today's shortages of developed energy and increasing petroleum prices, the grave danger for the fiscal and energy policy makers in the Congress is that they will look at only the short-run tax or economic consequences of proposed action without regard for the long-run consequences or the evaluation of all the economic considerations. The imposition of additional taxes on petroleum operations now would entail long-term public costs exceeding benefits and would not be in the national interest of expanding our domestic energy resources. If the tax laws cannot be changed to help solve energy problems, then surely they should not be altered in any way that will contribute to greater shortages.

There is widespread pressure in Washington to levy an "excess" profits tax on the oil industry in order to make certain that no one exploits the energy crisis to make profits far above the level needed to attract the capital required to reachieve a reasonable degree of energy self-sufficiency in the United States. Let me make clear that while the member firms of the American Petroleum Institute wholeheartedly support profits, they wholeheartedly oppose profiteering. But, when do profits become "excessive"?

What profits are excessive?

Perhaps the best way to answer this question is to specify what profits are not excessive. Clearly, profits are not "excessive" merely because they are increasing as time passes. We have seen that industry earnings were up about 50 percent in 1973, but a 50 percent increase over an unsatisfactorily low level does not necessarily mean an unsatisfactorily high level. Consider the case of a firm which was incurring losses in the base period established for an excess profit tax. Blanket prohibition of increases in profits could condemn it to unsatisfactory performance for the life of the tax. Indeed, "excess" profits taxes can almost always be expected to discriminate against some companies depending upon their performance in the base period. What matters is the rate of return on investment, not the rate of increase of profits as time passes.

Nor are profits "excessive" merely because they may reflect prices higher than required to attract capital in past years. In periods of persistent inflation—such as we have experienced since 1965—rising "profits" as determined by conventional accounting practice may not be rising in real terms at all. From the point of view of the corporate shareholder, profits per share must rise at least with inflation; otherwise his income will lose buying power.

Entirely apart from inflation, some industries are characterized by what economist call "increasing costs". In the minerals produc ng industries, for example, the geological prospects wh ch appear to be the best are tapped first. Therefore, as the industry expands, it must tap progressively more costly prospects. The lower investment and operating costs of fields discovered and developed years ago are irrelevant to what it will cost to bring on new supplies. New supplies will cost much more in terms of the real resources of men, materials, and invested capital required to bring them into production. Hence, expansion requires increasing prices and profits in order to maintain acceptable rates of return on the new, higher-cost investments. If capital requirements per barrel of oil producing capacity, say, double because it becomes necessary to move to more remote and hostile locations, the company must earn twice as many dollars merely to maintain its rate of return. And it may well need *more* than twice as many dollars because the results of investment in "frontier" areas are often much more uncertain than in proved areas The petroleum industry is now facing precisely this problem as it moves to exploration in the Artic and deepwater offshore areas, as well as to the exploitation of new energy sources requiring unproved and costly technology. Such increased uncertainty requires increased rates of return in order to attract capital.

Unquestionab'y then, both the absolute level of dollar profits and the rate of return for an increasing cost industry operating in an era of persistent inflation must rise as time passes. And the more uncertain the outcome of investments, the more rapidly profits must rise.

High profits attributable to occasional discovery of h ghly productive properties in an uncertain minerals industry must also not be considered excessive. The rate of return on a billion barrel oil field is likely to be high. But it is not excessive because the remote possibility of the big prize is undoubtedly a major motivating factor in attracting capital to the search for oil and gas, where the chance of break-even success has been only about 1 in 60 in recent years. (That figure is for break-even success on the productive venture without consideration of the costs of unrelated dry holes.) The investor's knowledge that he will receive the full fruits of a major find does muct to offset the negative influence of the dry hole. This is especially true because the Congress has recognized that the discovery value of a find—as approximated by percentage depletion—should be recoverable without taxation. Absence of the opportunity to realize the profits from a big find would make it far more difficult to attact capital to the petroleum industry.

It is sometimes argued that while consumers mu t reasonably expect to pay a price which compensates investors for the higher cost of expanded new production in an increasing cost industry (including return on investment), there is no reason why they should pay that price for old production which originally cost less than present replacement cost. Such a price for old oil would, it is said, lead to excess profits.

But why should consumers *not* expect to pay the replacement cost of the old oil or gas they use? When a barrel of lower cost old oil is used, it can only be replaced with higher cost new oil. The consumer actually has no grounds to contend that a price which covers the cost of replacing old production leads to excessive profits. With any lower price for its old oil, the firm will not generate sufficient profits to stay in business at past levels of operation—much less to expand. Internal generation of funds is particularly important in high-risk endeavors, such as petroleum exploration, where outside capital is less readily available.

Foreign profits are also not an appropriate subject for control by a United States excess profits tax. Profits from foreign ventures by American firms increase U.S. Gross National Product and improve the balance of payments. It would be wholly counterproductive to discourage U.S. foreign investment by taxing profits of those ventures at high rates above the foreign rate. That would make new ventures of American companies noncompetitive with those of foreign-owned firms. And it would expose existing American-owned facilities to retaliatory taxation by the foreign governments. If an excess profits tax is to be paid by the foreign ventures of Americans, why should the foreign government permit the tax to flow to the United States Government?

We have outlined a number of categories of profits which are not excessive. What, if any, profits *are* excessive? A common concept of excess profits would be any increase occurring as the result of extraordinary price increases during a period of emergency shortage. But we have seen that this concept is clearly inadequate because profits may have been sub-normal before the crisis, costs may have risen, etc. A far more acceptable concept would hold such profits to be excessive only if price had risen beyond the level required to equate supply and demand in the long run.

However, even profits attributable to prices well above the supply-demand equating level have long been recognized to have a useful economic function. Such profits (which economists call "quasi rents") give investors extra encouragement to increase capacity in an industry where demand temporaily exceeds supply. After sufficient supply is available, price would fall back to the equilibrium level; and these extra profits would disappear. They, in effect, self-destruct after their economic purpose has been served.

Requirements for an excess profits tax

We believe that levying an excess profits tax on the petroleum industry would be contrary to the national interest, since it would almost inevitably discourage investment. And increased investment is absolutely essential if we are to reachieve a reasonable degree of energy self-sufficiency. Is there any reasonable chance that investors will take such a tax in stride without any reduction in their plans to devote funds to the uncertain search for oil and gas and to the risky development of new energy sources? We think not, because Congressional action to increase taxes on the industry is virtually certain to discourage investment, no matter how carefully an "excess" profits tax may be designed to avoiding taxing those profits which are necessary, not excessive. The psychological effect on investors of knowing that success will be penalized can only be negative. We, therefore, oppose an "excess" profits tax.

If, however, we are to have one, what form should it take to be minimally damaging to the critical national interest in sharply increased output of domestic energy? Essential requirements of any excess profits tax are that it:

1. Treat all competing firms equally.
2. Define as "excess" or "windfall" profits only funds attributable to prices clearly higher than the level of price which will equate supply and demand in the long run—after allowing for inflation and rising real costs.
3. Permit minerals explorers to retain the profits from large discoveries.
4. Enable the industry to retain sufficient profits for the replacement of used-up facilities and to show an adequate rate of return on new facilities.
5. Affect only domestic profits.

What this really means is that "excess" profits taxes must never be imposed unless prices rise very sharply in supply emergencies to levels well beyond the long-run supply-demand balancing level. Moreover, the tax should expire when the emergency expires. And it should apply to any industry experiencing emergency shortages, not just to oil.

One must concede that the economically sound concept that profits are excessive only if attributable to prices well beyond the supply-demand balancing price may be administratively difficult to implement in an "excess" or "windfall" profits tax because a reasonably accurate estimate of the long-run equilibrium price is required. One promising device for dealing with the difficulty of estimating that price correctly would be to require reinvestment (within a reasonable time) of any profits attributable to prices higher than the estimated correct level. This would assure consumers that if they did, in fact, pay more than the long-run supply-demand balancing price, the funds would either be reinvested—thereby expanding capacity and putting downward pressure on prices and profits—or be taxed away. Amounts reinvested in replacing existing supplies and adding new ones are not windfalls.

We would like to evaluate three "excess" or "windfall" profit tax proposals now before the Congress in the light of these criteria.

Gravel proposal—Tax on uninvested profits from energy sources

Under this proposal profits from energy sources in excess of profit allowance would be taxed at 40 percent unless reinvested in energy projects.

There are many substantial conceptual and technical problems with the bill. On the other hand, it includes three of the essential requirements of an excess profits tax:

1. It is not measured by historical profits, thus permitting some needed profit increase and minimizing discrimination among taxpayers.
2. It appears that the profit allowance is based on investment in all energy related activities, thus providing a better measure of profits. (As discussed below, the 20 percent rate of return is somewhat deceptive since it is based on tax basis rather than the conventional book basis.)
3. A deduction for reinvestment is permitted. But let me discuss some of the problem areas.

Profits.—The starting point for computing the tax would be "profits from energy sources" which means taxable income (with certain modifications) from all phases of the energy business. Production transportation, transmission, importation and sale of consumable energy or of fuel for conversion into consumable energy are specifically included. While it is not entirely clear, it appears that in the case of the petroleum industry, all production, transportation, and marketing are specifically included. Presumably refining is also included. These points should be clarified. The inclusion of all phases of the energy cycle is proper since it is the only feasible method of measuring true profits.

In the case of oil, gas, and other minerals, the bill specifies that "taxable income from energy sources" has the same meaning as the term "taxable income from the property" for purposes of Section 613. This apparently is an attempt to simplify the calculation. However, in doing so, it has created a question on the allowance of depletion in computing taxable income subject to the excess profits tax since "taxable income from the property" is prior to either cost or percentage depletion. This should be clarified by adding the phrase "less allowable depletion" immediately after "taxable income from the property" in Section 4961(a)(2).

In determining taxable income from energy sources, certain modifications to taxable income would be required by the bill:

1. U.S. income taxes attributable to energy profits are deducted. As will be discussed below, there are problems regarding foreign income. Deduction of U.S. taxes is proper in arriving at the amount subject to this tax.

2. Accelerated depreciation is disallowed to the extent it exceeds straight-line depreciation. This is an unnecessary complication since only timing is involved. More importantly, it detracts from the investment incentive for new plants. Further, to the extent accelerated depreciation reduces the current income tax, the advantages of accelerated depreciation are already reduced since the deduction for income taxes will be smaller.

If this modification is required, then the investment base on which the profit allowance is computed should be adjusted to reflect the difference in tax basis due to accelerated depreciation. This point is discussed further below.

3. No deduction or capital loss is allowed with respect to outlays treated as a "qualified investment". (As discussed in detail below, "qualified investments" are those investments in energy projects that may reduce profits subject to tax.) As a result, if a depreciable item costing $100,000 is treated as a qualified investment, no depreciation will be allowed on that asset in computing taxable income from energy sources. Operating in this fashion, the reinvestment incentive is greatly diminished since only the timing of the tax may be involved.

In addition, this approach will present many difficult compliance problems in identifying deductions attributable to specific assets.

In some regards this is similar to the investment credit as originally enacted. It required reduction of the depreciable basis by the amount of the credit. Therefore, in part, it provided some timing incentive. The investment credit was subsequently amended to create a greater incentive by eliminating the basis adjustment. As so amended, it also avoided the compliance problems similar to the ones anticipated under the current proposal.

If the proposal is not changed, clarification is needed in Section 4961(b)(1)(B). As written, it seems to disallow deductions for expenditures that are only attributable to qualified investments, i.e., expenditures that do not represent the cost of qualified investment but merely were attributable to the same property would be disallowed. For instance, the provision could be interpreted literally to disallow the cost of drilling a well on a lease if the cost of the lease were a qualified investment.

The only reasonable interpretation is that this provision is meant to apply to expenditures that were treated as qualified expenditures under the "binding contract" rule of Section 4960(c)(1)(B). If that is the intention, the citation in Section 4961(b)(1)(B) should be specific.

In addition to the modifications contained in the bill, the income subject to the proposed tax should not include dividends from energy companies that are themselves subject to the tax, or there may be double taxation.

Foreign profits are included in the bill in the same manner as domestic profits. That is fundamentally wrong as discussed above. Further, to the extent refining and marketing profits on foreign crude are realized in the United States, those profits will be subject to this excess profits tax since downstream operations are included.

Profit allowance.—The bill provides that profits as determined above shall be reduced by the "profit allowance" which is 20 percent of the average net investment in energy properties.

The profit allowance based on investment is a key essential to any excess profits tax measured by net income since it will permit some profit increase for expansion. It also minimizes discrimination among competing companies. Of course, the difficult problem is in establishing the rate of return to be allowed.

At first impression, many will be inclined to believe the 20 percent rate proposed in the bill to be excessive when compared to historical rates of return. However, it must be recognized that the proposed rate of return is on a very different base. It uses the tax basis of investments in properties rather than the book basis which is traditionally used in financial reporting. Probably without exception, the book basis of any taxpayer in the oil and gas business will be substantially higher than the tax basis. The difference is primarily attributable to three items: intangible drilling costs, percentage depletion, and accelerated depreciation. For tax purposes, IDC may be currently expensed. Thus, the tax basis is zero. For financial reporting, IDC is generally amortized rather than expensed. Similarly, for tax purposes, the greater of cost or percentage depletion is deducted from lease-hold investment. Only cost depletion is deducted for financial purposes. Accelerated depreciation will also reduce the basis in assets below the book basis since, for financial purposes, no accelerated depreciation is used.

Because of these reductions of the base for computing the profit allowance, the rate of return on a tax basis must be substantially higher than 20 percent if the objective is to provide a 20 percent return on book basis.

Since drilling expense is one of the essential expenditures to increasing oil and gas supplies, there is substantial merit in expanding the definition of investment to include IDC. Excluding IDC from the investment base would be fundamentally wrong. The fact that IDC has been deducted for income tax purposes does not mean that there is no cost to the operator on which a return must be included. If the base is not expanded, no rate of return or profit allowance will be permitted on IDC. This will severely distort the calculation of producing profits.

Earlier it was mentioned that taxable income from energy sources should not be adjusted for the difference in accelerated and straight-line depreciation. If that adjustment is required, then the investment on which the profit allowance is computed should be adjusted upward to reflect the difference. Certainly it is inconsistent to deny the deduction for accelerated depreciation and, at the same time, reduce investment by the accelerated depreciation in determining the basis for computing the profit allowance.

The base should be expanded to permit a profit allowance on leased property. Leasing property is an effective method of spreading a limited amount of capital. However, if no return is allowed on leased property, taxpayers may be influenced by the operation of the excess profits tax to purchase rather than lease. Furthermore, property is used in the production of profits from energy sources whether it is leased or owned. For these reasons, leased properties should be included in investment. A reasonable approach is to capitalize rental property at eight times annual rentals. (This method has long been satisfactorily used in state income taxation to allocate income to the individual states.)

Section 4962, Net Investment in Energy Sources, refers to the "equity interest of the taxpayer". It provides further that such equity interest shall be determined by "taking into account indebtedness". The meaning of these phrases is not clear. Presumably, the "tax basis" of property is the investment on which the profit allowance is computed. The tax basis includes indebtedness on property. We are concerned that the term "equity" coupled with the phrase referring to indebtedness could be interpreted to require that debt be subtracted from the asset basis. We doubt that that is the intent, but clarification is needed.

Whatever rate of return is ultimately established, it should not be less than the historical rate earned during periods when investments and reserves were being increased. It is unlikely that even that rate will be sufficient since costs and risks have increased so greatly as a consequence of moving to the deeper offshore and remote areas such as the North Slope.

Reinvestment.—After deducting the profit allowance from profits, the remainder may be further reduced by investments in qualified energy projects.

A qualified energy project is one within the U.S. that expands or improves existing energy sources or furthers the exploration for, research on, or development of new energy sources. Further, the Federal Energy Administration must determine the projects that qualify. This may be done generally rather than by approval of individual projects.

This definition seems adequate with one exception. It is not clear that processing and refining facilities are included. Additional refining capacity is needed within the U.S. Also, processing facilities for oil shale or coal gasification will be required at great capital costs. Such activities should be included under the reinvestment provisions of this bill.

The bill provides that profits from energy sources in excess of the profit allowance must be reinvested or contracted for by the end of the taxable year following the year such profit is earned. Amounts which the taxpayer contracts to expend must actually be expended within two years to qualify. Because of the long lead-time involved in many projects—especially offshore production and oil shale or coal gasification plants—it is doubtful that the time period provided in the bill is adequate. At least one more year should be permitted under each provision. The taxpayer would thus have until the end of the second taxable year and could include expenditures to be made within three years under a binding contract. The maximum time period would still be just five years.

A carryover of excess qualified investments should be permitted. That would avoid hardship cases where large investments are made in one year but, more importantly, it would eliminate a potential deterrent to current spending. In other words, if no carryover were permitted, a taxpayer could be influenced to defer spending in excess of "usable" qualified investments. The carryover will eliminate such considerations.

It was earlier stated that foreign operations should be excluded from the bill. If they are not, reinvestment of foreign profits should also be permitted outside the United States.

Consolidated returns.—The bill does not specify who the taxpayer is in the case of an affiliated group of companies filing a consolidated Federal income tax return. It should be made clear that the consolidate group is the taxpayer for purposes of this tax. Otherwise, profits from some functions, such as oil and gas production that may be in a separate company, could not be reinvested in activities of other affiliated companies such as a separate coal or shale oil company. Also, since taxable income, the starting point for computing the tax under this bill is proposed on a consolidated basis, all other calculations under the tax should be consistent.

Termination.—The bill does not contain a termination clause. An excess profits tax should be imposed, if at all, only during emergency periods. It should never become a permanent part of the tax structure. The bill should provide a termination date or a reasonable provision for phasing it out.

Summary—Gravel proposal.—If the oil industry is to be singled out for an excess profits tax measured by net income, Senate bill 2806 provides a reasonable framework. It is based on an allowable rate of return rather than historical profits, thus permitting absolute profits to increase and minimizing competitive discrimination because of prior performance. Further, it provides for reinvestment of excess profits.

However, if the bill were to be enacted, it should be amended as follows:

1. "Profits from energy sources" should be clarified to specify the downstream operations that are included.
2. Depletion should be deducted in determining profits.
3. Accelerated depreciation in excess of straight-line should not be added to taxable income. If it is, the investment base should be adjusted accordingly.
4. Deductions attributable to qualified investments should not be disallowed.
5. Dividends should be excluded from "taxable income from energy sources".
6. Foreign profits should not be included.
7. IDC costs should be added to the investment on which the profit allowance is computed.
8. Rental property should be capitalized at eight times the annual rental payment and included in investment.
9. Refining and processing facilities should be qualified investments.
10. More time should be permitted in which to reinvest profits.
11. A carryover of excess qualified investment should be permitted.
12. If foreign operations are included, reinvestment should be allowed outside the United States.
13. Consolidated returns should be permitted.
14. A termination provision should be added.

McGovern-Aspin excess profits tax proposals

The McGovern-Aspin proposals would impose an excess profits tax beginning January 1, 1973, on corporations engaged in the production, manufacture, or sale of any form of energy. The tax would be 85 percent of the excess of taxable income over a surcharge exemption which is the greater of (1) the average taxable income for the base period of 1969 through 1972, or (2) 6 percent of invested capital. Excluded from income subject to the 85 percent surcharge is an amount equal to any increase in investment in energy properties or activities above the average investment during the base period.

The principal problem in these proposals is the use of prior profits as the measure of excess profits. That approach is unsound primarily becasue it discriminates among taxpayers and largely restricts additional profits potential. The reduction of profits subject to tax because of increased net investment partially cures the problem in that it encourages some reinvestment. The bill provides an alternative profit allowance, ostensibly a 6 percent return on investment—far too low to be very meaningful.

Taxable income.—The "taxable income" upon which this tax is based is the same as for calculating regular federal income tax. As discussed in commenting on the Gravel proposal, taxable income should be adjusted as follows:

1. Foreign operations should be excluded.
2. Income taxes should be deducted in arriving at "excess profits."

3. Consolidated tax return should be specified.
4. Dividends should be excluded.

Base period income.—The first surcharge exemption in computing the excess profits tax is average taxable income ~~for~~ the years 1969 through 1972. Since it is based on prior periods, it would affect taxpayers differently as a result of differences in taxable income in the base period. In other words, a taxpayer with low taxable income during the base period would likely be affected more adversely than a taxpayer with high taxable income during the same period. The differences in taxable income may be the result of many things such as large lease abandonments in the base period. For example, a taxpayer may have averaged $50 million taxable income during the base period before deducting an average $25 million abandonment loss. If the taxpayer had the same $50 million taxable income subject to this proposal and no abandonment loss, $25 million would be treated as excess profit even though actual profits before extraordinary losses are the same. Because of differences of this type, any proposal that relies on historical operations will discriminate against similarly situated taxpayers.

Adverse changes in the tax laws can also "create" profits under this proposal. In 1969, taxable income was computed with a 27½ percent depletion deduction. Reducing the rate to 22 percent increased taxable income. However, this proposal operates to treat the loss of depletion as excess profits. That result cannot be justified under any reasonable theory.

Using prior profits also tends to perpetuate base period performance which may have yielded profits that were already too low, and prevents expansion since no significant increase in profits can be realized.

Investment allowance.—The bills would permit a reduction of taxable income by 6 percent of net investment (presumably for tax purposes) in lieu of average taxable income in the base period. For example, a taxpayer with losses during the base period could deduct 6 percent of its tax investment from taxable income before computing excess profits; i.e., anything over 6 percent of investment would be considered excess profit. Since there is no provision for deducting income taxes in determining the base. the "profit allowance" is really much less than 6 percent.

The alternative of deducting an investment allowance is certainly better than allowing credit for only prior taxable income. However, the rate proposed is obviously far too low.

As discussed under S. 2806, calculating the rate of return on tax investment is very misleading since tax basis in the minerals industry is almost certain to be much less than book basis because of the different treatment of IDC, depletion and accelerated depreciation. Thus, a 6 percent rate of return on a reduced tax basis equates to a smaller return on the book basis, the conventional method for financial reporting.

Apart from the smaller base, the allowance is determined before taxes, thus, again overstating the return on investment. For example, if taxable income were $120,000, income tax were $58,000 (implying $62,000 net income after tax), and invested capital were $1,000,090, the excess profits tax would be computed as follows (assuming that the investment allowance is greater than average base period income and no reinvestment):

Taxable income	$120, 000
Less: Investment allowance (6%×$1,000,000)	60, 000
Amount subject to EPT	60, 000
Tax at 85%	51, 000

Thus, $60,000 of the $62,000 net income after income tax is treated as "excess profits." Therefore, the actual profit allowance under the proposals is only $2,000 or 0.2 percent. After both taxes, the profit would be $11,000 or a return on a tax basis of 1.1 percent.

The actual effective rate of the investment allowance will vary depending upon the relationship before-tax of income and investment, but it will always be substantially less than 6%. It is also possible for the combined taxes to exceed taxable income, i.e., the excess profits tax creates an after-tax loss. Any proposal that can create a combination tax rate in excess of 100% is obviously defective.

At the profit levels permitted under these bills, it would be impossible to generate or attract capital for the industry. To provide some realistic opportunity to expand energy sources, the alternative profit allowance should be expanded along the lines of the Gravel bill with the modifications suggested to it. Essentially, that would include in the investment base IDC and capitalized leased property and allow a rate of return no less than rates earned during periods when capital spending and reserves were being increased.

Reinvestment.—After deducting average base period taxable income (or the alternative investment allowance) from taxable income, a further deduction would be allowed to the extent average net investment increased over average base period investment. Certainly a reinvestment alternative is an essential part of any excess profits tax that will promote more energy. Thus, the basic concept of the reinvestment provision within these proposals is sound. However, the manner in which this reinvestment provision operates greatly reduces its incentive value.

Since only the increase in average net investment over the base period is "creditable" against the excess profits, the taxpayer must spend at least the amount by which investment is reduced through depreciation or capital asset dispositions before any amount would qualify for the special reinvestment deduction. To illustrate, if average net investment for the base period were $100 million and the annual depreciation rate were 10 percent, the average net investment at the end of the first year would be $95 million (the average of $100 million at the beginning of the year and $90 million at the end of the year). To maintain the same average investment, the taxpayer would have to spend $10 million (because of the averaging). However, the $10 million would not be treated as a reinvestment since there was no increase in average net investment. Similarly, if the taxpayer abandoned a worthless mineral property with a cost of $30 million, and paid that same amount for another lease, none of the expenditure would reduce the excess profits tax.

Since the reinvestment is keyed to prior investments, the incentive value of reinvestment is greatly reduced—especially when coupled with a surcharge exemption that allows an after-tax return on investment of substantially less than 6 percent. To be effective, the reinvestment provision should allow a special deduction for all such expenditures. This should be done along the lines of the reinvestment provisions we have suggested for the Gravel bill.

Summary—McGovern-Aspin proposals.—These proposals are basically defective since historical profits are used in computing the tax. An alternative profit allowance based on an allowable rate of return is permitted but the rate (substantially less than 6 percent) is far too low. A reinvestment provision is included but its incentive value is greatly reduced since only amounts in excess of capital recovery (depreciation, etc.) qualify.

The bills could be improved by the following amendments:

1. Taxable income should be modified to exclude foreign operations and income taxes should be deducted.
2. Base period taxable income should be adjusted for extraordinary items.
3. The rate of return for the profit allowance must be substantially increased.
4. The investment base should be expanded to include IDC and capitalized rentals.
5. Reinvestment should include all expenditures for energy related projects.

Administration proposal: Emergency windfall profits tax

The Administration has proposed a "windfall" profits tax which would be, in essence, a graduated tax based on the difference between the crude oil base price on December 1, 1973, and the actual or imputed sales price. There is no provision for plowback although the proposal suggested that Congress might consider (1) allocating the receipts to an Energy Development Bank for financing energy projects and (2) a refund of the tax to operators who reinvest their profits into energy producing projects. The President, in the January 19 Energy Message, stated that the reinvestment provision should be included.

Excess profits base.—Unlike either of the previously discussed proposals, the excess profits under the Administration plan would be based on the price of crude. The tax would be levied on crude oil produced in the United States, at rates which would increase as the price of the crude increases. The base price would be gradually modified so that after three years the tax would not apply to amounts below the expected average "long-run supply price", i.e., the price would balance supply and demand in the long run. However, for an additional period of two years beyond the initial three-year period, the tax would continue to apply to prices in excess of the long-term supply price, at tax rates ranging up to 85 percent.

One problem with this approach is that the initial base price must be established without any clear rationale for selecting any specific price, i.e., there does not appear to be any particular reason for selecting the December 1 price. Thus, establishing a base price is rather arbitrary.

The preferable approach would be to subject only prices in excess of the long-run supply price to the tax. Treasury estimated that to be about $7.00 per barrel. As discussed earlier, prices less than the long-term supply price cannot produce excessive profits.

The Administration proposal gives some recognition to the $7.00 long-run supply price by adjusting the base price upward over a three-year period. However, over the three-year period, several billion dollars would be diverted from the industry. Total tax payments would depend upon the amount of crude produced, including the amount of new supply brought on stream, the market price of crude not subject to price controls, and the ceiling prices permitted to be charged on crude subject to price controls.

If the tax is to apply to prices less than the long-run supply price, there could be a substantial deterrent to maximizing production. For example, to induce additional recoveries, price controls were recently removed from stripper well production so that it is now treated as "new" oil. Under the higher prices the economic life of marginal production may be substantially extended, thus increasing total recoveries. However, the current proposal would impose an immediate tax of about 89¢ per barrel if sales are at $7.00, the estimated long-run supply price, or $3.43 per barrel on oil selling at $10.00. Thus, the tax would be a substantial additional cost of production which would negate the effect of the price increase for stripper wells and reduce the life of marginal production. Any such effect could be greatly minimized by applying the tax only to prices in excess of the long-run supply price.

The proposed tax has been widely criticized as an excise tax which would have no effect because it would be passed on to consumers. In fact, the 85 percent rate would make it virtually impossible to pass on the tax, since a price increase many times the tax would be required.

Reinvestment.— If the recognition of the long-run price is deferred three years, much of the adverse effect of the proposal may be avoided by permitting reinvestment of the excess profits. The reinvestment provisions should be along the lines discussed in the Gravel proposal above. One of the most important provisions is the definition of qualifying expenditures. In our view, qualifying expenditures should not be limited to expenditures for additional oil and natural gas discovery and production and research and development of alternate energy sources. The energy supply job does not end with the production of raw crude and gas, nor is it limited simply to research and development of alternate sources. Qualifying expenditures should cover all energy sources and should include expenditures from the R & D stage, through exploration, production, refining or manufacturing, and transportation.

An adequate time period must be permitted to make the expenditures. For example, a rule could be adopted that the expenditures would qualify if actually made within two years following the close of the tax year or if a firm contractual obligation therefor is made within that two-year period.

Termination.—The Administration proposes that Congress review the tax during its stated five-year term to assure that it is not continued beyond the point where it can perform any worthwhile function and to avoid the risk that the atx could become embedded in the market mechanism and result in a permanent and unnecessary increase in energy costs. This we wholeheartedly endorse.

Summary—Administration proposal.—If a reinvestment provision is included, the Administration proposal may be preferable to other suggestions for taxing so-called windfall or excess profits. Without a reinvestment provision it would be a tremendous additional burden on the industry. It would take substantial amounts of capital directly from the industry and, since the value of investments in production would be reduced, make it more difficult to attract capital.

With a reinvestment provision, it is clearly preferable to proposals based on prior profits as in the McGovern-Aspin proposals. It also has the advantages of recognition of the long-run supply price, minimal discrimination among taxpayers, exclusion of foreign operations, and an automatic termination.

If the Administration approach were adopted with a reinvestment provision, it should also be amended to apply only to prices in excess of the long-term supply price, which was assumed by the Treasury to be about $7.00 per barrel.

Senator Gravel's proposal for a 14 percent investment tax credit

During Ways and Means Committee Hearings on March 19, 1973, Congressman Archer asked for views on the effectiveness of a 12½% exploration tax credit as a tax incentive.

A witness representing the API observed that one of the reasons oil and gas producers had not demonstrated greater enthusiasm for the proposal stemmed from their concern that the definition of exploration and development expenditures, to which the proposed credit would apply, might be made too restrictive.[2]

The Internal Revenue Code does not presently provide a definition of exploration and development expenses in the case of oil and gas wells, and H.R. 84 did not provide for the addition of such a definition, but rather left it to the Secretary of Treasury or his delegate to provide the necessary definition by means of regulations.

Following are specific examples of the restrictive nature of the Gravel proposal:

1. The restrictive definition of exploratory wells and the limitation of G & G costs to $50,000 per well are such that the tax benefit and, therefore, the incentive effect of this part of the proposal would be of little significance. It is estimated that the reduction in tax resulting from the credit on IDC and G & G costs would aggregate less than $100 million annually. The $50,000 per well limitation for G & G costs should be substantially increased to be meaningful. Because the proposal requires the taxpayer to assign his qualified G & G cost to exploratory wells in a manner prescribed by Treasury regulations, there does not appear to be any more reason for imposing a limit on eligible G & G costs than on intangible drilling and development costs.
2. To assure maximum incentive effect, the proposed credit should apply to both the regular Federal income tax and to the tax on tax preferences.
3. The vertical location restrictions imposed on the qualification of an exploratory well are not in accord with the industry's long established practice of distinguishing between exploratory and development wells.
4. Because of the restrictive nature of the base to which the 14% investment credit would be applied, the American Petroleum Institute continues to believe that the restoration of percentage depletion to the 27½% rate and the elimination of depletion from the list of preferences for purposes of the tax on tax preferences would be a more effective tax incentive for the industry to increase its exploration and development expenditures to the desired level.
5. Application of the proposed credit to all secondary and tertiary recovery expenditures would be a helpful incentive.

Two significant additional measures might be suggested as follows:

1. Elimination of the 50% of net income limitation with respect to percentage depletion on all petroleum properties on which non-conventional recovery methods are being applied. The additional costs of such recovery methods often work to deprive a producer of any percentage depletion on such properties.
2. Adding a provision to the Internal Revenue Code permitting producers applying secondary or tertiary recovery methods to expense currently all the costs of such recovery methods. In the past the Internal Revenue Service has in some instances required such costs to be capitalized and amortized over the productive life of the producing property. Such treatment has reduced the cash flow and potential profit to be realized from such activities and because of the large costs involved has, therefore, discouraged producers from undertaking such nonconventional recovery efforts.

Energy trust fund; tax on energy sources

Title II of Senator Gravel's bill, S. 2806, would establish an Energy Trust Fund in the U.S. Treasury which would be funded with the proceeds of an excise tax on domestic and imported energy sources according to their British Thermal Unit (Btu) energy content or the equivalent thereof.

Taxable energy sources would include the extraction of oil, gas, or coal and the production of electricity (or other consumable energy) using any other energy source within the United States as well as the importation into the United States of such energy sources or products or derivatives thereof. The rate of tax would commence at 4.1 cents per million Btu's (or equivalent content) for the one-year period starting July 1, 1974, ranging upward to 6.5 cents for the year starting July 1, 1978, and phasing down to 2.8 cents during the final year of its application starting on July 1, 1984. Revenues raised by the Tax on Energy Sources (estimated to be $50 billion over this eleven year period) would be placed in an Energy Trust Fund to be managed by the Secretary of the Treasury.

Expenditures may be made from the Fund to carry out the functions of the Federal Energy Administration established by Title III of the bill, and to cover the costs of the Commission on Energy Technology Assessment established by Title IV of the bill.

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[2] General Tax Reform (Public Hearings) Part 5, pp. 1959–1960, March 19–20, 1973.

Btu tax

As indicated earlier in this testimony, we believe funds from leasing of federal lands and federal royalties will be adequate to finance the activities of the proposed Federal Energy Administration. Consequently, we consider this tax unnecessary. But if the tax is to be imposed, the question arises as to how the burden of such a tax should be borne. We think that equitable considerations and requirements of administering the collection and enforcement of the tax clearly indicate that such a tax should be applied over the widest possible base of energy users and should be levied in accordance with a common denominator of consumption.

The goal of collecting revenue by a tax which places the costs of govrenmental assistance in developing adequate energy sources upon consumers of energy could better be achieved by a tax patterned (except as to rate and taxable items) after the Federal Excise Taxes presently imposed upon gasoline and lubricating oils. Such a tax would provide a more efficient, and administratively less expensive way, than the proposed Tax on Energy Sources. In addition, imposition of the tax as close to the consumer level as possible would facilitate consumer awareness of the tax and dampen demand.

Foreign tax provisions

Title X of the proposed bill would eliminate percentage depletion and the right to deduct currently intangible drilling and development costs for oil and gas wells located outside the United States.

It has been asserted that this proposal is likely to lead to increased domestic petroleum exploration and development activity since it would discourage foreign activity. There is no evidence to support this conclusion. It assumes that attractive opportunities in the United States have been forsaken in favor of foreign exploration. It is true that until 1972 domestic exploration had been decreasing. But, the decline in domestic exploration was attributable to (1) policies that have withheld federal acreage from exploration; (2) environmental restraints that have discouraged the search for new reserves; and (3) U.S. price restrictions. Raising taxes on foreign exploration and development will not assist domestic exploration and development. Domestic exploration and development will be undertaken on the basis of the adequacy of its own economic return to investors rather than in competition with foreign exploration and development. In the light of the critical shortage of fuels on a worldwide basis, both domestic and foreign exploration are urgently needed.

If taxes are increased on the operations of U.S. companies engaged in the search for overseas petroleum reserves, their competitive position will be impaired. Governments of other consuming countries actively assist companies based in their countries in the search for overseas petroleum reserves. In many cases, the direct economic considerations of a specific project are of secondary importance. Such government assistance is provided through tax incentives, subsidies, non-recourse interest-free loans, cash grants, and other means. Present law only insures that overseas operations of American companies are treated in a neutral manner so that the investment decision is not prejudiced by the U.S. tax law. Foreign operations have no tax advantage over comparable domestic operations under existing law. If the competitive position of the U.S. companies is impaired through increased U.S. taxes, their ability to compete for foreign petroleum reserves will rapidly diminish. Inability to search for those reserves will undoubtedly limit the supplies of foreign oil available to the United States in the future.

To the extent foreign oil and gas reserves are found and developed by U.S. companies, the U.S. balance of payments position is substantially improved. Moreover, large amounts of U.S. equipment will be used for exploration and development operations. Likewise, there are balance of payments savings where U.S. ownership of shipping is involved. If these foreign operations are conducted by foreign controlled companies, these savings in balance of payments will be lost.

Critics of the oil industry have alleged that taxes paid by oil companies to foreign governments are in reality royalties. These critics also allege that the oil companies have not resisted increases in foreign oil prices and taxes imposed by the foreign countries because the taxes are credited against the companies' U.S. taxes. Both of these allegations are false.

A U.S. oil company receives a credit for foreign taxes paid, but only up to the amount of U.S. tax that would otherwise be due. To the extent that the foreign taxes exceed the U.S. taxes, the excess foreign taxes cannot be used as credits against U.S. taxes.

As an example, in 1972 Gulf paid income taxes to Kuwait of $348 million. Its U.S. tax on that income without the foreign tax credit would have been $160 million. Thus, it had unused foreign tax credits of $188 million which were not used to reduce Gulf's U.S. taxes in 1972, nor can they ever be used in the future. The reason for this is that the actual and effective foreign tax rate was substantially greater than the U.S. tax rate on that income.

Consequently, the unused foreign taxes were an additional cost to Gulf. The only way that such costs can be recovered is through increased crude oil sales prices to customers. In some cases, market forces have permitted this to occur, but in many cases Gulf has had to absorb these costs.

A foreign government deals with the oil industry in two capacities: (1) as the owner of natural resources in place; and (2) as a sovereign taxing power. The foreign government collects royalty as the owner of the natural resources; and it levies an income tax on the profits in its capacity as the taxing sovereign. Each payment is separate, and each is made for different reasons. In recognition of this distinction, a U.S. tax deduction is allowed for the royalty; and a U.S. tax credit is allowed for the income tax to the extent that the U.S. would tax the same income. Thus, a tax credit is not allowed for oil royalties paid to foreign governments.

This system of payments parallels payments to the U.S. government on its own oil lands. It collects a royalty as the landowner and levies an income tax on the profits as the taxing soveriegn. There is no reason to treat payments to foreign governments differently. If foreign taxes were treated as royalties, U.S. companies would be double-taxed by the foreign country and by the U.S. This would be the same as treating the tax as a deduction.

The U.S. should not increase its taxes on foreign operations at a time of a severe worldwide energy crisis. In addition to promoting increased domestic production, United States tax policy should promote discovery of diversified crude oil supplies overseas by U.S.-controlled companies, as well as accelerate development and new exploration in existing producing countries. But increased U.S. taxation of foreign-source income would do exactly the opposite. At the most inopportune of times, it would seriously, if not fatally, disadvantage the operations of American petroleum companies abroad. This would be an irretrievable move, for once the American companies relinquish their position abroad, they will be immediately and permanently replaced by European and Japanese companies.

In conclusion, gentlemen, the United States is fortunate that it does have the resources to provide domestic self-sufficiency in energy. In order to realize this goal we must establish a national energy policy group, a Federal Energy Administration, and an Energy R&D Administration, and each of these should be a separate organization in recognition of the separate functions to be performed. The task of achieving energy self-sufficiency is so vast and the time frame so pressing that we can realize this goal only through the full and effective utilization of our entire industrial capacity. This will require a financial and economic climate favorable to the generation and investment of the unprecedented amounts of capital needed, both in the United States and abroad. Particularly important in achieving such an economic climate is a return to the free market and avoidance of punitive tax legislation.

Senator GRAVEL. Mr. Card.

STATEMENT OF ANNON M. CARD, SENIOR VICE PRESIDENT, TEXACO, ON BEHALF OF THE AMERICAN PETROLEUM INSTITUTE

Mr. CARD. Thank you, Mr. Chairman.

I will be brief also. We have presented the long statement to be filed for the record.

I would like to commend you also for the bill which you have introduced. Certainly the attitude that it reflects with regard to the free enterprise system and most of the elements in it we find are quite favorable and acceptable, and we think it will go a long way toward helping the situation, although there are some which we are not in agreement with. I think basically it is a positive bill.

My testimony will present some of the comments and information with regard to the petroleum supply and demand situation. First let me begin by stating that the energy shortage is real and not contrived. Just before the Arab oil embargo of October 1973, the United States was consuming over 17 million barrels a day of petroleum. Of this, approximately 11 million barrels a day came from domestic oil and domestic production. The remaining 6 million barrels a day had to be imported both as crude oil and as refined products.

If the supply and demand picture were to be normal during the first quarter of 1974, the United States would be consuming about 19 million barrels of petroleum a day, with approximately 8 million barrels of this imported, and approximately draw on inventory of 1 million barrels per day.

I would like to emphasize that we are providing estimates for a moving target, one that is constantly changing over time. All estimates are based on assumptions, and fast-changing events change these assumptions, such as the Arab decisions concerning the embargo, individual producing countries' actions regarding the embargo, weather conditions affecting fuel needs, voluntary conservation efforts, and Government regulations by governments for allocation and rationing.

This is how my company sees the extent of the current petroleum shortage. Various companies have estimated the shortfall amounts to 2, 2½ million barrels a day, and this figure is lower than original estimates for several reasons. First, the weather this winter has been milder than normal thus far. Two, conservation measures such as reduced use of gasoline and heating oil and electricity have made a significant impact. And three, in actual practice, the Arab oil embargo has been less stringent than originally forecast.

In order to prevent severe product shortages in the first quarter of 1974, voluntary allocation systems and conservation measures were adopted by industry and the public to extend existing inventories of petroleum. As a result, normal industry drawdown of inventories in November and December were not experienced and increases in demands were less than previous years.

Petroleum shortages existed before the Arab embargo, and they clearly illustrate the imbalance between domestic supply and demand. They manifested themselves as shortages of aviation jet fuel and low-sulphur residual fuels during the winter of 1972–73 and as shortages of gasoline during the summer of 1973. Industry was forecasting that there would be a tight supply situation during the winter of 1973–74 and that continuous unprecedented increases in demand would cause supply to lag behind the growth. That was before the embargo.

I would like to just go through quickly here a few of the reasons why this shortage has developed. First, the unprecedented increase of 7.7 percent in gasoline consumption in the year 1973 over 1972; the shortage of natural gas which was caused by the regulation of prices at unrealistically low levels; the decline in domestic crude oil production; environmental restrictions on the use of coal and high-sulphur residual fuels; the lack of adequate refining facilities caused by environmental factors; and the absence of assured supplies of crude oil; a failure to develop alternate sources of energy.

With regard to Senate bill 2806, the Energy Development Act of 1973, I would like to make a few comments. Mr. Henry has already commented on most of the tax aspects. We feel that the bill does represent a reasonable approach to the energy problem. We agree with its objectives to achieve energy independence, to permit free market forces to establish prices for the Nation's energy resources, and to provide for a Government-financed program to develop all energy sources.

The provision of the bill defining a safeguard against so-called excess profits tax on petroleum industry profits would be inherently inadequate in that it would severely impair the future climate for investment in energy development. At best the shortages that we have today will remain acute for at least a few years because of the long lead time involved for increasing domestic energy supplies.

Senator GRAVEL. Mr. Card. Mr. Card, excuse me.

Would you repeat that last thing you said, just before the beginning of your paragraph there.

Mr. CARD. Concerning the bill?

Senator GRAVEL. Yes.

Mr. CARD. OK.

These are the two basic comments that I have added, I believe, to Mr. Henry. We feel that the bill does represent a reasonable approach to the energy problem. We agree with its objectives to achieve energy independence, to permit a free market together with the full cooperation on the part of Government and industry will enable this Nation to take the necessary steps toward regaining its historic self-sufficiency in energy supplies.

Thank you very much, Mr. Chairman.

Senator GRAVEL. Thank you very much.

I think, obviously, I am very pleased with both of your contributions. There is one area that I want to pursue, which I think is very vital, and that is the area about the excess profits tax.

Let me say for the record that when I got to that section of the bill, working with Mr. Best, we looked at it as possibly the one that could destroy all other parts of the bill, in that here we are trying to create something to increase supply, but then we are talking about a section that could essentially destroy everything if we did not handle it properly. So where we took guidance was in testimony we received last October, the banking community, which is very knowledgeable on the capital requirements of your industry, and the academic community.

The point that was made—and I mentioned it earlier today—that the 18 percent profitability requirement suggested by Mr. John Winger of Chase Manhattan is because of the nature of oil, the innate difficulties involved. Oil companies do not finance themselves as other businesses, there is a very small content of debt and a very large content of equity, equity coming from profits, and that the requirement for development—his criterion—was 18 percent.

Now, I just read a congressional research study that brought forward the figure of 16 percent profitability. Be that as it may, these two figures are far in excess of what the industry has been earning in terms of profitability, so we are not even close. Thus I can share your view, and do, that it seems ridiculous to talk in terms of windfall profits and excessive profits when, based upon the capital requirements, you are not even near that level of profitability, and so I can understand your frustration, knowing what your needs are.

But now let me pose the other problem that we face as policymakers. That is that—and I think Senator Dole said it was 26 percent or 27 percent by the poll he heard—I may have been misinformed and may be misinformed, and so I am here to be corrected—but I thought I had heard of a poll that showed 90 percent of the American people thinking that the oil companies were at fault for the energy crisis.

Well, if you started out with that perception; right or wrong, it is an active perception; it does not make any difference from our point of view; those are their views. That is what you start with in the public arena, what the perception is, not whether the perception is right or wrong. So from a policymaker's point of view in a democracy we act as politicians reacting to the views held by the people. This is the controlling factor in Congress, or any system of representative government, and if the people have an erroneous view, that view must be "cottoned" to, so to speak. Otherwise, you do not survive, and most intelligent human beings first think in terms of survival and then think in terms of intelligent solutions to the problem.

So the dilemma we face is that, right or wrong, the people think that there are excessive profits. Now, if the API is coming forward with the proposal that we do not think there ought to be any excess profits tax, the quid pro quo of that statement being there are no excess profits, which I do not disagree with you on, the API is not recognizing the perception of the American people.

Mr. HENRY. True.

Senator GRAVEL. So we have to deal in the real world of that perception. Then how can we hope to get legislation through the Congress that does not embody some proviso to give confidence to the American people that excessive profits will not be ripped off?

Now, the bill does not address itself directly to the question that the people are not being ripped off. I think the chart I have asked you for will be very revealing in that respect. But if you find API wants to hold its position and not accept some type of reasonable excess profits tax, or whatever you want to call it, I think in an item we have in this bill it could be tagged either way, and I have no proprietary interest in what you call it, very well. But what the bill does wind up doing is assuring the American people that, profits above the amount of money necessary to provide the capital needs to meet our goal of self-sufficiency will be taxed severely. That needed profitability would be reached; in fact, we have tagged it 2 percent above that, so our figure is 20 percent profitability, and you can do what you want with that.

You can do whatever you want, just like any other American company or international company, to that 20-percent plateau. And then above it, if you are making 30 percent or 60 percent, then all you have to do is take everything above 20 percent and plow it back into capital improvements and you are not taxed on any excessive rate. We are just permitting you the same thing that you have here. We worked and really wracked our brains to get a device that does not destroy the ability of our private enterprise system to do the job.

Maybe if the American people have more confidence in the free enterprise system, and that there would not be windfall or excessive profits, we would not need the controls that we have experienced in our economy, which have completely failed, and we could get back to a total free enterprise system with some degree of confidence that it could be established.

I am asking for a comment if you choose to give it, and, if you do not choose to give it, then I am asking for API to go back and counsel with itself and really analyze what impact that section I have in this bill will have on the industry.

I understand your position. You are opposed to it because you feel it will have an adverse impact on the industry. In point of fact, will it? If we give you a 20-percent profitability umbrella to do what you want with, to put it back in capital, which I am convinced you will do, which Exxon is doing—and I am sure your report shows capital expenditures from your equity position below, much below, 20 percent—what is wrong with that? This is not, in my mind, a cosmetic approach for the American people which we are giving them some type of phony excess profits tax that is acceptable to the oil industry. What we are trying to do is to save the free enterprise system in the energy field, because if we fail right now there is chance that other tax proposals will not be within those confines.

Mr. CARD. Mr. Chairman, I would be glad to comment on this. First of all, about the profit situation, in 1973 we went to great effort in preparing our news release concerning 1973, because we knew that it must be explained to the people in this country, they should have the facts and should understand something about it. And I think if we could get this fully published, as we hoped that we could, with all of the facts in it, that they would understand a little.

Senator GRAVEL. We will put that in the record at this point in time. I want it in the record right now so it will be an integral part of this discussion.*

Mr. CARD. Very good.

For example, one sentence here—I will not go through all the details—but the U.S. earnings in 1973 increased for Texaco 3.6 percent over 1972.

Now, this is something that must be recognized.

Senator GRAVEL. The earnings? They have not done nearly as well as Exxon.

Mr. CARD. This is the U.S. earnings now—not to be a part of the picture. The total earnings for the company are up 45.4 percent in 1973 over 1972.

But one of the things that must be recognized, 1972, 1971, and those years were not satisfactory earnings years. The base over which you are calculating the increases is extremely important, and many times this is overlooked.

Now, I also would like to call attention to another element in this earnings report, and that is that 30 percent of the earnings outside of the United States came—or the amount was $387 million— represents the effect of the higher net value in terms of U.S. dollars of the operating earnings realized in the currencies of the countries in which we operate. In other words, the currency effect, and this is something

*The following comment was received for the record from the Gulf Oil Corp. "These comments were included in W. L. Henry's submission to the Committee on behalf of API. In addition similar comments will be submitted to the Senate Finance Committee by the API for its hearing on February 14, 1974." See Committee hearings entitled "Profitability of Domestic Energy Company Operations", pp. 85 ff.

that occurred in 1973. It may never occur again; it could go the other way.

So this is an important part to be considered, but these kinds of facts, unfortunately, seldom get the kind of explanation that they should. The big headline, it seems, is that one figure, 45.4 percent, 59 percent.

Now, you have to look into the depth of information behind what that means. And the industry, as the Chase Manhattan study indicated, between the period of 1970 and 1985 will have to have $1.35 trillion to do the job that it is going to be called on to do to provide energy that is required to meet the demands.

Now, this is for various forms of energy. It is an enormous amount of capital. On the basis of the historical performance, the industry would have to borrow over eight times as much as it has borrowed in the past in order to meet this kind of capital requirement. As you have said earlier, and I think you are quite right, the industry has to have the finances generated, the capital generated, in order to do this job.

I would like to again sound a note of caution which I have sounded previously this week as a witness before Senator Jackson's hearings, that any interference or legislation that creates additional uncertainties or interferes with the petroleum industry's capability for earnings could result in worsening the petroleum supply situation in this country, rather than increasing it, in a time when we face a real crisis and in a time when maximum effort on the part of the petroleum industry must be brought to bear. So this is a distinct and sincere——

Senator GRAVEL. Mr. Card, you were party to these hearings?

Mr. CARD. Yes, sir.

Senator GRAVEL. See if you draw the same conclusions. You read the papers a little bit, and I am sure your company has information sources around the country.

What do you think the impression, or the perception, to the American public was of these hearings? Do you think it was what you said or what Senator Jackson and Senator Ribicoff may have said with respect to the situation? Reading the newspapers, what do you think the perception of the American people was?

Mr. CARD. From the coverage that I saw on television and in the press, I must say that I think the American people got one side of the story, and that was from the standpoint of the subcommittee's side. It was not properly covered from the standpoint of the industry representatives, of which I was one.

I think that this is extremely unfortunate at a time when it was clearly indicated that the purpose was to get the facts and to get them out to the public. I do not think it did a good job of doing that, because it was not properly covered from the standpoint of the industry representatives' witnesses.

Senator GRAVEL. Well, then, I think we can conclude that you shot your best shot in a bad situation. Well, you are shooting another shot right now, and I am sure there will be other hearings.

Mr. CARD. We were told there would be.

Senator GRAVEL. Legislation is going to be made in the next 30, 45 days, and so these are all the shots you are going to get.

Now, you are right. I do not disagree with you on those facts. But the perception that comes to the American people is not based on the digestion of those facts as you have put them forward. It is based on the digestion of another set of facts that are commingled. Therefore, we in Congress are going to be faced with that perception, though we can lock ourselves in concrete that we are right, and by God, we are right. But that is not what is going to make policy, and this is the sobering reality of life we are trying to impart to the API at this point in time: Being right is not enough.

Mr. CARD. Mr. Chairman, I understand what you mean, and this is a time when we really need the cooperation of the Congress, of the committee, and these committees, to really understand what it is going to take in order to get out of this situation.

Senator GRAVEL. But you see what is going on right now in just appealing to understanding. That is the reason why I have taken the initiative to try to put forth a bill, and that is the reason why I have put in an excess profits tax, because it is my political judgment—and I could be wrong—but I will give you my best political judgment, and that is that there is nothing that is going to pass this Congress that does not have some type of an excess profits tax. It can be a good one or it can be a bad one.

My approach is, if we can take the initiative, we have a chance of making it a good one that industry can live and flourish under and meet the goals that are required. We must not pass a bad one—and it just failed by one vote—in fact, we are going to have a vote on Tuesday afternoon at 4:30 about a horrendously bad one. There is not an expert around who is willing to say it is any good, and it just by a wisp almost passed the Congress last December, and now we are going to take it up again. That is how close we came to total disaster in this area.

Now, to move away from total disaster to an intelligent policy is going to be quite a row to hoe. So if industry—which is what is happening right now—if industry wants to take a hard position and say, well, oh, boy, we just do not want any excess profits tax, that is fine, and I understand why you are doing it, and I may privately agree with your position. But as a political person with some experience and some political judgment, you are just committing hara-kiri with a dull knife.

Mr. CARD. Well, you have made a very——

Mr. HENRY. A very understandable statement, Mr. Chairman.

Mr. CARD [continuing]. A very sound statement.

However, if we knew, you see, what level of investment would be required, then we would know something about what internal capital generation you would need.

Senator GRAVEL. The best we have is—you use the same study that I am using. There is no magic to this.

Mr. HENRY. But on the basis of the study, Mr. Chairman, there is such a tremendous amount of capital required, any limitations, we think, would be a detriment to the realization of the maximum supply of energy.

Senator GRAVEL. Well, there is the interesting point. I think we have got to the crux of it. I do not think it is within the acceptability of the American public to tolerate—or the world public—to tolerate a profit margin, let's say, of 30, 40, 50 percent. And you will not even see that, you know you will not see it, and I know you will not see it, but they will not tolerate those profit margins even to finance the capital needs necessary. I would say there is probably a large enough body that would rather see the Government do it through appropriation, though, again, it is done by the same person, the consumer-taxpayer. And realizing all this, then you suffer the possibility of actually playing into the hands of those creating a socialistic society rather than contributing to maintaining a free enterprise society.

You must realize that the American public cannot buy that concept, to let you have "unlimited" profits. The average man in the street, let's face it, does not like you as an industry. He does not trust you, and he is not going to sit back and let you make exorbitant profits. But you are not making exorbitant profits. So what you are doing is you are defending something that is not going to happen, and that is killing your present political position.

So why fight the battle for this? It is not within the realm of possibility, and your profit pictures show it. So why defend something conceptually that is not acceptable within our present sociological and economic context and get yourselves wiped out in the process? Defend the ground that you need. I do not know how else to phrase it.

Mr. HENRY. Mr. Chairman, that is quite clear.

May I just comment philosophically?

You made two very good points, which is our credibility is very low and politically we are probably not going to be able to sustain a position which has no excess profits tax in it, and I understand that quite well, and I understand the reason. And I understand why you then propose putting into your bill an excess profits tax which is structured to do the best for the country and for the industry in the situation as you see it.

Senator GRAVEL. And save the free enterprise system, too.

Mr. HENRY. Yes, sir. I understand that.

Let me just make this point. Unfortunately—and I fully recognize what you just said in terms of the political realities of the situation. That position has been put forward by the people, basically, here in Washington, and is a belief, it is not a truth.

Is there a possibility that with leadership, such as yours, we can undo that belief, and can we get back to the situation that says, well, let us make a very serious effort to find out whether, in fact, there are excess profits?

Now, that same kind of leadership might conceivably come from the people who created the problem.

Senator GRAVEL. Mr. Henry, I am deeply flattered, but obviously I have made the judgment that my leadership will not be sufficient, and that is why I have put the excess profits tax in the bill.

Mr. HENRY. Yes, sir.

Senator, may I say to that, then, having accepted that position, our detailed statement covers in detail the provisions of your bill in terms of what we see it as a bill, accepting the fact that we think windfall profits are not there, we should not have an excess profits tax. But if we do, your bill, which provides for a return on capital and a plow-back provision is a good concept. We have detailed explanation. We would be most pleased to discuss it with you at your leisure.

Senator GRAVEL. Very good. I think what I was looking for was, call it compromise, or call it a different position that could take place.

Now, as you know the AFL-CIO has gone on record very strongly for an excess profits tax. I doubt that in today's climate we could see a bill pass in Congress that could garner enough present support to become law if it did not have those elements of compromise in it. So let me just say, I can understand, and I can really—and I just say this for the record—appreciate the emotions that go on. In fact, I was thinking as you were talking that it just may be that within the industry there also is not a political climate that permits the position taking we are talking about. Thus we may have two irreconcilable political claimants: that of the industry, because there is politics within the industry—human beings and their views—and that of the public. Obviously, two irreconcilable forces can only result in violent disruption of our economic system.

That, of course, is where I have my great fear, because I think the free enterprise system is the only way to allocate our resources and still retain our freedom.

Mr. CARD. Mr. Chairman, may I make just one short comment on this matter of excess profits?

As you know, countries throughout the world look at the United States very closely, and what the United States does in this regard many times is used as a pattern or model for what is done elsewhere. Sometimes, though, it becomes even more severe and more extreme, and this is something I think should not be lost sight of.

In 1973 I think most of the companies who reported their results have attributed a large part of their earnings for 1973 to the operations outside of the United States. This, as I have indicated, is certainly where a large part of our own earnings came from. So if the United States starts talking about passing an excess profits tax here on profits, which I have indicated were only 3.6 percent greater than 1972, and if we have an excess profits tax on that, then what will countries outside of the United States think, when you have substantially higher earnings attributable to the operations in those countries, envisioned, perhaps, excess profits tax or some other kind of tax being imposed which would severely limit the opportunity to generate earnings outside of the United States, which could possibly be utilized to some extent to help overcome our energy crisis here.

Senator GRAVEL. I saw that exact situation as you were talking earlier, and that is the reason why I wanted the charts, because the point that can be made with the charts is the fine balance between our international position which must be maintained as the world moves forward and what our domestic needs are to make us self-sufficient. We need the difference in profits showing what success is abroad, and what is domestic. We will see by this chart how much capital throw-off there is.

Obviously, it has to be over the present 18 percent to offset the deficiency of our own public policy. So, in point of fact, what may be happening is that we may have public policy in this country which whipsaws the underdeveloped nations of the world, and that may not be good public policy for the total world energy picture. We cannot determine that balance until we get this additional information, and that is why it is so important, if we are going to make policy—we are going to make it any way—we could make it in ignorance or we can make it with an issue of facts.

You people have the facts and the experience and the knowledge, and to not give us that counsel backed up with facts and figures, then, we all suffer, because we make ignorant decisions. You are party to holding information which could be very helpful in making a law which could be very just.

Mr. CARD. We will be happy to cooperate with you in any way that we can to give you the information that you need.

Senator GRAVEL. Thank you, Mr. Card. If you have an extra copy for the record, I would also like another copy for myself to read in the next day or so, since it takes time.

Mr. Best, do you have questions?

Mr. BEST. Yes; if you can bear with me, I would just like to help complete the record on a few points that I know other Senators would be interested in.

I think there is unanimity on the statement that we need a coherent national energy policy. It depends on how you define it.

Now, how would you define what energy independence or self-sufficiency means?

Mr. CARD. Sir, I think this is a good question—what is energy independence. Some people would say that it would be able or capable of supplying 100 percent of the energy needs of the United States from indigenous sources from within. I do not think that that is necessarily the right kind of energy policy to pursue.

It seems to me that some lower number—and I do not know what that would be and I do not think anyone else knows what that number would be. But let us assume, for example, that it did, after careful consideration and determination, it came out it is 85 percent, but have the capability to quickly move to 100 percent. And some policy of that type, it seems to me, is the way to approach the problem of independence.

Mr. BEST. That would imply that your imports would fill a gap of some 15 percent of your total energy consumption.

Mr. CARD. It would assume that you would be employing or requiring from offshore that gap. But again let me emphasize this capability or this standby or this reserve where in times of emergency or cutoff or other interruptions, that this country then instead of being short that much, could within a reasonable period of time move to have that additional supply available.

Mr. BEST. Well, to be able to do that within a reasonable period of time you would either have to have the stocks of the petroleum products in storage, or you would have to be able to tap, say, the naval reserves in Alaska in a quick period of time. Just because you had the extra 15 percent in the ground does not mean that you could develop it quickly, because we have it in the ground right now. Obviously, the gas reserves in this country are enormous, and so are the oil shale and oil reserves. So you either have to have large storage facilities or an ability to tap an existing reservoir rather quickly.

Mr. HENRY. You are exactly right, Mr. Best. Let me put it this way. I think that Mr. Card's point about 15 percent is exactly valid. If you take the point of view which you are expressing, which is correct, the American people have responded over the past 2 months to where the consumption has declined 10, 12, or 15 percent. We can really do this. The American people can do that any time they really want.

Mr. BEST. But I do not think if they had the choice they would prefer to have the supply, even at a higher price, then to have to wait in line for gas.

Mr. HENRY. It is physically impossible for us to turn the tap, as you suggested, to gear up on the 15-percent decline in the case of a national emergency. The physical characteristics of the reservoirs, refineries, tankers, and so forth that is required—and again, as Dr. Ray, who I listened to very closely this morning, you cannot just go out and put coal mines into production. There is leadtime involved.

So all I am suggesting is if we do take the 15 percent which Mr. Card has pointed out, it could be a very short period of time when either a shortage or a decline in consumption could handle an emergency situation.

What we cannot have, in my opinion, and when we set the target that we should look at, under no set of circumstances should our industrial capacity be penalized by lack of energy. That has got to be the minimum.

Mr. BEST. As you review historically what our policy has been through, we started out in the fifties on the concept of a national security provision which regulated imports, at first without any limitation, and then when President Kennedy came in, he put a 12.2-percent limitation, and then as exceptions developed during the sixties, the whole program became unraveled and finally was abandoned this past year.

So we are really not operating on any concept at all as to what self-sufficiency means in terms of import policy.

Now, we try to define it in this bill, and it could be consistent with your 15 percent. But we suggested that 5 percent for those countries which embargo products to the United States, and which thereby prove their own lack of reliability as a supplier was enough of a level of dependency on that source that a policy of self-sufficiency would dictate.

Now, if you think within 15 percent it could become dependent on the Middle East, which obviously is the largest source of proven reserves in the world—I think 65 or 70 percent—then what we will end up with is a policy where we continue these trends of import penetration, going up to the point where it is 50 percent; and then where there is a cutback the American people will revolt.

So I think what we have to do is to think the thing out realistically in terms of what is self-sufficiency and define it so that everybody knows the rules of the game.

Mr. CARD. Yes; I quite agree. However, I think it is important to point out that within this decade there is no way that we can talk about a 5-percent or a 15-percent dependency outside foreign sources. It is much greater than that, and there is no way that that is going to be eliminated. It is a much greater dependency, and I wish there was not.

Mr. BEST. Well, when you talk about a reduction from 35 percent or whatever it is now to 15 percent over 15 years, by 1 or 2 percentage points a year if you wanted to—just by saying we cannot talk about it in this decade sort of indicates well, we should not talk about it at all.

What we have got to do is say, well, OK, we are at 35 percent now, or something of this kind; if we want to get to 15 percent, we will have to have a scale. We know it has got to be a gradual decline. But let us define it now so that you know where you can put your investments and where you cannot put your investments. You are not going to spend $40 billion abroad or some such figure to develop refinery capacity when you know you cannot use that in 1985. But if you do not know now what the rules are going to be in 1985, you will build refineries there, and then you are going to be in support of the government policy which makes us dependent upon——

Mr. CARD. That is fine. I was referring to the 5-percent imports from these countries.

Mr. BEST. Well, the 5 percent could be put off until some future time, but you have got to define now how you get there.

Mr. HENRY. I agree. I do not think we quarrel with that concept.

Mr. BEST. Well, let me just play the devil's advocate, if I may, Mr. Chairman, on this question of inventories. There have been a few articles in the paper—Chris Ferrand and others—who have discussed the inventory thing as if you people are just holding off an enormous amount of supplies from the market and thereby jacking up prices and creating shortages and reaping the rewards.

Now, I do understand inventories are up. And the Secretary, the "Energy Czar," explained why they were up—the conservation measures, the weather—and I think you indicated that this morning.

What are the inventories of gasoline now? Is it 200 million barrels of gasoline in stock, something of that nature?

Mr. CARD. May I discuss the inventory situation generally, Mr. Best—gasoline and the whole thing?

Mr. BEST. Well, there are two specific questions there.

Mr. CARD. Well, maybe we had better answer this first. In Texaco's case—I do not have it for the industry—but in our own case it is about the same as it was a year ago. That is, something like 22 or 23 million barrels; and I believe it is near the same for the industry—about the same as it was last year.

[The following additional information was subsequently supplied for the record:]

Attached is a schedule showing inventories for the week ending January 25, 1974 compared to the same period a year ago. However, since this information is continually changing it may not be meaningful.

U. S. PETROLEUM INDUSTRY STATISTICS THROUGH WEEK ENDING JANUARY 25, 1974

		VOLUMES		% CHANGE OVER YEAR AGO	
		1/1/73-12/31/73	LAST 4 WEEKS	YEAR TO DATE	LAST 4 WEEKS
TOTAL PRODUCT DEMAND		17,440	18,047	5.2	-3.7
Total Gasoline		6,689	5,888	4.1	-3.6
Automotive Gasoline		6,643	5,864	4.2	-3.2
Jet Fuel (Kerosine Type)	M	833	780	3.7	-12.0
Kerosine		204	307	-13.2	-27.4
Distillate	B	3,076	4,039	5.5	-0.1
Residual	A	2,824	3,033	10.2	-8.0
Others	R	3,814	4,000	4.9	1.1
	R				
MEMO: TOTAL DEMAND	E	17,010	17,617	5.0	-3.8
	L				
TOTAL NEW SUPPLY	S	17,098	16,077	7.2	-2.2
PRODUCTION	P	10,972	10,898	-2.1	0.1
Crude Oil	E	9,209	9,158	-2.6	-1.5
Natural Gas Liq., etc.	R	1,763	1,740	0.3	1.2
IMPORTS	D	6,126	5,179	29.2	-6.6
Crude Oil	A	3,217	2,383	45.2	-12.8
Unfinished Oils	Y	136	141	8.8	6.8
Residual		1,840	1,743	5.6	-11.7
All Other Products		933	912	36.8	29.4
CRUDE RUNS TO STILLS		12,440	11,638	6.3	-4.5
% OF CAPACITY OPERATED	P	*	86.3	*	*
YIELDS	E				
Total Gasoline	R	52.8	51.3	-2.6	-0.6
Jet Fuel (Kerosine Type)	C	5.5	5.4	0.0	-6.9
Kerosine	E	1.7	1.6	-5.6	-33.3
Distillate	N	22.7	25.6	0.9	4.9
Residual	T	7.6	8.9	15.2	2.3
STOCK CHANGE - ALL OILS	M	32.1	-43.1	-	-
PRODUCTS		36.7	-31.2	-	-
Total Gasoline	O	-5.4	5.2	-	-
Jet Fuel (Kerosine Type)	F	3.6	0.3	-	-
Kerosine		4.0	-2.9	-	-
Distillate	B	46.7	-19.0	-	-
Residual	B	-2.1	-6.7	-	-
Others	L	-10.1	-8.1	-	-
CRUDE	S	-4.6	-11.9	-	-

STOCKS AT END OF PERIOD 1/25/74	MILLIONS OF BARRELS	DAYS SUPPLY#	% CHANGE OVER YEAR AGO	
			BARRELS	DAYS SUPPLY
ALL OILS	952.4	53	1.8	5.6
PRODUCTS	720.9	40	3.1	7.0
Total Gasoline	216.0	37	-3.5	0.0
Jet Fuel (Kerosine Type)	23.1	30	15.5	31.0
Kerosine	20.2	66	24.7	71.8
Distillate	184.5	46	34.7	35.6
Residual	47.3	16	-8.0	0.0
Others	229.8	58	-8.4	-9.3
CRUDE	231.5	20	-2.1	2.6

Source: 9 months Bureau of Mines data, supplemented by A.P.I. weekly data. % change computed over comparable year earlier data. # Stocks at end of period/demand in period.
*Not available, see report 7/16/73(week ending 7/6/73).

Energy Economics Division
Corporate Planning & Economics Dept.

Mr. BEST. I had understood it might be up 4 or 5 percent over what it was a year ago. I guess my first question is if inventories are the same or slightly above what they were a year ago, of gas, why is it that I cannot get gas at a Texaco station?

Mr. CARD. All right, sir. Here are the major reasons for that.

First of all, the consumption, as you know, was up, up until the conservation measures the consumption was still growing in the first part of 1973, and then we went into conservation measures, and then the allocation.

Now, the reason we have the amount that we have was because of the conservation and the allocation. We followed—and I think many others did—the voluntary allocation program prior to the mandatory allocation program. So those helped to make more gasoline available in inventory.

Senator GRAVEL. What you are saying then is the policies of the administration for short run prices were effective.

Mr. CARD. I agree, Mr. Chairman. They are effective. They are manifested in effect by the inventory being about the same. But this means that people are getting less.

Mr. HENRY. I was just provided a chart that shows the U.S. petroleum industry's statistics through the week ending January 11, so that is as of January 11, 1974. The gasoline decrease is minus 4.6 percent as compared with 1973. So actually we are down in gasoline. We are up in jet fuel 16.8 percent; up in kerosene, 24 percent; distillate, almost 30 percent; resid is down 5 percent; others is down 9 percent for basically no change on the average 0.5 percent increase.

Mr. BEST. Could you give us maybe a chart showing how the allocation system has worked on the distribution of gasoline? I do know that Senator Ribicoff made a point the other day that in his State of Connecticut it seemed to him it was bone dry, although I am sure anybody who waits in line must be sure his State is the dryest of all. But it may be that the allocation system is, because of the distributions and so forth, has had a skewed effect or an uneven effect on the States.

Is there any way of showing that—what the stocks are for Connecticut?

[The following information was subsequently supplied for the record:]

The voluntary gasoline program resulted in the following for Gulf Oil in the United States (including the West Coast):

Total gasoline sales 1972 (millions of gallons)	6, 679. 9
Original plan gasoline sales 1973 (millions of gallons)	6, 699. 2
Actual gasoline sales 1973 (millions of gallons)	7, 259. 7
Percentage increase, 1973 actual versus 1972 actual	8. 7

Gulf's voluntary allocation program generally covered contractual commitments for 1973 and additional supplies of gasoline were delivered as they became available. The intent was to comply with the voluntary program.

The first voluntary allocations of gasoline occurred in May of 1973 and were confined to Gulftane (low-lead) gasoline. Because of an unanticipated demand for this product, and limited refinery capacity to produce it, it was necessary to allocate this product based on the sales reported during the first three months of 1973.

The May Gulftane allocation was expanded in the months of June and July 1973 to cover all gasolines. The June and July allocations were based on available supply indicated in the latest 1973 4-Months Actual and 8-Months Forecast of supply and demand.

New supplies later became available based on further efforts at the refineries to achieve maximum gasoline production. Along with the increased production was the positive effect of curtailed industry consumer demand. This allowed a new higher allocation for July and higher allocations for the balance of the year based on estimated available supply.

As indicated in the above table, the final 1973 gasoline sales exceeded 1972 by 8.7%.

Mr. CARD. I was there when the Senator made his comments on the State of Connecticut.

Mr. BEST. He made it here. I guess he made it in your committee, too.

Mr. CARD. We looked in our own records on this, and actually in Texaco's case we had supplied substantially more gasoline in Connecticut in the year 1973 than we had in 1972. As far as the allocation method, prior to the 15th of this month the so-called voluntary method of allocation was in effect. Some, I think, elected to follow it; some, I think, did not on their own voluntary programs. However, it became mandatory. The mandatory allocation program is not only gasoline but other petroleum products and is now in effect; and this is clearly spelled out. And it does allocate or attempts to allocate the available supplies in an equitable manner.

And this is what in our case Texaco is following. And I believe that this now is in effect nationwide.

Mr. BEST. Well, do you believe now that inventories will be drawn down as we approach spring—of gasoline?

Mr. CARD. No. The inventory—we only mentioned gasoline—the inventory that is really high, as indicated here, is in the middle distillate area, and particularly No. 2, heating oil.

Let me explain why that was high. First of all, we are comparing with a year ago on it; so a year ago the inventories were critically short.

All right. That is the first thing.

The next thing is that we have had mild weather thus far this year. There is no question about it, that the records were a great deal less, at least the last I saw. They may have changed recently.

And the second is we have been on allocation, voluntary allocation. We have not supplied all of the customers with all of the No. 2 heating oil that they would have desired; and there has been conservation working.

Now, another thing, the refineries throughout the country, the people who refine the crude oil into the various products, have been on maximum yield of middle distillates, because we had foreseen a potential critical situation, so we have been running on maximum yield of middle distillates at the expense, in some cases, of gasoline. And this works the other way.

Senator GRAVEL. This would affect future gasoline inventories?

Mr. CARD. This is the point. Now, we are at a time—and some have applied already to the FEO to change this yield structure; and we are at a critical time now because unless we do change to run more gasoline, there is no possible way that we can build up the inventory to where it should be on gasoline going into the peak driving seasons of June, July, and August. So this is a very important point.

Mr. BEST. I understood from something Secretary Simon said that the ability of an average refinery to convert from home heating oil to gasoline was 5 percent or something in that range; that you just cannot turn a refinery around from one to the other. There is a fairly small margin of——

Mr. CARD. I agree with that. Somewhere between—and some refineries, depending on the type of equipment and type of crude oil they are running, may not have the flexibility over 2 or 3 percent.

[The following additional comment was received from the witness:]

The precise percentage depends on variables such as the type of crude oil being refined, equipment in the refinery, etc. However, the percentage of change is usually not more than ten percent.

Mr. BEST. Let me ask you this question on price. If the stocks of home heating oil are up 30 percent, as you have indicated, why is the price also up 20 to 30 percent?

Mr. CARD. Sir, on the prices let me emphasize that these prices have been under the Cost of Living Council control. They have been under price control, and in our case we have diligently followed the rules and regulations called for under the price control.

Senator GRAVEL. Let me pursue something here. In point in fact, if there were no price controls under the allocation system, we probably could have caused an increase of supply which could cause a depression in price, since we might have a surplus then.

Would that have taken place?

Mr. CARD. Mr. Chairman, you are making some assumptions that I would not really care to speculate on, what would have happened; because I think—really I do not know what would have happened. I think you can make assumptions and speculate, but the conditions have been changing so rapidly in the entire field of petroleum that I think it would be hazardous to speculate.

Senator GRAVEL. Is there any danger that we will be struck with a supply of middle distillates inventoried for a severe winter, and then because we have had a mild one, winding up with a lot of heating oil but have problems filling our gas tanks in June and July?

Mr. CARD. Mr. Chairman, in our own case we have very carefully studied these inventories and supply and projected what our needs would be, and have planned our supply situation to be at minimum inventory—and by minimum, I mean just the basics to fill the tanks' pipeline for minimum working stock. And this is another point about inventories.

You keep in mind there is a tremendous amount of product that has to always be in the pipelines, in the ships, and so forth, that is not usable. And we expect to be at minimum working inventories by the end of the heating season. I do not believe that that is a great danger.

Let me say one other thing. There has been a lot said about this business of inventories and the industry has been accused of hoarding and holding back products to increase the price. This is nonsense; and the American people should understand it.

What has happened, there has been some very careful planning; and I believe that the American people should consider the industry having done an outstanding job under these conditions; and that they have been in an extremely fortunate position for inventories to have been where they are going into this heating season.

Senator GRAVEL. And this week is the treatment you get for doing a good job.

Mr. BEST. I have got some more questions, and I will just ask that they be submitted for the record. One is, could you give us some figures on refining capacity, both here and abroad, that shows the trends of the last 5 or 10 years, and what factors have influenced the decisions to put refining capacities, say, in the Bahamas versus Texas, some of the tax haven countries, and so forth, and so on.

[The following was supplied for the record. Hearing continues on page 1499.]

Attached is an API compilation of estimated worldwide refining capacity. Also attached is a schedule showing Gulf's changes in processing capacity over the last ten years. Generally, the trends in refinery construction would follow the trends in demand for refined products both in the U. S. and abroad. United States government policies were principally responsible for most decisions to construct refineries in the Caribbean versus the U. S. It was not the result of tax considerations. Set forth below are the main reasons which caused Caribbean refinery construction:

1. Residual fuel oil imports were exempt from the U. S. mandatory import restrictions. Foreign oil was much cheaper than domestic oil at this time but its importation into the U. S. was limited. Therefore, it was economically attractive to construct refineries in the Caribbean which could run on foreign oil and then import the fuel oil into the U. S. East Coast Market without import restrictions. This resulted in a cheap source of fuel for the East Coast Market and resulted in many utilities changing from the burning of coal to the burning of fuel oil to generate electricity. Most of this fuel oil had a high sulfur content and sulfur limitations in East Coast cities in recent years reduced the available fuel oil supply and made low sulfur fuel oil more costly. This, coupled with the dramatic increases in foreign crude oil costs in the past years are now resulting in much higher costs for East Coast fuel oil consumers.

2. Environmental restrictions on the U. S. East Coast, including siting and sulfur restrictions prevented refinery construction in these areas.

3. Shallow harbor facilities and resistance to offshore super ports for mammoth tankers has also made it more economical to place refineries at locations outside the U. S. (such as Canada) which could the handle large tankers.

4. Exceptions to the mandatory import program for the import of products refined in Puerto Rico and the Virgin Islands attracted refineries to these locations.

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ESTIMATED WORLDWIDE CRUDE OIL REFINING CAPACITY BY AREA (AS OF JANUARY 1)

[Barrels per day]

Year	United States [1]	Other Western Hemisphere	Total Western Hemisphere	Middle East	Africa	Asia	Europe	Total free world	Sino-Soviet bloc	Total world	United States as a percent of free world	United States as a percent of total world	Western Hemisphere as a percent of free world	Western Hemisphere as a percent of total world
1950	6,696,300	1,450,500	8,146,800	916,500	39,000	266,000	859,200	10,227,500	1,134,000	11,361,500	65.5	58.9	79.6	71.7
1951	6,963,644	1,770,400	8,734,044	940,090	41,000	282,900	1,014,900	11,013,744	(2)	(2)	63.2	----------	79.3	----------
1952	7,332,885	1,700,100	9,032,985	950,000	49,000	344,000	1,495,000	11,870,985	(2)	(2)	61.8	----------	76.1	----------
1953	7,619,720	2,180,200	9,790,920	1,093,900	52,100	379,200	1,835,400	13,151,520	1,087,000	14,238,520	57.9	53.5	74.5	68.8
1954	7,983,977	2,392,700	10,376,677	1,159,700	72,400	459,800	2,077,500	14,140,077	1,246,100	15,392,177	56.5	51.9	73.4	67.4
1955	8,363,044	2,566,500	10,929,544	1,184,300	68,400	613,700	2,365,900	15,161,844	1,784,000	16,945,844	55.2	49.4	72.1	64.5
1956	8,582,636	2,776,800	11,359,436	1,272,800	72,400	731,000	2,373,700	15,809,336	1,481,000	17,290,336	54.3	49.6	71.9	65.7
1957	9,071,697	3,087,400	12,159,097	1,235,200	93,400	876,000	2,762,700	17,126,397	1,550,000	18,676,397	53.0	48.6	71.0	65.1
1958	9,358,307	3,438,600	12,796,907	1,253,700	98,400	1,088,500	2,902,900	18,140,407	(2)	(2)	51.6	----------	70.5	----------
1959	9,761,446	3,680,500	13,441,946	1,432,800	100,100	1,229,600	3,633,200	19,837,646	(2)	(2)	49.2	----------	67.8	----------
1960	9,543,329	3,762,300	13,305,629	1,434,800	116,500	1,374,600	3,977,500	20,209,029	3,322,000	23,531,029	47.2	40.6	65.8	56.5
1961	9,998,573	4,188,000	14,186,573	1,481,800	122,500	1,431,700	4,476,100	21,698,673	(2)	(2)	46.1	----------	65.4	----------
1962	10,033,047	4,442,900	14,475,947	1,514,100	140,300	1,913,000	4,918,100	22,961,447	(2)	(2)	43.7	----------	63.0	----------
1963	10,010,921	4,687,200	14,698,121	1,754,900	196,800	2,129,800	5,149,400	23,929,021	(2)	(2)	41.8	----------	61.4	----------
1964	10,305,774	4,828,400	15,134,174	1,801,300	365,200	2,537,000	6,263,500	26,101,174	(2)	(2)	39.5	----------	58.0	----------
1965	10,419,851	5,021,500	15,441,351	1,801,400	502,900	3,176,600	7,510,500	28,522,751	4,656,000	33,178,751	36.5	31.4	54.1	46.5
1966	10,393,839	5,344,500	15,738,339	1,910,200	613,300	3,516,700	8,541,900	30,320,439	6,305,000	36,625,439	34.3	28.4	51.9	43.0
1967	10,658,407	5,544,500	16,202,907	1,960,200	704,500	3,955,700	9,526,900	32,350,207	(2)	(2)	32.9	----------	50.1	----------
1968	11,353,404	5,883,100	17,236,504	2,052,700	720,100	4,323,900	11,085,000	35,418,204	6,842,000	42,260,204	32.1	26.9	48.7	40.8
1969	11,702,309	6,290,200	17,993,509	2,296,500	7[illegible]6,100	4,919,800	12,884,300	38,849,209	6,375,000	45,224,209	30.1	25.9	46.3	39.8
1970	12,021,273	6,512,500	18,533,733	2,437,900	784,900	5,565,900	13,941,400	41,263,833	6,952,000	48,215,833	29.1	24.9	44.9	38.4
1971	12,860,228	7,128,600	19,988,828	3,171,700	924,900	6,060,900	15,177,200	45,323,528	7,388,000	52,711,528	28.4	24.4	44.1	37.9
1972	13,292,468	7,578,600	20,871,068	2,851,300	902,400	6,817,700	16,982,800	48,425,268	7,690,000	56,115,268	27.4	23.7	43.1	37.2
1973	13,642,446	8,175,800	21,818,246	2,757,700	825,100	7,915,700	16,826,700	50,143,446	8,110,000	58,253,441	27.2	23.4	43.5	37.5

[1] Includes operating capacity plus operable shutdown but excludes shutdown inoperable capacity.
[2] Data unavailable.

Sources: United States: U.S. Bureau of Mines; rest of the world: "Oil & Gas Journal," "World Wide Issues," and "International Petroleum Encyclopedia".

CRUDE PROCESSING CAPACITY

[Thousands of barrels of crude oil per day]

	1973	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963
United States (total)	860.6	844.6	825.0	713.8	675.1	653.6	629.1	585.1	614.6	612.3	594.2
Canada (68 percent) (total)	223.0	223.0	223.0	136.9	128.8	131.2	131.2	131.2	115.9	115.2	113.9
Latin America:											
Ecuador	7.0	7.0	7.0	7.0	5.2	5.2					
Puerto Rico	37.8	37.8	37.8	37.8	37.8	37.8	37.8	38.0	32.5	32.5	32.5
Venezuela (67 percent)	105.7	105.7	103.8	103.8	103.8	103.8	103.8	103.8	103.8	103.8	101.2
Total	150.5	150.5	148.6	148.6	146.8	146.8	141.6	141.8	136.3	136.3	133.7
Europe:											
Denmark	90.0	90.0	90.0	90.0	76.0	76.0	28.5	28.5	28.5	28.5	28.2
Germany		47.5	47.5	47.5							
Italy	76.0	76.0									
Netherlands	94.0	94.0	94.0	94.0	75.0	75.4	71.0	57.0	57.0	28.5	28.2
Wales	103.0	103.0	86.5	78.0	78.0	78.0					
Switzerland (25 percent)	15.0	15.0	14.5	14.5	14.5	14.5	13.4				
France (18 percent)	68.2	68.2	61.0	57.1	49.2	44.4	36.2	36.2	34.6	23.6	24.9
Spain (40 percent)	44.8	76.8	32.0	32.0	32.0	32.0	16.0				
Total	491.0	570.5	425.5	413.1	324.7	320.3	165.1	121.7	120.1	80.6	81.3
Asia:											
Iran (7 percent)	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	28.8	28.8	28.8
Kuwait (50 percent)	143.5	143.5	141.0	138.5	129.3	129.3	125.0	118.7	118.8	118.8	118.8
Okinawa (45 percent—1972; 50 percent—1971)	43.2	41.6	46.8								
Philippines (68 percent)			19.2	15.6	15.0	9.7	9.7	9.5	6.8		
Taiwan (70 percent)	7.4	7.3	8.0	7.0	7.0	7.0	7.0	7.0	7.0		
Korea (50 percent—1970–72); (25 percent—1965–69)	75.9	83.7	55.0	55.0	27.6	27.6	13.2	8.8	8.8	8.8	
Total	300.1	306.2	300.0	246.2	209.0	203.7	185.0	174.1	170.2	156.4	147.6
Total crude processing capacity	2,025.2	2,094.8	1,922.2	1,658.6	1,484.4	1,455.6	1,252.0	1,153.9	1,157.1	1,100.8	1,070.7

Note: Percentages shown in parentheses are equity interest of Gulf Oil Corp. Barrels represent Gulf's share of total capacity for the country.

Mr. BEST. And on your profits, if only 3-percent increase has occurred in U.S. profits, 45 percent of profit would indicate to me that it is mainly due to increases in crude oil prices, which are perhaps reflected in refinery profits rather than at the sellers market.

But maybe you could break down your profits—production versus refining versus distribution—just so that people have some idea as to where the profits are made.

[The following comment was subsequently received for the record:]

No. We do not report our profits on a functional basis. Any such attempt to break the profits down on this bases would not be meaningful.

Mr. BEST. If the Arabs increase their crude oil prices from $10 to $20, does that automatically increase your take of $5, because their take is $15?

Mr. HENRY. Mr. Best, let's put it this way. We really cannot answer that question now. Let me tell you why. Because we do not really know what is going to be the income tax levied on us by the producing countries. And as a matter of fact, we have retroactive payments which are constantly assessed against the industries, which may go back 1, 2, 3, 4, years; and there are hundreds of millions of dollars.

Senator GRAVEL. Have they done that recently?

Mr. HENRY. Yes, sir. Yes, they have, Mr. Chairman.

Senator GRAVEL. In providing this other information would you give us some dates and times when they did this to you?

Mr. HENRY. Yes, sir. As a matter of fact, we will be glad to do that. We would appreciate the opportunity to do it.

[The following was subsequently supplied for the record:]

Under most Middle East concessions the agreements of the 1950's provided for the establishment of a posted price for crude oil sales. Royalties were 12.5 percent of the posted price and taxes were at the rate of 50 percent of the posted price, less royalty and producing and other expenses. With a world surplus of crude oil in the late 1950's the producing companies reduced the posted prices. As a result, the producing countries formed the Organization of Petroleum Exporting Countries (OPEC) and made a concerted effort to stabilize prices and maximize profits. Since that time tax rates have been increased to 55 percent to 65 percent; the producing countries have unilaterally increased prices; they have required reductions in production rates and have passed legislation to require participation in the concession by the producing countries or their national oil companies. Many of these changes have been made on a retroactive basis. Consequently, current taxes, prices or profits cannot be forecast with any certainty. History tells us that these profits are illusory.

It can be said with certainty that oil company profits from foreign production sources will be substantially reduced or restricted by anticipated OPEC actions for the following reasons:

1. Production levels will continue to be controlled and restricted by the OPEC countries, even though there is likely to be restoration of the current production cuts and possibly elimination of oil embargos in the near future. Countries like Saudi Arabia and Kuwait will not need to increase government revenues, and may want to take restrictive action to try to maintain high prices. The U.S. oil companies have never encouraged such action.

2. Quantities of crude oil available to the companies may be substantially reduced as the result of government equity ownership of oil acquired by participation agreements in the OPEC countries, which they will then offer for sale increasingly on a government to consuming government basis.

3. The companies will be required to purchase or buy back government equity oil at greatly increased prices from the producing government, leaving the companies only a small margin of profit, if any, on these volumes. If, for example, a producing country were to acquire 60 percent equity participation, the company's quantities of crude available at tax paid cost would only amount to 40 percent of total reduced production levels, rather than 100 percent.

4. OPEC has established unilateral pricing policies which are likely to involve block negotiations on overall terms of trade with OECD and other consumer groups. Since all parties seem to want to restore some stability to pricing now that OPEC has succeeded in greatly increasing oil prices, future windfall fluctuations will be minimized.

5. OPEC Resolution 90 of June 25, 1968, is a declaratory statement of petroleum policy in member countries. It includes a renegotiation clause stating that: "Notwithstanding any guarantee of fiscal stability that may have been granted to the operator, the operator shall not have the right to obtain excessively high net earnings after taxes. The financial provisions of contracts which actually result in such excessively high net earnings shall be open to renegotiation." It goes on to define excessively high net earnings as "net profits after taxes which are significantly in excess, during any twelve-month period, of the level of net earnings the reasonable expectation of which would have been sufficient to induce the operator to take enterpreneurial risks necessary." Governments will also take into account the degree of financial risk undertaken by the operator and the general level of net earnings elsewhere in the industry where similar circumstances prevail. It is anticipated that OPEC countries may well review current tax and royalty rates prevailing in the Middle East with a view to increasing government take by increasing fiscal rates. Unfortunately, most OPEC countries do not understand the industry's inability to recover increased government take as costs in consuming countries with stringent price controls, and the time lag involved in recovering such costs in full even in countries where permitted. If the U.S. imposes similar excess profits taxes on foreign income, it may eliminate U.S. companies from international oil competition.

Profits

Historically, oil companies have realized 30 to 50 cents per barrel on Middle East and other relatively low quality crude oils and about 15 to 25 cents per barrel more on the low sulfur crudes which yield a relatively high percentage of gasoline in U.S. refining. In some cases these profits appear to have doubled during the last part of 1973, but we fully expect that these profit margins will fall back to their historic level very quickly. OPEC representatives have publicly stated that they will not allow the companies to make more than 50 cents per barrel. Attached is a schedule showing the effect of a retroactive adjustment. These margins are less than one-half of the margins received for U.S. crudes on a per barrel basis. The only reason that the companies have been able to secure a reasonable profit at these low margin levels is because of the low per barrel operating costs resulting from the prolific production per well (5,000 barrels per day) in many of the African and Middle East fields. Attached are schedules showing the possible effect on taxes and profits resulting from a retroactive adjustment.

Senator GRAVEL. We are keeping the record open for 10 days, so anything you want to give us in that regard, and then anything that you have determined from the tenor of the committee's attitudes. We just want to get facts and information to make policy on, and if you wanted to give us additional information, do not hesitate to exercise your judgment.

Mr. HENRY. Thank you very much.

Mr. CARD. If I could just clarify quickly, since Mr. Best referred to the outside of U.S. earnings. The major reason for this, as I indicated, one-third or 30 percent came from this currency. The other big piece of it came in the tremendous movement of prices of products outside of the United States. They have been greatly depressed; 1971–72, the prices for products outside of the United States have been severely depressed, and 1973; and I think this is a major reason for the improvement.

Mr. BEST. Just to pursue that, and in fact because I think your statement about currency movements might be picked up. We have another subcommittee on money and national corporations, and Senator Church has one on the same; and we have investigated international currency movement, and there has been a lot of speculation that the oil companies were the ones that were speculating against the American dollar. And since you have said you made $300 to $400 million, could you just set the record straight so that nobody will say, well, there, we told you so. They made $400 million and they speculated against the American dollar—as to how you made the $400 million on currency movement.

Senator GRAVEL. Or better. Focus it even tighter than that.

Mr. CARD. It is outlined in my press release that I handed to you, Mr. Best. I think this would explain it.

Mr. HENRY. Mr. Best, let me say we did not speculate against the American dollar.

Mr. CARD. I can assure you we did not.

Senator GRAVEL. That is a charge that is made, and there are others, and they can go unanswered because we do not have it in the record.

Mr. HENRY. Yes, Mr. Chairman. I agree. That is why I would like to make it very clear that the Gulf Oil Corp., did not speculate against the American dollar.

Senator GRAVEL. And also if Texaco could or better, the API, I think, would give us some figures as to whether there are any dollar investments, let us say, during that critical period prior to devaluation a year ago February—let us say the 30-day period or so before that. If there were any large movements in the investment portfolios of, let us say, the big eight, then I think we might be able to respond if you give that to us right quick.

Very good.

[The following was subsequently received for the record:]

(*a*) A tabulation of Gulf's foreign currency transactions during the period January 31, 1972 through March 31, 1973, is attached. This information was submitted last year to the Senate Subcommittee on Multinational Corporations in connection with their investigation into whether or not U.S. companies were involved in speculating against the dollar. As the attached information demonstrates, and as Gulf witnesses have specified, Gulf was not involved in any such speculation.

(*b*) Our profits are expressed in dollars. Since the value of the dollar declined in 1973, in relation to other currencies, it resulted in local currency earnings being translated into higher dollar amounts. Since the dollar has strengthened in 1974 in relation to other currencies we may well have the opposite result this year.

GULF OIL CORP.

MAJORITY-OWNED DOMESTIC AFFILIATES, JAN. 31, 1972

[In thousands]

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
1. Cash deposits, government securities, and other cash items.			46 7	Bolivar 4.38. Miscellaneous.
			53	
2. Information not requested.				
3. Accounts receivable from other companies.	378	Miscellaneous	15	Do.
4. Information not requested.				
5. Information not requested.				
6. Information not requested.				
7. Information not requested.				
8. Information not requested.				
9. Forward currency sales 0 to 30 days	11,804	$2.5942 to pound		
10. Forward currency sales over 30 days	57,980	$2.5942 to pound		
11. Information not requested.				
12. Information not requested.				

GULF OIL CORP.—Continued

MAJORITY-OWNED FOREIGN AFFILIATES, JAN. 31, 1972—Continued

[In thousands]

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
1. Cash deposits, government securities and other cash items.	3,687	Peseta 64.9	44,118	Canada 99.42.
	4,852	Lira 585.82	387	N. Taiwan 40.
	5,037	Sw. Kr. 4.80	787	Kor. Won 370.
	1,384	Bel Fr. 43.91	4,883	Escudo 27.
	2,825	D. Kr. 6.99	380	3.04 to Nigerian pound.
	1,398	$2.594 to pound	336	N.Kr. 6.68.
	2,309	Miscellaneous	4,727	Miscellaneous.
	21,492		55,588	
2. Accounts receivable from affiliated companies.	379	Peseta 64.9	5,589	Canada 99.42.
			24	Miscellaneous.
			5,413	
3. Accounts receivable from other companies.	13,083	Lira 585.82	165,412	Canada 99.42.
	426	$2.594 to pound	4,124	N. Taiwan 40.
	957	Peseta 64.9	1,222	Sucres 26.1.
	13,046	D.Kr. 6.99	452	Rupee 7.29.
	8,286	Bel.Fr. 43.91	440	Peru Sol 42.6.
	19,533	Sw.Kr. 480	20,227	$2.594 to pound.
	112	Miscellaneous	3,260	Miscellaneous.
4. Information not requested.	55,443		195,137	
5. Bank borrowings and other borrowings due within 30 days.	1,595	$2.594 to pound	457	N. Taiwan.
6. Bank borrowings and other borrowings due within 1 yr.	623	Peseta 64.9	280	Rupee 7.29.
	1,168	Sw. Kr. 4.80	344	N. Taiwan 40.
	841	Bel. Fr. 43.91	1,368	Canada 99.42.
			24	Miscellaneous.
	2,632		2,016	
7. Accounts payable to affiliated companies.	866	Peseta 64.9	261	Mex.pesos 12.48.
8. Accounts payable to other companies	489	D. Kr. 6.99	56,924	Canada 99.42.
	1,929	Bel. Fr. 43.91	788	Peru Sol 42.6.
	510	Lira 585.82	2,146	N. Taiwan 40.
	704	Peseta 64.9	2,143	Miscellaneous.
	510	Sw. Kr. 4.80		
	714	Miscellaneous		
	4,856		62,001	
9. Information not requested.				
10. Information not requested.				
11. Information not requested.				
12. Information not requested.				

MAJORITY-OWNED DOMESTIC AFFILIATES, FEB. 29, 1972

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
1. Cash deposits, government securities, and other cash items.			46	Bolivar 4.38.
			7	Miscellaneous.
			53	
2. Information not requested.				
3. Accounts receivable from other companies.	25	Miscellaneous	7	Do.
4. Information not requested.				
5. Information not requested.				
6. Information not requested.				
7. Information not requested.				
8. Information not requested.				
9. Forward currency sales 0 to 30 days	11,971	$2.6064 to pound		
10. Forward currency sales over 30 days	46,282	do		
11. Information not requested.				
12. Information not requested.				

GULF OIL CORP.—Continued

MAJORITY-OWNED FOREIGN AFFILIATES, FEB. 29, 1972—Continued

[In thousand]

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
1. Cash deposits, government securities, and other cash items.	2,063	Peseta 64.9	45,916	Canada 99.95.
	6,202	Lira 585.48	521	N. Taiwan 40.
	5,828	Sw. Kr. 4.79	1,223	Kor. won 375.
	2,184	Bel. Fr. 43.80	1,271	Sucres 26.1.
	479	D. Kr. 6.98	3,629	Escudo 26.8.
	8,765	$2,606 to pound	225	$3.04 to Nigerian Pound.
	3,603	Miscellaneous	2,497	Miscellaneous.
	29,124		55,282	
2. Accounts receivable from affiliated companies.	381	Peseta 64.9	5,067	Canada 99.95.
			24	Miscellaneous.
			5,091	
3. Accounts receivable from other companies.	12,881	Lira 585.48	155,396	Canada 99.95.
	10,023	$2.606 to pound	10,171	$2.606 to pound.
	248	Peseta 64.9	3,907	N. Taiwan 40.
	14,368	D. Kr. 6.98	846	Sucres 26.1.
	12,591	Bel. Fr. 43.80	499	Rupee 7.25.
	22,203	Sw. Kr. 4.79	471	Peru Sol 42.6.
	1,420	N. Kr. 6.62	1,596	Miscellaneous.
	3,105	Miscellaneous		
	76,839		172,886	
4. Information not requested.				
5. Bank borrowings and other borrowings due within 30 days.	786	$2,606 to pound	224	N. Taiwan 40.
	1,420	Sw. Kr. 4.79		
	602	Miscellaneous		
	2,808			
6. Bank borrowings and other borrowings due within 1 yr.	623	Peseta 64.47	295	Rupee 7.25.
	814	"2.606 to pound	236	N. Taiwan 40.
	1,437		1,576	Canada 99.96.
			2,107	
7. Accounts payable to affiliated companies.	895	Peseta 64.9	261	Mex. pesos 12.4.
8. Accounts payable to other companies	937	D. Kr. 6.98	54,337	Canada 99.95.
	2,039	Bel. Fr. 43.80	800	Peru Sol. 42.6.
	1,107	Lira 585.48	2,115	N. Taiwan 40.
	1,069	Peseta 64.9	1,045	Miscellaneous.
	2,108	$2.606 to pounds	58,297	
	2,099	Miscellaneous		
	9,359			
9. Information not requested.				
10. Information not requested.				
11. Information not requested.				
12. Information not requested.				

MAJORITY-OWNED DOMESTIC AFFILIATES, MAR. 31, 1972

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
1. Cash deposits, government securities and other cash items.			6	Bolivar 4.37.
			8	Miscellaneous.
			14	
2. Information not requested.				
3. Accounts receivable from other companies.	93	Miscellaneous	7	Do.
4. Information not requested.				
5. Information not requested.				
6. Information not requested.				
7. Information not requested.				
8. Information not requested.				
9. Forward currency sales 0 to 30 days	14,672	$2.6168 to pound		
10. Forward currency sales over 30 days	31,794	$2.6168 to pound		
11. Information not requested.				
12. Information not requested.				

GULF OIL CORP.—Continued

MAJORITY-OWNED FOREIGN AFFILIATES, MAR. 31, 1972

Line	Col. 6		Col. 8	
	U.S. dollars	Other European currencies	U.S. dollars	Other currencies including Canadian dollars
1. Cash deposits, Government securities, and other cash items.	3,324	D.Kr. 6.98	54,935	Canada 1.0025.
	1,510	Bel.Fr. 43.94	921	N.Taiwan 40.0.
	8,424	Lira 580.72	1,172	Kor.Won 380.0.
	5,002	Peseta 64.1	1,049	Sucres 25.9.
	5,343	$2.62 to pound	4,065	Escudo 26.7.
	6,158	Sw.Kr. 4.78	242	$3.04 to Nigerian pound.
	3,196	Miscellaneous	1,455	Miscellaneous.
	32,957		63,839	
2. Accounts receivable from affiliated companies.	392	Peseta 64.1	5,015	Canada 1.0025.
			24	Miscellaneous.
			5,039	
3. Accounts receivable from other companies.	12,517	Lira 580.72	154,781	Canada 1.0025.
	1,803	$2.62 to pound	10,390	$2.62 to pound.
	508	Peseta 64.1	4,068	N.Taiwan 40.0.
	11,389	D.Kr. 6.98	1,362	Sucres 25.9
	17,058	Bel.Fr. 43.94	526	Rupee 8.32.
	29,030	Sw.Kr. 4.78	479	Peru Sol 42.6.
	2,262	Miscellaneous	1,800	Miscellaneous.
			173,406	
	74,567			
4. Information not requested.				
5. Bank borrowings and other borrowings due within 30 days.	4	D.Kr. 6.98	205	N. Taiwan 40.0.
	6	Miscellaneous		
		Miscellaneous		
	10			
6. Bank borrowings and other borrowings due within 1 year.	623	Peseta 64.1	266	Rupee 8.32.
	2,466	Sw.Kr. 4.81	340	N. Taiwan 40.0.
	757	D.Kr. 6.98	738	Canada 1.0025.
	420	Miscellaneous	24	Miscellaneous.
	4,266		1,368	
7. Accounts payable to affiliated companies.	1,047	Peseta 64.1	18	Sucres 24.75.
			261	Mex. Pecos 12.48.
			279	
8. Accounts payable to other companies	1,780	D.Kr. 6.98	60,093	Canada 1.0025.
	1,651	Bel.Fr. 43.94	7,896	($3.04 to Nigerian pound.
	1,012	Lira 580.72	890	Peru Sol 42.6.
	2,092	2.62 to pound	2,265	N. Taiwan 40.0.
	1,164	Peseta 64.1	1,096	Miscellaneous.
	989	Miscellaneous	72,240	
	8,688			
9. Information not requested.				
10. Information not requested.				
11. Information not requested.				
12. Information not requested.				

GULF OIL CORP.—Continued

MAJORITY-OWNED DOMESTIC AFFILIATES, JAN. 31, 1973

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
1. Cash deposits, government securities and other cash items.			72	Bolivars 4.38.
2. Information not requested.				
3. Accounts receivable from other companies.	102	Miscellaneous		
4. Information not requested.				
5. Information not requested.				
6. Bank borrowings and other borrowings due within 1 year.	35,760	$2.38 to pound		
	5,140	Lira 580.38		
	10	Miscellaneous		
	40,910			
7. Information not requested.				
8. Information not requested.				
9. Forward currency sales 0 to 30 days				
10. Forward currency sales over 30 days	16,688	$2.3840 to pound		
11. Information not requested.				
12. Information not requested.				

MAJORITY-OWNED FOREIGN AFFILIATES, JAN. 31, 1973

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
1. Cash deposits, government securities and other cash items.	1,227	D.Kr. 6.83	90,833	Canada .9998.
	937	Bel.Fr. 43.76	1,598	N. Taiwan 40.0.
	11,557	Lira 580.38	1,708	Kor. Won 400.
	5,801	Peseta 62.9	813	Sucres 23.81.
	1,537	$2.38 to pound	2,107	Escudo 26.60.
	7,643	Sw. Kr. 4.70	564	Bolivar 4.38.
	850	Miscellaneous	3,820	Miscellaneous.
	29,552		101,443	
2. Accounts receivable from affiliated companies.	1,808	Peseta 62.9	7,829	Canada .9998.
			24	Miscellaneous.
			7,853	
3. Accounts receivable from other com-	18,495	Lira 580.38	176,106	Canada .9998.
	1,687	$2.38 to pound	19,496	$2.38 to pound.
	1,448	Peseta 62.9	4,620	N. Taiwan 40.0.
	11,699	D. Kr. 6.83	2,375	Sucres 23.81.
	11,524	Bel. Fr. 43.76	467	Rupee 7.84.
	19,094	Sw. Kr. 4.70	418	Peru Sol 42.6.
	1,056	Miscellaneous	6,356	Miscellaneous.
	65,003		209,838	
4. Information not requested.				
5. Bank borrowings and other borrowings due within 30 days.	1,195	Sw. Kr. 4.70	202	N. Taiwan 40.0.
	1,583	$2.38 to pound	27	Miscellaneous.
	255	Bel. Fr. 43.76	229	
	10	Miscellaneous		
	3,043			
6. Bank borrowings and other borrowings due within 1 year.	846	Peseta 62.9	1,768	Canadian .9998.
			273	N. Taiwan 40.0.
			284	Rupee 7.84.
			2,325	
7. Accounts payable to affiliated companies.	1,906	do	1,761	Sucres 23.81.
8. Accounts payable to other companies	4,319	Bel. Fr. 43.76	73,875	Canada .9998.
	1,526	Peseta 62.9	3,077	N. Taiwan 40.0.
	1,916	Lira 580.38	2,628	$3.04 to Nigerian pound.
	1,287	Sw. Kr. 4.70	1,412	Sucres 23.81.
	459	D. Kr. 6.83	3,158	Miscellaneous.
	898	Miscellaneous	84,150	
	10,405			

GULF OIL CORP.—Continued

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
9. Forward currency sales 0-30 days	1,029	D. Kr. 6.83		
	3,090	Sw. Kr. 4.70		
	4,768	$2.3840 to pound		
	8,887			
10. Forward currency sales over 30 days	1,548	D. Kr. 6.83		
	3,092	Sw. Kr. 4.70		
	4,768	$2.3840 to pound		
	9,408			
11. Information not requested.				
12. Information not requested.				

MAJORITY-OWNED DOMESTIC AFFILIATES, FEB. 28, 1973

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
1. Cash deposits, Government securities, and other cash items.			72	Bolivar 4.27.
2. Information not requested.				
3. Accounts receivable from other companies.	75	Miscellaneous	531	Canada 1.0059.
4. Information not requested.				
5. Information not requested.				
6. Bank borrowings and other borrowings due within 1 year.	28,641	$2.49 to pound		
	5,581	Lira 561.80		
	10	Miscellaneous		
	34,232			
7. Information not requested.				
8. Information not requested.				
9. Forward currency sales 0 to 30 days	11,920	$2.3840 to pound		
10. Forward currency sales over 30 days	4,981	$2.490 to pound		
11. Information not requested.				
12. Information not requested.				

MAJORITY-OWNED FOREIGN AFFILIATES, FEB. 28, 1973

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
1. Cash deposits, Government securities and other cash items.	921	D.Kr. 6.13	102,020	Canada 1.0059.
	1,938	Bel. Fr. 39.22	1,891	N.Taiwan 38.0
	9,964	Lira 561.80	1,582	Kor.won 400.
	4,728	Peseta 57.1	1,732	Sucres 23.53.
	4,217	Sw.Kr. 4.44	3,987	Escudo 24.69.
	279	Miscellaneous	2,200	2.49 to pound.
	21,807		113,412	
2. Accounts receivable from affiliated companies.	2,435	Peseta 57.1	7,340	Canada 1.0059.
			24	Miscellaneous.
			7,364	
3. Accounts receivable from other companies.	19,129	Lira 561.80	173,789	Canada 1.0059.
	1,508	Peseta 57.1	22,176	2.49 to pound.
	13,657	D.Kr. 6.13	4,764	N.Taiwan 38.0.
	14,340	Bel.Fr. 39.22	2,854	Sucres 23.53.
	22,004	Sw.Kr. 4.44	479	Rupee 7.41.
	4,408	2.49 to pound	1,615	Peru Sol. 42.6.
	1,806	Miscellaneous	3,877	Miscellaneous.
	76,852		209,554	
4. Information not requested.				
5. Bank borrowings and other borrowings due within 30 days.	777	2.49 to pound	250	N.Taiwan 38.0.
	104	D.Kr. 6.13		
	135	Bel.Fr. 39.22		
	63	Miscellaneous		
	1,079			
6. Bank borrowings and other borrowings due within 1 year.	788	Peseta 57.1	1,742	Canada 1.0059.
	1,272	S.Kr. 4.44	211	N. Taiwan 38.0.
	107	D. Kr. 6.13	312	Rupee 7.41.
	154	Miscellaneous	30	Miscellaneous.
	2,321		2,295	

GULF OIL CORP.—Continued

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
7. Accounts payable to affiliated companies.	2,256	Peseta 57.1	1,462	Sucres 23.53.
8. Accounts payable to other companies	6,260	Bel. Fr. 39.22	69,027	Canada 1.0059.
	634	Peseta 57.1	3,290	N. Taiwan 38.0.
	2,428	Lira 561.89	2,741	$3.04 to Nigerian pound.
	1,585	Sw. Kr. 4.44	1,500	Sucres 23.53.
	1,150	D. Kr. 6.13	1,555	$2.49 to pound.
	923	Miscellaneous	1,675	Miscellaneous.
	12,980		79,788	
9. Forward currency sales 0–30 days	1,723	D. Kr. 6.13		
	3,273	Sw. Kr. 4.44		
	4,981	$2.4905 to pound		
	9,977			
10. Forward currency sales over 30 days	4,981	$2.4905 to pound		
11. Information not requested.				
12. Information not requested.				

MAJORITY-OWNED DOMESTIC AFFILIATES, MAR. 31, 1973

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
1. Cash deposits, government securities and other cash items.			23	Bolivars 4.27.
2. Information not requested				
3. Accounts receivable from other companies.	139	Miscellaneous	1,127	Canada 1.0014.
4. Information not requested.				
5. Information not requested.				
6. Bank borrowings and other borrowings due within 1 year.	22,293	$2.48 to pound		
	5,344	Lira 578.03		
	27,637			
7. Information not requested.				
8. Information not requested.				
9. Forward currency sales 0 to 30 days				
10. Forward currency sales over 30 days	3,716	$2.4770 to pound		
11. Information not requested.				
12. Information not requested.				

MAJORITY-OWNED FOREIGN AFFILIATES, MAR. 31, 1973

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
1. Cash deposits, government securities and other cash items.	5,313	D.Kr. 6.18	103,440	Canada 1.0014.
	3,575	Bel. Fr. 39.92	2,717	N. Taiwan 38.
	7,922	Lira 578.03	1,501	Kor.Won 400.
	4,748	Peseta 55.6	1,774	Sucres 23.5.
	4,258	Sw.Kr. 4.49	4,188	Escudo 24.69.
	303	Miscellaneous	3,000	$2.48 to pound.
	26,119		1,108	Miscellaneous.
			117,728	
2. Accounts receivable from affiliated companies.	3,275	Peseta 55.6	7,377	Canada 1.0014.
			24	Miscellaneous.
			7,401	
3. Accounts receivable from other companies.	19,516	Lira 578.03	178,611	Canada 1.0014.
	4,449	Peseta 55.6	18,022	$2.48 to pound.
	13,819	D.Kr. 6.18	4,915	N.Taiwan 38.
	13,680	Bel.Fr. 39.92	4,026	Sucres 23.53.
	34,317	Sw.Kr. 4.49	463	Rupee 7.41.
	5,750	$2.48 to pound	1,477	N.Krone 5.88.
	2,892	Miscellaneous	4,839	Miscellaneous.
	94,423		212,353	
4. Information not requested.				

GULF OIL CORP.—Continued

Line	Col. 6 U.S. dollars	Col. 6 Other European currencies	Col. 8 U.S. dollars	Col. 8 Other currencies including Canadian dollars
5. Bank borrowings and other borrowings due within 30 days.	264	Bel.Fr. 39.92	322	N.Taiwan 38.
	1,659	$2.48 to pound		
	5	D.Kr. 6.18		
	1,928			
6. Bank borrowings and other borrowings due within 1 year.	788	Peseta 55.6	1,333	Canada 1.0014.
	1,272	Sw.Kr. 4.49	206	N.Taiwan 38.
	6	D.Kr. 6.18	240	Rupee 7.41.
	2,066		1,779	
7. Accounts payable to affiliated companies.	2,325	Peseta 55.6	1,319	Sucres 23.53.
8. Accounts payable to	4,067	Bel.Fr. 39.92	68,714	Canada 1.0014.
	1,679	Lira 578.03	3,530	N.Taiwan 38.
	372	Miscellaneous	1,973	Sucres 23.53.
			2,855	Miscellaneous.
	6,118		77,072	
9. Forward currency sales 0 to 30 days	4,954	$2.4770 to pound		
10. Forward currency sales over 30 days				
11. Information not requested.				
12. Information not requested.				

GULF OIL CO.

PARENT COMPANY AND MAJORITY-OWNED DOMESTIC AFFILIATES, JAN. 31, 1972

[In thousands of U.S. dollars]

Selected balance sheet items	U.S. dollars in United States [1]	U.S. dollars outside the United States [2]	German marks at 3.22 to the dollar [3]	Swiss francs at 3.84 to the dollar [4]	Dutch guilders at 3.24 to the dollar [5]	Other European currencies [6]	Japanese yen at 310.40 to the dollar [7]	Other currencies including Canadian dollar [8]
1. Cash deposits, Government securities and other cash items [10]	$252,276	$225,002					$263	$3
2. Accounts receivable from affiliated companies	1,371,342	239,325						5
3. Accounts receivable from other companies	560,184	68,583	117		18	378		15
4. Other current financial assets, total (maturity within 1 year) [11]								
5. Bank borrowings and other borrowings due within 30 days [12]	729							
6. Bank borrowings and other borrowings due within 1 year [12]	66,671	1,111	8,410	7,135	2,575			
7. Accounts payable to affiliated companies	1,678,825	156,672						
8. Accounts payable to other companies	121,076	177						
9. Forward currency sales 0–30 days' maturity [12 13]						11,804		
10. Forward currency sales over 30 days' maturity [12 13]						57,980		
11. Forward currency purchases 0–30 days' maturity [12 14]								
12. Forward currency purchases over 30 days' maturity [12 14]								

MAJORITY-OWNED FOREIGN AFFILIATES, JAN. 31, 1972

Selected balance sheet items	U.S. dollars in United States [1]	U.S. dollars outside the United States [2]	German marks at 3.22 to the dollar [3]	Swiss francs at 3.84 to the dollar [4]	Dutch guilders at 3.24 to the dollar [5]	Other European currencies [6]	Japanese Yen at 310.40 to the dollar [7]	Other currencies including Canadian dollar [8]	Gold at $_?_ per ounce [9]
1. Cash deposits, Government securities and other cash items [10]	$5,040	$7,986	9,790	703	3,655	21,492	$1,159	$55,588	
2. Accounts receivable from affiliated companies	512,000	372,123				379		5,413	
3. Accounts receivable from other companies	14,703	160,551	12,176	6,064	15,689	55,443		195,137	
4. Other current financial assets total (maturity within 1 year) [11]									
5. Bank borrowings and other borrowings due within 30 days [12]	361	240	448			1,595		457	
6. Bank borrowings and other borrowings due within 1 year [12]	4,103	33,914	2,209	260	747	2,632	71	2,016	
7. Accounts payable to affiliated companies	231,330	428,082				866		261	
8. Accounts payable to other companies	13,336	11,817	4,430	862	2,385	4,856	3	62,001	
9. Forward currency sales 0–30 days maturity [12 13]									
10. Forward currency sales over 30 days maturity [12 13]									
11. Forward currency purchases 0–30 days' maturity [12 14]									
12. Forward currency purchases over 30 days' maturity [12 14]									

GULF OIL CO.

PARENT COMPANY AND MAJORITY-OWNED DOMESTIC AFFILIATES, FEB. 29, 1972

[In thousands of U.S. dollars]

Selected balance sheet items	U.S. dollars United States [1]	U.S. dollars outside the United States [2]	German marks at 3.22 to the dollar [3]	Swiss francs at 3.84 to the dollar [4]	Dutch guilders at 3.24 to the dollar [5]	Other European currencies [6]	Japanese yen at 310.40 to the dollar [7]	Other currencies including Canadian dollar [8]
1. Cash deposits, Government securities and other cash items [10]	$357,102	$246,429					$496	$53
2. Accounts receivable from affiliated companies	1,458,359	318,766						
3. Accounts receivable from other companies	589,965	58,388	91		81	25		7
4. Other current financial assets, total (maturity within 1 year) [11]								
5. Bank borrowings and other borrowings due within 30 days [12]	19,365							
6. Bank borrowings and other borrowings due within 1 year [12]	47,888	1,787	8,410	7,135	2,515			
7. Accounts payable to affiliated companies	1,714,142	226,452						
8. Accounts payable to other companies	86,586	478						
9. Forward currency sales 0–30 days' maturity [12 13]						11,971		
10. Forward currency sales, over 30 days' maturity [12 13]						46,282		
11. Forward currency purchases, 0–30 days' maturity [12 14]								
12. Forward currency purchases over 30 days' maturity [12 14]								

MAJORITY-OWNED FOREIGN AFFILIATES, FEB. 29, 1972

Selected balance sheet items	U.S. dollars in United States [1]	U.S. dollars outside the United States [2]	German marks at 3.22 to the dollar [3]	Swiss francs at 3.84 to the dollar [4]	Dutch guilders at 3.24 to the dollar [5]	Other European currencies [6]	Japanese Yen at 310.40 to the dollar [7]	Other currencies including Canadian dollar [8]	Gold at $_?_ per ounce [9]
1. Cash deposits, Government securities and other cash items [10]	$6,536	$2,014	3,169	976	8,060	29,124	$1,124	$55,282	
2. Accounts receivable from affiliated companies	426,199	388,111				381		5,091	
3. Accounts receivable from other companies	10,139	162,646	14,951	5,741	16,828	76,839		172,886	
4. Other current financial assets total (maturity within 1 year) [11]									
5. Bank borrowings and other borrowings due within 30 days [12]	365	32,284	520			2,808		224	
6. Bank borrowings and other borrowings due within 1 year [12]	4,122	2,152	2,215	260	506	1,437	71	2,107	
7. Accounts payable to affiliated companies	278,743	430,760				895	164	261	
8. Accounts payable to other companies	46,563	13,007	2,897	758	6,282	9,359		58,297	
9. Forward currency sales, 0–30 days' maturity [12 13]									
10. Forward currency sales over 30 days' maturity [12 13]									
11. Forward currency purchases 0–30 days' maturity [12 14]									
12. Forward currency purchases over 30 days' maturity [12 14]									

GULF OIL CO.

PARENT COMPANY AND MAJORITY-OWNED DOMESTIC AFFILIATES, MAR. 31, 1972

[In thousands of U.S. dollars]

Selected balance sheet items	U.S. dollars United States [1]	U.S. dollars outside the United States [2]	German marks at 3.22 to the dollar [3]	Swiss francs at 3.84 to the dollar [4]	Dutch guilders at 3.24 to the dollar [5]	Other European currencies [6]	Japanese yen at 310.40 to the dollar [7]	Other currencies including Canadian dollar [8]
1. Cash deposits, Government securities and other cash items [10]	$271,495	$296,693					$463	$14
2. Accounts receivable from affiliated companies	1,441,740	422,499						
3. Accounts receivable from other companies	603,021	61,493	64		19	93		7
4. Other current financial assets, total (maturity within 1 year) [11]								
5. Bank borrowings and other borrowings due within 30 days [12]	16,632							
6. Bank borrowings and other borrowings due within 1 year [12]	32,106	6,621	8,410	12,343	2,515			
7. Accounts payable to affiliated companies	1,727,461	135,896						
8. Accounts payable to other companies	103,412	530						
9. Forward currency sales, 0–30 days' maturity [12 13]						14,672		
10. Forward currency sales, over 30 days' maturity [12 13]						31,794		
11. Forward currency purchases, 0–30 days' maturity [12 14]								
12. Forward currency purchases over 30 days maturity [12 14]								

MAJORITY-OWNED FOREIGN AFFILIATES, MARCH 31, 1972

Selected balance sheet items	U.S. dollars in United States [1]	U.S. dollars outside the United States [2]	German marks at 3.22 to the dollar [3]	Swiss francs at 3.84 to the dollar [4]	Dutch guilders at 3.24 to the dollar [5]	Other European currencies [6]	Japanese yen at 304.20 to the dollar [7]	Other currencies including Canadian dollar [8]	Gold at $__?__ per ounce [9]
1. Cash deposits, Government securities and other cash items [10]	$6,606	$1,803	4,730	540	3,397	32,957	$1,025	$63,839	
2. Accounts receivable from affiliated companies	258,499	407,418				392		5,039	
3. Accounts receivable from other companies	9,687	160,075	15,762	5,562	15,543	74,567		173,406	
4. Other current financial assets total (maturity within 1 year) [11]									
5. Bank borrowings and other borrowings due within 30 days [12]	518		539			10		205	
6. Bank borrowings and other borrowings due within 1 year [12]	4,734	32,492	2,171		747	4,266	71	1,368	
7. Accounts payable to affiliated companies	223,787	442,691				1,047	16	279	
8. Accounts payable to other companies	13,040	13,760	3,018	593	1,662	8,688		72,240	
9. Forward currency sales, 0–30 days' maturity [12 13]									
10. Forward currency sales, over 30 days' maturity [12 13]									
11. Forward currency purchases, 0–30 days' matuirty [12 14]									
12. Forward currency purchases, over 30 days' maturity [12 14]									

GULF OIL CO.

PARENT COMPANY AND MAJORITY-OWNED DOMESTIC AFFILIATES, JAN. 31, 1973

[In thousands of U.S. dollars]

Selected balance sheet items	U.S. dollars in United States [1]	U.S. dollars outside the United States [2]	German marks at 3.20 to the dollar [3]	Swiss francs at 3.772 to the dollar [4]	Dutch guilders at 2.965 to the dollar [5]	Other European currencies [6]	Japanese yen at 301.10 to the dollar [7]	Other currencies including Canadian dollar [8]
1. Cash deposits, Government securities and other cash items [10]	$228,160	$247,655					$497	$72
2. Accounts receivable from affiliated companies	1,953,260	330,977						
3. Accounts receivable from other companies	649,426	189,359	61		10	102		
4. Other current financial assets total (maturity within 1 year) [11]								
5. Bank borrowings and other borrowings due within 30 days [12]	588							
6. Bank borrowings and other borrowings due within 1 year [12]	33,500	7,768	3,173	45,290		40,910		
7. Accounts payable to affiliated companies	2,319,178	381,840						
8. Accounts payable to other companies	133,574	481						
9. Forward currency sales, 0–30 days' maturity [12 13]								
10. Forward currency sales, over 30 days' maturity [12 13]						16,880		
11. Forward currency purchases, 0–30 days' maturity [12 14]								
12. Forward currency purchases over 30 days maturity [12 14]								

MAJORITY-OWNED FOREIGN AFFILIATES, JAN. 31, 1973

Selected balance sheet items	U.S. dollars in United States [1]	U.S. dollars outside the United States [2]	German marks at 3.20 to the dollar [3]	Swiss francs at 3.772 to the dollar [4]	Dutch guilders at 3.965 to the dollar [5]	Other European currencies [6]	Japanese Yen at 301.10 to the dollar [7]	Other currencies including Canadian dollar [8]	Gold at $__?__ per ounce
1. Cash deposits, Government securities and other cash items [10]	$1,759	$17,309	9,171	4,985	6,433	29,552	$1,100	$101,443	
2. Accounts receivable from affiliated companies	462,917	624,564				1,808		7,853	
3. Accounts receivable from other companies	51,443	146,159	12,638	7,482	20,143	65,003		209,838	
4. Other current financial assets total (maturity within 1 year) [11]									
5. Bank borrowings and other borrowings due within 30 days [12]	384	135	1,527	297		3,043		229	
6. Bank borrowings and other borrowings due within 1 year [12]	8,330	39,561	38			846	71	2,325	
7. Accounts payable to affiliated companies	273,966	407,203				1,906		1,761	
8. Accounts payable to other companies	11,839	9,580	928	529	1,412	10,405		84,150	
9. Forward currency sales, 0–30 days' maturity [12 13]						8,887			
10. Forward currency sales, over 30 days' maturity [12 13]						9,408			
11. Forward currency purchases, 0–30 days' maturity [12 14]									
12. Forward currency purchases, over 30 days' maturity [12 14]									

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GULF OIL CO.

PARENT COMPANY AND MAJORITY-OWNED DOMESTIC AFFILIATES, FEB. 28, 1973

[In thousands of U.S. dollars]

Selected balance sheet items	U.S. dollars United States [1]	U.S. dollars outside the United States [2]	German marks at 2.96 to the dollar [3]	Swiss francs at 3.36 to the dollar [4]	Dutch guilders at 3.0465 to the dollar [5]	Other European currencies [6]	Japanese yen at 270 to the dollar [7]	Other currencies including Canadian dollar [8]
1. Cash deposits, Government securities and other cash items [10]	$299,796	$333,402						
2. Accounts receivable from affiliated companies	1,860,512	482,468					$487	$72
3. Accounts receivable from other companies	668,796	183,424	59		7	75		531
4. Other current financial assets, total (maturity within 1 year) [11]								
5. Bank borrowings and other borrowings due within 30 days [12]	2,020	5,000	39	6,388				
6. Bank borrowings and other borrowings due within 1 year [12]	35,765	5,268	3,490	45,834		34,232		
7. Accounts payable to affiliated companies	2,224,778	555,670						
8. Accounts payable to other companies	112,957	521						
9. Forward currency sales 0–30 days' maturity [12 13]								
10. Forward currency sales, over 30 days' maturity [12 13]						11,920		
11. Forward currency purchases, 0–30 days' maturity [12 14]						4,981		
12. Forward currency purchases over 30 days' maturity [12 14]								

MAJORITY-OWNED FOREIGN AFFILIATES, FEB. 28, 1973

Selected balance sheet items	U.S. dollars in United States [1]	U.S. dollars outside the United States [2]	German marks at 296 to the dollar [3]	Swiss francs at 3.36 to the dollar [4]	Dutch guilders at 3.0465 to the dollar [5]	Other European currencies [6]	Japanese yen at 270 to the dollar [7]	Other currencies including Canadian dollar [8]	Gold at $_?___ per ounce [9]
1. Cash deposits, Government securities and other cash items [10]	$14,953	$20,800	15,288	4	5,897	21,807	$1,090	$113,412	
2. Accounts receivable from affiliated companies	557,196	328,470				2,435		7,364	
3. Accounts receivable from other companies	48,148	142,233	15,625	117	18,688	76,852		209,554	
4. Other current financial assets total (maturity within 1 year) [11]									
5. Bank borrowings and other borrowings due within 30 days [12]	9,485	2,843	145			1,079		250	
6. Bank borrowings and other borrowings due within 1 year [12]	6,933	28,984	43			2,321	71	2,295	
7. Accounts payable to affiliated companies	262,062	152,936				2,256	19	1,462	
8. Accounts payable to other companies	33,314	9,711	587	656	835	12,980	9	79,788	
9. Forward currency sales, 0–30 days maturity [12 13]									
10. Forward currency sales, over 30 days' maturity [12 13]						9,977			
11. Forward currency purchases, 0–30 days' maturity [12 14]						4,981			
12. Forward currency purchases, over 30 days' maturity [12 14]									

GULF OIL CO.

PARENT COMPANY AND MAJORITY-OWNED DOMESTIC AFFILIATES, MAR. 31, 1973

[In thousands of U.S. dollars]

1. Cash deposits, Government securities and other cash items [10]	$177,911	$193,479					$522	$23
2. Accounts receivable from affiliated companies	2,088,433	341,292						
3. Accounts receivable from other companies	639,248	177,142	129		14	139		1,127
4. Other current financial assets, total (maturity within 1 year) [11]								
5. Bank borrowings and other borrowings due within 30 days [12]	14,391		35	6,168				
6. Bank borrowings and other borrowings due within 1 year [12]	22,537	5,268	3,455	38,087		27,637		
7. Accounts payable to affiliated companies	1,798,875	854,258						
8. Accounts payable to other companies	120,442	506						
9. Forward currency sales 0–30 days maturity [12, 13]								
10. Forward currency sales, over 30 days' maturity [12, 13]						3,716		
11. Forward currency purchases, 0–30 days' maturity [12, 14]								
12. Forward currency purchases, over 30 days' maturity [12, 14]								

MAJORITY-OWNED FOREIGN AFFILIATES, MAR. 31, 1973

Selected balance sheet items	U.S. dollars in United States [1]	U.S. dollars outside the United States [2]	German marks at 2.84 to the dollar [3]	Swiss francs at 3.14 to the dollar [4]	Dutch guilders at 2.853 to the dollar [5]	Other European currencies [6]	Japanese yen at 264.00 to the dollar [7]	Other currencies including Canadian dollar [8]	Gold at $_?_ per ounce [9]
1. Cash deposits, government securities, and other cash items [10]	$18,713	$58,423	$770	$3,130	$5,432	$26,119	$876	$117,728	
2. Accounts receivable from affiliated companies	503,687	385,000				3,275		7,401	
3. Accounts receivable from other companies	56,686	216,918	427	7,079	19,379	94,423		212,353	
4. Other current financial assets total (maturity within 1 year) [11]									
5. Bank borrowings and other borrowings due within 30 days [12]	16,645	29,142				1,928		322	
6. Bank borrowings and other borrowings due within 1 year [12]	7,036	3,669	38	318		2,066	71	1,779	
7. Accounts payable to affiliated companies	279,090	361,279				2,325	19	1,319	
8. Accounts payable to other companies	57,414	10,696	369	1,411	1,267	6,118	9	77,072	
9. Forward currency sales, 0–30 days' maturity [12, 13]						4,954			
10. Forward currency sales, over 30 days' maturity [12, 13]									
11. Forward currency purchases, 0–30 days' maturity [12, 14]									
12. Forward currency purchases, over 30 days' maturity [12, 14]									

Senator GRAVEL. Again, I want to thank you. I think we have had excellent testimony; and I can assure you I will go through the full test of it because I do not want to be excluded from some of the facts. I think you have added to the body of knowledge and our ability to help bring some information to the American people.

Thank you very much, Mr. Card and Mr. Henry.

[The prepared statement of Mr. Card follows:]

PREPARED STATEMENT OF ANNON M. CARD, SENIOR VICE PRESIDENT, TEXACO, IN BEHALF OF THE AMERICAN PETROLEUM INSTITUTE

1. Prior to the Arab oil embargo, it has been projected that U.S. dependence on oil imports would increase to about 50 percent of domestic demand by 1980. It now seems unlikely that foreign oil will be available in these quantities even after the embargo is lifted. Some major producing countries have adopted measures to prolong the life of their petroleum resources for future generations.

2. The petroleum industry is fully cooperating in the government's mandatory allocations programs and supports the adoption of conservation measures by energy users. However, an all-out effort is required to find new domestic energy supplies in order to avoid serious disruptions of the U.S. economy. This will call for massive expenditures by oil companies and will require government policies that permit the petroleum industry to carry out its monumental task.

3. Singling out oil companies for an excess profits tax would severely impair their ability to attract much needed capital.

4. Petroleum industry earnings in the first 9 months of 1973 were 47 percent above those for the same period a year earlier. However, this improvement follows an unfavorable performance in the first 9 months of 1972, when earnings were actually down from a year earlier.

By comparison, earnings of all manufacturing companies increased by 31 percent in the first 9 months of 1973, following a 16 percent increase in the comparable period a year ago.

5. The current improvement in petroleum industry profits comes after four years of lacklustre earnings growth. Between 1968 and 1972, earnings of 18 large oil companies increased only 7.3 percent—an annual growth rate of only 1.8 percent. This is far below the 18 percent annual increase that the Chase Bank has estimated to be needed to support an adequate level of capital expenditures. Clearly, the growth in petroleum industry profits is not out of line and there is no evidence that profits are excessive.

6. The Chase Manhattan Bank has recently estimated that the petroleum industry will need to spend $1.35 trillion between 1970 and 1985. A large portion of these funds will have to be financed through increased earnings, as oil companies have already increased their debt-equity ration substantially in recent years.

7. The solutions to the energy crisis involve prompt and favorable governmental action on such proposals as offshore leasing; orderly decontrol of prices; deregulation of natural gas; adequate incentives for exploration for crude oil and natural gas; expediting the construction of the Alaskan pipeline and deepwater ports; accelerating alternate energy development; and rebalancing environmental restrictions with energy goals.

STATEMENT

Mr. Chairman and Members of the Subcommittee on Energy of the Senate Committee on Finance, I am Annon M. Card, Senior Vice President of Texaco Inc. Accompanying me is Mr. William L. Henry, Executive Vice President of Gulf Oil Corporation. We appear before you today in behalf of the American Petroleum Institute in response to your invitation to testify on S. 2806, The Energy Revenue and Development Act of 1973, and other tax-related energy proposals.

My testimony will present some information concerning the current petroleum supply and demand situation, an enumeration of factors which have created the present tight energy balance, and a discussion of related economic and financial considerations affecting America's energy prospects. Mr. Henry will discuss the role of government in dealing with the current energy situation and the tax aspects of that situation. Mr. Chairman, we are pleased to have this opportunity to appear before you.

The United States has less than six percent of the world's crude oil reserves, has been consuming 32 percent of all the petroleum products of the world, and has been depleting its crude oil reserves four times as fast as the remainder of the world. In his January 19th radio address, The President reported that in 1973 the U.S. daily petroleum consumption was 18 million barrels. This was met by U.S. production in excess of 11 million barrels a day with the balance being imported. The President stated further that in the first quarter of the current year, our imports will fall short of our normal import demands by 2.7 million barrels a day.

The staff of the Senate Committee on Interior and Insular Affairs prepared an analysis, "An Assessment and Analysis of the Energy Emergency", on December 4, 1973. Their estimate of the basic shortfall due to the Arab cutoff was 2.5 million barrels per day. The staff report concluded with the following:

> It seems clear that, under any set of circumstances which does not include an immediate resumption of the flow of Arab oil, the United States must anticipate the most grievous shortages ever experienced in this country.

Many companies communicated their estimates and their views on the subject to United States governmental agencies, including the United States Departments of State, Defense, Treasury and Interior. In addition to these estimates of the total industry situation, individual companies also provided estimates of their own positions to various government authorities.

I would like to emphasize that we are providing estimates for a moving target—one that is constantly changing over time. All estimates are based on assumptions, and fast-changing events change the assumptions, such as Arab decisions concerning the embargo, individual producing countries' actions regarding the embargo, weather conditions affecting fuel needs, voluntary conservation efforts, and regulations by governments for allocations and rationing. A factor contributing to the uncertainty about the extent of the shortfall has been the topping off of automobile tanks by motorists, thereby holding substantial added gasoline inventory.

Various companies have estimated that the shortfall currently amounts to 2.0 to 2.5 million barrels per day. This figure is lower than our original estimate for several reasons:

1. Conservation measures, such as reduced use of gasoline, heating oil and electricity, have made a significant impact;
2. Arab oil restrictions have been somewhat eased from the severe reductions originally outlined; and,
3. Weather this winter has been milder than normal.

Causes of energy shortages

The present shortage of petroleum product supplies in this country has been caused by factors rooted in the total energy supply dilemma that we are experiencing today. The obvious cause of this shortage is the imbalance between unprecedented demand and declining supply. In our view, restrictions on free market action, both in the past and at present, have increased supply problems at a time when U.S. crude oil and natural gas production has levelled off and is now declining.

The evolution of this present shortage situation can be traced as follows:

The imposition of price controls on natural gas by the Federal Power Commission has been a major reason for our developing energy shortage. These controls have kept the price of natural gas at an unrealistically low level for some 20 years while the cost of exploration and development has increased sharply. There has not been an adequate price incentive for the development of new natural gas reserves during this period.

Environmental restrictions on crude oil exploration and production became another step in the evolution of the present shortage. Exploration in potentially productive areas of the United States, and production in Alaska and offshore California, have been limited by such restrictions, thereby hastening the decline of U.S. crude oil production.

It had been anticipated five years ago that coal consumption would grow at an annual rate of increase of 4 percent; but it turned out to be only 1 percent because air quality standards, another environmental restriction, have severly limited the use of coal as a source of industrial energy. Use of heavy fuel oil has also been restricted by air quality standards and industrial users turned to cheap supplies of natural gas.

Tightening supplies of natural gas, caused by the increased demand for this cheap source of clean-burning energy, forced many industrial consumers to turn increasingly to middle distillate fuel oil of low sulfur content to help meet air quality standards. Middle distillates are the sources for home heating oil, aviation jet fuel, and diesel fuel for over-the-road trucking, railroad trains and buses of urban mass transportation systems.

With regard to tax policies, Congressional action in 1969 reduced incentives for exploration of crude oil in this country. The resulting increased taxes paid by the petroleum industry (over $500 million annually) have served to hamper the ability of the industry to generate adequate capital resources for the necessary investment needed to cope with supply difficulties.

To meet electric power demands and to observe air emission standards, while at the same time being effectively prevented from building conventional steam-generating plants or selecting sites for nuclear generating units, the electric utility industry initially installed gas turbines, powered by diesel fuel, for peak load shaving. In 1967, this small beginning amounted to the consumption of only 8,000 barrels a day of diesel fuel. By 1972, this trickle had swelled to 186,000 barrels a day—or about 80 percent of all the diesel fuel used by America's railroads.

Past import controls that restricted crude oil imports became untenable as U.S. production of crude oil was levelling off. Because of crude shortages, U.S. refineries were not able to run at rated capacity. New refining capacity construction was halted in large part by this import situation because of the uncertain long-range availability of crude oil stocks in either adequate quantity or acceptable quality.

When increases in refining capacity were planned despite the uncertainty of crude oil supplies, environmental restrictions again prevented this needed action. For example, plans to construct two major new refineries for the Norther Atlantic Coast area of this country, one in New England and one in the Middle Atlantic States, were shelved as a result of these environmental restrictions.

Finally, petroleum demand has increased steadily and substantially on a worldwide scale. This has resulted in a tight worldwide supply for crude oil and products. It has driven up the price of petroleum energy both in the United States and abroad. Price controls here in the United States have created uncertainty about recovering added costs, thereby making it difficult to bid competitively in the free world market.

Implications for the United States

Prior to the Arab oil embargo, my company projected that U.S. oil imports would increase from 4.7 million BPD in 1972 to 11 million BPD in 1980—an increase of more than 6 million BPD. U.S. dependence on oil imports was projected to increase from almost 30 percent of demand in 1972 to about 50 percent by 1980.

There are obvious risks to national and economic security from such dependence on imported oil. As a result of recent conservation measures by producing countries, it seems unlikely that sufficient foreign oil will be available even in normal items. Some major producing countries may not permit the expansions previously projected, preferring instead to prolong the life of their resources for future generations.

While more efficient utilization of energy through conservation measures can reduce some of the need for future oil imports, it is imperative that the United States must launch a full-scale effort to explore for and develop new domestic energy supplies to avoid the risks of serious disruptions to the U.S. economy. This will require massive expenditures on refining and other processing facilities as well as development of primary fuel reserves, both from conventional and unconventional sources. The derivation of fuels from unconventional sources could run as high as $1 billion for a single 100 thousand barrel per day project.

Clearly, any increase in taxes would deprive the oil industry of urgently needed capital for domestic exploration and development and other U.S. investment programs. Moreover, a so-called excess profits tax on petroleum industry profits would be inherently inequitable and would severely impair the future climate for investment in energy development. Companies that have risked billions of dollars to develop crude oil reserves at high risk, and at less than an adequate return in the past would be severely penalized if additional taxes were levied which would prevent them from receiving for their crude oil its replacement values. Over the past ten years, the costs of drilling and equipping an oil well have more than doubled. Costs of constructing refineries, building tankers, and other facilities have all increased at equivalent rates. The petroleum industry should be permitted to attempt to earn in the marketplace a return based on the current value of its facilities. Singling out oil companies for an excess profits tax would not be highly discriminating, but it would severely impair the ability of oil companies to attract capital relative to other industries since in many cases the rate of return on investment in other industries has been higher than in oil.

In addition, a tax increase on the industry would severely reduce incentives for greater efficiency which are urgently needed to help keep down the cost of energy. In the long run, higher production and greater efficiency are the keys to reasonable energy prices.

Today's problems of energy supply

The long-term evolution of energy supply restrictions and demand increases has created a very definite energy supply problem today. The problem of gasoline supply is now a major national challenge, and will remain so through the peak motoring season and beyond, possibly for several years to come. There is still a continuing problem with distillate fuel supply for the current heating season.

The petroleum industry is taking every possible action within its capabilities to provide additional supplies in order to do its full part in alleviating these supply shortages. Refineries are currently operating at the maximum level consistent with present reduced availability of crude. Even if the embargo is lifted, there would be a serious question of adequate low sulfur crude oil being available commencing in the first quarter of this year.

Industry profits

Turning now to a consideration of industry profits. In view of the timing of the release of oil industry earnings, it is impossible to give a summary of the full year's performance for 1973, as reports are just now becoming available. But, in the first 9 months of 1973, while petroleum industry earnings were 47 percent above a year earlier, this improvement followed an unfavorable performance in the first 9 months of 1972, when petroleum industry earnings were actually down from a year earlier. By comparison, earnings of all manufacturing companies increased by 31 percent in the first 9 months of 1973, following a 16 percent increase in the comparable year ago period. Thus, oil industry earnings during the first 9 months of 1973 were up 46 percent over the comparable period two years ago, compared with a gain of 52 percent for all manufacturing corporations. Clearly, petroleum industry earnings growth during a period of economic expansion is not out of line with that in other industries.

The current improvement in petroleum industry earnings comes after 4 years of lacklustre earnings growth. Between 1968 and 1972 earnings of 18 large oil companies increased only 7.3 percent—an annual growth rate of 1.8 percent—far below the increase needed to support an adequate level of capital expenditures.

In view of the compelling importance of channeling investment into the oil industry, it is essential that the industry earn a rate of return on investment sufficient to produce the needed level of investment. Yet, in 7 out of the last 10 years, the rate of return on investment in the petroluem industry was below that for all manufacturing companies. In 1972, oil's rate of return was only 10.8 percent, compared with the 12.1 percent for all manufacturing. In 1972, 25 out of 38 other major industries had a higher rate of return than the petroleum industry, with some industries earning as high as 17–22 percent.

Financial requirements

The Chase Manhattan Bank has recently estimated that the petroleum industry will need $1.35 trillion between 1970 and 1985 for capital, exploratory and R&D expenditures, debt services, dividend payments and other financial requirements. This represents a sharp upward revision from the $1 trillion which the Chase had previously estimated that would be needed during this period. Of the revised total, some $800 billion will be needed for capital and exploratory expenditures.

A large proportion of these funds will have to be financed through earnings, as the petroleum companies have already increased their debt burden substantially in recent years due to inadequate cash generation. In 1972, a group of petroleum companies generated internally only 69 percent of financial requirements (investment, debt service, dividends, additions to working capital), compared to internal cash generation of more than 87 percent of requirements as recently as 1963. As a result, the ratio of long-term debt to invested capital has been increasing sharply—from about 13 percent in 1963 to almost 23 percent in 1972.

The Chase has pointed out that after allowing for the amount of money that can prudently be borrowed and the maximum amount of capital recovery permitted by law, the industry's indicated dependence on earnings in the 1970–1895 period to meet its financial needs amounts to $755 billion. The industry would have to achieve an average annual growth in net earnings of *18* percent to generate this sum.

Corrective actions

The petroleum industry is fully cooperating in the government's mandatory allocation programs on crude oil and products in order to distribute available supplies to customers on a fair and equitable basis. The Federal Energy Office is promulgating regulations and establishing guidelines with which the industry is complying.

Both industry and government have encouraged the adoption of conservation measures by energy consumers to decrease the demand for products in this country. Industry has channelled advertising funds into informing the public about ways to conserve gasoline by changing driving habits, and distillates by home heating suggestions. A program aimed at conserving the use of electricity and heat in office buildings, industrial plants, and private homes has done much to help energy suppliers to meet the demand during this heating season.

As a result of these measures, substantial savings have already been made. In this last Saturday's energy talk the President pointed out that December gasoline gasoline consumption was down 9 percent from expectations; 19,000 New England homes surveyed showed a 16 percent drop in heating oil consumption under last after adjusting for variations in weather; utilities reported natural gas consumption down 6 percent from last year and electricity consumption down about 10 percent.

In the long term, new domestic sources of energy and new refining capacity in the U.S. must be developed in order to provide for additional supplies of petroleum products.

Industry must be able to explore the continental shelf off the U.S., employ sophisticated secondary and tertiary methods for recovery, move oil from existing fields, develop alternate sources of energy such as coal by gasification and liquefaction, shale oil and tar sands, nuclear and geothermal.

Because of the inadequacies in the administration of the former oil import program, assured sources of supply of crude oil, the environmental restrictions, inadequate port facilities, uncertainty of product specifications, and the difficulty in earning an adequate rate of return, there were no new grass roots refineries under construction in the United States for a period of time. Although several refinery expansions have now been announced, substantial additional capacity is required. At present new refinery construction is generally being held in abeyance pending clarification of the crude oil supply situation.

While the government's actions have recognized the need for new domestic energy sources and for additional refining capacity, our evolving national energy policy must also recognize the need for prompt action to make Federal lands and offshore areas available for exploration and development, to facilitate the location of new refining capacity in this country, and to develop port facilities to accommodate supertankers. The approval of proper sites has, for example, been slowed down by a variety of overlapping government regulations. Coordination of Federal, State and local authorities responsible for the various types of permits and licenses involved must be achieved to facilitate the prompt undertaking of new domestic energy projects. Some federal funds will be required to help finance the enormous expenditures required for the research and development of alternate sources of energy.

Conclusions

The continuous and unprecedented growth in demand makes it extremely difficult to forecast the extent of these petroleum product shortages. The extent and duration of these shortages will depend directly upon the rate of increase in demand and upon the actions taken and to be taken to correct those factors which are responsible for the shortages.

The solutions involve prompt and favorable governmental action on such proposals as offshore leasing; orderly decontrol of prices; deregulation of natural gas; adequate incentives for exploration for crude oil and natural gas; expediting the construction of the Alaskan pipeline and deepwater ports; accelerating alternate energy development, and rebalancing environmental restrictions with energy goals. The solution also depends upon the extent to which the Government refrains from imposing excessive taxation or other restrictions on the industry. A proper investment climate is essential to a solution of the energy problem.

The era of cheap and plentiful supplies of energy is over. All of us must realize that the next decade must be an era of energy conservation. We must seek a total commitment on the part of all Americans to continue to conserve energy and to use available supplies efficiently.

At best, the shortages will continue to be a problem until the end of this decade because of the long lead time involved for increasing energy supplies and the likelihood that the OPEC will continue to conserve their supplies of crude oil. Full cooperation on the part of government and industry, will enable this nation to take the necessary steps toward regaining its historic self-sufficiency in energy supplies.

Senator GRAVEL. We will reconvene at 2:15.

[Whereupon, the hearing recessed at 1:10 p.m., to be reconvened at 2:15 p.m.]

AFTERNOON SESSION

Senator GRAVEL. The hearing will come back to order.

Our next witness is J. Hilbert Anderson, Sr., president of Sea Solar Power, Inc.

Mr. Anderson, please come forward. You may have anyone accompany you that you wish—your son. Why do you not sit next to the other microphone so we have you both in front of microphones.

Mr. Anderson, you may proceed.

STATEMENT OF J. HILBERT ANDERSON, SR., PRESIDENT, SEA SOLAR POWER, INC.; ACCOMPANIED BY JAMES H. ANDERSON, JR.

Mr. ANDERSON, SR. Mr. Chairman, I wish to introduce my son, James H. Anderson, Jr., who has been associated with me for a number of years in the development of sea solar power.

It is, indeed, a pleasure and a privilege to be here to testify on the energy situation in association with what appears to us to be a very important bill.

Within 4 years we can build a pollution-free sea solar powerplant demonstrating the making of electricity, fuel for our automobiles, fresh water, and hydrogen for our gas lines—all at lower costs than prices we pay today.

Senator GRAVEL. For conventional energy use?

Mr. ANDERSON, SR. Yes, sir.

What is sea solar power, otherwise known as sea thermal power? I will take a few minutes to show the principles of operation of sea solar power for those who are not familiar with it.

Sea solar power simply means using the sun's energy collected on the surface of the ocean where it warms the water, where underneath you have lots of cold water. When you have the warm and cold water close to each other, you can generate power.

As shown by the diagram [indicating],* we have at the surface of the ocean in the tropics water at about 80 degrees Fahrenheit. If we take this water down to a boiler where it transmits heat to a refrigerant such as propane at high pressure, this can then be expanded through a turbine which directly drives a generator and generates electricity. The exhaust from the turbine goes to a condenser where it condenses at low pressure. It is condensed by cold water brought up from the depths of the ocean. The propane or refrigerant is then recirculated.

And this is basically all there is to this utterly simple process. It is not exotic; it is extremely simple. The beauty of this is that not only can you generate power, but you can then convert lots of the sea water to fresh water. From the fresh water and electric energy you can

*Charts referred to are attached to Mr. Anderson's prepared statement.

electrolyze hydrogen, and from hydrogen and carbon dioxide in the water, you can convert this very easily to methanol, which is ready to pour right into our gasoline tanks of our automobiles.

Now, what is the crux of the situation as far as whether or not this is an available source of power? First of all, many people for many years have agreed that there is almost an infinite supply of water in the ocean to produce this power.

The second question—and the real question is—how much does it cost? Any energy supply must eventually stand the test of economics. In the next slide, we have taken a look at all of the currently proposed major sources of energy supply and plotted the cost of power plants in dollars per kilowatt on this scale over here [indicating]. And here are the various forms of power.

Down here, the black spots are the present forms of fossil fuel power. Here [indicating] is nuclear power, going from $400 to a projected $1,100 per kilowatt. These three figures here [indicating] are sea thermal power that we are talking about—geothermal power, and wind power. Notice that the plants for these—and these are figures that we got from the National Science Foundation—largely are in between the cost of our present fossil fuel plants and those of nuclear plants.

Now, the cost of power is not just the cost of the plant. We have two other factors to recognize. One is, of course, does it take fuel? Obviously, you must pay for the fuel as we all now well know. Secondly, how much of the time will the plant operate? If the plant operates 1 day a year, obviously it costs a lot more per unit of power than one that runs every day of the year.

So let us look at the next chart where we plot the actual power costs, recognizing the cost of the plant—the fixed cost, that is—and the cost of the fuel, and the load factor. Here we have power costs plotted in cents per kilowatt hour. The top of this chart represents 10 cents. The reason the chart is topped at 10 cents is because this is actually about what you are paying for power to run your automobile today.

So this tells us that so far as willingness to pay for power, we are willing to pay up to 10 cents for power. Many of these forms of power run above that. An interesting one over here is the horse. We calculated the power of a horse, one horsepower; and found that if we were to convert back to animal power, as some people say that we should, the cost would be 30 to 40 cents per kilowatt hour—three times as much as we pay in the automobile.

Now, on these various power charts going from zero down here to 10 cents here, we have plotted all of these forms of power, starting on the left with those that have a low load factor—for example, a horse would have a load factor of only 23 percent—going to those which have a high load factor, and of course, this affects the cost. All of those in solid black are power sources that require fuel—gas turbine, nuclear power, fossil fuel, and geothermal power. All of the others do not require fuel, such as wind power and sea thermal power.

When we look at this chart, we see that of all of these sources of power, the only major ones that can compete in cost with our present sources of power and have infinite supply are wind power, geothermal power, and sea thermal power. Of all of these, sea thermal power stands alone as being lowest in cost and having the highest potential of all of them.

How long would it take to build a sea thermal power plant? We have been told that by 1985 when we are projected to have the breeder reactor, we will have spent $9 billion on nuclear power. If we can have 1 percent of that $9 billion, we can build a sea thermal power plant by 1978.

What better opportunity do we have to get clean, safe power, plus fuel for our automobiles at a lower cost than we pay today?

Sir, I submit to you that sea thermal power is the most important technical development in the world today. By starting sea thermal power now, along with nuclear power and the others, we can take the world out of oil bondage to the Arab nations. My plea is that we start now.

We believe S. 2806 is a wonderful start in this direction, and we wish to add our full support to it.

Thank you. And I shall be glad to answer any questions.

Senator GRAVEL. Sir, it is very impressive. First off, how much money did you say you would need? One plant—what costs would accrue? What would be a good prototype plant and what would be the costs of a prototype plant?

Mr. ANDERSON, SR. We do not claim to know this accurately. This is a very round number. But we have said if we would get between $50 and $100 million, we could produce the first plant.

Incidentally, we are building a plant right now, a small prototype, our own money merely to demonstrate the process.

Senator GRAVEL. How much is that plant costing you, the one that you are building?

Mr. ANDERSON, SR. We expect that this one will cost us $20,000 to $40,000.

Senator GRAVEL. Where did you get the money to do that? Is it your own money?

Mr. ANDERSON, SR. The start is our own money. We are hoping to get some money from the Government a little later on.

Senator GRAVEL. I notice you have created Sea Solar Power, Inc. Tell me a little bit about your background for the record—how you came into this field and how long you have been working in this.

Mr. ANDERSON, SR. I have been a mechanical engineer for almost 40 years. Early in my career, I read about the efforts that George Claude made where he actually built the first sea thermal power plant back in 1930. He actually produced power, but this was not an economic success partly because the time was not right, partly because he did not approach it in the right way. Therefore, over many years, I have been interested in this. In the meantime, I have spent many years in turbo-machinery design, power machinery, refrigeration machinery, all of which relate to this problem.

In 1962 I finally, after many years of, shall we say, thought or brainstorming, decided that this could be done and decided that I should quit my job and go into this, because I felt that there was going to be an energy shortage; we would need this; and this is something the world would need.

Senator GRAVEL. In 1962 who were you working for?

Mr. ANDERSON, SR. I was chief engineer of large machinery of the York division of the Borg-Warner Corp.

Senator GRAVEL. You were chief engineer there?

Mr. ANDERSON, SR. Yes, sir.

Senator GRAVEL. And from 1962 on you went into business for yourself to try to develop this sea polar power system?

Mr. ANDERSON, SR. Yes, sir.

We first presented, after a year of study of this, we presented our first paper on this subject in 1964.

Senator GRAVEL. And obviously, nobody was interested enough at that time, or what happened then?

Mr. ANDERSON, SR. The way I like to put it is they did not even bother to laugh at us.

Senator GRAVEL. So you had no credibility. What happened after that? You had your first paper in hand. What did you do then?

Mr. ANDERSON, SR. Well, little by little—of course, we have been working in many fields of endeavor as consulting engineers and doing many things in the field of refrigeration. We have worked on geothermal power and other sources of power. But in the meantime by supporting ourselves we were able to produce more studies and more papers on sea thermal power, until, of course, people finally realized there was an energy crisis; and, of course, the interest then has increased.

Senator GRAVEL. What exposure has your idea had? For example, you sat here this morning, and heard a couple of large international oil companies that are in the energy business and are spreading out beyond the energy business—but have you tried to sell your concept to some companies like that?

Have you talked to the AEC, their research areas?

What do people say when you come in? This is pretty impressive.

Certainly they can put pencil to paper and maybe get some analysis of it.

Have you had any that you consider intelligent analyses of your proposal by somebody in authority?

Mr. ANDERSON, SR. We have had many perfunctory analyses of it. At first people said well, obviously you are all wrong. And whenever we asked people where we were wrong, they could not prove it. Little by little we have heard all of the objections that I think can ever be heard on this; and little by little people have become—when they become knowledgeable about this, they have become more and more convinced that this is a sound proposal.

We now have people in large companies come to us and say, this appears to us to be by far the best approach to the use of solar energy. So that we are encouraged now by the fact that after 10 years we have found no objection that could not be surmounted. And we now have a number of people who agree with us that this is probably the most viable way to produce energy at a cost competitive with other forms of solar energy.

Senator GRAVEL. Can you get for the record some documentation from this source to agree with you? Here is our problem right now. You are coming before us and testifying; and assuming we take the assumption that these tables are valid, and it is everything you say it is, we are making a tremendous mistake—private or public sector, it makes no difference—as to our ability to acquire some sizable amounts of power right now that is competitive with oil.

There is no need to go tear up the countryside, put up a billion dollar shale plant, and do a whole host of other things, if this is accurate. So in order to push the Government for a grant or an appropriation, I—certainly, we could try to get the attention of the AEC which is supposed to have a Solar Division—I have been trying to get money for it—if getting some analysis of this at this point in time can increase your credibility so that we can take the next step—that is, to get some funding in the process and go at it—it is very difficult, I know.

What we are doing right now, what I am doing right now with you—and I used to be a developer, so I know the problems of trying to promote an idea, but what we are doing right now is what should have been done at some level, lower level of corporate enterprise or of Government scientific research area in taking in your paper, assessing it. If you are not satisfied with the assessment, then you respond to it. But if they cannot objectively tear this down, then somebody has got to go forward with it. And I am prepared to use my good offices to do something in that regard if we can build a case around it.

I am personally obviously impressed, but I think we have got to take the other step; and that is to get someone of some scientific prowess to try and destroy your thesis. And if that cannot be done, then we start living with it.

Mr. ANDERSON, SR. I think part of the answer is that part of that has been done. We, of course, with our papers have subjected this to as many people as we could over the years; but more recently, the National Science Foundation—and Dr. Cohen is here and I think would corroborate what I say. The National Science Foundation has funded so far one investigative study of this which started last year; and the first part of it was completed, and the results of that study as far as they went say and do corroborate that what we say is true—that this is, indeed, a viable source of power.

Senator GRAVEL. This is the National Science Foundation?

Mr. ANDERSON, SR. They are now funding further studies. Several other universities have become interested. We in our own company have felt exactly what you say needed to be done; and we have now at least gotten enough investors interested so that they have agreed. And we are presently funding a study by the United Engineers and Constructors in Philadelphia, which is one of the largest engineering corporations in the world. They are now doing a feasibility study for us; and the whole purpose is to check—are we telling the truth or are we not.

Senator GRAVEL. It is not a question of truth. It is a question of are you correct or are you not correct.

Mr. ANDERSON, SR. That is what I mean. Yes. In other words, we do not pretend to know all of the accurate data until we build a plant. Nobody does. But——

Senator GRAVEL. When will the studies be completed? I am interested in the timeframe. First off, when will we have the National Science Foundation's research study, is it very voluminous? I would like it for the record.

Mr. ANDERSON, SR. That study was carried out by the University of Massachusetts; and I do not know how many pages it is.

Senator GRAVEL. We will prepare a letter to go to the Director of the National Science Foundation, asking an evaluation of the statement made by Mr. Anderson, president of Sea Solar Power, Inc., and if there is any degree of corroboration with respect to past studies; and if there are continuing studies to be made, what would be the timeframe of accomplishing those studies, and what would be the constraints on that timeframe; and what would be necessary to shorten that timeframe so that the Congress might be apprised of the possibilities that would exist in this type of proposal and the necessary funding or an evaluation of what the funding would be necessary to build a viable operating prototype.

An excerpt from a letter submitted by the NSF follows. The complete letter appears in the appendix at p. 1760.

NATIONAL SCIENCE FOUNDATION,
Washington, D.C., February 25, 1974.

Hon. MIKE GRAVEL
U.S. Senate, Washington, D.C.

DEAR SENATOR GRAVEL: In response to your inquiry as to several statements on energy technology recently presented to your Subcommittee on Energy, members of our staff have provided the following information:

SEA THERMAL POWER—STATEMENT OF MR. J. HILBERT ANDERSON

The National Science Foundation has selected ocean thermal energy conversion as one of its six solar energy programs because of the large potential for energy production from that source. During the past eighteen months we have been funding a systems study of ocean thermal energy conversion at the University of Massachusetts at Amherst under Professor William E. Heronemus, and for the past eight months a similar study at Carnegie-Mellon University under Professor Clarence Zener. Both projects will continue through calendar 1974. The study at the University of Massachusetts includes a small subcontract with Mr. Anderson's firm, Sea Solar Power, Inc., and another with United Aircraft Research Laboratories.

Although it is premature to come to any quantitative conclusion concerning Mr. Anderson's cost and time estimates for the development of sea thermal power, our studies to date are encouraging in those regards. Ocean thermal energy conversion technology mainly requires adaptations of existing technologies, and its ultimate cost and the time frame for its development will depend on how well, how soon, and how economically we can make such adaptations. Professor Heronemus and his group are currently estimating costs of about $500 per kilowatt of plant capacity, and that it might require about six years to produce the first large-size demonstration plant. Mr. Anderson estimates that this could be done more rapidly at lower cost per kilowatt.

We are currently preparing a Program Solicitation (as mentioned in the enclosed announcement copied from Commerce Business Daily of January 4) that will enable us to award one or more contracts seeking to obtain an independent engineering evaluation of the technical and economic feasibility. Meanwhile, our plans for the Ocean Thermal Energy Conversion Program will place emphasis on research on component hardware and testing. The objectives of this program in the next five years is to accomplish the research that will permit us to design a proof-of-concept experiment. This would probably be a near-shore or ocean-based pilot plant of about 10 Mw capacity.

* * * * * * *

Sincerely yours,

H. GUYFORD STEVER, *Director.*

Senator GRAVEL. That is pretty much the dictation of the letter.

I think that has served our purposes, Mr. Anderson. At this point I do not know of any further questions. I would have to read over the material very carefully. I would like to see that first slide again and have you walk me back through the process—not the economics of it. I have had economics 101, but I was very weak in physics.

Mr. ANDERSON, SR. We have here [indicating]—consider this a floating ship out in the ocean. At the surface of the ocean we have an intake where we take in the warm water from the surface. This flows down to a boiler. Now, the reason this boiler is deep like this is so the water pressure deep in here balances the pressure created in the fluid, so that this permits you to make a cheap heat exchange. Then the fluid——

Senator GRAVEL. A boiler like that, would it be suspended by cables underneath?

Mr. ANDERSON, SR. By a complete pipe structure.

Senator GRAVEL. It would be like a drilling platform that the oil companies use that would go all the way to the bottom of the ocean?

Mr. ANDERSON, SR. As a matter of fact, we will show you an additional slide to show you an actual model that we built.

Senator GRAVEL. OK.

Mr. ANDERSON, SR. After the vapor boils and some of the heat has been taken out of the water—here it starts at 82; here it drops to 79—that heat goes to boil this vapor. That is where your energy comes from. And when that boils the high pressure gas goes up, expands through a turbine which drives a generator.

Senator GRAVEL. The water is just pumped down——

Mr. ANDERSON, SR. It is just pumped through here [indicating] and goes out again. That is all there is to it.

Senator GRAVEL. You do not have to pump it do you?

Mr. ANDERSON, SR. You do have to pump it because to get it through the boiler through all the heat exchange surfaces there is friction. Also, the water at the surface is lighter than the deeper water, so to move this warm water to a deeper place you actually have to have a pump to do it.

Senator GRAVEL. So you need some power to do that?

Mr. ANDERSON, SR. That is right, you need pumping power to do that.

Now, after it expands through the turbine, of course, in order for it to expand through the turbine you have to have a pressure drop so that the rear or exhaust end of the turbine must be at lower pressure. The way it's maintained at lower pressure is you condense the liquid on a cold surface just like you condense your breath on a cold windowpane and that produces a lower pressure, and it condenses then back to a liquid. This cold water must be brought from deep in the ocean. If you go down 2,000 to 3,000 feet deep in the ocean almost anywhere temperature is down around 40 degrees Fahrenheit, almost down to freezing. If you pump that water up, that provides the cold you need to complete the engine. Having liquefied the turbine exhaust vapor you then put it through a pump and put it back in the boiler so the propane, as we show here, or whatever the refrigerant you use merely is pumped around and around. You never lose it. So all you are using is water.

Now, the beauty of this is that having water you also have a little leftover heat, because the water goes out here at 79 degrees Fahrenheit and this water goes out here at 49. By putting those streams together you can produce a vacuum and produce fresh water out of the saltwater with a little additional effort. Having the freshwater, you can then use the electricity generated to electrolyze the salt water into hydrogen.

Again, taking the fresh water here, in order to produce the fresh-water you have to take the gases out of it. Some of those gases in there are carbon dioxide, by taking the hydrogen that you make, combining it with the carbon dioxide, you will make methanol, or methyl alcohol, which is a fuel directly burnable in your automobile.

That is the reason——

Senator GRAVEL. So you would have fresh water, which is a very desirable item in any locale?

Mr. ANDERSON, SR. Yes.

Senator GRAVEL. Would it be drinkable?

Mr. ANDERSON, SR. Yes, sir. Absolutely pure water.

Senator GRAVEL. So you would have fresh water and methanol to power small engines.

Mr. ANDERSON, SR. Right.

Senator GRAVEL. And you could have electricity.

Mr. ANDERSON, SR. Right. And you can supply them in almost any proportion that you want depending on demand.

Senator GRAVEL. Do you have a patent on this?

Mr. ANDERSON, SR. We have a number of patents, not on the basic idea, because the basic idea of generating power from the ocean like this dates all the way back to 1881. D'Arsonval suggested it.

What we have patents on are the way to accomplish that at a low cost and good economic efficiency, which is the thing that was lacking in the original idea. He said theoretically you can do this, but, how do you do it practically?

We are firmly convinced after 10 years of study now that we can do it practically and at low cost.

Will you switch that slide just to show the model.

This [indicating] is a picture of a model that we made a long time ago and shows the general idea. You have a floating hull here, and at the surface you have to have a large water intake. Remember, it takes tremendous quantities of water. That water is pumped down through these pipes [indicating]. Here is the boiler [indicating].

The cold water comes from a pipe deep in the ocean up to the condenser, where it acts as a condenser. Then these pipes here [indicating] convey the propane up to the turbine and generator, which is in the hull. So it is basically a very simple plan, and the beauty of it is that most of it is under the water, so you are not very subject to storm damage. As anybody in undersea development knows, once you get a structure well deep in the water, it is very stable and not subject to storm damage.

Senator GRAVEL. Thank you.

Very good.

I can think of no additional questions. I think I understand it.

Mr. ANDERSON, SR. May I say one thing, Senator?

Senator GRAVEL. Certainly.

Mr. ANDERSON, SR. We have said we can start now and do this within 4 years. The reason why, we have a 10-year headstart on everyone else is that we started on this back in 1962. But there is one other important thing. Nothing in this plant requires technology that we do not have today. In other words, the equipment, the parts of this plant can be built with existing technology and with existing machinery and existing plants. So basically, we could build these plants much more rapidly than we could, say, nuclear powerplants, because the capability to build this machinery exists all over this country. There are a lot of plants that would participate in building sea solar powerplants.

Senator GRAVEL. Again, obviously, you sketched it out in our discussions, but what would that item cost, and how much power would it produce?

Mr. ANDERSON, SR. Are you referring to this sketch?

Senator GRAVEL. Yes. Roughly, for a sum of money, say.

Mr. ANDERSON, SR. It is difficult to say what the first one costs. We projected that model from a scale model of what we thought would be a 100,000 kilowatt plant. We estimated the cost of that not on the basis of the developmental cost, but the cost that would take after you knew how to build it——

Senator GRAVEL. The factory cost?

Mr. ANDERSON, SR. Yes. We figure that the cost of that 100,000 kilowatt plant would be $16 million.

Senator GRAVEL. $16 million?

Mr. ANDERSON, SR. $160 a kilowatt.

Senator GRAVEL. How does that compare with a nuclear powerplant?

Mr. ANDERSON, SR. The present nuclear powerplants, if you look at our cost charts, the present nuclear powerplants that are being finished today cost between $400 and $500 a kilowatt. The projected cost of those that are being started now, will cost $1,000 to $1,100 a kilowatt. So that we have a lot of leeway for mistakes in our estimate.

Senator GRAVEL. In your detailed statement, you do have those comparative figures?

Mr. ANDERSON, SR. Yes. On the inside chart, we show the nuclear versus the sea thermal plant.

Senator GRAVEL. So for $16 million we could have an operational prototype?

Mr. ANDERSON, SR. No; you should not say that, because the $16 million, as I say, is based on having had experience to build a number of plants. So it is a production cost. The first plant would be a crash program.

Let me comment on this, because this came up in testimony this morning. The question of what is cheapest, should we go through a so-called ordinary, orderly development phase, where we research every phase of this, or should we go on a crash program and build a plant?

Many people have asked us this question. We have said—and I say this from long experience in engineering—that the fastest way and the cheapest way to get on target with a new thing is to go ahead and build it. You will make a lot of mistakes but you will save enough in time. Invariably, we find in engineering that the mistakes that you make are the ones you did not plan for; the problems you planned for never turn out to be troublesome. So the best way to do it is to go ahead and build it. You will make a lot of mistakes but you will get to the target faster.

That is the reason we say we can, if we had the money and the authority and the undivided responsibility, we could go ahead now and build a plant in 4 years.

Senator GRAVEL. Probably one of the ways to do it would be to get the utilities. Have you talked to various utilities? Has anybody shown any receptivity at all?

Mr. ANDERSON, SR. Individuals have shown a great deal of receptivity. The utility industry at large has shown no receptivity.

Senator GRAVEL. Is there any individual in a position of power in any utility who has shown receptivity?

Mr. ANDERSON, SR. Let us put it this way; not sufficient power.

Senator GRAVEL. Because if we had a utility company willing to go at this, and you were able to get the Federal Power Commission to approve it for their rate structure, they might be willing to gamble.

Mr. ANDERSON, SR. I think the basic problem is, that we must all recognize that utilities have a cost structure built in which is virtually a cost-plus contract. They really have no incentive to go out and build——

Senator GRAVEL. I well know that.

Mr. ANDERSON, SR. And I think this is one of the problems why they are very lukewarm about this, although individuals in the utilities have, and also some of the oil companies, have shown great interest, and they recognize that what we have said is basically true. They may not agree with all of our numbers, and certainly we do not pretend that all of our numbers are exactly right. But on our basic principles and the fact that they now agree, many of them, that the problems they see can be solved, I think more and more people are beginning to agree that this is true.

Senator GRAVEL. What about GE and Westinghouse? Those are the two major manufacturers of nuclear plants. What do they—someone mentioned that you had a Westinghouse person interested in this?

Mr. ANDERSON, SR. I worked for Westinghouse as a consulting engineer for many years. I have brought this up to them, and they so far have not shown a great deal of interest.

I think, again, this, like any new development, is not generally of interest to somebody who is busily making something with which this is in direct competition. I do not expect that the people who now build nuclear plants will show the greatest interest in developing this.

Senator GRAVEL. Very good.

Well, Mr. Anderson, you will hear from us again. I can assure you of that. I am impressed with this proposal, and we are going to be hearing from William Heronemus, I believe, on Monday, and we probe with him your proposal.

Do you have other copies of this? Could you leave some copies with our staff so that we can send this to Dr. Ray at the AEC and see what few dollars are lying around and see what they are doing with it, and if we can accelerate this?

Mr. ANDERSON, SR. We would be very happy to, indeed.

Senator GRAVEL. Thank you for coming forward and testifying about a concept you believe in strongly. If you are correct, you have done a great service to mankind.

Mr. ANDERSON, SR. Thank you very much. It was a privilege to have been here.

Senator GRAVEL. Thank you, sir.

[The prepared statement of Mr. Anderson, with an attachment, follows. Hearing continues on page 1528.]

STATEMENT ON ENERGY RESEARCH POLICY, BY J. HILBERT ANDERSON, PRESIDENT, SEA SOLAR POWER, INC., JANUARY 25, 1974

All of the furor about the energy crisis has stimulated thousands of suggestions. Each proposer of a solution or partial solution is sure that his idea is most important to the overall effect. As a result we have myriads of roads to travel but no direction or mileage signs.

It is now time to take a hard look at the economics of our possible sources of energy, and decide which ones we can really afford to develop.

We, in the United States have been blessed with enough energy and ingenuity so that power has been ridiculously cheap. As late as ten years ago we were promised nuclear power "too cheap to meter". Now that the mirage has disappeared we can get down to some honest hard work to solve the problem.

What is the real measure of what we can afford to pay for energy? When we tried to analyse this on a logical basis we suddenly realized that our real objective is simply to produce power cheaper than animal power. If we can't produce power cheaper than animals can produce it, then we will obviously go back to an animal powered society. Whether the animals are human or not, has no bearing on the case.

Probably the best measure of the cost of animal power is the horse, our traditional source of power, prior to the industrial revolution, and a source that is still in use. A draft horse currently costs about $300.00. If we say that one horse produces one horsepower, or three quarters of a kilowatt, then the cost of a horse-powered plant would be $400.00 per kilowatt. Since a horse can work only eight hours per day, and perhaps 250 days per year, the percentage of time worked, or the load factor is only 22.8%. The fuel cost is the food cost for the horse, which we are told is approximately $1.25 per day. If the horse produces 1,490 kilowatt hours per year and the cost of food is $456.00 per year, the the cost of fuel is 30.6 cents per kilowatt hour. If we assume the fixed charges for maintaining a horse are 15% per year, then this adds $60.00 per year to our cost, or 3.0 cents per kilowatt hour. Our total cost of power is then 33.6 cents per kilowatt hour. As an approximation we can say that any source of power that will cost more than 34 cents per kilowatt hour is hardly worth developing.

Now, let us look at costs of presently used sources of power, and compare them with estimated costs of proposed potential sources of power. This should tell us where we should really spend our development effort.

Our first chart, Fig. 1 shows the approximate range of installed costs for various types of power plants. Much of this data was taken from information supplied by the National Science Foundation.

The first three bars on the left of the chart show costs of conventional fossil fueled plants, ranging from a minimum of $200.00 per kilowatt for gas fired plants to $400.00 for coal plants.

The next bar shows Sea Thermal Power. This means power generation from the warm solar heated surface waters of the ocean. The costs of $300 to $500 per kilowatt were estimated by the National Science Foundation. Our own original estimated costs were $160 per kilowatt.

Geothermal power is shown with plant costs from $100 to $500 per kilowatt. The wide variation will depend largely on the temperature and corrosiveness of the water or steam supply, and the type of cooling system used.

Wind power is estimated to cost from $200 to $600 per kilowatt, and these estimates seem to be based on sound experience.

Nuclear power plant costs range from a little more than $400 per kilowatt for plants presently being completed to about $1,000 for the projected breeder reactor plants.

Solar thermal plants collect the sun's energy on man made collectors in desert locations, convert it to heat energy, which in turn drives a more or less conventional power plant. Cost estimates run from $900 to $1,900 per kilowatt, depending upon how optimistic one is about the cost and efficiency of solar collectors.

PV Earth represents direct conversion of the sun's energy to electricity by photovoltaic cells arranged in huge arrays. The upper figure of $70,000 represents costs based on present prices of photovoltaic cells. Proponents say that if cell efficiency can be improved considerably, and if manufacturing costs can be reduced by a factor of more than 100 to 1, then costs might come down to $300 per kilowatt.

PV Space uses photovoltaic collectors in a huge array placed in a synchronous orbit as a space station. This station then transmits power to an earth station by microwave transmission. One advantage is that solar radiation is far more intense outside the earth's atmosphere, thereby boosting cell output. This is already demonstrated by the synchronous satellite presently in use. The other major advantage is that power output is held constant and is developed for about 23 hours of the day vs. only about 10 hours per day for a similar station on earth. Present cost estimates show a price of $200,000 per kilowatt. Proponents hope that costs might come down to $500 after many years of research and manufacturing development.

The cost of power depends not only on the plant cost, but also on how much of the time power can be produced, commonly called the load factor. The fixed cost for power can be represented simply by the formula:

$$\text{Fixed cost/kwh} = \frac{.15 \times \text{capital cost/kw}}{\text{load factor x 8760}}$$

The capital cost of 15% is a fairly common figure, including interest, taxes, maintenance, and profits.

To the fixed cost for power we must add fuel costs. Solar, hydro, wind, and tidal power plants require no fuel. All others require fuel. The fuel cost for power can be represented by:

$$\text{Fuel cost/kwh} = \frac{3413}{\text{Efficiency}} \times \frac{\text{Fuel cost}}{\text{Btu}}$$

The total power cost produced at the plant is then the sum of the fixed cost and the fuel cost.

On Fig. 2 we show the power costs from the different energy sources. These costs in cents per kilowatt hour are calculated from the above equations, taking into account capital cost, load factor, and fuel cost. They are arranged on the chart in order of probable load factor, varying from 22.8% for a horse to about 95% for a solar space station. The sources which require fuel are shown in solid black. Those which do not require fuel are shaded. The percent load factors are shown on the chart.

It is interesting to note that if we take recently published average automobile running costs of 13 cents per mile the cost also comes out to about 10 cents per kilowatt hour. This merely shows that the public is willing to pay this much for power, if they have to. Note, however, that the cost of power on the automobile or the horse are for power delivered to the user, not power at the plant, as defined in the other cases.

This tells us that we can really afford, and are willing to pay as much as 10 cents per kilowatt hour for power, if we have to. In the extreme we would be willing to pay as much as 30 or 40 cents, which is the cost of power from horses. Therefore, any form of power that doesn't extend above this chart in cost is economically feasible. However, it can safely be said that the economic wealth and well being of the whole world depends directly upon the cost of energy, and it behooves us to develop those sources. We will discuss here briefly the costs from the various possible sources shown on the chart.

Tidal power plants can operate at a load factor of only 25%. The only large tidal power plant existing is that on the River Rance in France. It cost about $350 per kilowatt. Projected cost of the Passamaquoddy plant proposed for the U.S. were approximately $800 per kilowatt. This would bring power costs to six cents per kilowatt with no fuel cost.

Small wonder that more tidal plants have not been built!

The gas turbine is the cheapest form of fuel fired plant, at costs as low as $125 per kilowatt. However, efficiency is low and fuel prices are very high, so that the current load factor is quite low. This results is a high cost of up to 22 mills per kilowatt hour for gas turbine power. Gas turbine cycle efficiencies can be almost doubled, but this is counteracted by rapidly increasing fuel prices.

PV on earth is shown at a load factor of 33%. This brings presently projected costs to about $3.50 per kilowatt. Since a storage system must be added to these costs to provide power at night the economics look poor indeed.

Solar thermal power will have a low load factor similar to that of PV. Maximum estimated costs of 10 cents per kilowatt hour do not include costs of required energy storage systems. Therefore, the cost will probably be higher than 10 cents shown on the chart.

The hydroelectric power plant cost of $400 per kilowatt was based on the average of a world wide survey published in *Fortune* several years ago. Actual costs ranged from about $200 to $800 per kilowatt. Load factors probably average about 50%, because of large variations in water supply.

The average load factor for nuclear plants has been 60%. Cost of nuclear fuel is quite low, although disposal costs for residual fuel should be added. Based on a fuel cost of about three mills per kilowatt hour added to the fixed costs nuclear power total costs should vary from about 15 mills to about 32 mills.

Wind power is estimated to have a better load factor than that established by nuclear plants. Since wind power has a random load factor, rather than a fixed one like solar power, storage requirements will be much less, and can be lessened largely by means of a wide distribution network. Therefore, the costs varying from seven mills to 17 mills should not have to be increased greatly for storage systems.

Fossil fuel steam plants have a probable load factor of about 70%, although the U.S. average is lower than this. Based on a fuel cost of about three mills per kilowatt hour and the capital costs from $175 to $400 per kilowatt the power cost would vary from about 6.6 mills to 12 mills per kilowatt hour. As fuel costs go up these costs will certainly be higher.

Geothermal plants have an excellent load factor already demonstrated to be over 90%. A load factor of 85% is shown here. Fuel costs are presently a little less than three mills per kilowatt hour. Adding this to the fixed cost charges shows a power cost of five to 12 mills per kilowatt hour. This is presently and will almost surely continue to be one of our lowest cost sources of power available on a large scale.

Sea Thermal Power should have an extremely high load factor, and has a slight advantage over geothermal power in that maximum power output occurs in the summer, when demand is greatest. Therefore we have assumed the load factor to be 90%. Since there is no fuel cost the power cost varies from an estimated three mills to nine mills.

Photovoltaic solar power in space has an advantage of providing power about 23 hours out of 24, so should have a load factor of about 95%. The extreme costs of the equipment rule it out as a practical source of power except as a possibility for the distant future.

The chart says very clearly that of all the possible new sources of power only Wind power, Geothermal power, and Sea Thermal power appear to be clearly economical in competition with present sources. If we accept this as a possibility, then we must ask ourselves what is the potential of each, where is it available, and how soon can we develop it.

The potential for wind power has been estimated by different authorities. Heronemus [1] reports the total Northern Hemisphere wind energy at 10^{11} megawatts in winter and 60% of that in summer. The World Meteorological Organization estimates that 2×10^7 megawatts of wind power is available at favorable sites. This compares to a total average U.S. usage of 1.76×10^3 megawatts in 1970. Obviously the potential is big enough to be worthwhile.

In the case of geothermal power wildly different estimates of the potential are made. Be that as it may, most authorities do agree that there is sufficient potential to be worthwhile, and estimates are rising quite rapidly.

The biggest problem in developing geothermal capacity is that of heat rejection, but new cooling systems now appear to be able to solve that problem, so that a large potential for geothermal power can be realized.

Sea Thermal Power has more potential than we can probably ever use. The Gulf Stream alone has a potential power production capacity of more than 100 times the total U.S. usage.

[1] "Pollution-Free Energy from Offshore Winds", W. E. Heronemus, presented to "Marine Technology Society", Sept. 1972.

The possible location of these various sources of power is really not as important as some people seem to think. For example, if I generate Sea Thermal Power in Florida and save a barrel of oil there, then that barrel of oil is available for use in Minnesota. Or if I save a barrel of oil in California by using Geothermal power, then that barrel is available for New York.

Fortunately Wind power, Geothermal power, and Sea Thermal power complement each other very well in their availability. Many favorable wind sites occur in New England and the Midwest. Geothermal hot water occurs on the West coast, Pacific Northwest, Rocky mountains, Gulf coast, Alaska, and Hawaii. Sea Thermal power is readily available close to Florida, Georgia, Puerto Rico, and Hawaii. These three sources can conveniently and economically provide power for practically the entire United States, and eliminate our dependence on foreign oil.

Let us now look at development timing for each of these power sources.

Wind power has been in use for thousands of years. Further development is only needed for large scale planning, better operating efficiency, and manufacturing capability. Small wind power plants are already marketed. Within less than five years we could have many wind power plants operating.

Geothermal power plants are already in operation at 300 MW total capacity. These are natural steam plants. A hot water demonstration plant can be built within one year after site selection and availability of funds. The turbines for such a plant are already built, waiting to be used. Manufacturing capability is available for rapid construction of these plants. They can be built far more rapidly than nuclear plants.

We could have a Sea Thermal plant within four years after authorization and availability of funds. While there are numerous development problems, they are all of a routine engineering nature, and solutions are virtually assured for all of them. The fastest way to a solution of the problems is simply to build a plant.

A vitally important factor in evaluating any possible solution for our energy problem is time. How fast can we build plants, once we know how. Currently, nuclear plants require an estimated eight years from start to production of electricity. This great time lag is caused by siting, safety, and legal problems, plus long production times for the huge units of machinery, which can only be built by a few manufacturers.

Now, consider the manufacturing possibilities and time required for wind, geothermal, or Sea Solar plants. Siting problems are much less restrictive because the safety problems and heat rejection problems are far less difficult. These plants are made up of many small items, easily built by literally hundreds of manufacturers. Therefore, the time to build plants will be much shorter than to build nuclear plants. Also, the expansion of capability to build such plants can be much more rapid than for nuclear plants.

It is now clear that we must change direction. Instead of putting nearly all our funds into the development of nuclear energy, we should divert a relatively small amount of this money into Wind power, Geothermal power, and Sea Thermal power. These funds will move us faster toward a solution of our energy problems in less time and at less cost than by any other conceivable path. They will also solve this problem with the complete approval of all those interested in protecting our environment for the good of mankind.

We have been told that in order to have the breeder reactor by 1985 we will have to spend five billion dollars in addition to the four billion already spent on nuclear power. For a mere 1% of this we can have a Sea Thermal Power plant within four years of the starting time, with no attendant dangers to our environment, and a practically infinite potential supply of power. What better gamble can we ask for?

The time for action is *now*.

Further delays and inaction will cost us far more in money and human suffering than the little money that we need spend to complete these developments.

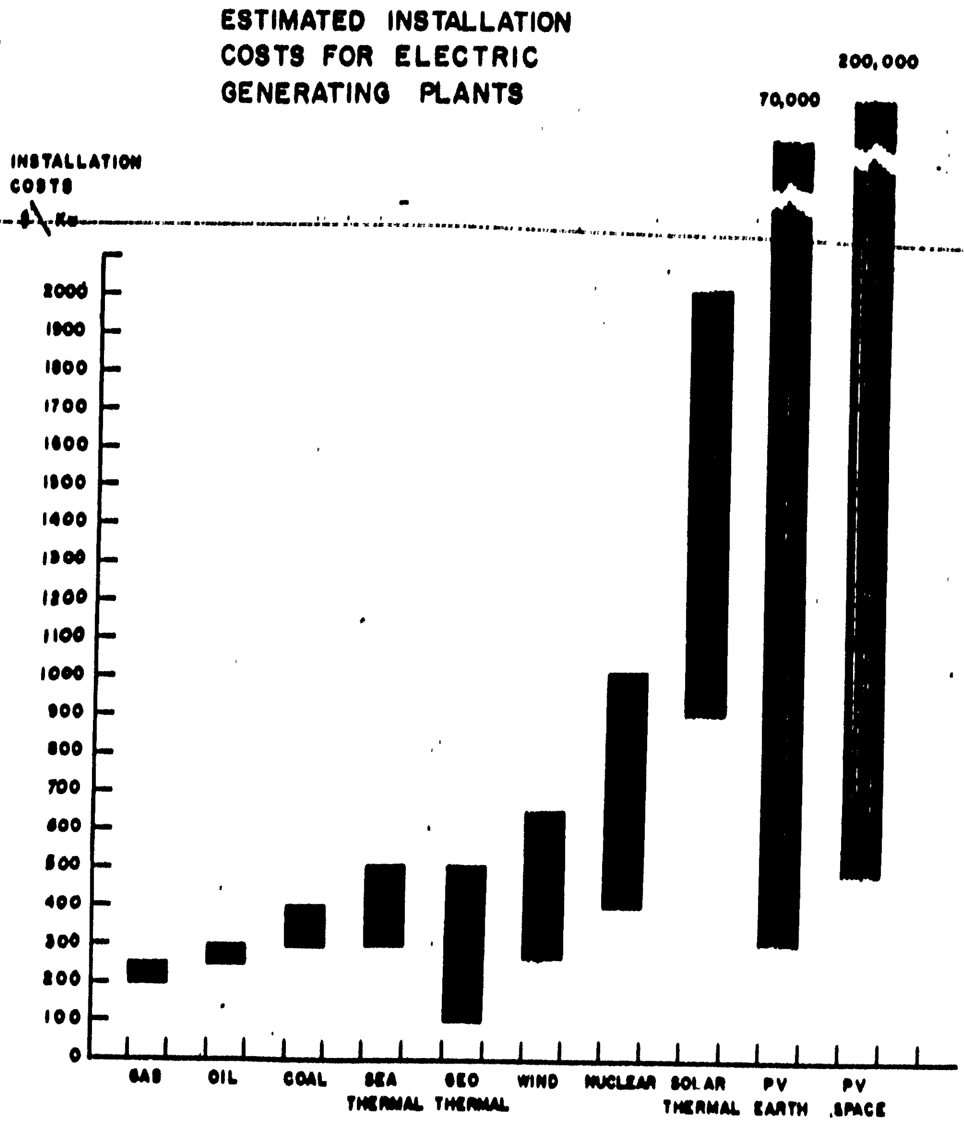

ESTIMATED INSTALLATION
COSTS FOR ELECTRIC
GENERATING PLANTS
INSTALLATION
COSTS
$/Kw
70,000
200,000
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
GAS
OIL
COAL
SEA THERMAL
GEO THERMAL
WIND
NUCLEAR
SOLAR THERMAL
PV EARTH
PV SPACE

FIGURE 1

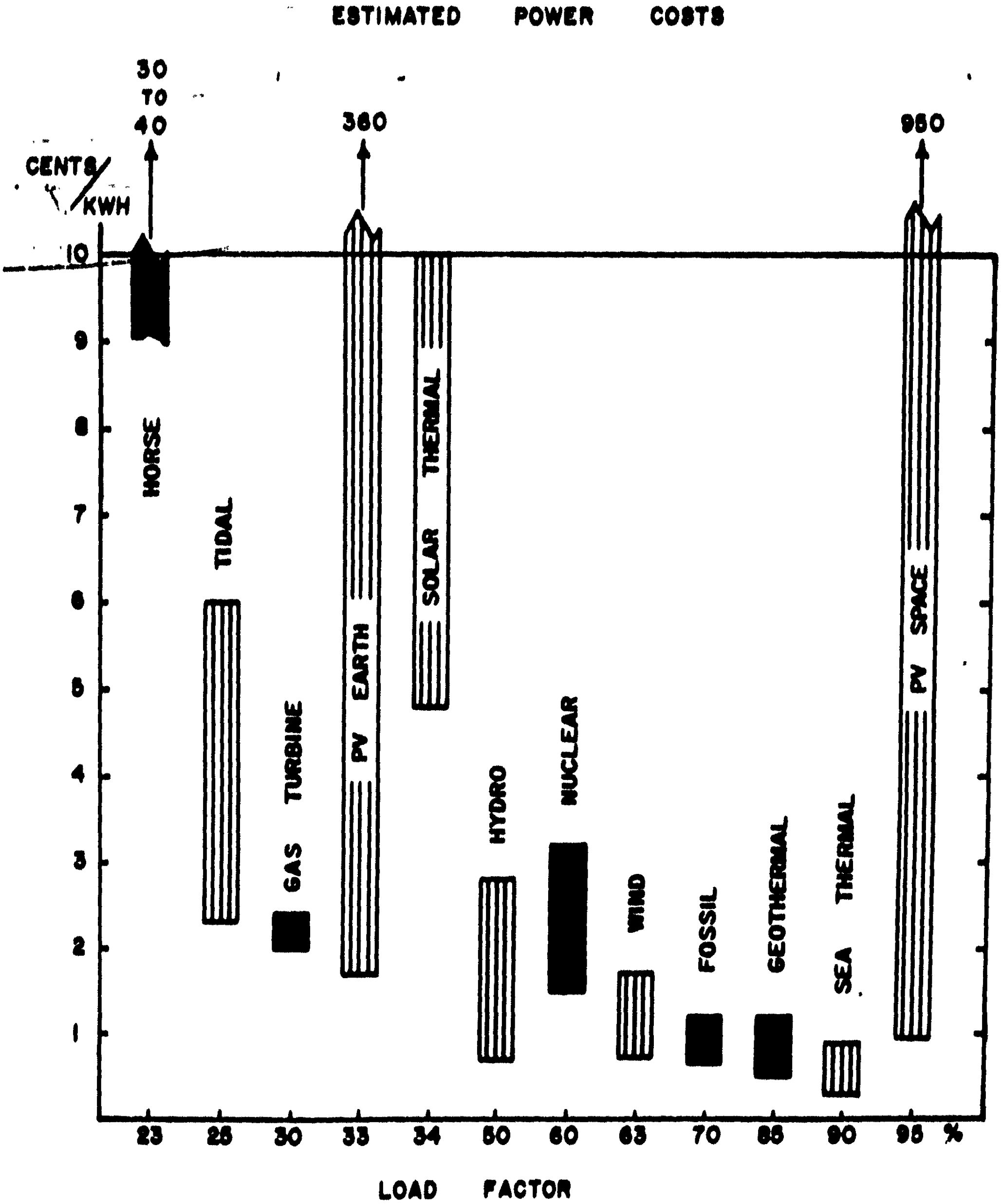

ESTIMATED POWER COSTS
30 TO 40
360
950
CENTS/KWH
10
9
8
7
6
5
4
3
2
1
HORSE
TIDAL
GAS TURBINE
PV EARTH
SOLAR THERMAL
HYDRO
NUCLEAR
WIND
FOSSIL
GEOTHERMAL
SEA THERMAL
PV SPACE
23
25
30
33
34
50
60
63
70
85
90
95 %
LOAD FACTOR

FIGURE 2

Economic Power and Water From Solar Energy

(By J. H. Anderson, Jr.)

INTRODUCTION

The ocean covers 71 percent of the earth's surface. The sun provides radiation to the ocean. When the sun is directly overhead, 426 Btu/sq ft-hr strikes the ocean.

A portion of this energy is reflected, but most is absorbed. Because there has to be an energy balance, the absorbed energy is either reradiated in long wave (heat) radiation, used up in photosynthesis and evaporation, or used in setting up waves, currents, and winds. The most significant heat flux which takes place in the ocean is as follows: The surface waters of the ocean are heated in the tropics. This warmed water flows toward the poles and gradually gives up its heat. Some ice in the polar areas is melted. The warm surface water has cooled by the time it reaches polar regions. In cooling, it becomes more dense and gradually sinks. Slowly, the cooled water meanders back to the tropics along the ocean floor to replace the surface water constantly flowing away from the equator.

Some individual strong currents may not seem to follow this pattern; however; this is the general oceanic circulation.

It is clear then that the ocean itself acts as an immense collector and distributor of solar energy. Furthermore, since some of the vast water area is always in sunshine and the mass of the ocean has such large heat storage capacity, there is very little nocturnal decrease in ocean surface temperature. Thus, the ocean is a remarkably good collector and storer of solar energy.

This eliminates two costly problems that have always plagued solar energy schemes. We do not have to spend money on a collector, and we have a continuous energy supply day and night, as well as on cloudy days.

HOW POWER IS OBTAINED

Theoretically, any two bodies at different temperatures can be connected by a heat engine to produce power. In a heat engine, heat flows from the higher temperature source into the engine. By the first and second laws of thermodynamics, only some of the heat flow can be converted into power. The rest of the heat flow can be converted into power. The rest of the heat must flow out of the heat engine to the lower temperature sink. Theoretically, the maximum amount of work which can be obtained is

$$\frac{T_1-T_2}{T_1} \text{ Carnot efficiency}$$

where:

T_1 = high-temperature source
T_2 = low-temperature sink

In tropical waters, as well as in many of the warm ocean currents, the warm surface water at 75 to 90 F is separated from the deep cold water at 30 to 45 F by only 2000 to 5000 ft. If, for example, we assume 82 F surface water and 43 F cold water, the ideal thermal efficiency would be 7.2 percent. This does seem to be low; however, the real test is whether the investment cost for such a power plant is low enough to provide economic power. If the price for a power plant to work on these two bodies of heat is no more than a fossil fuel plant, then the overall cost of power will be much less than the cost from a fossil plant because there is no fuel to buy.

The mechanics of the actual heat engine are simple. The warm surface water boils a fluid (the working fluid). The vapor expands through a vapor turbine and then condenses back to liquid in a cold condenser. It is a flow of cold water that keeps the condenser cold. The working fluid is then pumped up to boiler pressure by a pump.

A very important practical question is what working fluid should we use. The choice of working fluid determines, most importantly, the heat exchanger design and the turbine design. It is fundamental that we will require large area of heat transfer. The cost of heat-transfer surface must be low. and the temperature drop from hot to cold in each heat exchanger must be smal. In large heat exchangers, the effective price of the units is proportional to the amount and type of material used for surface area. The amount of material can be reduced to a minimum by removing any difference in pressure between the two sides. Then the material is required only to separate the working fluid and water but does not need to be very strong. Therefore, a thin sheet construction is possible.

The working fluid determines the turbine design. The working fluid must have the property that its pressure at boiling temperature (78°F) and condensing temperature is well above atmospheric pressure. Also, since the amount of work per pound of working fluid is small, a lot of fluid must flow through the turbine for each kw output. Therefore, the density of the vapor should be high so that the turbine need not be so large to handle the flow volume.

For example, suppose water were chosen as the working fluid. At 78 F boiling temperature, the saturation pressure is 0.47 psia, and the specific volume of steam is 674 cu ft/lb. At the condensing end, say 55 F, the saturation pressure of water is 0.21 psia and the specific volume is 1431 cu ft/lb. To use water as the working fluid would require that all non-condensible gases be drawn off and a very good vacuum in the system maintained. The turbines would be extremely large and costly. One low-pressure steam turbine for 20,000 kw at these conditions might be 380 in. in diameter, run at 1100 rpm, and have two stages (1).[1]

TABLE 1.—GAS PROPERTIES

Gas	Pressure: p_1 PSIA at 77° F	Pressure: p_2 PSIA at 48° F	p_1/p_2	Boiler depth feet	Condenser depth feet
Butane	36.0	10.0	1.00	51	12.7
Isobutane	52.0	20.0	1.80	87	35.0
R-12	94.5	54.5	1.73	182	83.0
Propane	137.0	82.0	1.67	278	154.0
Ammonia	145.0	78.0	1.87	207	145.0
R-22	153.0	88.0	1.73	314	168.0
Propylene	165.0	101.0	1.63	341	197.0
R-13B1	235.0	145.0	1.62	408	206.0
R-13	520.0	330.0	1.58	1,140	712.0

Table 1 shows a list of possible working fluids. All of these have operating pressures well above atmospheric pressure. Their vapor densities in this temperature operating range are tremendously less than that of steam. If we choose propane, for example, a propane turbine for 20,000 kw running at 3600 rpm would have single wheel of 42 in. in diameter. The propane turbine should cost about 4 percent of the steam turbine.

Other fluids could be chosen. It is important to note that the depth of the heat exchanger is determined by hydrostatic pressure. Then there is no pressure differential across the heat exchanger surface. Since men will have to inspect the heat exchangers, it is best to place them within working depth of divers. Propane seems to be a very likely fluid to use. It is relatively cheap, too.

FLOATING PLANT

The plant is constructed as a floating structure with the majority of its mass beneath the ocean surface. From Table 1, the propane boiler would be 278 ft deep and the condenser, 154 ft deep. These heat exchangers comprise a large portion of the volumetric structure of a Sea Thermal Power plant. A typical configuration is shown in Fig. 1(2). With most of the structure deep below the ocean surface, waves and storms have little effect and do not move the plant. This floating plant design permits the long, large, cold water pipe to be isolated from surface wave action and currents. The design of this pipe is the subject of another technical paper.

[1] Numbers in parentheses designate references at end of paper.

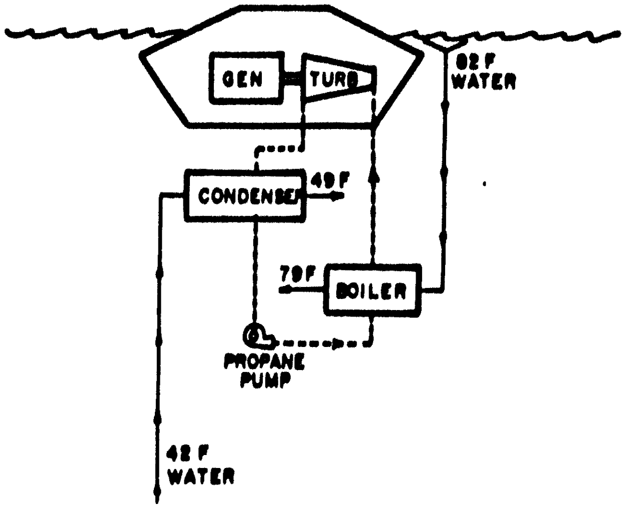


FIGURE 1

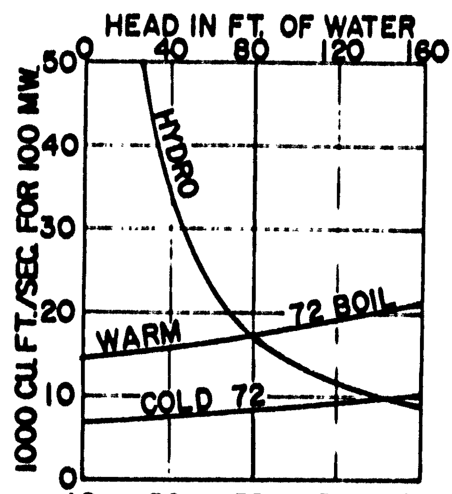


FIGURE 2

WATER FLOW

A lot of water is required for the propane boiler and condenser. Fig. 2 shows the amount of warm (boiler) water and cold (condenser) water required for a 100,000 kw plant (3). The amount of water for the same size hydro plant is also shown. Actually, the water required for a Sea Thermal Power plant is somewhat less than that required for most ordinary hydro plants, and the water lines for a Sea plant are less than 3000 ft long—short compared to most hydro plants.

An optimization study is done to establish just how much boiler water and condenser water should be pumped, as well as the size of the boiler and condenser. If a greater amount of condensing water is pumped up and the condenser is made larger, then the condensing temperature will be closer to the water temperature and the resulting cycle efficiency is better. However, more surface area and more water costs money and power. For a 100,000-kw plant with a 2000-ft-long cold water pipe and a flow of 10,000 cu ft/sec, the water pumping head loss is 6.35 ft-lb/lb, requiring 8500 hp. The boiler water flow requires about 4650 hp.

Many ask the question: is not the warm water and the deep cold water in any one area used up or mixed? This subject has been researched by numerous engineers. It is found that if the intakes are designed properly, flow will be drawn from an isothermal layer and will not be vertically mixed (5-7). It would be advantageous to use a warm surface current flowing toward the poles so as to permit Sea Thermal Power plants farther from the equator.

In a perfectly still ocean, if the used water were discharged on the surface, the plant can slowly move around keeping in warm water. Roughly two square miles of ocean based on solar radiation collector area would be required for each 100,000-kw plant if there were no addition of warm water by currents.

If we could use the warm Gulf Stream flow northward through the Florida Straits, many times all the power the United States consumes could be generated here.

TABLE 2.—*Main plant material*

Boiler	2, 400, 000
Turbines	720, 000
Generator	1, 235, 000
Condenser	2, 450, 000
Boiler water pumps	820, 000
Condensing water pump	640, 000
Warm water pipes	131, 000
Cold water pipe	708, 000
Inlet screens	304, 000
Boiler feed pumps	120, 000
Boiler circulating pumps	32, 000
Total	9, 560, 000

TABLE 3.—*Auxiliaries*

Propeller power	30, 000
600 kW. emergency generator	42, 800
Auxiliary boiler	38, 000
Bilge and ballast pumps	4, 800
Flush pumps	4, 600
Auxiliary boiler feed pump	2, 000
Screen rakes	45, 000
Propane compressor	12, 000
Propane condenser	2, 000
Propane storage receivers	207, 000
Propane charge	22, 000
Two air compressors	23, 000
Radio station	10, 000
Total	443, 200

TABLE 4.—*Cost summary*

Main plant	9, 560, 000
Auxiliaries	443, 200
Structure and assembly	4, 210, 000
Assembly of cold pipe	262, 000
Total	14, 475, 200
Engineering and supervision	724, 000
Contingency	1, 448, 000
Total	16, 647, 000

Cost per kW.=\$166.00
Yearly owning and operating cost=\$1,870,000
Rated yearly capacity=876×10^6 kW. hrs.
Estimated yearly output=656×10^6 kW. hrs.
Cost per kW. hr.=\$0.00285

TABLE 5.—*Water desalting plant (63 Million GPD)*

Condenser	1, 560, 000
Compressors	134, 000
Pumps	1, 170, 000
Boilers and deaerators	2, 000, 000
Engineering design	240, 000
Total	5, 104, 000

Daily fixed costs	1,795
Daily power cost (9570 kW)	551
Total daily cost	2,346
Cost per thousand gallons	.037
Transport cost (40 miles)	.055
Delivered cost per 1000 gals	.092

ECONOMICS OF A SEA THERMAL POWER PLANT

Tables 2, 3, and 4 (3) show the economics for a 100,000-kw Sea Thermal Power plant. These are not costs for a prototype development plant, but the cost after the first few plants are built. They are calculated from the cost of similar equipment manufactured today.

It is apparent that the cost of production of power is well within a competitive price range. Furthermore, the price of fossil fuels has been increasing. This can only mean that power from fossil plants will have to go up in price.

FRESH WATER PRODUCTION

It is possible to construct a very inexpensive and large capacity fresh water plant in conjunction with a Sea Thermal Power plant.

Warm surface water is pumped into a vacuum chamber where dissolved gases are removed by a compressor system. The water then goes through a series of vacuum evaporators. The water boiling in the evaporators is condensed in a series of condensers. The condensers are kept cold by the cold water coming out of the power plant condenser. In a typical case, the water enters the power condenser at 42 F and leaves at 49 F. The 49 F water enters the vacuum desalination condenser and condenses the fresh water. There is enough 49 F water to produce 60 to 100 million gallons per day of fresh water. The schematic of the desalting plant is shown in Fig. 4. For 60 million gallons per day of fresh water, the deaerator requires approximately 700 hp for the compressors. About 7000 hp is the pumping power required for pumping the warm and cold water through the desalting system. Table 5 shows the cost for constructing a fresh water plant in conjunction with a Sea Thermal Power plant, since the deaerators, boilers, condensers, piping, piping, compressors, and pumps are constructed on the hull of the power plant.

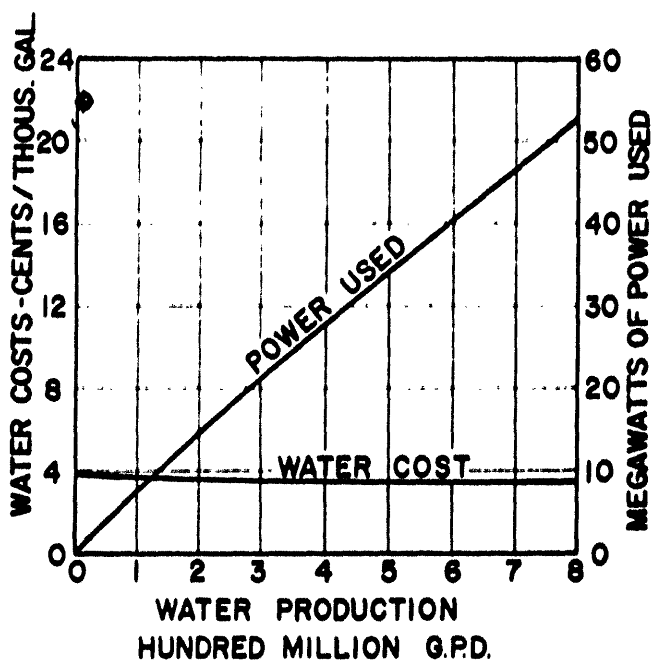


FIGURE 3

As shown in Fig. 3, the water production can easily be increased to 800 million gallons per day from a 100-MW generating plant. Note that at a production of 800 million gallons per day, more than half of the generating capacity is used in the water plant, leaving approximately 50 MW for commercial sale. It is apparent that at these costs, 3.7¢/1000 gal of fresh water could be barged to most major coastal cities cheaper than municipal water systems gather water from surrounding lakes and reservoirs. Also, arid lands can be cultivated at these water costs.

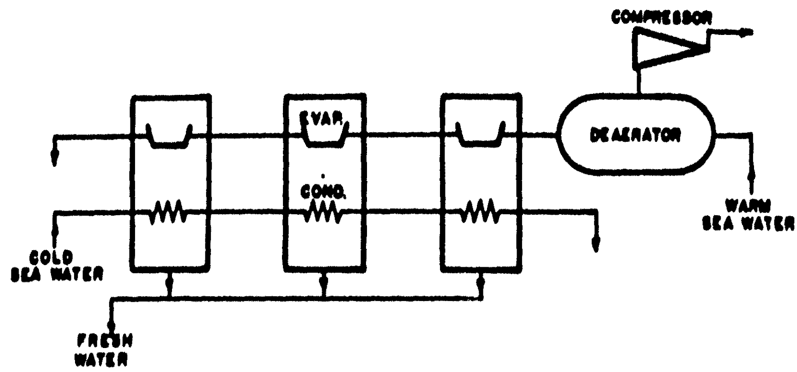
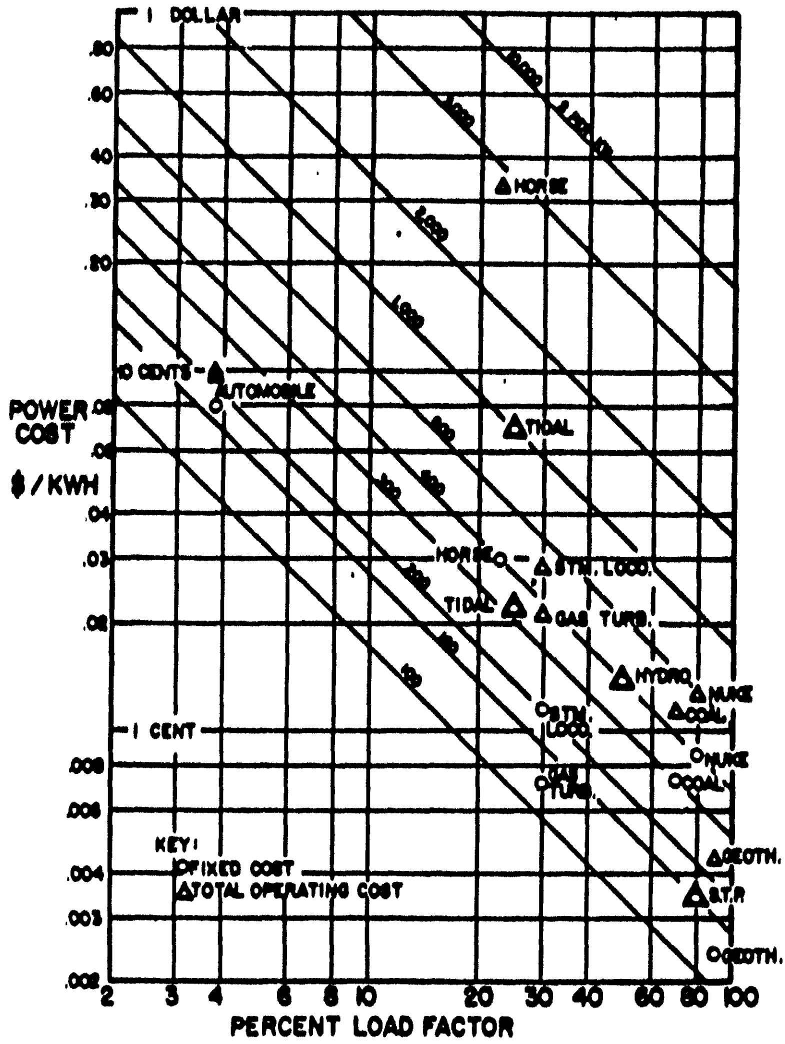


FIGURE 4.—Water desalting plant.

OXYGEN PRODUCTION

With the deaeration of the salt water entering the fresh water plant, it would be ideal to build an oxygen recovery plant. Since the power is available and the oxygen more plentiful in sea water gases than in air, an oxygen production plant is a natural. (Gases dissolved in natural sea water are composed of approximately 34 percent oxygen, whereas atmospheric air contains only 23 percent oxygen). Separation of oxygen from air is basically a refrigeration process. This requires heat exchangers, refrigeration compressors, a heat sink, and power to run the compressors. With a higher percentage of oxygen in the supply, less refrigeration and equipment is needed. The cold water sink reduces required power input as well as cost of compressors and heat exchangers. The condensed propane from the power plant condensers can be used as the refrigerant to cool the air to the oxygen plant. The propane from the boilers can also be used to energize propane turbines to drive the refrigerant compressors. This eliminates the conversion to electric power for refrigeration. These combined factors can reduce the cost of oxygen to less than half of what it costs today.

A typical plant of 100-MW gross power capacity and 60,000,000 gallons per day of fresh water capacity could also produce 115 tons of oxygen daily from the gases that must be removed from the water. This can be an extremely valuable byproduct with many uses.



$$\text{FIXED COST / KWH} = \frac{.15 \times \text{CAPITAL COST / KW}}{\text{LOAD FACTOR} \times 8760}$$

$$\text{FUEL COST / KWH} = \frac{3413}{\text{EFF.}} \times \frac{\text{FUEL COST}}{\text{BTU}}$$

FIGURE 5.—Fixed and total operating costs for various power systems.

A side benefit of removing oxygen from the water occurs because oxygen is the primary cause of the corrosive action of sea water on metals. Removing the oxygen before passing the water through the boilers should virtually eliminate corrosion. It should also eliminate fouling by marine organisms, because most of them require oxygen to live.

HYDROGEN PRODUCTION

There is a lot of interest today in promoting hydrogen as a fuel for heating or for small engines, such as automobiles. Hydrogen burns clean, producing water as a residue. The American Gas Association is researching the use of hydrogen as a replacement for our dwindling natural gas reserves. It is expected that there would be a minimum of difficulty switching from natural gas, shipping, storage, and use to hydrogen. The real question is can hydrogen be produced sufficiently inexpensively. The answer is yes if we use Sea Thermal Power plants. For about $80/kw (4), an electrolyzer plant of 50,000-kw input capacity and a hydrogen liquefaction plant with three-month output storage capacity can be added.

STEEL AND ALUMINUM

It seems immediately logical to use a Sea Thermal Power plant as a base for a steel plant or for an aluminum plant. Either of these facilities use a lot of power. Cheap oxygen is also important for steel production. Deep water docking is also easily available.

Other chemicals and minerals can be removed from sea water by electrolytic methods possible with cheap power.

ECOLOGY

The overall energy flux is from the sun into the sea and then out of the sea in the form of electricity and desalted water. The net effect on the ocean is not completely understood. However, we estimate that the average thermal energy storage of the ocean will increase slightly. A large slab of warm surface water is brought into the plant. This means that the surface layer over a large area is thinner, and solar heating effect will reach colder water. In other words, the absorptivity of the surface layer will increase.

For every 100 Btu's taken from the warm surface water, only 3 Btu's leave the ocean in the form of electricity. The other 97 are put back into the ocean in the colder condenser water. Since this colder water can be discharged near the surface for fish farming, it will also absorb more solar radiation than the warmer water at that level. Thus, it stands to reason that the net effect of Sea Thermal Power plants will be a slight increase of ocean thermal energy.

It is important to remember, however, that we are dealing with an extremely small percentage of the solar radiation captured by the ocean. For example, the sun's rays falling on just 1 percent of the area of the Caribbean would provide enough energy for the United States electric demand. Therefore, it is likely that almost any conceivable effect of power generation would be of lesser magnitude than year to year normal climatic variations.

Water can be discharged at a low velocity in or near the level where the water temperature equals the respective effluent water temperatures. The effect is, for example, to take a strip of 78 F surface water, cool it to 72 F, and discharge it at the 72 F level in the ocean.

It will be desirable to discharge all the condenser water slightly below the surface where it can be directed away from the boiler water intake. The water from the deep brings up with it nutrients that significantly enhance fish growth. A natural case of this happens in the Pacific Ocean off the Western coast of South America. Here a strong sub-layer current rises from the ocean depths, bringing vast quantities of cold nutrient rich water up to mix with the warm surface water. These fishing grounds prove to be some of the most fertile grounds anywhere in the world both for fishermen and for the birds. Recent tests in St. Croix have proved that water brought from the depths does indeed promote marine life growth.

CONCLUSIONS

It is clear that we must start to tap the sun's radiation as a source of continuous energy for the earth. We have demonstrated the cost to be very reasonable and competitive with present fossil plant prices. We have studied in some detail all the major problems and components. We are thoroughly convinced that Sea Thermal Power plants can be built right now without any exotic equipment or machinery.

Our first paper on Sea Thermal Power was presented in 1964. Since that time, these proposals have been presented to many different people who have studied, criticized, and raised questions about the ideas. These questions and criticisms have been valuable and constructive. After evaluating all of the criticisms and questions, we have become more thoroughly convinced that Sea Thermal Power is indeed a practical economic possibility, of almost incalculable consequence to the living standard of the whole world. We are glad to note that others are also beginning to share our views.

It should not be pretended that Sea Thermal Power can become a reality without development effort. However, the time and money required can be quite small compared to fusion power, breeder reactors, magnetohydrodynamics, or other more exotic schemes. In this connection, it is useful to list the items which need to be programmed for the development of Sea Thermal Power.

1. Development of heat exchangers.
2. Structure design and model testing for storm resistance and required propeller power.

3. Study of possible ecological effects of Sea Thermal Power.
4. Corrosion testing.
5. Development of air removal system.
6. Design of salt water evaporators for fresh water production.
7. Design and testing of deep water pipe in model tank.
8. Design of large cold water pumps.
9. Design of power transmission line and connection to plant.
10. Research into site locations and depth of warm water strata.
11. Analysis of warm water flow into structure to insure continual high-temperature supply.
12. Analysis of maximum economic plant size possibility.
13. Economic analysis of optimum depth of cold water pipe.
14. Investigation into legal problems of plant location.
15. Design of underwater maintenance system.
16. Study of optimum water discharge depth.
17. Detailed design of pilot plant.

Sea Thermal plants could be built and operating within four years. Can we afford not to start now?

REFERENCES

(1) Anderson, J. Hilbert, and Anderson, James H. Jr., "Power from the Sun by Way of the Sea, Power, Jan.-Feb. 1965, pp. 64-65.
(2) Anderson, J. Hilbert, "The Sea Plant—A Source of Power, Water and Food Without Pollution," presented at the International Solar Energy Society Conference, May 1971.
(3) Anderson, J. Hilbert, and Anderson, James H., Jr., "Large Scale Sea Thermal Power," ASME Technical paper No. 65-WA/SOL-6.
(4) Heronemus, William E., "The United States Energy Crisis: Some Proposed Gentle Solutions," Paper presented January 12, 1972, West Springfield, Mass. to local sections of ASME and IEEE.
(5) Dake, J. M. K., and Harleman, D. R. F., "Laboratory and Analytical Studies of Thermal Stratification in Lakes and Ponds," Report 99 of Hydrodynamics Laboratory at the Massachusetts Institute of Technology, 1966.
(6) Huber, W. C., and Harleman, D. R. F., "Laboratory and Analytical Studies of Thermal Stratification of Reservoirs," Report 112 of Hydrodynamics Laboratory, Massachusetts Institute of Technology, 1968.
(7) Koberg, Gordon E., and Ford, Maurice E., Jr., "Elimination of Thermal Stratification in Reservoirs and the Resulting Benefits with Special Emphasis on Study of Lake Wohlford, California," United States Geological Survey, 1965.

Senator GRAVEL. Our next witness is Dr. Cox, Prof. James Cox, Department of Economics, University of Massachusetts.

Dr. Cox, it is a pleasure to have you here.

STATEMENT OF JAMES C. COX, PROFESSOR, DEPARTMENT OF ECONOMICS, UNIVERSITY OF MASSACHUSETTS

Dr. Cox. Thank you, Mr. Chairman.

Senator GRAVEL. We are glad you have been patient to wait on us. Please proceed at your leisure.

Dr. Cox. My remarks today are based on a detailed evaluation of S. 2806, which my colleague, Arthur W. Wright, and I have written and submitted for your consideration. I will speak from a summary of the written statement.

However, I would like to request that the entire statement be included in the record.

Senator GRAVEL. It shall be placed in the record.

You do not have a copy of your summary, or is it just notes?

Dr. Cox. I brought printed copies of the summary to the subcommittee yesterday.

Senator GRAVEL. All right. Good, I have both documents.

Dr. Cox. I shall take up the topics we discuss in the order shown in the ~~table of~~ contents of the summary, beginning with oil impórt policy.

Senator GRAVEL. Please go ahead.

Dr. Cox. The variable import duty proposed in S. 2806 has two defects, one of conception and one of omission. However, if we revise the conceptual defect, the defect of omission can be remedied at least in part.

The variable import duty as presently proposed would only be assessed when the domestic U.S. and foreign prices of oil differed. However, under the market conditions implicit in S. 2806, that is, no quantity controls on imports and no domestic price controls on energy goods, those prices would always be equal, and the variable duty would not vary at all. It would always be zero.

In other words, in the absence of market interferences not found in the bill, the variable import duty in its present form would never become operational. Essentially, this provision is a clumsy way of recommending a completely free market in imported oil in the United States.

If the Subcommittee on Energy intends to use import duties to discourage oil imports, it can formulate a proposal which is consistent with that philosophy of no quantity or price controls. Such a proposal would entail using import duties to drive a wedge between the United States and the foreign prices of oil so that the two would be unequal. This would promote greater self-sufficiency in any given time period. Domestic oil would cover a larger proportion and imports a smaller proportion of total U.S. oil consumption than if there were no duty.

Self-sufficiency is not, however, the same thing as energy independence, which is a stated objective of S. 2806. Although similar on the surface, these two objectives are not identical, and they have different implications for oil import policy. The defect of omission in import duty proposals for controlling oil imports is that, while they encourage present energy self-sufficiency, they do so at the expense of future energy independence.

In section I.C of our written statement, we explain in detail the important difference between energy self-sufficiency and energy independence. As an illustration of the difference, we cite the effects of the now defunct mandatory oil import quota. Our analysis reveals clearly the wisdom behind the language in S. 2806 which stresses energy independence; that is, reduced vulnerability to sudden import interruptions, rather than self-sufficiency as the basis of national energy policy.

Independence entails maintaining spare domestic capacity to provide current output in case expected imports are disrupted without forewarning. Independence also entails not using domestic productive capacity to substitute for imports when those imports are flowing normally.

With this point in mind, let us examine one possible way to modify the import duty proposal in order to remedy the defect of omission; namely, the failure to promote oil independence. We offer this proposal in rough outline for the subcommittee's consideration. Details would have to be worked out, but we think the proposal interesting enough and, more important, pertinent enough to the stated objectives of S. 2806 to warrant inclusion in our statement.

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To increase oil independence, we would want to decrease the current use of domestic productive capacity, but hold some excess capacity in reserve in case of emergency. Our proposal would curtail domestic production, replace it with imported oil, and encourage the holding of some excess domestic productive capacity to meet emergencies.

It would work as follows. Suppose, initially, that an import duty has been placed on oil with no quantity or price controls on oil. We would be more self-sufficient in oil as a result of the duty since more domestic oil and less imported oil would be sold, compared to the free market situation.

In addition, of course, we would also be depleting domestic oil resources at a faster rate than with a completely free market and no duty, thereby jeopardizing our independence later.

To slow down the rate of domestic depletion without increasing U.S. vulnerability to a cutoff of oil imports, it would be possible to offer oil companies rebates of the oil import duty provided they would acquire additional domestic productive capacity and set it aside as an emergency reserve. Thus, the price of imported oil would be brought back into equality with the domestic price for participating firms.

That would lead to an expanded share of imports, and a reduced share of domestic production, in current consumption. Along with the reduced self-sufficiency, though, we would achieve increased spare domestic productive capacity; that is, increased independence. In short, we would trade off some current self-sufficiency in oil for an increase in longer term oil independence.

A policy of holding excess capacity in the crude oil industry is clearly feasible, as the many years of experience with market demand prorationing show.

Senator GRAVEL. Let me take another run at this. I do not think I understand it completely.

First off, would this operate if the domestic price is less than foreign price?

Dr. COX. Yes.

Senator GRAVEL. Why do you not take it from the beginning again? I apologize for the required redundancy, but I just did not grasp it.

Dr. COX. Let me just reiterate briefly.

Senator GRAVEL. OK.

Dr. COX. The first point we make is that the variable import duty described in the bill would never become operational, assuming that the other provisions of the bill were passed along with it. The other provisions of the bill provide for, (a) the elimination of all price controls on petroleum products and some other products, and (b) the bill makes no mention of quantity controls on imports. In fact, quantity controls on imports seem to be alien to the market philosophy which underlies the bill and the supporting materials.

Under those conditions, the price of domestic oil and the price of imported oil (f.o.b. the United States of the same grade) would necessarily be equal, because to keep them unequal you would either have to put price controls on domestic oil or restrict the flow of imports.

Senator GRAVEL. So what you are saying is, if we deregulate oil and gas, the price of oil would go to what the price is set through a command system in the Persian Gulf?

Dr. Cox. It is not clear which way it would go. You see, the prices would be equal, but it is not clear whether their price would come down or ours would go up, or some of both.

Senator GRAVEL. Because, in the end, the price of oil will clear the market at what will be the cost of alternate methods of providing energy.

Dr. Cox. If the OPEC cartel holds together then the limit on its monopoly price would be the price of alternate sources of energy.

Senator GRAVEL. But in the short run, this could aggravate itself on the consumer, because he would go through the fluctuation of paying that command cartel price until the leadtime is satisfied to bring into being alternate sources of cheaper energy, at which point in time you will then force down the price of oil to that level. Let's say—we do not know; maybe sea power; but let's say shale, which, prior to the inflationary problem, we estimate would come in at $7 a barrel.

Now, we are over $7 a barrel, so everybody is going to rush into the area, create energy at somewhere under the economic umbrella that is presently established, and then whatever that is, that economic umbrella will have to fold down to that level or just above it, to continue for profits.

Is that correct?

Dr. Cox. Yes.

Senator GRAVEL. So that is, in your mind, not independence?

What definition does it meet?

We have capacity at that point to satisfy our energy needs without importing oil, because we have gone to satisfying ourselves by alternate means. But once you have built in that capital requirement to do that, then, in OPEC's free market they can again command the price of oil lower than what you have already made a capital investment for. And if that is not under long-term contracts, then you wind up by destroying that capital investment in a continued free market situation.

So once they destroy it, then they can turn around and rejack the price up, and then take advantage, unfair advantage, on account of the leadtime to put that back on in service, though it might be shorter at that point in time.

Dr. Cox. By "they" do you mean OPEC countries?

Senator GRAVEL. Whoever can command significant quantities of oil in a command situation, which has to be OPEC in this case.

Dr. Cox. I think we may have gotten a little bit off the track. We are really pointing out two things; one, that assuming the other provisions in the bill are passed as is, they eliminate all price controls and all quantity controls on petroleum products. Then the U.S. and the world prices would always be kept the same by market forces, so the variable import duty in the bill would never become operational. It is defined to be that rate of duty which makes the domestic and the foreign prices equal. But market forces would always keep them equal, so the duty would always be zero.

Senator GRAVEL. Well, yes. I do not disagree with you there. But let me pose this other point. It is that the reason for this variable import duty was if, just as I was indicating earlier, once you brought them down to your cost of alternate energy, in order for them to get back into an advantageous position, since the cost of lifting the oil is minuscule to the profit, they can cut their profits in half. That means if they are charging $12 a barrel for oil, they can cut it to $6, which is a dollar cheaper than what it might cost you for shale.

So how do the shale productive forces stay in the marketplace without being undercut?

The reason why we put it under variable levy was to protect that capital investment once it is made.

Now, what are you doing? Taking that extra increment and putting that into a reserve capacity?

Dr. Cox. If, in fact——

Senator GRAVEL. Maybe what you ought to do is take another run at me with your self-sufficiency and independence.

Dr. Cox. OK.

Can I say a couple of words about this first thing and then get back to self-sufficiency and independence?

Senator GRAVEL. Surely.

Dr. Cox. We are certainly not questioning what you are trying to do with an import duty, because it is quite true that costs of production in the Middle East are so low that they could, after we built up a domestic capacity, for example, in shale oil, undercut the price if there were no controls on imports and thereby create serious difficulties.

What we are suggesting is, that given the way that the variable import duty is presently defined, unless you could successfully take advantage of some sort of price changes over time, it could never achieve the objective you set for it, which is to make up the difference between the domestic and foreign prices when the foreign price is lower, because the market would always keep them equal.

What we are suggesting as an alternative is really in two steps. The first step is to drive a wedge between the U.S. and foreign prices by imposing a regular tariff of some percentage on imported oil. This would not have the problem of the variable import duty proposed in the bill, which is that it might not work. That is the first step. So that would be a tariff that you could be sure would achieve its objective. It is not clear that the variable import duty provision as written would achieve that objective.

Now, the further step is, then, to note that all workable import duty proposals have this problem, that they increase the price in the domestic economy over what it would be if imports could come in with no tariff. In the process, they raise the share of domestic production, because imports have been reduced. Therefore, since oil reserves are a depletable resource, over time they reduce your independence in petroleum for the simple reason that you have depleted more of your low-cost reserves earlier, because domestic production has been a larger share in domestic consumption.

That is the purpose in the full written statement, of the similation that appears about page 6, which shows what the effects would have been if over the last approximately 13 years from 1959 to 1972, the United States had followed this policy: imports as a 10 percent larger share of domestic consumption, domestic production 10 percent lower as a share of domestic consumption, and maintained the same level of investment in crude reserves.

What would this entail? It would entail holding larger excess capacity in the oil industry that is operating wells at reduced rates of output. This would meet the independence objective of being able to respond very fast to any cutoff in imports and would not have the problem of larger domestic production which would deplete reserves faster and make it much more difficult to have independence in the future.

In fact, what the example leads to is this conclusion. If over the period 1959–72 import as a share of domestic consumption had been 10 percent larger and domestic production as a share of domestic consumption had been 10 percent smaller, and if we had acquired the same amount of crude reserves, then in 1974 we would not be very vulnerable to any embargo from the Middle East for the simple reason that we would have excess capacity and we could simply step up the rate of output from the wells that had been operating at reduced rates.

Senator GRAVEL. Excuse me.

I have to excuse myself for one moment, and I will come right back, and I want to pursue this, because I think we have an interesting proposal.

[A brief recess was taken.]

Senator GRAVEL. Thank you, Doctor, for your patience.

In the thesis, once the command market forces the OPEC cartel to come back and let us say lower the prices to wipe out this new level, then what you are saying is that if they can get lower price, we, rather than put up a barrier, we keep the market free and absorb that new lower price to the consumer.

What device do we use to absorb the cost above that, which is excess capacity, which is held in reserve which then gives us, by your definition, independence, and still permits a total free market and the cost of that independence is up here, which has to be borne by somebody.

And the question is, through what device? Obviously, that somebody should be as large and diffuse a group as possible, and be the total consuming public, or the total taxpaying public, whichever depending upon the device you use, is what it will be. If it is done by the private sector, it will be the consuming public. If it is done by the Government, it would be the taxpaying public.

Am I on target with the point you are making?

Dr. COX. Yes. In fact, the nice feature about this, I think, is that it would, in a sense, pay for itself in this way. The companies who had the excess capacity would be the ones who were meeting the independence objectives, in the sense that they could increase output faster if imports were cut off. They would have the tariff rebated to them. The companies who did not hold the excess capacity would not.

Senator GRAVEL. Say that again.

Dr. COX. The companies who held the excess capacity would have the tariff rebated to them.

Senator GRAVEL. The tariff would be placed on whom?

Dr. COX. On imported oil.

Senator GRAVEL. There would be no tariff collected if——

Dr. COX. No. This is our alternative tariff.

I am sorry. We are talking past each other here.

You could not do this with the tariff you suggested in the bill.

Senator GRAVEL. With what we suggested, you cannot do it. You are right. What we do is this: If we are seeking an equilibrium, and this is foreign and this is domestic, our tariff system lets this come in at (indicating) and we shore up this side of the deal. Apparently, what you are suggesting is that we let that come up and shore up that (indicating) side of it.

Dr Cox. No. I am suggesting that market forces will always keep those domestic and imported prices equal if you do not have price or quantity controls.

Senator GRAVEL. Except that you upset the capital market of the companies in question.

Dr. Cox. But a workable tariff will prevent that.

Senator GRAVEL. It would if you permit the oil to be sold at the lowest domestic market price.

Dr. Cox. If you fixed the base price at some point and used a constant price as the base on which the tariff was always calculated, rather than proceeding, as is now in the bill, by taking the average of each month's price and basing the tariff on that, then you could prevent foreign oil exporters from lowering the domestic U.S. price by applying a variable import duty.

As the bill is presently written, it will not accomplish this objective because it requires you to continually revise the base price.

What we are suggesting is an alternative tariff that would not be subject to these base revision problems because it would not be based on variable foreign-domestic price differentials; it would, rather, always make imported oil more expensive than domestic oil. In that case, you could then promote independence rather than self-sufficiency by rebating the tariff to companies that, when they import oil, hold excess domestic productive capacity. In so doing, we are gaining more independence, because we have this excess capacity that we can use to make up for any cutoff of imports. Consumers are better off because part of the increased imports—assuming they are coming in at a lower price, which is all that makes these tariffs relevant anyway—consumers will gain because part of the oil will be cheaper, so they will get a somewhat lower price.

The companies will be able to cover the costs of the excess capacity by keeping part of the tariff that is rebated to them. They would not pass all of it along to consumers through lower prices.

Senator GRAVEL. So, how would you apply your rate?

How would your tariff be applied?

You would have to arbitrarily pick a figure of how much tariff you are going to put on it to equate the shortfall that they would have to compensate on the other side.

Dr. Cox. I cannot pick a particular rate at this time.

Senator GRAVEL. How would you apply it?

Dr. Cox. To make this feasible, this independence business?

Senator GRAVEL. Yes.

Dr. Cox. We have many years of experience with a policy that required oil companies to hold excess capacity. It is the policy called market demand prorationing that was followed in the five major producing States that hold 75 percent of U.S. crude reserves outside of Alaska.

Senator GRAVEL. What did these States do?

Dr. Cox. You have something called rated allowables on each well, which is the maximum rate you can produce from the well.

Let's take the State of Texas, for example. The State of Texas' Railroad Commission sets something called a market demand factor, which tells owners of all controlled wells that they can produce the next month, let us say, 60 percent of their rated allowable output.

What you are saying then, in effect, is that on those wells you have approximately 40 percent excess capacity. These are the policies reinforced for these five States by the Connally Hot Oil Act. These policies, until approximately 2 years ago, always required us to have excess capacity in those States. Sometimes the market demand factor in the late 1950's and early 1960's was around 0.5, which is to say that we required companies to hold, on controlled wells, approximately half of their capacity as excess capacity.

Now, that policy functioned for many years. So I think that it clearly shows that, at least on oil wells, you can design an independence policy that will work, that will require the oil companies to hold excess capacity. And if they do that, the nice part about this is that everyone gains. Consumers, if you rebate the tariff, will get a lower price than they would if it were not rebated. The companies are not being penalized, because the cost of holding their excess capacity can be covered by their keeping part of the rebated duty. In fact, they are getting oil at a lower price; they are not having to pay a duty on it; they are not having to incur the higher costs of domestic production.

Senator GRAVEL. What would happen when you think about going to alternate sources of energy other than oil, where you might have this experience. Let us take an oil shale plant.

How do you cover their costs with prices now below their production costs?

Dr. COX. I cannot really answer that because you are asking me about a technology that does not really yet exist in an economically viable form.

Senator GRAVEL. But that is what will happen when it comes into being; we will have alternate sources of energy other than oil, whether they are sea power, sea thermal, or coal, or gas, or shale. All of these things not atomic. We have already been paying exorbitant costs for the energy we have been getting.

Dr. COX. If it turned out that it was not feasible, I think it is just unknown whether it would be in oil shale; if it turned out that it was not feasible to have them hold excess capacity in oil shale, we could certainly do it all in ordinary oil wells. It does not really matter where it is held, as long as we have, of course, the necessary transportation and processing facilities.

Senator GRAVEL. What I do not understand, though, is if I build an oil shale plant for $1 million, that produces 250,000 barrels a day, and it costs me $8 a barrel to produce that, and then OPEC comes in and they are selling oil at $6 a barrel, I cannot operate my plant.

Dr. COX. That depends on what the tariff rate is.

Senator GRAVEL. So, if the Government is going to set up a tariff rate to protect me, which is the system here under our proposal, and that tariff rate under our proposal would be $2, so we would have $2 that would keep the price to the consumer at $8, which makes me economically viable, and also permits me to choose foreign or domestic. But at that price, I can stay in business. You maintain that we will never employ our price rise of $2.

Dr. Cox. No. The problem is that it is a question of the possibility of the prices being unequal if you remove the price controls and do not reinstitute import controls.

Let me give you a little scenario. Suppose that S. 2806 is passed as is, and the provision goes through for eliminating all price controls on petroleum products. In the current situation, imported oil is more expensive than domestic oil, which has not been the historical relationship. If price controls are eliminated then the domestic price would go right up to the imported price. Why should they keep it any lower?

So, clearly, then, the domestic and foreign prices would become equal. Now, in that case, the tariff would clearly not operate because the domestic price could not force its way past the import price; as demand increased you would simply increase your imports.

So, the question, then, is how would the tariff rate ever become nonzero, because it only becomes nonzero when the foreign price is lower. And I suppose what is intended in the bill is to prevent the foreign price from ever becoming lower than the domestic price once they have initially become equal.

Senator GRAVEL. No, what would happen before that is this: the foreign price is, say, $12 a barrel. Oil shale can come on the market at, let's say, $7 a barrel. So you can say that domestic prices will rise to $12. They will, in the short run. But then, as these technologies come on board, and they realize that if they are making exorbitant profits, that this will be visible, and the public will not stand for it. So, what happens is, somebody is going to come in, if we have a competitive situation, and say, I am going to supply, sell oil at $8 a barrel, which is what my shale plant costs.

Now on the foreign market it is still $12, but somebody is selling enough oil at $8 a barrel, because that is what the competition is all about. If they are all selling it at $12 a barrel, there is enough competition that somebody will come in and say, hey, I am going to cut you, and I am going to sell it for $7 a barrel; and the guy is going to want to market, and I am going to sell it for $6 a barrel. And, lo and behold, the domestic prices are down, and they will be so attractive, that maybe they will build enough oil shale plants, and we will be expanding and exporting oil to Europe until the OPEC countries realize that they cannot sell their product; and maybe they will wait a long time, because they have got enough money to live off of. And they will wait until these ultimate sources of energy cut deeply enough into their market, and therefore, they will begin to drop their price.

So, the thesis that you are starting off with is that we are going to rise to whatever price they set, and we are going to float there. Well, I do not envision that happening in our market situation; at least, with the projections that we get, it will not happen that way.

Dr. Cox. I was giving you an illustrative example. It does not really make any difference where the impetus for changing the price comes from, because if you have no quantity controls on imports, and you have no price controls on the U.S. market, it is clear that the market will keep the United States and foreign price the same. The market will do that.

Senator GRAVEL. That is what I am just saying. The market will bring down foreign price, right?

Dr. Cox. Perhaps; it might very well.

Senator GRAVEL. Okay.

Dr. Cox. So, the foreign and domestic prices will be equal and the tariff will be zero.

Senator GRAVEL. Which is the thesis that I was making from the very beginning; that the price of oil will be the cost of alternate methods of energy. Oil will sell at what it costs to supply significant quantities of the market with an alternate source.

Dr. Cox. Perhaps, if the cartel holds together, it will. If the cartel breaks down, it will not.

Senator GRAVEL. What will happen if the cartel breaks down?

Dr. Cox. If the cartel breaks down, the most reasonable expectation, I think, is that the price would drop back toward where it was, say, in 1969, before the cartel started to become effective in pushing the price up, which is back toward $2 a barrel.

You see, what I am pointing out about the variable import duty really does not depend upon who is forcing the price up or down.

Senator GRAVEL. You say, then, the cartel, if it is to fall apart, there has to be insufficient demand to bring that about?

Dr. Cox. For the cartel to break down?

Senator GRAVEL. No, for the cartel to begin bidding against itself.

Dr. Cox. It is clear that now, in the Middle East, there is excess oil capacity, so that the incentive is already there to bid against each other; and this is the historical process of how cartels do, in fact, break down.

Senator GRAVEL. So, from a consumer point of view, the best thing to do would be to go ahead and develop this independence, right?

Dr. Cox. Yes.

And it would not be at the expense of the oil industry, by the way, because they would be able to—through getting the imported oil and getting the tariff rebated—they would still——

Senator GRAVEL. The only problem I have is, I do not understand how you are going to pay that tariff, the rebated tariff, the tariff you are rebating. If you are in a free market situation, and the oil comes down to $2, when are you going to start charging a tariff, and how much of a tariff are you going to start charging? I do not see what you are doing as any different than what we were doing in our efforts at maintaining an economic level. You are doing the same thing we are doing. The only thing is, you are calling it rebating tariffs to the private sector, and what we are calling it is maintaining a price that permits these investments to continue to be economical.

Dr. Cox. They are not quite the same. They are different in this way. In the variable import duty proposal, just leaving aside the question of whether or not it would ever become effective, the after-tariff imported and domestic prices will always be the same when there are no quantity controls on imports. In that case, what we are suggesting is a policy that would lead, in two steps, to more independence.

The first step—not chronologically but logically—would be to impose a tariff on imported oil that makes it more expensive than domestic oil. This leads to an incentive to increase domestic production over what it would be if the prices were equal.

Senator GRAVEL. If we had a blackboard, would that help you?

Dr. Cox. Perhaps.

Senator GRAVEL. Would you get a blackboard out here and put it right next to him? As a professor, you must be used to using a blackboard, and I think it might help you explain it to me if you had a blackboard.

Go ahead while they are getting a blackboard. Keep trying to do it verbally.

Dr. COX. Suppose the prices of foreign and imported oil were the same; start at that point, whether it is brought about by market forces, a variable import duty, or whatever, they are the same. Start from there, and make the next step of putting on a tariff that made imported oil more expensive. This is what we are proposing as the first logical step.

This would lead to an expansion in domestic production and a reduction in imports.

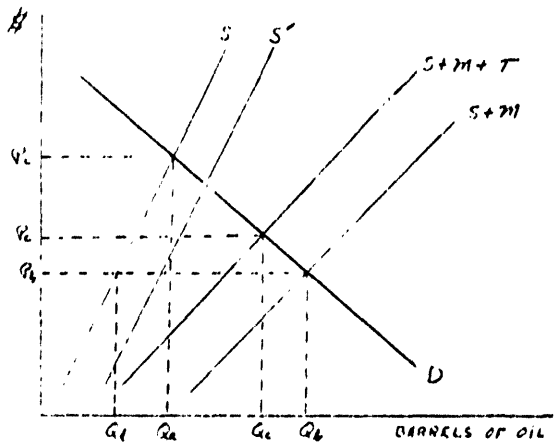
Senator GRAVEL. Yes.

Dr. COX. This would lead to more self-sufficiency than a proposal that kept the prices the same, because domestic production would increase and total consumption would decrease—because you have a higher price once you put this tariff on.

Senator GRAVEL. Do you want to try your hand on the board?

Dr. COX. OK.

[The drawing follows:]



Dr. COX. Suppose we measure here [indicating the vertical axis] dollars; and on this [indicating the horizontal axis] the quantity of oil. And we have a demand curve in the United States; I draw it to be the straight line, labeled D, because we do not know exactly what the shape is. But we do know that it is downward-sloping, which is important. And let this [indicating the curve S] be the supply curve of domestic petroleum.

And then, let's add to that the supply of imported petroleum, so we get the sum of the two; total supply into the domestic market. And let's call it S + M (for imports).

Now, let's start by making this comparison. If you simply put up a wall and put an absolute prohibition, a zero quota on oil imports, then what you would observe would be this price [indicating Pa] and this quantity [indicating Qa] in the market. We simply chop out any difference between domestic supply and total domestic plus imported supply. If the after-tariff foreign and domestic prices were equal, this is what is now in the bill in the variable import duty proposal, you would have this lower price (Pb) and this larger quantity (Qb) here.

What we are proposing is that you, first of all, impose a tariff that would make imported oil more expensive than domestic oil; not the same, you would make it more expensive. This is what we usually do with tariffs. This would, in fact, decrease the supply imported into the domestic market. Let T be the tariff rate. The effect of a tariff is to reduce the importation of a particular product.

Therefore, it takes this whole supply curve (S+M) and shifts it back to the left (to S+M+T), a higher price for any given quantity. And with this new supply curve, you would wind up at this higher price (Pc) here, and a quantity that was somewhere between this one [indicating Qa], which is absolute prohibition of imports, and this one [indicating Qb] which is where you always keep the prices equal. Thus, you would have a quantity and price between those two, if you just stopped there and put the tariff on it in that way.

The question then is, if you start with this sort of situation, can you improve on it? And what we are suggesting is that we think you can improve on it in the following way: Suppose that, for any individual company, if they are willing to hold excess domestic capacity, you rebate the tariff to them. In effect, you allow them to be on supply curve S+M rather than S+M+T, but you only do it if they have excess capacity.

Ultimately, the price would drop back down if the rebate policy became fully effective, that is, if all the tariff was rebated; which means, the rate would be zero. You would be back at this [indicating Pb] lowest price here, which is what you foresee in the bill now, and this largest quantity [indicating Qb].

But there would be one other change. In the process of adjusting to this, you would require that the companies hold excess capacity. So, in fact, you would require that this domestic supply curve (S) shift to the right, to S′.

Now, S′ is supply only in the sense of potential supply. You would not actually produce on this curve unless imports were cut off. But this is the purpose of the independence policy. So what you would observe is, when imports were flowing freely, we would have this [indicating Pb] price, which would be the same price as with no tariff. The total amount supplied would be Qb and the market price would be Pg. The quantity of domestic production would be here [indicating]; call this [indicating] Qd. The difference between consumption and domestic production (Qb−Qd) would be the quantity of imports.

Now, with this proposal, if you first of all move to (Pc, Qc) by making the tariff effective, and then rebated it for companies that hold excess capacity, you would end up back here, at the original point, with this quantity (indicating Qc) and this price (indicating Pb). Domestic production would be here (indicating Qd), the original place, but one thing would have changed. You would have acquired the excess capacity represented by this curve (indicating S′). So that if imports were then reduced suddenly (the problem now is that they are reduced suddenly, and the industry does not have a chance to adjust to it) you would, at least in the case of oil wells, immediately increase your production; if they were free-flowing wells that were maintained at a lower-than-maximum efficient rate of production, as we have observed for some 20 years in the prorationing States. What you would end up with would be the same lower price, and larger quantity as in your proposal. You would end up back with this larger quantity and lower price, but in the process you would have acquired this excess productive capacity.

Senator GRAVEL. How do you establish, now, the formula for rebates? Let us say, just on oil, then, you have got to define your units or your quantities, and give them a scale, do you not?

Dr. COX. On this diagram?

Senator GRAVEL. Yes; the space between S and S′ is the quantity—you have got to make an estimate of what that tariff is going to be.

Dr. COX. Oh, you mean how does one chose this amount? And how does one know the companies would in fact choose to take advantage of the rebates rather than just pay the tariff on imported oil? That is a question, in fact, a really very important question at the heart of this, which is how would one implement it especially given where we are starting now, with very large imports. First of all, we would have to select a measure of productive capacity.

If we are going to hold excess capacity, we would need to know how to measure it, and there are several measures in the industry. One possibility would be something like API proved reserves, although I suspect that one might want to have the FEA develop its own measure, rather than depend upon the industry. I think this is the intention already in the bill. That would be one possibility. There are other industry measures now of productive capacity. Presumably, one of the things that FEA would be doing anyway, as part of its national energy plan, would be developing measures of productive capacity in the oil industry. It would be natural then to use that as the measure on which to base excess capacity. In other words, excess capacity would be the difference between actual production and the measure of capacity production selected.

The next sort of problem would be how does one choose the tradeoff between imports and domestic production. For example, the first idea that would occur would be, I suppose, if you want to import a barrel you have got to hold a barrel of excess capacity. Well, it is not clear that you want to start there. It is also not clear that the companies would begin by accepting the rebates on that sort of tradeoff, especially in the current market.

What one could do would be to start with a very low requirement of excess capacity for rebates; rather than having an excess capacity of one barrel, if you want to import one barrel, have an excess of capacity of some fraction of a barrel for importing one barrel, and see what proportion of the companies take advantage of this. Also, independent importers could make some sort of contractual arrangement with domestic producers to let their excess capacity count.

Senator GRAVEL. So what we have established by law, or let us say, given to the Federal Energy Administration, would be, then, for them to set a formula that for a person to import he would have to offer some excess capacity?

Dr. COX. Yes. And the critical point would be how much?

Senator GRAVEL. Until you got into a position like right now, where we have a shortage or a crisis. You have to get over that hurdle. That is the first hurdle you have to get over, because you cannot require excess capacity until you have satisfied——

Dr. Cox. In fact, what I wanted to suggest is the way it might work in the following way. You might want to do this anyway, but certainly——

Senator GRAVEL. Let me ask one thing. What about Europe? You know, it has in-ground storage, which is very important, because they can weather a winter, if it comes to that.

What would be wrong if—just as an arbitrary policy—we required storage?

Dr. Cox. It would be a lot more expensive than operating wells at reduced rates of output. To store by in-ground storage, you have to dig holes in the ground and put in expensive tanks, and then put the oil in them. It is much cheaper—in fact, there is a saving in the efficiency of operation of the wells—if you produce from wells at reduced rates of output. So rather than incurring a positive storage cost—in fact, there would be a savings in more efficient production from the wells.

Senator GRAVEL. But we have to get to that point of full production, and then when we get to it, since we have experience just in oil, would it cause a skewness in the marketplace if we only applied this to, let's say, crude oil?

Dr. Cox. Do you mean if we did not apply it to, say, coal, for example?

Senator GRAVEL. Or gas or alternate methods of energy, just to leave those alone and let our excess capacity be in one type of fuel

Dr. Cox. Yes. But you see the problem——

Senator GRAVEL. It might cause a geographic skewness, would it not?

Dr. Cox. If what?

Senator GRAVEL. If you were shutdown from abroad, let's say if energy demands in Boston are now dependent upon Algeria, and our supply is cut down, you have some excess capacity in Texas, and in Alaska in the ground with oil, but that does not do Boston much good. which is now on the gas system.

Dr. Cox. On a gas system?

Senator GRAVEL. Yes; they are importing LNG.

Dr. Cox. I assume that the price controls on natural gas would be lifted and we will not be importing large quantities of natural gas. This is really aimed at oil in particular, and it would not cause any sort of change in the shares of different energy products in the economy, because when you reduced domestic oil production you would always increase oil imports. So it is not really a question of either reducing the share of oil, compared to coal or something else, or increasing it. It is really just a question of changing the shares of domestic production and imports in your given consumption of oil.

The critical question, then, is how would we select our excess capacity import ratio, rather than a barrel-per-barrel fraction. And I think one way it could work very well would be to start with a very small fraction after the embargo is lifted and see what proportion of the companies take advantage of the tariff rebate option. And then, as that proportion increases over time, as capacity in the domestic industry expands, then gradually increase the proportion, so you are getting progressively larger imports as a share of your domestic consumption. And you are at the same time not becoming more vulnerable to a cutoff of imports, because you are building up excess capacity by operating wells at lower rates of output.

Now, you could keep pushing up the tradeoff ratio, starting from a very small ratio of domestic excess capacity per barrel of imports. Then increase the proportion over time, always giving the industry time to adjust; and stop increasing the tradeoff ratio at the point where you see the proportion of companies getting the rebates starting to decrease, because that would tell you you have gone too far. By going further than this point, you would be defeating your own objectives, because you would cause more companies to start paying the tariff. This would cause them to start reducing their imports and increasing domestic production; and this would not be pursuing the independence objective. That would be the key as to how to work this out over time.

Senator GRAVEL. Very good.

OK. Continue.

Dr. COX. I have several more sections.

Senator GRAVEL. Have we covered it all?

Dr. COX. This important policy? I think we have covered it very well.

I would like to turn, then, to the issue of American policy toward the OPEC cartel, which I alluded to.

As we know, at the present time, the dominant force in the world oil market is the OPEC cartel, and I think American policies will be important in determining the future course of OPEC, whether it remains intact, leaving world oil prices at a monopoly level, or whether it breaks up, allowing oil prices to drop toward their previous much lower levels.

It seems to me that the provisions in section 704 of S. 2806 dealing with negotiations between oil importing and oil exporting countries, are defective in both ends and means. The national interest of the United States would be best served by the dissolution of the cartel and a resulting decline in world oil prices, not by negotiating with the cartel. If there is one policy which will practically guarantee the continued existence of the cartel, it is for the United States and other oil importing nations to bargain collectively over the quantity and price of oil traded on world markets.

With whom would they bargain? With the OPEC cartel, of course.

The last thing we want to do is encourage the internal cohesiveness of a collusive monopoly among the world's major oil exporters by proposing to bargain collectively with them. Instead, U.S. policy should be aimed at encouraging the centrifugal forces always at work within collusive monopolies and already appearing in the OPEC cartel.

Even if one assumes the cartel would remain in existence, prospects for dealing with it through collective bargaining, as envisioned in section 704 of the bill, do not appear bright. The interests of the various oil importing countries, even if the group were restricted to the industralized nations, are probably much more diverse than those of the members of OPEC. Hence, the importing nations would inevitably be the weaker party in bilateral negotiations. Moreover, by any realistic appraisal, the provisions in section 704 of S. 2806 assigning sovereign powers to the negotiating body and proposing "big-stick" trade penalties, portend stiff resistance to cooperation by other nations, not just France. Worse, they would compel risking a major trade war with our most important trading partners. It seems to me a high price to pay for the doubtful benefits to be derived from collective bargaining over oil.

These considerations lead us to urge strongly that section 704 be deleted from S. 2806.

Senator GRAVEL. We do not disagree.

Dr. COX. I turn now to titles V, VI, VII, VIII, IX, and X, which deal with price deregulation, export licenses, and domestic and foreign tax changes.

At the present time, domestic prices of energy goods are under severe upward pressure as a result of the OPEC cartel's monopoly price increases. This situation, coming on top of the preexisting shortages, confronts policymakers with three options: (a) let prices rise enough—a sizable amount—to equate supply and demand; (b) rely on some form of nonprice rationing to allocate the inadequate quantities supplied at less than market-clearing prices; or (c), some combination of price increases and rationing.

The principal advantage of option (a), letting prices rise to market-clearing levels, is that it both curtails the amount demanded and induces an increase in the quantities supplied. If the higher prices lead to increased corporate profits, those profits will induce an expansion of capacity in energy industries, causing supply to increase and future prices to fall.

The principal disadvantage of price increases is that they redistribute income, probably regressively, from energy goods consumers to owners of energy-producing resources.

Nonprice rationing, option (b), permits the avoidance of the income redistribution which price increases would entail. It also curtails the quantity of energy demanded at prevailing prices. The principal defect of nonprice rationing is that it provides no incentive to producers to increase output or expand capacity. Hence, it delays the adjustment of energy markets to the objective conditions of demand and supply.

Our only experience with the long-term rationing of energy goods, in the field market for natural gas, confirms our worst suspicions about nonprice allocation. As the subcommittee staff materials show, the long-term shortage of natural gas is a result of wrongheaded underpricing by the Federal Power Commission, which has regulated field prices of natural gas since the mid-1950's.

As if we were with Alice in Wonderland, the argument is being made that we should not deregulate the field price of natural gas because, says the Mad Hatter, the price to consumers would rise too much.

Both current output and productive capacity are falling at the present time. The industry is charged with a conspiracy by consumer advocates and even by the FPC staff. But the plausible explanation is the prolonged underpricing of gas at the wellhead.

Compromise combinations of price increases and rationing can be invented ad infinitum in an attempt to blunt the worst income redistribution effects of price increases, but still leave some incentive for producers to expand output and new capacity.

As with any compromise, however, there is always a danger of falling between two stools. A case in point is the Nixon Administration's proposal to ration gasoline but to permit the sale of coupons. The latter provision makes the curtailment of quantities demanded easier, but the rationing itself removes much of the incentive for producers to expand supplies because prices to producers will be kept at considerably less than market clearing levels.

The preceding discussion of price controls and nonprice rationing leads us to commend highly the provisions in S. 2806 calling for the lifting of price controls on energy goods.

As regards export licenses, the contradiction between the market philosophy behind the rest of 2806 and title 8, which calls for the export licensing of energy-related products, is all too readily apparent. We fail to see the necessity for the export licensing provision in view of the other measures proposed in S. 2806. Including such provisions imparts a grab bag quality to a bill which is otherwise, for the most part, well motivated and well thought through.

We, therefore, urge that title 8 be dropped.

As regards domestic tax changes, the liberalization of the Federal Income Tax treatment of domestic oil and gas producers proposed in title IX would interfere with market allocations by further subsidizing those producers, compared to producers in other industries.

The subsidies would increase the incomes of those producers (or their shareholders) and of owners of oil and gas resources. Also, the extra subsidies would reduce the prices of oil products and natural gas in the United States.

The question then is: Do the additional subsidies to oil and gas producers yield additional benefits which justify the allocation and income redistribution effects they would produce? One should resist the natural predisposition to question Federal tax subsidies simply because an industry already enjoys sizable such subsidies. There seems to be no justification, however, for new tax credits for expenditures on secondary and tertiary recovery (sec. 901) or depreciable property (sec. 902).

If the price controls on crude oil and refined products and on natural gas are removed, as S. 2806 would provide, oil and gas producers would need no further encouragement to adopt the economically appropriate production techniques.

Senator GRAVEL. So the thesis that you are making is that price can do it itself, market clearing can do it?

Dr. COX. Yes, when it becomes economically justified to make the expenditures on secondary and tertiary recovery, if the price is allowed to rise the firms will do it. They do not need further tax incentives in order to make them do this.

Senator GRAVEL. But if we want to condition price to the consumer as a result of political realities, we could do this by granting them these concessions, and therefore they will make profits, not so much from price, but because of government antitrust.

Dr. COX. I think there is a problem with that. If you attempt to lower price through special tax provisions for the industry, there is a large leakage from the total Treasury loss in tax revenues that never gets to the consumers. There is a large leakage into higher rents in the oil industry and higher profits for the oil industry.

Senator GRAVEL. Like if we do away with the depletion allowance, supposing we do not give any investment tax credit?

We do away with depletion allowance and keep the intangibles on them, which is a deduction like these other factors. So the oil industry or the energy industry winds up with intangibles and nothing else. The price of the product will go up until it reaches a clearing point, and we will have a simpler system of accounting.

Dr. COX. We would have a simpler system of accounting; and also, I see no reason why this industry should be singled out for extensive subsidies. If we intend to let the price rise far enough to do something——

Senator GRAVEL. What do we do with the inflationary problem in the meantime, just bite the bullet?

Dr. COX. We are really not getting around the inflationary problem by hiding the higher cost through lower tax collections. Consider the possibilities: Either the consumers who are getting the lower prices for the petroleum products would have to pay higher taxes; or Government expenditures would have to be reduced; or, if neither of those two, then we would have a larger deficit and more inflation from that side of it. So saying that we are fighting inflation by providing subsidies to an industry, so that the price might be a little lower, is really kind of a losing battle. You are giving up a lot more than you are gaining, I think.

Senator GRAVEL. Yes.

Dr. COX. And the danger of that sort of reasoning is that it would say, why not subsidize all industries then. That is the way to fight inflation.

Senator GRAVEL. Of course, that is exactly what we have been doing. We subsidize gas and oil. We subsidize mining. We subsidize milk. We subsidize wheat.

Dr. COX. As I say, we are not really relying on the market.

About these tax provisions, we may want to put one of them in a special category. As regards exploratory drilling, it seems that the situation is somewhat less clear-cut. The reason is that there are externalities in exploratory drilling—namely, the spillover of information that it yields and the objective of national independence in energy, which market signals will not register. Therefore, the proposed investment tax credit for exploratory drilling may be an effective public policy.

Whether this judgment is warranted would depend on how the tax credit compared with other possible policies in terms of budgetary costs, benefits achieved, and side effects. In our opinion, there may well be grounds for regarding an investment tax credit for exploratory outlays as a replacement for the present, more diffuse tax subsidies to oil and gas producers, which cover both exploratory and development drilling.

Senator GRAVEL. What would that be now?

Dr. COX. One of the provisions in the bill is the 14 percent tax credit on exploratory wells. And we think that it might be a good idea to consider replacing the existing diffuse provisions, for example percentage depletion that pays off to production, which is not what we want so much as capacity to produce—that is, the acquisition of proved reserves—to replace provisions like that with a provision such as the one in the bill calling for a 14-percent tax credit on outlays on exploratory drilling costs. This would, of course, require a very careful definition, as is the one in the bill now, of what an exploratory well is.

Senator GRAVEL. You are only thinking in terms of oil, but we have got to think in terms of the full spectrum of energy. But I see your point. If we are going to do something, do away with depletion and keep the investment tax credit, that is closer to proper than the present system.

Dr. COX. In fact, some recent research, by Professor Wright and me, indicates that the percentage depletion allowance is not cost effective in inducing the industry to hold larger proved reserves of oil and gas.

However, the provision for expensing, instead of depreciating, intangible drilling costs for tax purposes does appear to be somewhat more cost effective than the depletion allowance. This is the case where you have a specific policy, rather than a diffuse one that pays off to production. Your investment tax credit would be rather closely related to the existing expensing of intangible drilling costs, but it would be narrowed down to exploratory wells as opposed to all wells.

I would like to turn now to title VI, which proposes an excise tax on uninvested profits from energy sources. It would be very useful to stress, in the supporting materials for the bill, that this provision is not the same thing as an excess profits tax. An excess profits tax on energy industries would be antithetical to restoring market allocation in those industries and to achieving national independence in energy. We hope that Congress will not yield to emotional appeals to slap an excess profits tax on energy producers. Such a tax would only aggravate the existing bad situation.

The excise tax on uninvested energy profits proposed in title VI avoids the undesirable effects of an excess profits tax. However, in view of the other measure to promote energy independence in S. 2806, we seriously question the need for this additional measure. Its inclusion again suggests a grab bag approach to energy policy, rather than a carefully worked out set of proposals.

In addition, the mechanics of the energy profits excise tax appear exceedingly complex. In this respect, the measure does resemble an excess profits tax, which we know from past experience to be notoriously difficult and costly to administer. If the subcommittee should decide, however, to include title VI in the final bill, we would recommend one major change. As presently stated, the measure includes a profit allowance; that is, an amount of profits not subject to the excise tax, and hence beyond the reach of the investment incentive, of 20 percent of a firm's equity capital stock used in energy production. As we show in our written statement, this allowance would render the tax, and therefore the incentive as well, ineffective, unless the rate of return on depreciated book equity capital was greater than 20 percent. In recent years, according to the supporting data for S. 2806, rates of return in energy industries have hovered around half of that figure. Thus, title VI would be a tax tiger with few if any teeth. Once the lack of teeth became known, the tiger would not even scare people, let alone change their investment behavior.

A simple way to amend title VI, if it remains in the bill, to overcome its present toothlessness, would be simply to drop the profit allowance. Also, that would avoid the costly administrative aspects of that title.

I turn finally to provisions in title X calling for tax credits and deductions for energy saving investments in private residences. We think the measures in S. 2806 to restore energy market operations would suffice to deal with problems of this kind. If one is concerned about the expense of residential modifications for poorer families, there are far cheaper ways to ease the burden of that expense than measures such as this, which would subsidize all taxpayers, rich and poor alike. We therefore urge that this particular tax provision be deleted from S. 2806.

Turning now to foreign tax changes, the proposal in title X to eliminate the percentage depletion allowance and the option to expense intangible drilling costs on petroleum wells located outside the United States is commendable. The next question is, why the foreign tax credit was not also eliminated or largely restricted. As it is, with the large excess of foreign tax credits of the big international oil companies, eliminating percentage depletion and intangible drilling costs on foreign wells will have little if any effect on their tax payments. It is common knowledge that a very high proportion of the so-called income taxes paid by the oil companies to foreign governments is really royalty expense. Hence, it should be deducted from taxable income, just like any other expense, not credited against U.S. tax liability.

By our estimate, 18 major oil companies, accounting for most of the foreign oil income of U.S. corporations, received extra tax relief through the foreign tax credit in 1970, compared to the average U.S. company with foreign income in that year, of about $850 million.

As the Arab oil embargo of 1973–74 has plainly shown, any possible energy independence rationale for tax subsidies to foreign oil production has vanished. Moreover, OPEC's monopoly power permits it to expropriate most of the tax breaks granted to U.S. firms operating in OPEC countries simply by revising the royalty "agreements."

There is no point in having U.S. taxpayers augment the already huge sums filling OPEC member's coffers as a result of the drastic price increases which have occurred since 1970.

As regard the "trust fund" method of financing government programs, this method has both advantages and disadvantages, as we detail in our written statement. We could find neither the advantages nor the disadvantage to be decisive, and therefore made no recommendation on title II.

Finally, the last topic I will discuss is the monetary awards and loan guarantees of title III. One thing markets do not do well is allocate funds to research, especially basic research, because the product in question—information or knowledge—is a "public good". That is, it is often not possible for a private person to prevent others from benefiting from money spent on research.

The monetary awards proposed in title III provide a method by which both the enforcement and restriction costs of patenting new energy technology can be avoided. This would be accomplished by requiring that patent rights be forfeited, and the new technology be made freely available, as a condition of granting the award.

Loan guarantees for activities in category one, which covers the design, construction, operation, and maintenance of facilities for unconventional energy sources, can be justified on the same grounds as the monetary awards, since the guarantees would apply to loans to firms engaged in energy research and development. This justification does not extend, however, to category (2), which deals with prospecting, exploration, development and production of oil and gas. There may be an informational externality in oil and gas prospecting and exploration. However, the public good argument breaks down entirely when it comes to loan guarantees for oil and gas production. In view of the other measures in S. 2806 for achieving energy independence, we recommend that the provisions of loan guarantees in category (2) be dropped.

Senator GRAVEL. Doctor, thank you very much. I really appreciate the paper.

Dr. COX. Thank you, Senator.

Senator GRAVEL. It has such contents, I can assure you, that I am going to have to go through it again privately. And I think we have covered the subject. I think it is the best analysis that we have probably had on the bill this far.

Dr. COX. Thank you very much.

Senator GRAVEL. Thank you very much, and thank your colleagues for their efforts behind it.

[The prepared statement of Professors Cox and Wright follows. The staff subsequently requested Professors Cox and Wright to supplement their statement with a paper on how a rebatable tariff scheme might work, and a paper concerning the foreign tax credit. Their responses follow their prepared statement at page 1561. Hearing continues on page 1575.]

PREPARED STATEMENT OF PROFESSORS JAMES C. COX AND ARTHUR W. WRIGHT, HARVARD UNIVERSITY

BIOGRAPHICAL DATA

James C. Cox, who received his Ph.D. degree from Harvard University in 1971, has made theoretical contributions in the areas of public program evaluation and the economics of uncertainty. He participated in the development of the curriculum for the Public Policy Program at Harvard and has since developed and taught the graduate public finance courses at the University of Massachusetts, Amherst.

Arthur W. Wright, who received his Ph.D. degree from M.I.T. in 1969, has been involved in Federal tax matters since 1965. He has offered expert testimony on pricing questions in percentage depletion cases litigated by the Tax Division of the Department of Justice, and was a consultant to the Treasury on depletion regulations. During the 1969 hearings on Tax reform, he testified on percentage depletion before the House Ways and Means and Senate Finance Committees.

Currently Professors Cox and Wright are conducting joint research on the effectiveness of Federal tax expenditures on the mineral industries.

SUMMARY

We generally favor S. 2806, the Energy Revenue and Development Act of 1973' However, we have a number of suggestions regarding the bill, among them the following:

The variable import duty proposal, as presently drafted, will necessarily be inoperative; it is, in effect, a clumsy way of recommending a free market in imported oil. A differently drafted proposal could be used to promote short run energy self-sufficiency, but such a tariff will make it more difficult to achieve longer run independence of the actions of foreign energy producers. In this respect, a petroleum tariff would have many of the same harmful effects as the now-abandoned oil import quota program.

True energy independence involves maintaining spare domestic productive capacity and abstaining from the use of domestic energy resources when imports are flowing normally. Tariff rebates to firms which set aside spare productive capacity are one way to achieve this.

The Organization of Petroleum Exporting Countries is a collusive monopoly, or cartel, which U.S. foreign policy has materially assisted. In dealing with OPEC, the goal should be to break up the cartel, thus bringing lower world oil prices. But

Section 704 of S. 2806 will probably have the effect of strengthening the cohesiveness of the OPEC cartel.

The current energy shortages are the direct result of errors of commission and omission in government policy. Policy makers are now faced with only three options: sizeable price increases, rationing, or some combination of the two. The best interests of all Americans would be served by allowing free market forces to operate in the energy area even though this will undoubtedly result in price increases for fuels.

There is no justification for granting new tax benefits to the petroleum industry. Nor can we justify the bill's proposed tax subsidies for energy saving investments in private homes. Market forces will solve these problems without the need for new tax subsidies. But a tax credit for exploratory drilling might be an appropriate replacement for the less effective and more diffuse tax subsidies now granted to oil and gas producers.

An excess profits tax on oil producers would simply aggravate existing energy problems. An excise tax on uninvested energy profits is perhaps a better solution, but it too has serious defects.

Elimination of percentage depletion on foreign wells is a commendable step. But it seems that the foreign tax credit should also be eliminated or restricted. Tax subsidies for foreign oil production simply make it easier for foreign governments to increase the amounts charged to U.S. oil firms.

We make no recommendation regarding the proposed energy trust fund, but we are concerned that it may provide a focal point for lobbying by special interests. The money awards for basic energy research and development proposed by S. 2806 can be justified on public policy grounds, but there is no justification for also extending direct subsidies to oil and gas exploration and production, especially if market forces are allowed to set the prices for oil and gas.

STATEMENT

In the winter of 1973–74, the United States is experiencing disruptions in the flows of energy goods and excess demands ("shortages" in popular parlance) for oil products and natural gas at existing prices. This situation, together with numerous predictions of even worse "shortages" in the future, has come to be known as The Energy Crisis. The Energy Revenue and Development Act of 1973 (S. 2806) is a legislative response to the Nation's energy problems which we think has many virtues and a few defects. The point of view which underlies S. 2806, and also Senator Gravel's speech to the Senate and the supporting documents prepared for this Subcommittee, is that current energy problems reflect a crisis of public policy, not inadequate energy resources. We applaud this approach, which we think is based on a correct interpretation of the evidence.[1]

S. 2806 proposes to correct the present crisis in energy policy by creating a Federal Enefgy Administration (FEA) and by funding it through an Energy Trust Fund. The FEA would be charged with, among other things, making the United States independent of other countries for our energy supplies by 1985. In this statement we assess the various provisions of S. 2806 in terms of their contribution to furthering the objective of independence and other objectives of public policy. The balance of our discussion will be critical, but this should not be interpreted to mean that we disapprove of S. 2806 in general. We have chosen to concentrate on constructive criticism of provisions which in our opinion could be improved, rather than praise for provisions which do not need amendment.

I. Oil Import Policy

A. The "Variable Import Duty"

Title VII of S. 2806 proposes "variable import duties" (VID) on imported oi as a means of limiting imports and reducing U.S. dependence on foreign supplies The duties would vary automatically, being set equal to the difference, if positive between the average price of domestic crude oil and the price of imported oi f.o.b. the United States, so that imported oil would never sell for a lower price than domestic oil in the domestic market. This proposal has two defects, one of conception and one of omission; however, if we revise the conceptual defect, the defect of omission can be remedied, at least in part.

[1] We have previously presented at some length a similar interpretation of the evidence. Therefore, we shall not take up space to add further support for it here. For an exposition of our interpretation of energy problems, see our paper, "Federal Tax Policy and Energy Problems," in U.S. Congress, House Committee on Ways and Means, *General Tax Reform*, Part 9 and 11 (February 26, 1973), pp. 1392–1412.

The VID, as presently proposed in S. 2806, would only be assessed when imported oil entered the U.S. market at a lower price than domestic oil. Then the VID would serve the function of equalizing the two prices, presumably to remove the "competitive advantage" which the lower-priced domestic oil would have over the higher-priced domestic oil. However, it should be recognized that the market price of domestic oil and the price of imported oil (f.o.b. the United States, of the same grade) will necessarily be equal unless there are either quantity controls on oil imports (such as the now-defunct mandatory oil import quota) or price controls on oil and oil products in the U.S. (as there have been since August 1971). There is no mention in S. 2806 of quantity controls on oil imports, and the language in the bill and its supporting documents suggests a strong predisposition against such controls. Furthermore, there is provision in Title V for the termination of price controls on oil and other products. Hence, under the market conditions envisaged by S. 2806, the domestic market prices of imported and domestic oil would be made equal by market forces. But if those prices are equal, the import duty assigned to equalize them will always be zero and will never "vary" at all. In other words, in the absence of market interferences not found in the bill, the VID provision in present form would never become operational. Essentially, this provision is a clumsy way of recommending a completely free market in imported oil in the United States.

B. A Workable Import Duty Proposal

If it is the intention of the Subcommittee on Energy to use import duties to discourage oil imports,[2] then it could formulate a proposal for an import duty which is consistent with the philosophy of no quantity or price controls. Such a proposal would entail using import duties to drive a wedge between the U.S. and the foreign prices of oil, so that the two would be unequal.[3] By making foreign oil more expensive than domestic oil, imports of oil would be reduced and domestic production increased, compared to the free-market situation. The increase in domestic production would not be as great in magnitude as the decline in imports, so that the U.S. price would be higher with the tariff than without it.

This proposal would promote greater self-sufficiency in any given time period: domestic oil would cover a larger, and imports a smaller, proportion of total U.S. oil consumption than if there were no duty. Self-sufficiency in oil at any given time is not, however, the same thing as energy indepence, which is the stated objective of S. 2806. Although similar on the surface, these two objectives are not identical, and they have different implications for oil import policy. Herein lies the defect of omission in import-duty proposals for controlling oil imports: while they encourage present energy self-sufficiency, they do so at the expense of future energy independence.

C. Energy Independence versus Self-Sufficiency

The distinction between energy independence and energy self-sufficiency merits a detailed examination. Let us consider first the effects of self-sufficiency. As an objective of policy for depletable resources such as petroleum, coal and uranium self-sufficiency has the effect of mortgaging the future. Since rational producers tend to exploit the cheapest, most productive resources first, over time the cost of the resource will tend to rise (given the available technology)[4] as the resource is depleted. In other words, greater and greater quantities of scarce productive inputs—labor, capital and land—must be expended to maintain (let alone expand) production of the resource.

A policy of self-sufficiency in the production of the resource will lead to domestic production which costs more than substitute imported goods. (If domestic costs were below import prices, we would not need an explicit policy of self-sufficiency.) Another way to put it is that self-sufficiency will increase the rate of depletion of domestic resources over what it would have been under a free-trade policy; the increased rate of depletion will cause costs to rise to higher levels sooner than if imports had been substituted for some domestic output. It is this result which

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[2] There are, of course, other methods to achieve U.S. independence in oil, and these methods should be included as possible alternatives to tariffs in any final consideration of the optimal method or combination of methods for achieving independence. See Cabinet Task Force on Oil Import Control, *The Oil Import Question* (Washington: Government Printing Office, 1970); also, the several works of Professor Walter Mead on this subject.

[3] This proposal is similar in basic outline to the one advanced by the President's Cabinet Task Force on Oil Import Control (op. cit.) but rejected by the Nixon Administration.

[4] Improved technology will, of course, offset the tendency of costs to rise.

leads critics of self-sufficiency policies to characterize them in, say, the oil industry as policies designed to "drain America first."

Now let us consider what is meant by energy independence. In economic terms, national independence means not being vulnerable to the actions of decision makers outside your sovereign control. For energy, independence consists of having the spare domestic capacity to replace all or a substantial part of the imported energy supplies which are under the control of foreign governments or individuals who are not effectively liable to Americans for their actions. Independence in this sense involves greater costs than the United States would have to pay if it could guarantee that outsiders would never exploit American vulnerability. It can also bring benefits, of course, in the form of being able to avoid the possibly greater costs of disrupted business and household activities if foreign energy supplies are suddenly cut off.

To decide how far to pursue energy independence, it is necessary, first, to select the least-cost combination of methods for providing the stand-by domestic capacity, and, second to compare the extra benefits achieved against the extra outlays required for successive increments of independence. Most probably, complete independence would be too costly for the benefits achieved; rather, part of the cost of sudden interruptions of foreign energy supplies might best be borne in the form of temporary disruptions. With a policy of independence, however, the effects of those disruptions could be held at tolerable levels and their ramifications contained within narrow limits.

Now let us compare the objectives of self-sufficiency versus independence in energy. The former objective leads to a paradox: pursuing self-sufficiency today may well mean greater dependence on foreign energy sources tomorrow, at a given level of cost. The alternative to greater dependence tomorrow would be the more costly one of diverting more scarce inputs to the production of energy goods than if imports had been substituted for some domestic production today. Paying more for energy of course means having less of other goods and services.

An example of the paradox of self-sufficiency is the effects of the mandatory oil import quota of 1959–1973. Under the quota, oil imports were subject to a physical maximum equal to a small proportion (about one-eighth) of domestic U.S. oil usage. The discrepancy between the prices of a barrel of U.S. oil and of a barrel of foreign oil f.o.b. the U.S. East Coast—roughly $1.25 for most of the period—indicate that substantially more foreign oil could have been substituted competitively for domestic oil.[5] The higher prices to consumers and the more rapid depletion of U.S. domestic oil resources caused by the import quota were justified on grounds of self-sufficiency—the need to maintain a "strong" U.S. oil industry in order to protect the "national security." In fact, the "drain America first" effects of the quota left the domestic industry much weaker, in terms of energy independence, when the Arab oil embargo was imposed in late 1973, than if the U.S. had been less self-sufficient in crude-oil production during the 1960's, but had maintained (as an independence policy) the same level of gross additions to domestic proved oil reserves as we actually had. An additional benefit (to consumers) of such an alternative policy to the mandatory oil import quota—at no cost in terms of energy independence—would have been lower retail prices for refined oil products from 1959 to 1973.

The sample calculations presented in Table I illustrate the preceding point.[6] Suppose that, for the period 1959–1972 (spanning virtually the entire life of the import quota, which was removed early in 1973), oil imports, as a share of total domestic consumption, had been 10 percent higher than actual and domestic crude oil production 10 percent lower than actual. Suppose also that gross additions to domestic proved reserves of oil had been held at their actual yearly levels through appropriate government policies (one such policy is described below). The reductions in domestic production would therefore be net additions to the stock of proved reserves which actually prevailed. At the end of the first year, 1959, simulated proved reserves would have been larger than they actually were by 10 percent of 1959 consumption, or 975 thousand barrels. At the end of the second year, 1960, simulated reserves would be larger than actual by the cumulated

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[5] The tendency for the share of imports to rise in the late 1960's and early 1970's, as the quota was relaxed in fits and starts by the NixonAdministration, was cited as a portent of a new and different degree of scarcity in oil. In fact, much the same shares would have prevailed all along, had they not been suppressed by the artificial restriction of the quota.

[6] The purpose of this simulation is to illustrate the paradox inherent in pursuing an objective of self-sufficiency in production from a depletable natural resource. We are not attempting to show that the mandatory oil import quota was a "bad" policy. Such a conclusion would require a comparison with various alternative policies, so that we could say "good" or "bad" relative to *what?* Such a comparison is attempted in Cabinet Task Force on Oil Import Control, *op. cit.*

total of the 1959 and 1960 reductions in current domestic oil output. And so on: over the years the net additions to proved reserves from reducing current domestic oil production, while holding annual gross reserve additions at their actual levels, would have accumulated to 6,373 (= 39,909 − 33,536) million barrels.

Let us assume that those extra reserves would have been held as unutilized current production capacity through an appropriate government policy (for example, an increase in "shutdown days" in the major oil-producing states which practice "market-demand prorationing").[7] Under that assumption, the simulated reduction in U.S. oil self-sufficiency during the period 1959–72 would have increased our oil independence in 1973. Using the actual reserve-output ratio in 1972 (see Table 1) of 33,536 ÷ 11,180 = 3.0, the additional 6,373 million barrels could have supported in 1974 an added production of 6,373 ÷ 3 = 2,124 million barrels per day. That figure is near the highest estimates of 1974 excess demand if the Arab oil embargo becomes fully effective. Thus, we can restate the distinction between energy self-sufficiency and energy independence in the following way: if we had been less self-sufficient in oil for the last 15 years, we could have been more independent in oil today.

TABLE 1.—ILLUSTRATION OF THE SELF-SUFFICIENCY PARADOX[1]

Year (t)	Actual total consumption[2] (C_t)	Actual domestic production (Q_t)	Actual imports (M_t)	Actual proved reserves (R_t)	Simulated domestic production[3] ($\hat{Q}_t$)	Simulated imports[4] ($\hat{M}_t$)	Simulated proved reserves[5] ($\hat{R}_t$)
1959	9,749	7,933	1,780	38,241	6,958	2,755	38,597
1960	10,000	7,965	1,815	38,429	6,964	2,816	39,150
1961	10,159	8,174	1,917	38,835	7,158	2,933	39,927
1962	10,578	8,353	2,082	38,701	7,295	3,140	40,179
1963	10,961	8,640	2,123	38,644	7,544	3,219	40,522
1964	11,234	8,760	2,258	38,738	7,646	3,381	41,026
1965	11,710	9,014	2,468	39,376	7,843	3,639	42,002
1966	12,208	9,570	2,573	39,781	8,350	3,802	42,945
1967	12,876	10,220	2,537	39,991	8,932	3,825	43,625
1968	13,635	10,599	2,840	39,305	9,236	4,204	43,437
1969	14,381	10,827	3,166	37,775	9,389	4,604	42,432
1970	14,968	11,297	3,419	37,104	9,800	4,916	42,307
1971	15,449	11,155	3,926	35,767	9,610	5,471	41,534
1972	16,589	11,180	4,741	33,536	9,521	6,400	39,909

[1] All figures are in thousands of barrels per day, except reserves figures (R_t, $\hat{R}_t$) which are in millions of barrels. The source of data is app. C of Senator Mike Gravel's speech, printed in Congressional Record, Senate, Dec. 13, 1973, pp. S22733–S22734.

[2] $C_t = Q_t + M_t - X_t$ is exports in year t.

[3] $\hat{Q}_t = Q_t - 0.1\ C_t$.

[4] $\hat{M}_t = M_t + 0.1\ C_t$.

[5] $\hat{R}_t = R_t + 0.365 \cdot \sum_{\tau=1}^{t} (Q_t - Q_t)$.

The foregoing analysis reveals clearly the wisdom behind the language in S. 2806 which stresses energy independence—reduced vulnerability to the sudden abrogation of commercial contracts by foreign governments—rather than self-sufficiency as the basis of national energy policy. Independence entails maintaining spare domestic capacity to provide current outputs in case expected imports are disrupted without forewarning; independence also entails not using domestic productive capacity to substitute for imports when those imports are flowing normally.

With this point in mind, let us examine one possible way to modify the import-duty proposal discussed in section I.B. in order to remedy the defect of omission, namely, the failure to promote oil independence.

D. Greater Independence through Tariff Rebates

We offer the following proposal in rough outline for the Subcommittee's consideration. Details remain to be worked out, but we think the proposal interesting enough and, more important, pertinent enough to the stated objectives of S. 2806 to warrant inclusion in this statement.

[7] "Market-demand prorationing" was practiced during this period in Kansas, Louisiana, New Mexico, Oklahoma, and Texas; together, these states contain about 75 percent of total U.S. proved reserves of oil, excluding Alaska. On the operation of "market-demand prorationing," see S. L. McDonald, *Petroleum Conservation in the United States* (Baltimore: Johns Hopkins Press for Resources for the Future, 1971); also, the present authors' paper, "The Cost-Effectiveness of Federal Tax Subsidies for Petroleum Reserves: Some Empirical Results and Their Implications," in Gerard M. Brannon, ed., *Studies in Energy Tax Policy* (Boston: Ballinger, forthcoming in 1974).

To increase oil independence, we would want to decrease the current use of domestic productive capacity but hold some excess capacity in reserve in case of emergency. If imports are flowing normally, there is no reason not to replace the reduced domestic production with imported oil—provided that spare domestic capacity is available if imports are suddenly cut off. Our proposal would curtail current domestic production, replace it with imported oil, and encourage the holding of some excess domestic productive capacity to meet emergencies. It would work as follows.[8]

Suppose initially that an import duty has been placed on oil (with no quantity or price controls on oil). The duty would have the effect of restricting the total quantity of oil supplied in the U.S. market, domestic and foreign, at all prices. The U.S. market price, and along with it domestic quantity supplied, would increase while the quantity of imported oil sold would decline, compared to the completely free market situation. In other words, we would be more self-sufficient in oil as a result of the duty on imported oil. In addition, of course, we would also be depleting domestic oil resources at a faster rate than with a completely free market and no duty.

To slow down the rate of domestic depletion, at the same time not increasing U.S. vulnerability to a cutoff of oil imports, it would be possible to offer oil companies rebates of the oil import duty, *provided* they would acquire additional domestic productive capacity and set it aside as an emergency reserve. Thus, the price of imported oil would be brought ba k into equality with the domestic price for participating firms; that would lead to an expanded share of imports, and a reduced share of dometic production, in current consumption. Along with the reduced self-sufficiency, though, we would achieve increased spare domestic productive capacity—that is, increased independence. In short, we would trade off some self-sufficiency in oil in any given time period for an increase in longer-term oil independence. Note, too, that this proposal would tend to reduce the prices of refined oil products paid by consumers towards the levels of the completely free market case. We would be able to consume oil and have it, too, but it would not be a trick: consumers would pay the lower prices because of the freer access to the U.S. market of the imported oil. The condition of that freer access, however—the holding of additional excess domestic capacity—would mean that consumers were not enjoying the lower current prices at the expense of future independence.

The precise details of this proposal—the size of the duty, the percentage rebate, and the schedules of additional capacity required to qualify for the rebates—and the timetable for implementing it, especially during the initial transition period, would be complicated to work out. The proposal could also prove difficult to administer (e.g., the determination of whether a firm had in fact qualified for the rebate of import duties paid). But the United States has many years of experience with a policy that required crude oil producers to maintain large excess productive capacity—namely, the market demand prorationing policy.[9] Whatever the efficiency implications of that policy, it at least worked tolerably well to create excess productive capacity for many years. With this as an example, we think a policy along the lines indicated here would be feasible.

II. United States Policy Towards the OPEC Cartel

A critical issue in any discussion of American oil import policy is what happens to the world price of oil in coming years. At the present time, the dominant force in the world oil market is the collusive monopoly, or cartel, operated by the Organization of Petroleum Exporting Countries (OPEC). As we have argued previously,[10] U.S. foreign policy played an important role in helping OPEC attain the necessary cohesion to restrict output and drive up the world price of oil to many times the cost of production, without the threat of serious price-cutting which usually plagues and eventually destroys cartel effectiveness. By the same token, American policies will also be important in determining the future course of the OPEC cartel: whether it remains intact, leaving world prices at monopoly

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[8] We are implicitly assuming here that the U.S. is a net importer of oil. A similar assumption underlies the reasoning of S. 2806. If the U.S. were a net oil exporter—not an unforeseeable event—the analysis would be different; but, then, the problems of self-sufficiency and independence would be much less urgent.

[9] See footnote 7 on market-demand prorationing.

[10] See our paper of February 26, 1973, submitted to the House Ways and Means Committee, *op. cit.* in footnote 1. For a detailed recitation of the evidence for this view, see M. A. Adelman, "Is the Oil Shortage Real?" *Foreign Policy*, Number 9, Winter 1972–73, pp. 69–107; this article was the chief source of our own analysis.

levels, or whether it breaks up, allowing oil prices to drop towards their previous, much lower levels.

The provisions in Section 704 of S. 2806, dealing with negotiations between oil-importing and oil-exporting countries, are defective in both ends and means. The national interest of the United States, as well as the other industrialized nations and especially the non-oil-producing developing nations, would be best served by the dissolution of the cartel and the resulting decline in world oil prices. Besides the enormous transfer of wealth from those nations to the OPEC countries, the monopoly control of oil production will lead to an inefficient allocation of the world's economic resources; many resources will be devoted to less than their most productive uses because of the restricted output and inflated price of world oil brought about by the cartel.[11]

Now, if there is one policy which will practically guarantee the continued existence of the OPEC cartel, it is for the U.S. and other oil-importing nations to bargain collectively over the quantity and price of oil traded on world markets. With whom would they bargain? With the OPEC cartel, of course! The last thing we want to do is to lend integrity to and spur the internal cohesiveness of a collusive monopoly among the world's major oil exporters by proposing to bargain collectively with them. Such a policy would help to "stabilize" world oil prices at their present inflated monopoly levels, to the vast gain of the OPEC countries and the equally vast detriment of the oil-importing nations.[12] Instead, U.S. policy should be aimed at encouraging the centrifugal forces always at work within collusive monopolies and already appearing in the OPEC cartel: capacity production by non-Arab countries such as Iran, and widespread cheating on the production cutbacks by Arab members of the cartel (e.g., Iraq) even with the disciplining effect of the 1973 Middle East war. Thus the call, in Section 704 of S. 2806, for collective bargaining between the oil-importing and oil-exporting nations, like similar proposals mooted by Secretary of State Kissinger and other members of the Nixon Administration, is patently not the proper goal of American policy towards OPEC.

Even if one assumed that the cartel would remain in existence, prospects for dealing with it through collective bargaining, as envisioned in Section 704 of the bill, do not appear bright. The interests of the various oil-importing countries, even if the group were restricted to the industrialized nations,[13] are probably much more diverse than those of the members of OPEC: collective bargaining, if OPEC was forced into it, would be interpreted (correctly) as a potential threat to total cartel monopoly profits, which is the sole centripetal force holding the cartel together. Hence the importing nations would inevitably be the weaker party in bilateral negotiations.

Moreover, by any realistic appraisal, the provisions in Section 704 of S. 2806 assigning sovereign powers to the negotiating body and proposing "big-stick" trade penalties, portend stiff resistance to co-operation by other nations (not just France). Worse, they would compel risking a major trade war with our most important trading partners when they refuse to go along. A trade war would be a high price to pay for the doubtful benefits to be derived from collective bargaining over oil.

The above considerations lead us to urge strongly that Section 704 be deleted from S. 2806.

III. Price Deregulation, Export Licenses, and Tax Changes

Titles V, VI, VIII, IX and X of S. 2806 contain proposals for eliminating price controls on energy goods, adding controls on energy-related exports, and changing the Federal income tax laws as they apply to energy producers and consumers. We discuss them all under a single heading, because their several provisions all have to do with the theme of the proper role of markets in the U.S. economy and what happens when that role is constricted by different kinds of government intervention. We shall deal first with price deregulation and then take up the tax changes.

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[11] The undesirable effects of monopoly power provide the rationale for American antitrust policy and the common practice of regulating public utilities (sometimes called "natural monopolies"). There is no rationale for moving against monopoly at home but condoning and even furthering it abroad.

[12] It is instructive that the Shah of Iran and other OPEC spokesmen recently issued invitations to the oil-importing nations to negotiate the "stabilization" of world oil prices the day after the announcement of the new "reference" prices which translated into transactions prices at about the level—$7-$9 a barrel—which has been estimated to be the monopoly-profit maximizing price.

[13] Such a restriction, which is implicit in the references in S. 2806 to the "major importers of petroleum and petroleum products," would most likely mean costs in terms of U.S. (and other nations') foreign policy towards the "Third World." Those costs have not been dealt with at all, at least in public discussions to date.

A. Price Deregulation

We are currently experiencing "shortages" of several energy goods: virtually all refined oil products; natural gas; and, during "brownouts," electric power. As the staff materials in support of S. 2806 clearly point out, these shortages are the direct results, not of inadequate energy resources, but of errors of commission and omission in government policy.

We have had errors of commission in government-originated market interferences: the Phases 2 *et. seq.* price controls (oil products), and prolonged underpricing by the Federal Power Commission (natural gas at the wellhead). We have had errors of omission: the absence of a Federal policy for energy independence; the failure of state public utility commissions to replace price discrimination between large and small users with uniform peak-load pricing. As a consequence of these energy policy failures, the amounts of the above energy goods demanded at the prevailing prices exceed what producers are willing and able to supply at those prices; economists refer to this state of affairs as "excess demand."

At the present time (January 1974), domestic prices of energy goods are under severe upward pressures as a result of the OPEC cartel's monopoly price increases (see section II), and perhaps because of the disruption of normal world market trade flows of energy goods which followed the Arab oil embargoes of October 1973. This situation, coming on top of the pre-existing shortages, confronts policy makers with three options: (a) let prices rise enough (a sizeable amount) to equate supply and demand; (b) rely on some form of (non-price) rationing to allocate the inadequate quantities supplied (at less than market-clearing prices) among consumers; [14] or (c) some combination of price increases and rationing.

The principal advantage of option (a), letting prices rise to market-clearing levels, is that it both curtails the amount demanded and induces an increase in the quantity supplied. If the higher prices lead to increased corporate profits, those profits will (if they are not transitory and if energy industries are kept competitive)[15] induce an expansion of capacity in energy industries, causing supply to increase and prices to fall (given demand). The principal disadvantage of price increases is that they redistribute income, probably regressively, from energy-good consumers to owners of energy-producing resources.

Non-price rationing, option (b), permits (although by no means guarantees) the avoidance of the redistribution of income which price increases would entail. It also curtails the quantity of energy demanded at prevailing prices by assigning relative priorities to the various excess-demanders. The principal defect of non-price rationing is that it provides no incentive to producers to increase output or to expand capacity. Hence it delays the adjustment of energy markets to the objective conditions of demand and supply. If supply is stagnant and demand increases over time, the longer non-price rationing stays in effect the larger the suppressed price increase becomes. Then with a logic worthy of Lewis Carroll's Wonderland, the prospect of very large price increases becomes the rationale for continuing the non-price rationing.

Our only experience with the long-term rationing of an energy good, in the field market for natural gas, confirms our worst suspicions about non-price allocation. The Federal Power Commission (FPC) has controlled the wellhead prices of natural gas since the 1950's. Since the mid-1960's, the FPC's price ceilings have been set below market-clearing levels. The result has been a growing excess demand for natural gas and (inevitably) along with it the need for increasingly detailed regulations to ration the limited quantities produced. The FPC's policy, designed to "protect" consumers and based on the unsupported contention that natural gas productive capacity could not be expanded if prices rose because of monopoly

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[14] Another way of viewing non-price rationing is that it distributes the shortage (excess demand) among the would-be but inevitably frustrated claimants. Notice that, whenever prices are prevented from attaining market-clearing levels, some form of non-price rationing, official or unofficial, must occur. Thus it is only correct to say that we do not yet have rationing of gasoline, for instance, in the sense of an officially organized rationing scheme. A wide variety of unofficial non-price rationing schemes has sprung up in the winter of 1973–74.

[15] We discussed the effects of monopoly in section II, on the OPEC cartel. There is little systematic evidence that domestic U.S. energy markets were not reasonably competitive, when markets functioned normally, during the 25 years after World War II. The few exceptions involved cases of government intervention (e.g., restriction of the supply of crude oil in the U.S. market through the combination of the mandatory oil import quota and the Connally "Hot Oil" Act, under which state production controls on output destined for interstate commerce were able to function legally). Ironically, numerous instances of monopoly practices have cropped up since the advent of general price controls in 1971, and especially during the height of The Energy Crisis of the winter of 1973–74: gasoline at 99.9¢ a gallon (and at Christmastime, yet), rampant price discrimination in No. 2 or "home" fuel oil, favoritism to regular gasoline customers, appointments to buy gasoline, and so on.

power and resource limitations,[16] has led to numerous lawsuits, distortions oe relative energy prices, increased production costs in industries forced to buy morf expensive fuels because they were unable to obtain gas supplies, and (recently) to long-term contracts for high-price imported liquefied natural gas (LNG).[17] The argument is being made that we should not deregulate the field price of natural gas because (says the Mad Hatter) the price to consumers would rise too much. Both current output and productive capacity are falling at the present time; the industry is charged with conspiracy by consumer advocates and even by the FPC staff (who cannot or will not admit their longstanding error of simple economic theory), but the plausible explanation is the prolonged underpricing of gas at the wellhead.

Compromise combinations of options (a) and (b) can be invented ad infinitum, in an attempt to blunt the worst income-redistributive effects of price increases but still leave some incentives for producers to expand output and new capacity. As with any compromise, however, there is always the danger of falling between two stools. A case in point is the Nixon Administration's proposal to ration gasoline but to permit the sale of coupons. The latter provision makes the curtailment of quantities demanded easier, but the rationing itself removes much of the incentive for producers to expand supplies. The reason is that prices to producers will be kept at considerably less than market-clearing levels, and recipients of the free coupons will earn the added income from any coupons that they sell. With the market out of equilibrium, the coupons should trade for somewhat less than the difference between the actual and the market-clearing prices.

The preceding discussion of price controls and non-price rationing leads us to commend highly the provisions in S. 2806 calling for the lifting of price controls on energy goods and endorsing market-pricing as the best means of allocating energy goods in the U.S. economy. We do not think that, in the long run, the interests of any group of Americans (except possibly the bureaucratic class, if such exists) would be best served by replacing markets with "coupon book economics." The present mess we find ourselves in derives in important part from government interference with market processes. Moreover, our only long-term experience with the suppression of the market and non-price allocation in energy—the regulation of natural gas prices at the wellhead—bears out the folly of tampering with the market mechanism and replacing it with regulations which, in the end, defeat the objectives of a sound national energy policy (including the very objectives the regulations were intended to promote).

B. Export Licenses

The contradiction between the philosophy just stated and Title VIII of S. 2806, which calls for the export licensing of energy-related products, is all too readily apparent. We fail to see the necessity for the export-licensing provisions, in view of the other measures proposed in S. 2806. Including such provisions imparts a grab-bag quality to a bill which is otherwise for the most part well-motivated and well-thought through. We therefore urge that Title VIII be dropped.

C. Domestic Tax Changes

It is useful to begin this discussion by reiterating several points made earlier. First, we endorse the philosophy of keeping government out of energy production and marketing decisions where markets are the best means of guiding those decisions. Second, government interventions are called for where social policy requires that factors "external" to market decision processes be taken into account in allocation decisions. One example of such an "external" factor is the objective of national independence in energy discussed in Section I. A second example is the spillover of benefits ("external effects") of a major petroleum "find" to persons owning or holding options on surrounding properties. (Yet a third example, the difficulty of appropriating the economic gains from basic research, is discussed in Section V.)

The proposed tax changes in Titles VI and IX can be evaluated within the preceding framework. The liberalization of the Federal income tax treatment of domestic oil and gas producers proposed in Title IX would interfere with market allocations by further subsidizing those producers compared to producers in other

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[16] The best available economic evidence is that field markets for natural gas were largely competitive before FPC price regulation became fully effective; see P. W. MacAvoy, *Price Formation in Natural Gas Fields* (New Haven: Yale University Press, 1962). There was and is no reason to expect prospective natural gas deposits to vanish after fields of a certain productivity have been discovered and developed.

[17] The fallacy of protecting consumers against price increases by underpricing domestic natural gas will be revealed when the gas utilities begin (as seems likely) "rolling" the LNG prices into their rate bases.

industries.[18] The subsidies would increase the incomes of those producers (or of their shareholders) and of owners of oil and gas resources. Also, to an extent which depends on U.S. import policy and on price regulation of natural gas, the extra subsidies could reduce the prices of oil products and natural gas in the U.S.[19] The question then is, "Do the additional subsidies to oil and gas producers yield additional benefits which justify the allocative and income-redistributive effects they would produce?"

The decades-old controversy over the Federal tax treatment of oil and gas is a swamp which it is well to avoid here.[20] One should resist a natural predisposition to question further Federal tax subsidies simply because an industry already enjoys sizeable such subsidies. There seems to be no justification, however, for new tax credits for expenditures on "secondary and tertiary recovery" (section 901) or "depreciable property" (section 902). If the price controls on crude oil and refined products and on natural gas are removed, as S. 2806 would provide, oil and gas producers would need no further encouragement to adopt the economically appropriate production techniques. (Subsidies for the development of new techniques are another matter, of course—see section V below.)

With regard to exploratory drilling, the situation is less clear cut. There are "externalities" in exploratory drilling—namely, the spillover of the information which it yields—which impede the appropriation by the people deciding how much to spend on exploratory drilling of the full expected economic gains from their investment.[21] If market prices are the sole guide, therefore, investment in exploratory drilling may fall short of what is socially optimal. In addition, market signals will not include the objective of national independence in energy; hence, tax subsidies are a possible alternative (or supplement) to the import-duty proposal examined in Section I above.

In this light, the proposed investment tax credit for exploratory drilling may be an effective and desirable public policy. Whether this judgment is warranted would depend on how the tax credit compared with other possible policies in terms of budgetary costs benefits achieved, and side effects. In our opinion, there may well be grounds for regarding an investment tax credit for exploratory outlays as a replacement for the present, more diffuse tax subsidies to oil and gas producers, which cover both exploratory and development drilling.[22] In recent research, the present authors have found some evidence that the percentage depletion allowance is not very cost-effective in inducing producers to hold larger proved reserves of oil and gas; however, the provision for "expensing" (instead of depreciating) "intangible" drilling costs for tax purposes appears more cost-effective than the depletion allowance.[23] Even if the tangibles-expensing provision were retained, it should perhaps be restricted to exploratory drilling.

We turn now to Title VI of S. 2806, which proposes an "excise tax on uninvested profits from energy sources." It will be helpful in discussing this proposal to begin with some discussion of how investment is allocated in a private-enterprise market economy.[24] In such an economy, flows of new investment are allocated among industries by relative rates of return (or "profit"), adjusted for differential risks. If capacity in industry A is to expand relative to that of industry B, the rate of return (adjusted for risk) in A must exceed that in B. Whether that will happen depends on the relative profitability of the two industries, which depends in turn on their relative costs and prices. If product and input markets are functioning, profitability will be determined by demand and supply, hence price and cost, conditions in the two industries. If demand increases and or supply decreases in industry A compared to industry B, the resulting higher profitability of A will attract investment resources. The measures proposed in S. 2806 to restore energy markets, if adopted, would create the necessary conditions for investment in the energy industries to occur as called for by market forces.

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[18] For a discussion of why the present special Federal tax provisions for oil and gas amount to a subsidy, and of the policy ramifications of such a subsidy, see the authors' paper, "The Economics of the Oil Industry's Tax Burden," in *The Petroleum Industry's Tax Burden* (Arlington, Va.: Taxation With Representation, 1973); reprinted in U.S. Congress, House Committee on Ways and Means, *General Tax Reform*, Part 5 of 18 March 10, 20, 1973), pp. 2290–2330.

[19] See the staff materials entitled *Fiscal Policy and the Energy Crisis* (November 20, 1973), p. 28.

[20] See the authors' paper on the oil industry's tax burden (*loc. cit.*) for references to the voluminous literature on this controversy.

[21] See F. M. Peterson, "Two Externalities in Petroleum Exploration," in G. M. Brannon, ed., *op. cit.*

[22] It is noteworthy that one of the major petroleum companies, Arco, has recently come out for doing away with all Federal tax subsidies to oil and gas—provided no price controls are imposed on the industry

[23] See our paper on the cost-effectiveness of Federal tax subsidies to petroleum in G. M. Brannon, ed, *op. cit.*

[24] For a more detailed discussion of this question, see our statement in U.S. Senate, Committee on Interior and Insular Affairs, *Financial Requirements of the Nation's Energy Industries* (Washington, 1973), pp. 250–258.

Earlier, though, we suggested that the objective of national independence in energy could mean that a completely free market allocation would not be socially optimal, since market prices would not reflect the social value of energy independence. The energy independence objective could be served by having more investment in energy-producing industries than market forces alone would call for. If this is so, a policy measure of the kind envisioned in Title VI of S. 2806, designed to assure that extra investment was diverted from non-energy to energy industries, could be justified.

It would be very useful to stress, in the supporting materials for the bill, that this provision is not the same thing as an "excess profits tax" on petroleum firms of the kind which has been proposed by a number of members of Congress and other people. An "excess profits tax" on energy industries would be antithetical to both the goal of restoring market allocation in those industries, and the objective of achieving national independence in energy. Such a tax would curtail investment in energy capacity below the level called for by market forces. It is sincerely to be hoped that the Congress will not yield to emotional appeals to slap an excess profits tax on energy producers, for such a tax would only aggravate the existing bad situation.

The excise tax on uninvested energy profits proposed in Title VI of S. 2806 avoids the undesirable effects of an excess profits tax. There is reason, however, to question both the need for this Title of the bill and its specific operation. In view of the other measures to promote energy independence in S. 2806, we seriously question the need for this additional measure. Once again, it suggests a grab-bag approach to energy policy rather than a carefully worked out set of proposals (a label which could characterize other parts of the bill). In addition, the mechanics of the energy profits excise tax appear exceedingly complex. In this respect, the measure does resemble an excess profits tax, which we know from past experience to be notoriously difficult and costly to administer.

If the Subcommittee should decide to include Title VI in the final bill, we would recommend one major change. As presently stated, the measure includes a "profit allowance," that is, an amount of profits not subject to the excise tax and hence beyond the reach of the investment incentive, of 20 percent of a firm's equity capital stock [25] used in energy production. It can be shown that this allowance would render the tax, and therefore the incentive as well, ineffective unless the rate of return on depreciated ("book") equity capital was greater than 20 percent.[26] In recent years, according to the supporting data for S. 2806 presented in Senator Gravel's speech to the Senate about the bill, rates of return in energy industries have hovered around half of that figure.[27] If left as is, then, Title VI would be a tax tiger with few if any teeth. Once the lack of teeth became known, the tiger would not even scare people, let alone change their investment behavior.

A simple way to amend Title VI to overcome the above toothlessness would be simply to drop the profit allowance. Otherwise there would be little point to including the energy profits excise tax measure in any energy policy bill.

We turn finally to the provisions in Title X calling for tax credits and deductions for energy-saving investments in private residences. No conceivable "external" factor is involved in private decisions concerning home heating and other residential energy uses which will not be registered by functioning markets and thus incorporated into the decisions. Therefore the measures in S. 2806 to restore

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[25] The term used in the bill is "net investment," which an economist might construe as a flow per year: In paragraph 4962, however, "net investment" is defined for legislative purposes as the "equity" capital stock, net of long-term debt. In the present d'scussion, we shall ignore the minimum profit allowance of $100,000 a year.

[26] Define P = profits from energy sources;
R = reinvestment in energy capital goods from P;
K = equity capital stock in energy production.

Then the energy profits excise tax function can be written

$$T(P) = 0.40\,(P - 0.2K - R), \text{ if } (.) \geq 0$$
$$= 0 \text{ otherwise.}$$

In the extreme case in which reinvestment R is zero, the tax would be positive only if $(P - 0.2K) > 0$. That would only happen, however, if the rate of return on equity capital (see footnote 27) were greater than 20 percent: $(P - 0.2K) > 0$ if $P/K > 0.2$.

Now, in the normal course of events, reinvestment in energy assets R would be positive without any tax incentive. It is straightforward that, for $R > 0$, the larger is R the higher must be the rate of profit before the tax would become an effective incentive for additional reinvestment. That suggests that the energy profit excise tax, as proposed, would not have much effect.

[27] We do not know whether the rate of return figures presented in Appendix C of the speech are computed on total adjusted-basis asset value or on the equity value net of debt stipulated in the bill. If the former, the tax incentive would be somewhat greater than our calculations suggest, although probably not substantially so. The difference would be smaller, the smaller the ratio of debt to equity in an industry's financial structure.

energy market operations would suffice to deal with problems of this kind.[28] If one is concerned about the expense of residential modifications for poor families, there are far cheaper ways to ease the burden of that expense (or of higher fuel outlays if they so choose) than measures such as this which would subsidize all taxpayers, rich and poor alike.[29] We therefore urge that this particular tax provision be deleted from S. 2806.

D. Foreign Tax Changes

The proposal in Title X to eliminate the percentage depletion allowance and the option to expense "intangible" drilling costs on petroleum wells located outside the United States is commendable. The next question is why the foreign tax credit, which the major international oil companies are able to take better advantage of than firms in other industries, was not also eliminated or sharply restricted. Even before the formation of the OPEC cartel, one could make only a tenuous case at best for allowing the two special deductions on foreign oil income. As for the foreign tax credit, it is common knowledge that a very high proportion of the "income taxes" paid by the oil companies to foreign governments is really royalty expense; hence it should be deducted from taxable income just like other expenses, not credited against tax liability.[30] By our estimate, 18 major oil companies (accounting for most of the foreign oil income of U.S. corporations) received extra tax relief through the foreign tax credit in 1970, compared to the average U.S. company with foreign income in that year, of about $850 million.[31]

As the Arab oil embargo of 1973–74 has plainly shown, any possible energy independence rationale for tax subsidies to foreign oil production vanished with the formation of the OPEC cartel, which accounted for the effectiveness of that embargo where earlier ones had failed. Moreover, OPEC's monopoly power permits it to expropriate a large share, if not all, of any tax breaks granted to U.S. firms operating in OPEC countries, simply by revising the royalty "agreements." There is no point in having U.S. taxpayers augment the already huge sums filling OPEC members' coffers as a result of the drastic price increases which have occurred since 1970. By removing the special tax deductions on foreign oil income and sharply limiting the foreign tax credit for oil companies, we would merely be reducing the inflated monopoly profits now being enjoyed by the oil-producing countries (and, possibly to some extent, by the major international oil companies).

IV. The Energy Trust Fund

The "trust fund" method of financing government programs has both advantages and disadvantages. Hence we shall not make a clear-cut recommendation on Title II of S. 2806, dealing with the Energy Trust Fund. The Congress must decide, after weighing the pros and cons, whether an energy trust fund should be included in a national energy policy.

The trust fund approach has the merit of providing the tax revenues needed to pay for the planned expenditures. This may make for a more consistent national fiscal policy than if expenditure bills are adopted independently of revenue bills and of the overall budget position (surplus, balance, or deficit) appropriate to macroeconomic stabilization policy. Tying expenditures to receipts in one segment of the Federal budget, however, may make fiscal policy more difficult to design and execute if Congress ignores the stabilization implications of *other* funding measures.

An implicit assumption in the trust fund approach to government finance is that those who bear the tax burden to create the fund also stand to reap the benefits of the expenditures from it, or the benefits of other activities, the effects of which the trust fund outlays are designed to offset or ameliorate. Thus the Highway Trust Fund comes from taxes on vehicle fuels and tires, on the premise that those goods are purchased by users of highways (who also benefit from highway safety research and other non-construction uses of the tax revenues). In the case of energy, the user-charge feature is not so obvious as for highways. One can make a case that users of energy derived from depletable resources are hastening the de-

[28] Relative prices (and inconvenience costs) have already begun to induce people to insulate then home s better rather than pay much higher fuel bills, and that is even without full energy marirket functioing.

[29] As so often happens, this measure would not help the really poor person who pays no taxes (and probably does not own a house).

[30] See, for example, the testimony of Professor J. Reid Hambrick before the House Committee on Ways and Means, printed in *General Tax Reform*, Part 9 of 11 (Washington, 1973) pp. 1364–1376. See also Glenn P. Jenkins, "United States Taxation and the Incentive to Develop Foreign Primary Energy Resources." in G. M. Brannon, ed., *op. cit.*

[31] See our "The Oil Industry's Tax Burden," *op. cit.*, p. 24.

pletion of those resources, and should pay a user charge over and above the market prices of the energy sources, since the market price will not include the loss of national energy independence over time associated with the depletion of domestic resources.[32] It would be helpful, if only in raising the intellectual level of public discussions of national energy policy, if this case (or whatever other case the sponsors of S. 2806 wish to make) were spelled out explicitly in the supporting materials for the bill.

The trust fund method of financing government outlays has the disadvantage of creating a focal point around which vested interests—those whose economic wellbeing depends on the size and disposition of the trust fund—can coalesce. If that happens, pressures to continue the trust fund will still be exerted long after the trust fund and its associated uses cease to be warranted. Consider again the case of the Highway Trust Fund. That fund financed an immense system of interstate highways and supporting local road networks. In the process, however, the powerful "highway lobby," comprised of the automotive, cement, steel and construction industries, coalesced around it. The vested interests in building more highways made it very difficult to allot Highway Trust Fund monies to non-highway programs (e.g., urban mass transit), even though in principle part of the user charges for highways should go to reduce and alleviate the air pollution and other "external effects" caused by automobile use. The plan to phase out the tax on energy sources by 1985 may avoid this problem, although the Congress could always revise the schedule of the phase-out. Also, lobbyists are fully capable of applying pressure in the regular appropriation and expenditure processes of the Congress and the Executive Branch, so that the "vested interest" problem does not arise solely under the trust-fund approach.

V. Monetary Awards and Loan Guarantees

Title III of S. 2806 proposes monetary awards for scientific and technical contributions to energy technology. In addition, it proposes loan guarantees to individuals, firms and other parties who engage in activities in two categories: (1) the design, construction, operation and maintenance of facilities for coal gasification, production of energy from oil shale, and other unconventional sources of energy; and (2) prospecting, exploration, development and production of oil or natural gas. New production techniques, of course, increase the supplies of energy which can be economically produced at any given price. There are some compelling reasons for government to subsidize the discovery and working out of new techniques. We shall examine the proposed monetary awards and loan guarantees in turn, as possible public policies for promoting new technology in energy.

The provision of monetary awards would establish government support of research and development expenditures on energy technology. One thing markets do not do well is allocate funds to research, especially basic research, because the product in question—information or knowledge—has "public good" aspects. That is, it is not always possible for a private person to prevent others from benefiting from money spent on research. Patent laws are one way to establish private property rights in the product of research and development, and thus to allow market allocation to function in this area. However, patent rights are often difficult to enforce, especially on the fruits of basic research. Furthermore, engaging in research which yields patentable information is only profitable if a charge can be made for the use of that information. But the assessment of such charges restricts the use of the information and, since information is not depleted through use, imposes an avoidable decrease in income on the society.

The monetary awards proposed in Title III provide a method by which both the enforcement and restriction costs of patenting new energy technology can be avoided. This would be accomplished by requiring that patent rights be forfeited, and the new technology be made freely available, as a condition of granting the award.

Loan guarantees for activities in category (1) above can be justified along the same lines as the monetary awards, since the guarantees in this category would apply to loans to firms engaged in energy research and development. This justification does not, however, apply as well to category (2). As we have seen, there is an

[32] Unlike highways, for which there are no organized markets in the United States (toll roads may be an exception of sorts), functioning energy markets will permit recovery of opportunity costs in energy production, including any tendencies for costs to rise over time. Hence an additional charge over market price must be justified on grounds of some "externality" which markets do not capture and include in prices—e.g., the public policy objective of energy independence which no single producer would have an incentive to pursue.

informational "externality" in the results of oil and gas exploration (and perhaps also in development, although it is much weaker than in exploration). The public good argument breaks down almost entirely, though, when it comes to loan guarantees for oil and gas production. An argument that loan guarantees for oil and gas production are in the public interest would have to be based on the energy-independence public policy objective which was discussed earlier. We do not find such an argument compelling, in view of the other policies in S. 2806 for achieving energy independence. We conclude, therefore, that provisions for loan guarantees in category (2) should be dropped from S. 2806.

"A Rebatable Tariff Proposal for Promoting Energy Independence"

A Report to the Subcommittee on Energy, Committee on Finance, U.S. Senate, February 1974

By James C. Cox and Arthur W. Wright, Department of Economics, University of Massachusetts, Amherst

As we detailed at some length in our written statement of January 25, 1974, energy independence is not the same thing as self-sufficiency. The paradox of pursuing self-sufficiency in a depletable resource is that the greater domestic production required today will *reduce* independence in the future. Instead of simply raising the share of domestic production in current energy consumption, a policy of energy independence should encourage the *current* use of imports—but also provide the capacity to switch to domestic production if foreign supplies are suddenly cut off. Since in a market economy no individual private producer will have an incentive to promote national energy independence, the government must intervene in energy markets if independence is to be achieved.

The possible government policy measures include direct controls, tax or expenditure subsidies, outright government purchase, and tariff schemes. For reasons having to do with the proper roles of government and private decision makers (also spelled out in our full statement), we think the last kind of measure, using tariffs, is preferable to the other kinds. A tariff scheme is the most indirect of the possible policy interventions cited, in that it influences rather than replaces the market mechanism. It also avoids both the windfall profits to select groups which direct controls frequently entail, and the budgetary involvement which often leads to special interest pressures to enlarge subsidies. Finally, the incidence of tariff schemes is divided between producers and consumers, according to relative supply and demand elasticities.

In what follows, we describe a possible tariff measure for encouraging energy independence. The essence of the measure is to impose a tariff on imported oil, but to rebate the tariff to companies which invest in *excess* domestic production capacity. We first carefully outline the way the tariff-rebate measure would operate. Then we address the practical matter of implementing such a measure.

Analytics of the Tariff Rebate Proposal

The proposal calls for setting a tariff on imports of crude oil and refined oil products, on the assumption that oil will continue for some time to be the principal focus of American problems with energy independence.[1] Provided that no quantitative barriers to market operation are imposed, the tariff would drive a wedge between the prices of domestic and of imported oil: domestic oil would be made cheaper at the margin than imported oil, and thus its share in total U.S. oil consumption would increase. Any tariff would make the United States more *self-sufficient* in oil than it would be with completely free trade. However, in order to promote energy *independence*, we propose to rebate the tariff on imported oil to firms which qualify by holding required minimum amounts of domestic excess capacity to produce crude oil. The logic of the rebatable tariff proposal can be explained with the aid of a number of graphs, as follows.

Figure 1 depicts a supply curve for domestic U.S. crude oil output; it has the usual property of supply curves, namely, that higher prices will induce larger quantities supplied. Figure 2 depicts a supply curve of imported oil, which relates the quantity of imported oil supplied in the U.S. market to the price of oil in that market. This curve is also drawn with an upward slope; if, however, the import supply curve were to be horizontal (as is sometimes thought), it would make no basic difference in the subsequent analysis. Figure 3 shows the total supply curve of oil in the U.S. market, S+M; it is derived by horizontally summing the domestic supply curve in Figure 1 and the import supply curve in Figure 2. For example, in order to determine the total quantity of oil which would be supplied at price P^*, we add the quantity of domestic oil supplied at that price, Q^*_d (see Figure 1), to the quantity of imports supplied at that price, Q^*_m (see Figure 2), to get the total quantity supplied at price P^*, namely, $Q^*=Q^*_d+Q^*_m$ (see Figure 3). Finally, Figure 4 depicts a domestic demand curve for oil; it has the usual property of demand curves, namely, that a larger quantity will be demanded at a lower price.

In Figure 5, we show the domestic supply curve S from Figure 1, the total supply curve S+M from Figure 3, and the domestic demand curve D from Figure 4. This combination permits us to describe the effects of indirect import controls such as tariffs. If imports were kept at zero, through either quota restrictions or a high-enough tariff, domestic supply S would constitute the total supply of oil in the U.S. market. In that case, the market-clearing domestic price would be P^1, at which price the domestic quantity supplied would be Q^1_d; since imports would be zero, Q^1_d would also be the total quantity supplied. This would be the result of a policy of complete *self-sufficiency* in oil.

[1] Imports of other forms of energy do not appear likely to increase significantly enough over their present levels to pose a serious threat to our energy independence, should they be suddenly cut off. If they do become more important, however, the present proposal could be adapted to apply to all imported energy goods.

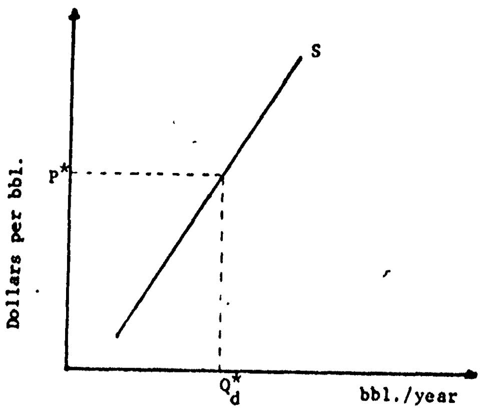


Figure 1

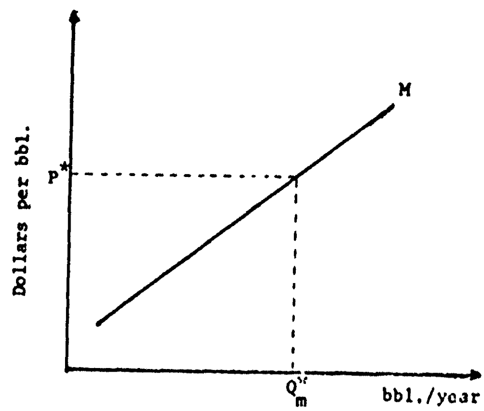


Figure 2

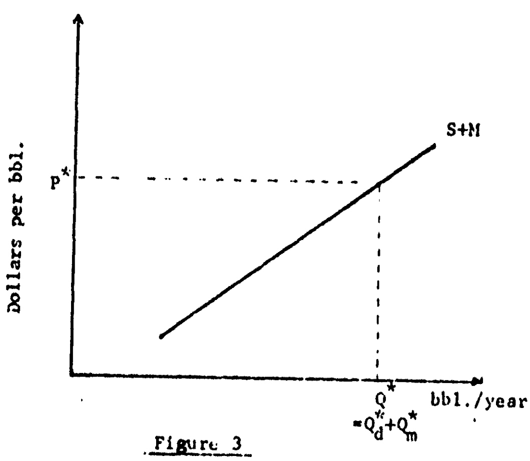


Figure 3

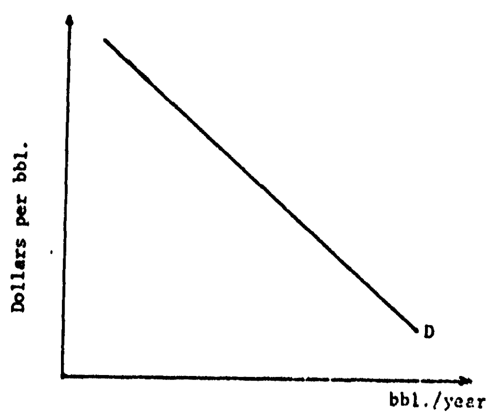


Figure 4

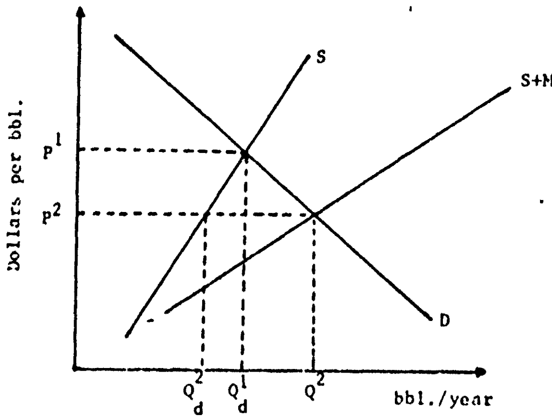


Figure 5

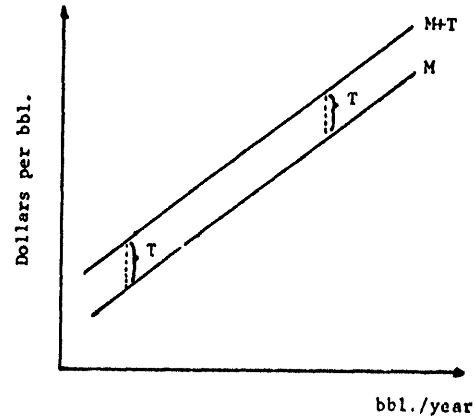


Figure 6

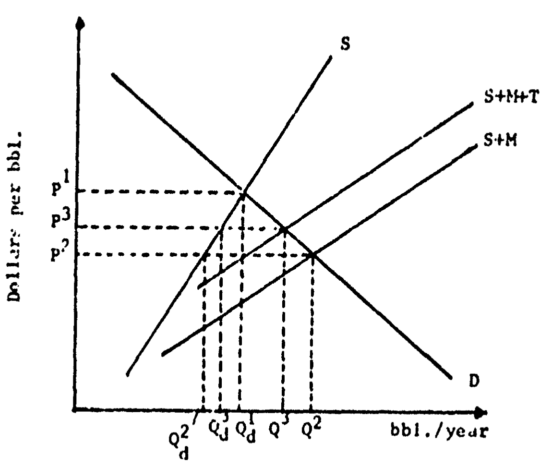


Figure 7

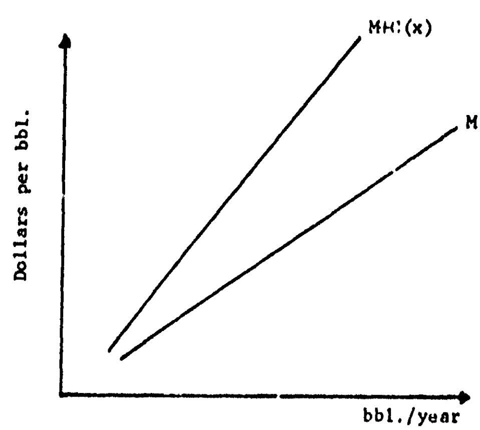
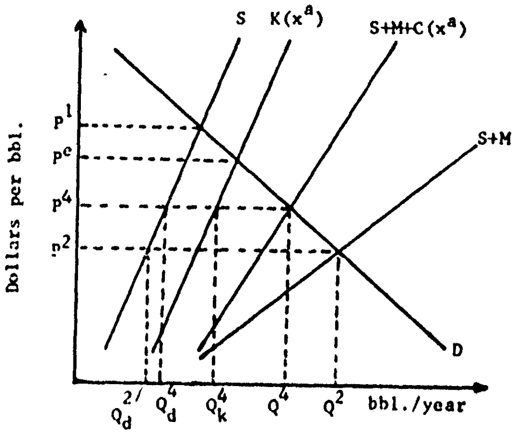


Figure 8



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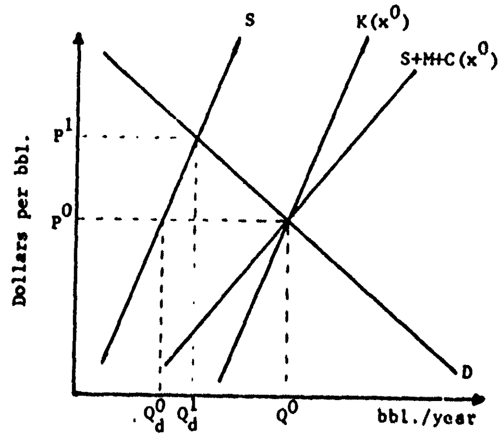

Figure 10

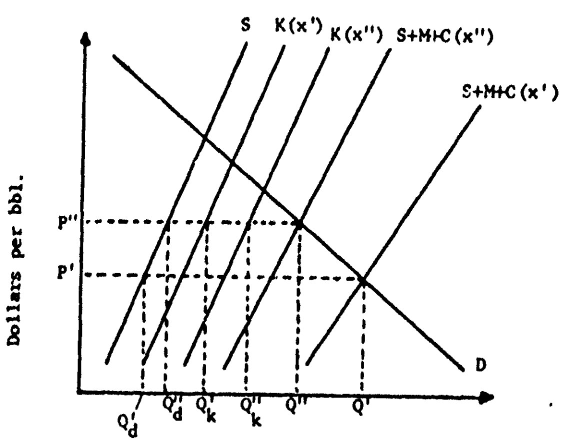

Figure 11

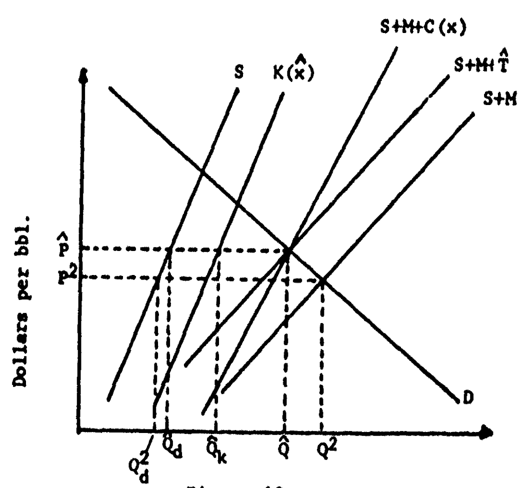

Figure 12

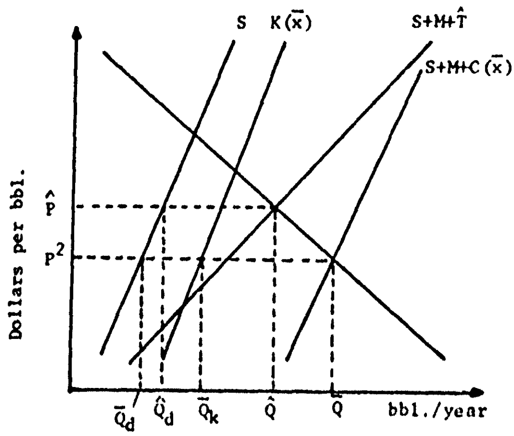

Figure 13

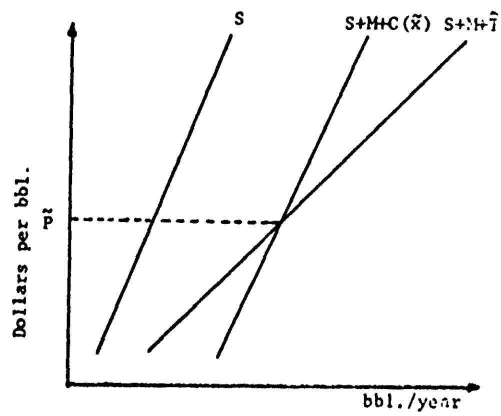

Figure 14

If, however, imports were allowed free access to the U.S. market, the relevant supply curve would be $S+M$. In that case, the market-clearing price would be P^2, and the total quantity supplied would be Q^2. At price P^2, domestic quantity supplied would be Q_d^2 and imports would be Q^2-Q^2_d. This would be the outcome of a policy of *free trade* in oil.

The complete self-sufficiency outcome (P^1, Q^1_d) and the free-trade outcome (P^2, Q^2_d, Q^2) are the boundaries of the range of prices and quantities over which a tariff policy can operate.

Suppose a specific tariff of $T per barrel is imposed on imported oil. This means that an amount T is added to the supply price of each barrel of imported oil; thus we derive the new after-tariff supply curve of imports, $M+T$, in Figure 6, by vertically adding the constant amount T to the import supply curve M from Figure 2. The new after-tariff total supply curve, $S+M+T$, in Figure 7, is then derived by horizontally summing the domestic supply curve S in Figure 1 and the after-tariff import supply curve $M+T$ in Figure 6. In Figure 7, the market-clearing price for oil, given demand D (from Figure 4) and a tariff on imports at rate $T/bbl., is the price P^3, which falls between the complete self-sufficiency price P^1 and the free-trade price P^2. The domestic quantity supplied at the after-tariff equilibrium price P^3 is the quantity Q^3_d; total quantity supplied is Q^3 and thus imports are Q^3-Q^3_d.

Since $Q^3<Q^2$ and $Q_d^3>Q_d^2$, imposition of the tariff T increases the share of domestic oil in the total quantity supplies: $Q_d^3/Q^3>Q_d^2/Q^2$. Therefore, the tariff provides more self-sufficiency and thereby greater independence *in the present period* from foreign suppliers. However, since domestic production with the tariff (Q_d^3) is greater than domestic production without the tariff (Q_d^2), domestic oil-producing resources are used at a faster rate and the attainment of energy independence *in the future* is made more expensive. The impairment of *future* energy independence will result from any policy which restricts present imports and, through the resulting higher market price of oil, induces an increase in *present* domestic oil output. As we shall show next, however, adding to a tariff policy a rebate provision which is tied to excess domestic capacity would provide present energy independence, but with less present self-sufficiency and therefore less impairment of future independence.

Under our proposal, a company would qualify for rebate of the tariff by holding a certain amount of excess domestic production capacity—say, enough to sustain an output rate of x barrels per year for one year. Holding excess capacity would not, of course, be costless to the company, since it would incur the cost (interest plus returns to equity owners) of tying up financial capital in the excess capacity. Let us call this cost $C(x)$ and suppose that $C(x)$ would increase as the policy variable x increased. Since we would require that x barrels of idle domestic capacity be held for each barrel of oil imported tariff-free per year, we can view the cost $C(x)$ of the excess capacity as an addition to the supply price (ex-tariff) of imported oil. Thus, in Figure 8, we depict the new import supply function, *cum* excess capacity costs (but net of the tariff, which would be rebated), as $M+C(x)$. The slope of $M+C(x)$ as depicted in Figure 8 is based on the reasonable assumption that the unit-cost of excess capacity rises as more excess capacity is acquired and held; hence, given the ratio of excess capacity to imports x, $C(x)$ would rise with the quantity of imports.

The outlays giving rise to the cost $C(x)$ would, of course, yield excess domestic production capacity—i.e., capacity over and above that with which domestic oil companies would produce the current outputs summarized in the initial domestic supply schedule S in Figure 1. The new total domestic capacity curve after the rebate proposal was adopted and implemented is depicted in Figure 9 as $K(x^*)$, where x^* is some particular chosen value of the excess-capacity policy variable x. Excess domestic capacity at any given price in Figure 9 would be $K(x^*)-S$; the new total supply curve *cum* excess capacity costs would be $S+M+C(x^*)$. Given demand D, we find that the market-clearing price is now P^4, again (as with the tariff alone) less than the self-sufficiency price P^1 but higher than the free-trade price P^2. At P^4, total quantity supplied is Q^4, domestic supply is Q^4_d, and imports are $Q^4-Q^4_d$. For the particular value of the excess-capacity/import ratio shown in Figure 9, x^*, the excess capacity held ($Q^4_k-Q^4_d$) could replace up to about one-half of imports ($Q^4-Q^4_d$) at the price P^4. If imports were cut off entirely, and if the price were allowed to rise to clear the market, it would go to P^*, which is between the self-sufficiency price P^1 and the previous price P^4; more than half of the missing imports would then be replaced by domestic oil, but with a higher market price.

It would be possible to set the policy variable x high enough to allow for 100 percent replacement of imports. This possibility is illustrated in Figure 10, where the excess-capacity/imports ratio x^0 has shifted K(·) to the right and S+M+C(·) to the left so that they both intersect the market demand curve D at P^0. At that price, domestic output would be Q^0_d and imports $Q^0-Q^0_d$; domestic excess capacity, $K(x^0)-S$, is equal to imports $Q^0-Q^0_d$ at P^0.

While it would therefore be *possible* to attain complete independence from foreign suppliers through a rebatable tariff, it would not necessarily be *desirable*. This is because each increase in x, yielding greater *present* independence, also increases the domestic market price and hence present domestic output. In Figure 11, for example, the greater present independence associated with x'', compared to the lower excess-capacity/imports ratio x', would be "purchased" at the cost of a higher market price $P''>P'$ and gretaer present domestic output, $Q''_d>Q'_d$. The latter would make future independence more expensive, since domestic oil producing resources would be used at a faster rate. As noted above in the discussion of Figure 7, the impairment of future independence is a necessary consequence of any policy which restricts present imports and increases the domestic market price. We shall show next, however, that a rebatable tariff tied to excess capacity would give greater present independence, for a given impairment of future independence, than would a straight tariff or other policy which merely increased self-sufficienty by curtailing imports. Alternatively, the rebatable tariff would impair future independence less, for given present independence.

In order to understand these two propositions, let us first compare the effects of a non-rebatable tariff and a rebatable tariff which would produce the same domestic market price (hence the same present domestic rate of output). In Figure 12, the non-rebatable tariff $\hat{T}$, added to S+M to give the total supply curve $S+M+\hat{T}$, would lead to the market-clearing price $\hat{P}$. Thee xcess-capacity/import ratio $\hat{x}$ with a rebatable tariff would give the same market price—i.e., $S+M+\hat{T}=S+M+C(\hat{x})$ at $\hat{P}$. Under both policies, domestic production would increase from the free-trade amount Q^0_d to the amount $\hat{Q}_d$; hence future independence would be impaired equally by the two policies. Under the rebatable tariff, however, there would be excess capacity of $\hat{Q}_k-\hat{Q}_d$ (at price $\hat{P}$) held in reserve in case some portion of imports $(\hat{Q}-\hat{Q}_d)$ were suddenly cut off. Therefore the rebatable tariff would yield greater present independence than the non-rebatable tariff, at the same sacrifice of future independence.

The alternative proposition, where the rebatable tariff compared to the non-rebatable tariff implies less impairment of future independence for the same amount of present independence, is illustrated in Figure 13. The quantity of *dependent* imports $(\hat{Q}-\hat{Q}_d)$ is the same under the non-rebatable tariff $\hat{T}$ as under the excess-capacity/import ratio $\bar{x}$ $(\bar{Q}-\bar{Q}_k)$ because imports equal to $\bar{Q}_k-\bar{Q}_d$ can be replaced at $\bar{P}$ by bringing the excess capacity into production. However, since $\hat{P}>\bar{P}$, present domestic production under the non-rebatable tariff $(\hat{Q}_d)$ exceeds that under the rebatable tariff $(\bar{Q}_d)$. Hence, while the two policies yield the same present independence, the rebatable tariff accomplishes this with less sacrifice of future independence. In addition, in this case consumers would get a lower price under the rebatable tariff $(\bar{P})$ than they would under the non-rebatable tariff $(\hat{P})$

The preceding outcome, that rebatable tariff would always outperform a non-rebatable tariff in furthering energy independence, is not, of course, a "free lunch." The cost of the rebatable tariff scheme would be the tariff revenue, which would be rebated to oil importers who qualify by holding excess domestic capacity. Under a non-rebatable tariff, the revenue would be retained by the Treasury for use in financing other public programs or retiring Federal debt. In effect, by adopting a rebatable tariff tied to excess oil production capacity, the Federal Government would be deciding to spend the tariff revenues on energy independence.

Before we turn to the question of implementation of a rebatable tariff, there is one final analytical point—in fact, a point which pertains to implementation. We assume that oil importers would be free to choose whether or not to qualify for the tariff rebates by holding excess capacity. That is, importers would have the option to pay the tariff and not hold excess capacity if they found it profitable. For the rebatable tariff policy to achieve its objectives, however, most companies would have to choose the excess-capacity option most of the time (at least under normal oil market conditions). In order to insure this result, the tariff would have to be set high enough to create the needed incentive to hold excess capacity. In Figure 14, for example, oil importers would *not* try to qualify for rebates of the tariff at any price above P, since to do so would make imported oil *cum* excess capacity cost more expensive than imported oil *cum* tariff. If the market price were higher than P, a rebatable tariff policy for promoting energy independence would not be effective.

A simple way to ensure that a tariff rebate policy is effective would be to choose a very high tariff rate. For a given excess capacity/import ratio x, raising the tariff above T would shift the curve S+M+T upwards and to the left; since the curve S+M+C(x) would not shift, however, the maximum price at which the tariff rebate would still be effective could be made sufficiently high to ensure that the policy would work. Note that, since policy makers would *not* want to keep the tariff proceeds, the level of the tariff would not be important—so long as the excess capacity option was chosen by firms. Hence the agency implementing a rebatable tariff proposal like ours should "err" on the high side in selecting the size of the tariff.

Implementing a Rebatable Tariff

The question now before us is, how could the proposal detailed above be implemented? To answer this question, five crucial matters must be dealt with: (1) the measurement of crude-oil production capacity; (2) setting the ratio (x) of excess capacity to tariff-free imports; (3) the basis on which the tariff would be set and the size of the tariff; (4) the feasibility of holding and activating excess capacity; and (5) the treatment of refined oil products under a tariff. We shall discuss each of these matters in turn.

(1) Measuring production capacity: The Federal Energy Administration (FEA) proposed in S. 2806 should be charged with choosing or developing an operational measure of crude oil production capacity appropriate to ensuring independence in case oil imports were suddenly cut off. A number of measures of petroleum production capacity have been devised and discussed in the literature. Perhaps the best known measure is that compiled by the Productive Capacity Committee of the Independent Petroleum Association of America (IPAA). The IPAA measure is defined as "the average rate of production from existing wells that could be maintained for a period of from 6 to 12 months without further development and with no significant loss of ultimate recovery . . . [and assuming] no substantial modification of producing facilities or operating methods." [2] The National Petroleum Council (NPC), an industry group convened by the Secretary of the Interior, has periodically compiled estimates of production capacity on a somewhat different basis; recently the NPC had distinguished capacities which could be made available after 90 days, after 180 days, and so on.[3] A rough approximation to production capacity is the ratio of proved reserves to current output, much beloved of industry spokesmen and Jeremiahs of energy-resource exhaustion alike; in our opinion, this measure is too rough an approximation to be useful.[4]

To select the one measures of domestic crude oil production capacity most appropriate to the purposes of a rebatable tariff for promoting energy independence would require considerable study. We do not pretend to have made such a study, nor do we want to proscribe the choices of the FEA. In all likelihood, however, a measure akin to the "productive capacity" concepts employed by the IPAA or the NPC would be more appropriate (and consistent with our earlier concept of "total domestic capacity," K(x)) than looser measures such as the ratio of proved reserves to current output.

(2) Setting the excess-capacity/import ratio (x): Our rebatable tariff proposal would operate by having the FEA set values of the policy variable x, the annual rate of production sustainable from excess capacity, required to qualify for rebate of the tariff on one barrel of imported oil. The FEA would be charged with determining a target level of excess capacity required for attaining independence in oil (see our earlier discussion, ca. Figure 10, of the tradeoff between complete (100%) current independence and future independence). The FEA would then

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[2] Quoted from S. McDonald, *Petroleum Conservation in the United States* (Baltimore: Johns Hopkins Press for Resources for the Future, 1971), p. 166, n. 14. The IPAA figures are given in convenient form (through 1968) in American Petroleum Institute, *Petroleum Facts and Figures 1971* (Washington, 1971), p. 101.

[3] See the NPC's *U.S. Energy Outlook 1971-1985* (Washington, 1972).

[4] For a general discussion of the concepts and measurement of oil production capacity, see A. D. Zapp, "Future Petroleum Producing Capacity of the United States," *Geological Survey Bulletin* 1142-H (Washington: Government Printing Office, 1962).

set the value of x for a given period, taking into account the existing size of excess capacity compared to the independence target level and the degree of adjustment by the domestic oil industry to the prevailing value of x. The industry could not, of course, profitably adjust to each new value of x instantaneously. A good indicator of (more or less) complete adjustment would be that all or most of the tariff revenue was being rebated—i.e., that firms had acquired the necessary excess capacity to qualify for the rebates, given the prevailing value of x. The FEA would periodically raise the value of x until the independence target level of excess capacity had been reached. Thereafter, changing conditions of domestic demand, domestic supply and import supply (or changing assessments of the need for independence in oil) could require adjustment of the x variable.

(3) Basis and size of the tariff: The FEA would be charged with imposing a tariff on imported oil. Tariffs may take a variety of forms. The most usual forms are as fixed dollar amounts or as a percentage of the c.i.f. price of the good (analogous to specific and *ad valorem* taxes, respectively). Another form of tariff is used to fix the domestic price of a commodity which is both imported and produced domestically. The variable tariff on agricultural commodities which is assessed by the European Economic Community (EEC) is a tariff of this type. This tariff is administered in the following manner. A domestic "target price" is set by the government of the importing country. The variable tariff is then assessed at a rate which is equal to the difference between the target price and the market price of imports. The variable import duty assessed in this way restricts imports to enable the importing country to maintain the domestic price at the target price level. Thus market-pricing is replaced by bureaucratic price setting when a variable import duty is used in this way.

We favor the fixed-dollar and *ad valorem* forms of tariff. The target price form of the variable import duty too easily lends itself to a particular price target becoming a *shibboleth*. Furthermore, we do not find any convincing argument for totally replacing market-pricing of petroleum products with bureaucratic target-pricing. Regarding the size of the tariff, recall our discussion at the end of the preceding section (ca. Figure 14) of the importance of setting the tariff high enough to be effective. Since under our proposal the tariff would be designed to be rebated anyway, a useful guideline for the FEA in setting the tariff would be to err on the high rather than on the low side.

(4) Feasibility of holding and activating excess capacity: That it would be feasible for domestic crude oil producers to hold excess production capacity is shown by the existence of considerable excess capacity throughout the 1950's and 1960's in the five major producing states which practice "market-demand prorationing."[5] The excess capacity was created in those states by state regulations which held production from the existing stock of wells below their rated capacities.[6] We assume that the FEA could administer a Federal program of excess capacity in such a way as to eliminate the incentive to overdrill (given the capacity rate of output) which led to substantial waste in the prorationing states.[7]

Excess capacity held in the above manner could, in case of emergency, be brought into production on relatively short notice: the rates of production from existing wells would simply be raised towards their capacity levels by the requisite amount to meet the emergency. The FEA would have to devise a set of procedures to be followed for increasing production rates when it was determined (by the appropriate authorities) that U.S. independence in oil was threatened.

(5) Treatment of refined oil products: Imports of refined oil products could be substituted for imports of crude oil. In the short run (given production capacity), the choice between importing crude and importing products would be based on relative *after-tariff* prices and on the availability of refinery capacity. In the long run, the relative rates of tariff on crude and on products could influence the location of new refinery capacity. To illustrate this point, let us suppose that a high rate of tariff was imposed on crude oil but no tariff was imposed on refined products. There would then be a strong incentive (with or without a tariff rebate provision) to construct refineries outside the United States and ship products rather than crude into the U.S. market in order to avoid the tariff. That would, of course, defeat the energy independence policy embodied in a rebatable tariff in

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[5] The five states are Kansas, Louisiana, New Mexico, Oklahoma and Texas; see McDonald *op. cit.*, p. 165

[6] In Texas, the regulatory agency (the Texas Railroad Commission) sets the "rated allowable" (Maximum) production on each well when it first begins operating; in addition, the Commission sets the number of "shutdown days" per month—that is, it sets the proportion (the "market-demand factor") of maximum allowable production which may actually be produced in a given month. See *ibid.*

[7] See M. A. Adelman, "Efficiency of Resource Use in Crude Petroleum," *Southern Economic Journal* October 1964.

two ways: (1) the crude oil tariff rebate provision would not be effective in inducing crude oil producers to hold excess capacity; and (2) the transfer of new refinery locations from domestic to foreign locations would make the U.S. more dependent on foreign refinery capacity.

Tariffs on refined oil products would therefore have to be included in any rebatable tariff policy for promoting independence in oil. It would then be important to choose the *relative* rates of tariff on crude and on tariffs in such a way as to create the desired incentives for locating new refinery capacity. There are three policy alternatives: (a) assess relative rates of tariff on crude and on products which would be *neutral* with respect to refinery location—i.e., tariff rates which would lead to the same refinery location incentives after as before the tariff was imposed; (2) set the tariff on crude oil relatively lower than the tariffs on products in order to encourage construction of domestic refineries (for greater independence in refinery capacity); and (3) set the tariff on crude relatively higher than the tariffs on products in order to discourage construction of domestic refineries (e.g., in order to export the environmental damage caused by refineries).

The first alternative, a tariff policy of neutrality with respect to refinery location, would be the most difficult to implement. The reason is the difficulty of determining tariffs on refined oil products which would be equivalent to a given tariff on crude oil.[8] In fact, given the ability (both short- and long-run) of refiners to vary their mixes of refinery products, it is doubtful that there is any one solution to this problem which would not over time give rise to distorting incentives to refiners, compared to the free trade situation. We suggest that the FEA be charged with initially choosing a provisional "standard" refinery mix (e.g., a weighted average of the mixes prevailing at all foreign refineries from which products were shipped to the U.S. market), but given the authority to modify that standard mix to adapt to problems which might arise. The FEA could be empowered to impose differentiated tariffs on products from different refineries. The FEA could also be empowered to exempt specific imported products from the tariff-rebate-excess-capacity mechanism—i.e., to have free trade in specific products—along the lines of the treatment of residual fuel oil destined for the U.S. East Coast after 1966, under the old mandatory oil import quota.

While refined oil products present some problems, they may also offer opportunities for U.S. energy policy. It could be desirable to use product tariffs deliberately to achieve desired policy ends—e.g., to alter foreign refinery mixes (including *ex ante* designs) or to provide incentives to locate refineries in the United States or in particular foreign countries.

A Report to the Senate Subcommittee on Energy, Committee on Finance, Concerning the Foreign Tax Credit, March 8, 1974

BY JAMES C. COX AND ARTHUR W. WRIGHT, DEPARTMENT OF ECONOMICS, UNIVERSITY OF MASSACHUSETTS, AMHERST

The sudden onset of the "energy crisis" in the autumn of 1973 brought with it an awareness that U.S. energy policy should be directed in part towards ensuring independence[1] of foreign sources of oil supply. Such an awareness is reflected throughout S. 2806 as originally drafted. One aspect of U.S. energy independence touched upon in S. 2806 is the tax treatment of foreign income. The bill in present form calls for eliminating the percentage depletion allowance and the option to "expense" so-called "intangible" drilling costs on foreign operations. In our written statement, we agreed with these changes, but went further to suggest also modifying the foreign tax credit as it now affects the foreign operations of U.S. petroleum companies.

In this supplementary report, we develop the rationale for the last recommendation, and indicate a possible way to implement it. Looking ahead, we argue that petroleum company "income taxes" paid to the governments of countries in which they produce crude oil are in fact payments for the right to produce the oil; hence they should be *deducted* from gross revenue in arriving at taxable income (as is done in similar cases for domestic operations), not *credited* against taxes owed. Furthermore, the present foreign tax credit has been used by the international

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[8] The Cabinet Task Force (*ibid.*) recommended an "interim" tariff on products (excluding residual fuel oil), plus a "study group of qualified experts" to resolve the difficulties foreseen for the interim measure. The latter recommendation, like the rest of the Task Force's report, was never implemented.

[1] We argued at some length in our written statement that energy *independence* was not the same thing as energy *self-sufficiency*. The latter causes U.S. domestic energy resources to be depleted at a faster rate now at the expense of higher costs—i.e., more expensive independence—later.

companies to shift taxable income, via inventive transfer pricing between subsidiaries, from the consuming countries (not only the United States), to the tax-haven producing countries. Finally, if we do not greatly reduce the tax privilege inherent in the foreign tax credit as presently practiced, eliminating other special tax provisions (such as percentage depletion on foreign operations) will make scarcely any difference to the oil companies or (more importantly) to U.S. energy independence.

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That the so-called "income taxes" paid by the international oil companies to the oil-producing countries are not in fact corporate income taxes, in the sense in which that term is used in the U.S. tax law, can be seen from the way the tax is calculated.[2] "Income" is defined as output multiplied times a fictitious "posted price," less production costs and a token "royalty" payment. Since the posted price is set by negotiation between the producing country (which is a sovereign power) and the companies (which, in spite of their vaunted power, are guests in the host country), this "income" has nothing to do with actual revenues received by the companies. Adelman has likened the tax calculated as a percentage of this "income" to an excise tax, set by the government without reference to actual company revenues,[3] and Jenkins has interpreted it as a royalty payment, extracted by the host countries as the "economic rent from low-cost oil reserves."[4] The only sense in which these taxes can be regarded as "income taxes" is that the Internal Revenue Service (and the courts) have allowed them to be credited against U.S. corporate income tax liability.

The total dollar amount of the possible foreign tax credits against U.S. income taxes has grown steadily over time, especially since the OPEC group of producing nations achieved their monopoly in 1970 and proceeded to raise the fictitious posted prices drastically. Since the maximum size of the credit is limited to possible U.S. tax liability, however, the companies have not used up all of the possible credits. With the carry-back and carry-forward provisions in the present tax law concerning the foreign tax credit, the companies have accumulated enormous excess foreign tax credits. The major international oil companies have been able to take relatively much greater advantage of the foreign tax credits than the average U.S. corporation with foreign operations.[5]

The large excess credits constitute an irresistible temptation to shuffle income from areas of high income tax rates into areas with low (effective) income tax rates such as the oil-producing countries and countries such as Liberia and Panama. That the oil companies have not resisted this temptation has been documented by Jenkins, who shows (for example) a very low proportion of reported income (from a very high proportion of capital investment) in the high-tax major developed oil-consuming nations, and a very high proportion of reported income (from a very low proportion of investment) in low-tax countries.[6] The shuffle of income is accomplished by altering internal transfer prices, assigning high prices for goods produced in low-tax countries and transferred to high-tax countries.

Jenkins also shows how the indirect tax shelter thus afforded investment in Western Europe stimulated the building of refinery capacity there while it was being neglected in the United States. Such a stimulus is scarcely compatible with an energy policy directed at U.S. energy independence. The huge excess foreign tax credits also mean that other special tax treatments of foreign oil operations, such as the percentage depletion allowance, are not really effective; hence removing them while leaving the foreign tax credit intact would be an empty gesture. Finally, as we argued in our written statement, the monopoly power now exercised by the OPEC cartel permits the OPEC countries to siphon off a high proportion (up to 100 percent) of any tax privileges granted to U.S. oil companies' foreign operations—this, on top of the already swollen revenues accruing to OPEC treasuries because of the monopoly price increases.

The preceding argument is a more than adequate basis for concluding that the foreign tax credit as presently constituted is damaging the interests of the United

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[2] See M. A. Adelman, "Is the Oil Shortage Real?", *Foreign Policy*, No. 9 Winter 1972-73, p. 78, n. 7. Also, Glenn P. Jenkins, "Tax Preferences and the Foreign Operations of the U.S. Petroleum Industry," Statement to the Subcommittee on Multinational Corporations, Senate Committee on Foreign Relations, Jan. 30, 1974; *idem.*, "United States Taxation and the Incentive to Develop Foreign Primary Energy Sources," forthcoming in G. M. Brannon, ed., *Studies in Energy Taxation* (Energy Policy Project).

[3] *Op. cit.*

[4] Jenkins, "Tax preferences . . . ," *op. cit.*, fn. 2.

[5] See our paper, "The Oil Industry's Tax Burden," in *The Petroleum Industry's Tax Burden* (Arlington, Va.: Taxation With Representation, 1973), p. 73-24.

[6] Jenkins, *op. cit.*

States, including the policy goal of energy independence. We therefore urge that S. 2806 be modified to include a provision eliminating or greatly reducing the foreign tax credit on income earned on foreign oil production. The next question is how to implement this recommendation.

A simple measure would be to add to the present tax law a provision explicitly prohibiting the foreign tax credit from being granted where the income base of the foreign tax was not computed from revenues and costs arrived at on the basis of "arm's-length" pricing practices. There is ample precedent for such a measure in the regulations for implementing the percentage depletion allowance on mineral output in the United States. Where there are no arm's-length sales, the depletion regulations provide for a procedure to estimate what the price would be, if such sales did exist.[7]

A second measure, not necessarily mutually exclusive with the first one, would be to require that income qualifying for foreign-tax credit treatment bear a "reasonable" relationship to investment. This measure would presuppose a further requirement that companies use the per-country method rather than the overall method of computing foreign income for purposes of U.S. tax treatment.[8] Tying income more closely to investment on a per-country basis would reduce if not eliminate the possibility of shuffling income from one country to another by imaginative internal transfer pricing.

Senator GRAVEL. The committee will stand in recess until 9:30 on Monday.

[Whereupon, at 4:30 p.m., the subcommittee recessed, to reconvene at 9:30 a.m. on Monday, January 28, 1974.]

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[7] The regulations call for the use of a "representive field or market price" to compute "gross income from mining (Section 1.613-3(a) and (c)). Where such a price does not exist, the "proportionate profits" estimating method is to be used (Section 1.613-3(d) (1)).

[8] We are indebted to Glenn P. Jenkins for first suggesting this measure to us in conversation. On the per-country *versus* the overall method of determining eligible income for foreign tax credits, see Jenkins' two papers (*op. cit.*, fn. 2). Recent news reports indicate that congress is considering requiring the use of the per-country method.

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FISCAL POLICY AND THE ENERGY CRISIS

MONDAY, JANUARY 28, 1974

U.S. SENATE,
SUBCOMMITTEE ON ENERGY
OF THE COMMITTEE ON FINANCE,
Washington, D.C.

The subcommittee met, pursuant to recess, at 9:45 a.m., in room 2221, Dirksen Senate Office Building, Senator Mike Gravel (chairman of the subcommittee) presiding.

Present: Senator Gravel.

Senator GRAVEL. The hearings will come to order.

This is a continuation of a weeklong hearing schedule on the Energy Review and Development Act.

We have three witnesses today, Professor Heronemus, Dr. Lindmayer, and Dr. Stephen Krajcovic-Ilok—and I apologize for not pronouncing that right.

Dr. Heronemus and Dr. Lindmayer are both in the solar field, and I wonder if it might not be more efficient for all of our time for both of you gentlemen to come forward and each make your presentation and then we could have a dialog, all three of us together, on the subject of solar energy and things related to it.

Now, Dr. Krajcovic-Ilok—is Dr. Krajcovic-Ilok here?

No, he is not here.

Gentlemen, I am very grateful. Please each take a seat.

Gentlemen, I am very, very happy for your taking the time to prepare testimony.

Dr. Heronemus, why do you not proceed first, at your leisure, make a presentation, and then we will have questions and then we will go to Dr. Lindmayer.

[A biographical sketch of Dr. Heronemus follows:]

BIOGRAPHICAL SKETCH OF WILLIAM E. HERONEMUS, DEPARTMENT OF CIVIL ENGINEERING, UNIVERSITY OF MASSACHUSETTS

William E. Heronemus was born in Wisconsin, educated in Madison public schools, the University of Wisconsin, the U.S. Naval Academy, and the Massachusetts Institute of Technology. He served as a commissioned officer in the United States Navy from 1941 to 1965 when he was placed on the retired list. Most of that service involved management of the design, construction, and repair of submarines. From 1965 to 1967 he was associated with the United Aircraft Corporation in Farmington. In 1967 he was asked to join the Civil Engineering Faculty in the University of Massachusetts to assist in creation of a new teaching and research program in Ocean Engineering. During the last three years he has become completely involved in alternative energy sources, particularly those whose use requires ocean sited power plants.

Recent Publications include: (1) "The United States Crisis: Some Proposed Gentle Solutions," The Congressional Record, Vol. 118, No. 17, 2/9/72, Part II, pages E. 1043-9, (2) "Power From the Offshore Winds," Proceedings, 8th Annual Conference and Exposition, Marine Technology Society, Sept. 1972, Washington, D.C., pages 435-466, (3) "Alternatives to Nuclear Engineering," CATALYST, Vol. II, No. 3, Fall 1972, pages 21-26, (4) "A Proposed Two-Increment Windpower System for the Production of Electricity for Long Island," presented 16 January 1973 as testimony in the matter Long Island Lighting Company Proposed Shoreham Nuclear Power Station, AEC Docket No. 50-322, (5) "Alternatives to the Heating and Evaporation of Groundwater While Still Satisfying the U.S. Energy Appetite," presented to the ASCE Water Resources Management Conference, 1 February 1973, Washington, D.C., (6) "The Possible Role of Unconventional Energy Sources in the 1972-2000 U.S. Energy Market," a statement, page 493, Hearings Before the Subcommittee on Science, Research and Development of the Committee on Science and Astronautics, House of Representatives, Ninety-Second Congress, Second Session, Energy Research and Development (No. 24), (7) "Windpower, Look Backward, Then Move Forward Confidently," Conference Paper C74098-0, IEEE PES Winter Meeting, January 1974, (8) "Windpower: Near Term Partial Solution," Conference Paper, IEEE EASCON, September 1973, (9) "A Preliminary Study of a Large Windpower Electricity System Sited in the Lake Ontario Region," Testimony read at the Oswego, New York hearings of the AEC Licensing Board Inquiring into the Approval of a Construction Permit for Nine Mile Point Number Two, October 1973, (10) "The Feasibility of Windpower Utilization in the Wisconsin Energy Market," Published privately, prepared for Senator Doug LaFollette of the State of Wisconsin, (11) "Solar Energy: A Key to Global Survival," prepared for the Center for the Study of Democratic Institutions; presented at their December 1974 Conference on Energy and the World System, to be published in the proceedings of that conference, (12) "Ocean Thermal Power Plant Design," with J. M. McGowan, J. W. Connell, and P. D. Cloutier, Conference paper 73-WA/Oct-5, ASME Winter Meeting '73, (13) "Alternative Energy Sources From the Ocean," to be published in the Marine Technology Society Journal, Vol. 8, No. 1, 1974.

STATEMENTS OF PROF. WILLIAM E. HERONEMUS, DEPARTMENT OF CIVIL ENGINEERING, UNIVERSITY OF MASSACHUSETTS, AND DR. JOSEPH LINDMAYER, PRESIDENT, SOLAREX CORP.

Mr. HERONEMUS. Thank you, Mr. Chairman.

My name is William E. Heronemus. I am a professor of civil engineering in the University of Massachusetts at Amherst. A résumé of my education and professional experience is appended to this statement.

During the past 5 years I have devoted the majority of my effort to the study of energy problems, concentrating therein on the feasibility of alternatives to combustion, fission or fusion. I am identified by some as a strong proponent of solar energy process, a believer in the proposition that such solar energy processes could be developed and put to use in this country in the very short term. They could be used economically and to our overall benefit and improved well-being. In my support of that proposition I have over the past 3 years become somewhat outspoken against the peaceful use of atomic energy, primarily because I have become convinced that its advocates constitute a formidable power group who have been able to block even a semblance of competition with proliferation of nuclear power.

The demonstrated capacity of that group to stamp out competition of ideas as to future energy resources and practices is identified by me at least as a dangerous state of affairs in a democracy. I am also convinced that the published U.S. energy policy, which places primary emphasis upon expansion of combustion and fission processes, is fundamentally in error insofar as the long-term survival of mankind on Earth is concerned.

Rather than simply complain about the processes which I think are wrong, I have at all times disciplined myself to show that there could be alternatives, and that they would bring us significant net advantage rather than a reduced quality of life. I personally am opposed to the waste of energy that occurs in this country and I am concerned about the rate at which irreplaceable fossil fuels are being burned. But I am equally concerned about the consequence to our domestic and international system that would accompany any sizable decrease in energy consumption. All of the above has led me to the conclusion that solar energy alone could and should become the mainstay of our domestic and global energy system, starting just as soon as we can make the arrangements.

I therefore look with great favor on the content and the intent of S. 2806, the Energy Revenue and Development Act of 1973. The circumstances which to date have not been available and which are necessary for the development and growth of solar energy systems do seem to have been provided for in that bill.

I would like to speak first to the concept of the Commission on Energy Technology Assessment as set forth in title IV of the bill. The idea of open and broad debate, and the constant injection of that which a reasoning group selects as best suited into a U.S. energy policy is in my opinion excellent. The introduction of social, political, economical as well as technical and scientific parameters into those debates is essential. It is perhaps in that respect that we have failed the most in past and recent past attempts to promulgate a useful energy policy. I wonder, however, how well it will work, unless the bill itself tackles the problem of insuring that the members will represent a broad spectrum of energy thinking. It has been my sad experience to realize that breadth of approach is almost universally missing from most of the scientists and engineers to whom we ascribe the accolade of expert competence.

There is a fundamental difference between the lawyer who can and will weigh evidence and decide each new issue on the weight of evidence, and the expert scientist or engineer. In my opening remarks I stated my strong convictions regarding energy sources. Those convictions are based on what I consider to be careful study and my own value judgments, and they are reinforced continually. It is quite fair to state that it would be impossible for me to ever find the weight of evidence on the side of an accelerated breeder reactor program. I submit that it will also be impossible for any nuclear physicist of AEC background to serve on that Commission and ever find the weight of evidence on the side of solar energy.

My experience in industry and in the university compels me to warn against the idealistic concept that 21 scientists, engineers, and economists, of such caliber and stature that they have achieved a measure of recognition worthy of their being sought for such a task, will ever respond to the debate contrary to the convictions held by them before the debate began. It is therefore suggested that title IV contain the provision necessary to insure that the Commission include a balance of expert points of view and that the balance be maintained. There should be representatives of solar energy, coal-based energy, petroleum-based energy, fission-based energy, fusion-based energy, geothermal energy, other geophysical energy resources, energy conservation systems, and in nearly equal numbers, on that Commission.

The scientists should be carefully selected to include some whose research has been in the past supported by the AEC and those who have either been refused or have refused AEC patronage. This perhaps sounds cynical, but let us remember how difficult it has been for nearly 25 years to hear Government sponsored advocacy of anything other than nuclear power systems. It has been several years now since the Congress of the United States amended the law of the land to permit the AEC to interest themselves in alternative energy resources: We are all aware of the total lack of sincere and willing effort that has been expended in response.

The second specific point on which I wish to comment is that raised in title I, section 102, on page 3, line 9. The operative words are "assured public financing." There is tremendous importance in those words, and the authors of this bill are to be commended for their inclusion. There has been an attempt on the part of the electric utility industry to preempt the public role in this area via the creation of the Electric Power Research Institute whose financing was to be provided by a nationwide tax on electricity consumers, a tax which would flow into the EPRI coffers. I do not know to what extent that program has proceeded, but I do know at least these things about that program. When it first was proposed it constituted little other than an industrial front for further public financing of the breeder reactor program: The initial plan called for almost three-quarters of the income to be channeled directly into support of the breeder.

During one of its formative meetings in Williamsburg, the proponents of EPRI stressed that unsolicited research proposals, particularly proposals from universities which dealt with energy source research and development, would simply not be welcome. Within the year, the chief executive of that group has stated before another committee of Congress that decisions as to what research should be conducted and to what level of support should best be left to representatives of the industry.

I cannot accept even the suggestion that those men currently making their fortunes within the electric utility industry would be motivated toward backing research that might produce results which might bring their establishment down around their shoulders. I strongly support the need for "assured public financing" of research and development in the field of energy. That which has been done so amply for nuclear power in the past should now be done for competitive ideas, and a public agency is the best suited to create and manage the broad program.

The third specific point to which I will speak involves title III, section 303(5), page 17, in which the parties with which the administration may deal are listed. No specific provision is made for an entity comprising a number of the States bound together in a regional consortium. It is hoped that the absence of that specific entity, a regional power authority, for example, does not mean that it would be excluded.

Specifically, I can see the New England Windpower Authority as a natural entity for the development of that resource, and I can see a Southeast Coast Ocean Thermal Power Authority as another natural entity for the development of the ocean thermal differences process.

My next comment is general, and is meant to convey my backing of S. 2806. It is my opinion that S. 2806 goes to the very heart of the problem of bringing into being a new energy system in title III, section 304, first on page 24 where "The administration agrees to purchase any such energy so produced on a cost and reasonable profit basis." Here is the offer of a customer. That may sound strange, but you all realize that almost all electricity customers at least are owned. Today, if some corporate entity were to build and deploy the first increment of an offshore windpower system off Boston Harbor, they would be licked before they could start, because all electricity consumers to whom that system could deliver are now owned by the franchised utilities. Shippingport was able to usher in the shoreside nuclear power program because the Government agreed to purchase the produced energy on a cost-plus basis. It's noteworthy and commendable that the same treatment would now be offered to competing alternative energy systems.

Working from that provision downward, my reading of S. 2806 says that a recognized entity who wishes to introduce a novel energy system into the economy can be assured that:

First, there will be a market for his energy product;

Second, there will be a guarantee on the loans he must take up to 90 percent of the total investment he must make;

Third, there will be assistance with any other Government agencies involved in licensing the venture;

Fourth, there will be assistance at no cost in the research and development appropriate to bringing the venture to the point of commercial feasibility;

And last, there will be an official welcome attitude toward the entity that wishes to embark on the venture.

All of the above is almost the equivalent of the assistance that has been given to the nuclear power industry since 1954, and is highly appropriate. The nuclear competitor, however, would still have at least five significant advantages, however, which despite S. 2806 might still permit them a competitive edge:

First, there is still a defacto subsidation with government funds of the enrichment of nuclear fuel—and that is worth quite a bit on the capital cost comparison sheet.

Second, there is still a defacto channeling of electricity at very low cost into the enrichment of nuclear fuel. It can be argued that that electricity is charged at its dump-power value. It can also be argued, however, that the value of that electricity could be escalated to New York City peak power rate if some imagination and venture capital were invested in using that dump power to create hydrogen, the hydrogen were then stored briefly, then fed during peak demand-hours into the most expensive of our peak power markets. This will never happen, though, so long as the U.S. Government insists that uranium enrichment enjoys most-favored-customer status.

Third, there is still the enormous expense of the AEC borne by the taxpayers under the guise of R. & D. but which in reality has become part and parcel of the operation and maintenance costs of the nuclear power industry, an expense paid by taxpayers rather than by electricity consumers.

Fourth, there is the present day avoidance of cost of high level waste management simply because there is not yet a practical waste management system whose real costs can be assessed to the electricity consumers.

Fifth, there is no requirement to create by sinking fund the capital that will be required to deactivate and entomb each abandoned nuclear plant, thus the avoidance again of a significant added cost to those who use nuclear power and another burden quietly reserved for the taxpayers who will one day have to pay for cleaning up thousands of abandoned nuclear powerplant sites.

So, if it was intended that S. 2806 rigorously grant equal economic competitive status to nonnuclear energy systems, then perhaps some offsetting allowances should be made for the alternatives. This might be done by calculating two sets of values for percentage of loan guaranteed, percentage of profit permitted on sale of produced energy, profit allowance on the taxable income derived from energy property, accelerated depreciation, and any of the other tax incentives for increased production of energy that might apply.

The next point I wish to address concerns title X, Miscellaneous Tax Provisions, Credit or Deduction for Residential Energy Conservation Expenditures. I speak specifically of section 42, page 77, starting with line 7. The encouragement of the individual investment in solar energy systems or devices is thought to be one of the more farseeing, commendable portions of S. 2806, truly a cornerstone for significant fossil fuel conservation in the future. I would suggest, however, that it be expanded or modified to take into account some possibilities of the following size and scope:

First, it now appears that an investment of the order of $6,000 in a flat plate solar collector would reduce space and water heating fuel expenditures at a residence in the northern half of the United States by as much as 1,260 gallons of heating oil per year. That system could achieve a useful lifetime of 30 years, and at 9 percent cost of money plus 1 percent for amortization, a 10-percent mortgage loan would permit acquisition. A conventional mortgage loan would cost the owner about $640 per year. With $60 per year for maintenance added, annual cost would be $700. The investor would break even if heating oil cost 55 cents a gallon. Fortunately, that is not the case; therefore, there is no economic incentive to the homeowner to install the system. Heating oil does cost 30 cents a gallon now. If the homeowner knew that he could deduct the exact difference between annual cost of owning the solar device and the annual cost of saved fuel from his income tax, he would probably purchase the system. It is thought that section 42, pages 76 through 79, are aimed at accomplishing that result, but I fear they fall short.

If 10 million U.S. homes were to save 1,260 gallons of heating oil per year, the U.S. requirement for oil imports could be wiped out. If the Government lost on the order of 10 million times $304 annual tax revenue by supporting that action, that is a handsome sum, some $3 billion tax dollars per year, would we as a nation be ahead or behind at the end of each year? I personally think it would be a magnificent bargain, a very commendable application of tax refunds. I would hope that S. 2806 would permit it to happen.

Second, a very similar system based on windpower could probably be used to conserve heating oil. All of the numbers in the above would be repeated here. Again, would the Nation benefit by relinquishing tax revenue to reduce petroleum consumption?

Third, preliminary calculations suggest that a $10,000 investment in wind-driven electricity systems, complete with storage, at the individual residence level, would satisfy a 10,000 kilowatt-hour-per-year demand. In Massachusetts in 1973 the average annual cost for that much electricity was of the order of \$360. By 1975 that annual bill will probably be \$500. The annual cost again of a 10 percent, 30-year mortgage loan to own that equipment would be of the order of \$1,060. For each 250,000 residences so equipped at least one 1,100-megawatt electrical nuclear baseload plant plus some 300 megawatts electrical of intermediate and peaking plant would not have to be built at all. Should title X of S. 2806 be expanded to encourage such action?

Those three examples cited above would encourage real conservation of fossil fuels at the individual building level, and could aggregate into a significant conversion toward the use of renewable energy resources. They do not, however, constitute the most economical way to do that job. The heating of homes with centrally distributed electricity or hydrogen gas, created in larger and much more cost-effective solar energy driven systems, would be an even more appropriate route to take. There must therefore be some means to protect the individuals who make the early gesture to switch to solar energy from the comparative loss they might sustain should later central system solar energy generated electricity become available to them. The concept of assuring an individual that he will be reimbursed for any extra costs above those of currently available energy resources should be extended to this situation too.

I began these remarks advocating the early and well organized switch over from combustion and fission energy processes to solar energy processes. On the face of it that has no appeal to anyone associated in any way with the coal or petroleum industry. But I ask you to avoid that obvious conclusion for a few minutes; I simply do not believe that it is true. There will be a market for all of our carbon and hydrocarbon resources even if we banned their consumption as energy fuels. Please permit me to attempt to illustrate with an insignificant but perhaps all-too-common story.

During the past month we have been unable to obtain epoxy resin, a petrochemical product, even in the small quantity we want to construct the parts of a wind generator. We don't know when those resins will be readily available again, because the petroleum that had been flowing into their manufacture is now being diverted to fuel production. By converting petroleum into epoxy resin, then using it plus other materials to build that wind generator, we can actually multiply the energy value of that petroleum by a factor of 1,000. With that number in mind, is it really antagonistic to the concepts of a strong economy and high level of material well-being to suggest that the diversion of that petroleum to fuel and its subsequent destruction by burning is wrong?

Is not the consumption of those precious carbon and hydrocarbon materials by burning a crime against man and nature?

The economy need not slip the slightest bit let alone slide into depression if we deliberately wean ourselves away from the burning of precious fossil fuels. In fact, if you gentlemen were to visit places like Leominster, Mass., today you would find a situation that would remind you of the 1930's, if you can remember the 1930's, a situation where quite a large number of people wish that we were not putting quite so much petroleum into fuel but were indeed giving them the feed stocks for the plastics from which they make their living.

No capitalist need lose anything, no jobs need be lost if we carefully and deliberately move toward an economy in which those precious resources were used solely as petrochemical base, and the equivalent required heat is obtained by one or more solar energy processes.

It can and it should be done.

I would like to expand upon that hypothesis, starting from the statement made in title I, page 2, line 13 of the bill. It is indeed true that the United States "has massive energy sources." It is also indeed true that we can and will achieve energy independence in a very short period of time if we so resolve and act. It is realized that we probably must expand our domestic fossil fuels industry to cope with the next 5 to 10 years' shortfall in energy supply. But from there on I would urge a broader viewpoint be taken, primarily because of the irreplaceable and valuable nature of those resources, but also for the reasons woven together below. It may not be appropriate for this bill to so state, but I would urge that the drafters of this bill give serious throught to this.

First, despite the fact that the fossil fuel resources, including uranium, available to the United States are massive compared with our current annual demand, and even when compared in total against the resources of the rest of the world, they are puny when compared against the solar energy resource wasted by this country each day.

Second, the massive fossil fuel resources, including uranium, available to the United States comprise along with their advantages, a massive opportunity for massive and probably totally unacceptable pollution, if consumed by conversion to heat, at too fast a rate.

Third, the massive fossil fuel resources, including uranium, available to the United States are no longer accompanied by the massive heat sink necessary to their use if consumed by conversion to heat. And this limitation applies not only in the first instance to the local or regional problem of managing heat rejected in the conversion cycle, but to the entire amount of heat with which Earth must deal while maintaining a global heat balance.

It is my clear conviction that "rapid development of these massive energy sources" is fraught with peril. When one stands back and looks at the entire picture and does so with the assumption that man may be meant to continue on this Earth for more than another century one might really wish that the intent and language of the bill were more along these lines:

> Dependence upon domestic energy resources is imperative; an economic system free from depression and widespread harm to many does require some growth in energy consumption until a satisfactory steady-state economy has been created. During that interim period there will therefore have to be increased consumption of fossil fuels. But, it is also imperative that the increase in consumption be as small as possible. The replacement of an energy economy that consumes finite resources by an energy economy based on renewable resources should be the highest priority project for achievement in the nation.

The United States of America is the strongest and wealthiest of all nations.

Senator GRAVEL. Doctor, that is an excellent statement; please continue.

Mr. HERONEMUS. It is also dedicated to such fundamental humanistic concepts as the right to life, liberty, and the pursuit of happiness. It is the destiny of the United States to lead the world to an energy economy based on renewable resources. It is the destiny of the United States to show how petrochemicals can be conserved so that they will be sufficient to the needs of countless future generations of mankind should divine providence permit the species to continue. It is the destiny of the United States to show how the release of radioactivity above that naturally existent in our ecosphere can be stopped, totally stopped. And it is the destiny of this country to show how all that can be accomplished while still improving both the material well-being and the quality of life of all mankind.

The answer lies in the early development and application of solar energy processes. That can be accomplished. S. 2806 would assist materially in our getting on with this task. It is probably politically necessary that S. 2806 encourage growth in conventional energy practices, and it is probably the height of arrogance for me to suggest that the only appropriate conclusions from the proposed deliberations of a CETA will of necessity be corroboration of that which has been stated above, but there it is.

There are a number of solar energy processes which can be applied toward the total solution of our energy problem in the next 4- to 10-year period if we choose to get on with them. Generally speaking the hydroelectric process has been good for mankind. There have been those instances where the high dam, a demonstration of application of advanced technology to accommodate greed, has been very counterproductive. But all in all, this, the third oldest of the solar energy processes has done well for man. The oldest of the processes, husbandry of fuel crops based on photosynthesis, has been very successful, and could be expanded many fold to our benefit. Whereas the direct combustion of wood or fiber in large quantity in some areas can lead to unacceptable temporary air pollution, the conversion of wood to energy via the methane or methanol route could replace much of our petrochemical consumption. When the conversion of fuel crops is accompanied by the conversion of animal and vegetable wastes to fuel via methanation, a large fraction of the demand can be met. Windpower, the second oldest solar energy process could provide us with huge quantities of electricity or hydrogen fuel, generated without pollution, and economically.

The low temperature photothermal process, the flat plate solar collector system for the heating and cooling of buildings, will be able to impact that market in a large part of the United States, at least for new construction, within 5 years at most. The ocean thermal differences process for the generation of electricity or hydrogen fuel could be demonstrated in as few as 6 years and by 1990 could have taken over at least 10 percent of the electricity market, easily, and very economically.

I would like to expand upon that just a bit. It so happens that I work with a team of 10 professors and some 15 students. We have been funded for 18 months now in a research project whose goal was to verify the technical and economic feasibility of the ocean thermal differences process. We have come very close to verification of the economic goal. I feel that we have definitely verified the technical feasibility of this. This is indeed the black horse in the energy sweepstakes as far as I am concerned.

Here we have a process which, if practiced in any one of three ways in the United States of America, could take over the whole job by the year 2000 and do it economically, and to our better well-being.

There is strong suggestion in several quarters today that even photovoltaics could break the economic barrier in as few as 10 years if we so desire. I might comment that as few as 2 years ago few suggested that that could be done in 20 or 30 years. It would not be foolish at all to state unequivocally that this country could be totally energized by solar energy processes and other renewable geophysical processes, and by pollution-free geothermal systems by the year 2000 if we so desire.

Mr. Chairman, may I conclude with one more remark that might help set this all into perspective? If all of mankind persist in their planned growth of energy demand for another 26 years, at that point in time, the year 2000, the total world's annual energy consumption will be of the order of one quintillion, that is, 10[illegible] British thermal units per year. To achieve that rate of energy release by combustion and fission processes, we will be clawing apart the earth to obtain coal, we will be at the point of maximum feasible production of native petroleum and gas resources, we will have a pyramid of high level radioactive wastes still above ground in South Carolina waiting for that solution to their safe storage, we will have very little clean air, very little blue sky and very little clean, cool ground water left, and we may well have created irreversible weather modifications. While this great horde of humans busies itself frantically in all of that to create one solitary quintillion per year, the sun will be sending 36,000 quintillion to us during that same year, free goods, available to use or to waste as we see fit.

Mr. Chairman, is it not time that we humbly accept the bounty of a nature that wants to see mankind live in peace with the rest of all that which lives in earth? We can, and we should, and it can be done without loss of wealth, health, liberty or happiness. Because I believe that this bill, S. 2806, would help us get on that right road, I hope that it will be enacted.

Senator GRAVEL. Doctor, that was an excellent paper, and when you talk of trying to get scientists to think in some breadth, you provide a guiding light.

I have to present myself to make a quorum. I understand you have a time constraint, Doctor? What time do you have to be out of here?

Mr. HERONEMUS. I should be out of here by 11 o'clock at the latest.

Senator GRAVEL. Dr. Lindmayer, do you have a similar time constraint?

Dr. LINDMAYER. No.

Senator GRAVEL. We will get through all of our witnesses by the morning.

I would like to excuse myself for 5 to 10 minutes, no longer than that, and we will have you out of here, Doctor, by 11 o'clock.

So I will return. We will recess for a maximum of 10 minutes, no more than that.

[A brief recess was taken.]

Senator GRAVEL. Dr. Lindmayer, I wonder if you would permit me, because of the time-frame of Dr. Heronemus', that I will deal with his paper, and then he can hang in as long as he can, until you are to present yours, because he has a time constraint?

Mr. LINDMAYER. Fine.

Senator GRAVEL. Looking to your statement on the problem of the Commission on Energy Technology Assessment, it is very interesting, because we have had almost unanimous disapproval of that section, I think primarily because of misunderstanding, particularly by the bureaucracy, which I suppose either consciously or unconsciously would feel threatened, and by the private sector, which thinks this is just superfluous expenditure of money.

I think you are the first witness who has come in strong, realizing, in point of fact, this could offer probably the greatest economy of all if we were able to structure a true adversary, a true, honest, type of adversary situation.

You look to the problem, and rightfully so, of what happens in putting human beings on there, in that they come with their own persuasions. I wonder, within the context of—what, I think, are 26 members on this Commission—if we can truly handle the problem of diversification not only among the disciplines that we need to focus on the problem, but, let's say, philosophies within each discipline, or sufficient biases within each discipline, to get what you call balance, to get a balances of experts.

I do not know if we can do that within the number 26. And if we cannot do it within 26, do we not suffer the threat of expanding to such a degree that we would have anarchy in our efforts to at least bring some type of focus and some type of criticism?

We have addressed ourselves—I do not recall exactly, maybe Mr. Best can direct me—to the automatic funding that would take place. Here I think is something that we have got to structure, and I would like your counsel on this, because as some as an adversary starts being a real adversary, he makes himself unwanted and becomes an undesirable creature. The system of government is such that we try to annihilate those people, much like the capitalist system tries to annihilate competition because that is uncomfortable. It is more efficient and easier to do without competition, as it is in the intellectual area not to have critics and objective analyses on what we are doing, because we feel so comfortable in our own areas, in our own intellectual pursuits.

So you call for balance, but can you elaborate on how we could get that a little more specifically? I share the problem with you. I wish I could figure out a way to deal more effectively and be more precise within the structure of legislation, because this operates against Parkinson's law and the Peter principle, which are operative in Government, and to conquer those laws is no small accomplishment.

Mr. HERONEMUS. About the only suggestion I could give here is that which I have given. I would suggest that you have to call out these recognized energy economy concepts and then do your best to obtain advocates therein and see if they will, indeed, continue the debate.

Now, I know this is going to be extremely difficult, but I like the idea that this debate would be held. There is nothing like this going on anywhere in the United States today. In fact, there is nothing like this going on in the world today. There have been a couple of attempts. There is that organization over in Vienna that is only 2 years old now, the so-called Institute for International Systems.

Senator GRAVEL. How do they get funded?

Mr. HERONEMUS. Well, that particular group is funded by member nations, and they were supposed—among other things—they were supposed to hold continuing debates about energy in the world system. Already, however, it appears that the idea of free and open debate has been subverted, and it has gone almost in the direction that the IAEA wants it to go.

Mr. Chairman, I am not sure I can help you too much more here. I wish I could, as to how this group should go. Of course, in the Navy we were always confronted with this business of advocacy. The strength of the Navy used to lie in the fact that it would allow proponents of certain ideas to come forth and state their ideas and be heard and not take the lash as a consequence.

Senator GRAVEL. Doctor, we could probably, within the bill, specify that the Senate is to question whether we will have sufficient breadth over all the disciplines within its Members—maybe we could alter the number slightly—and to take up your recommendation that they be recognized authorities in each one of those disciplines.

The other thing is that we put in the bill a 1-percent automatic financing. It is the concept which I worked upon a few years ago in purchasing power. And this 1 percent would really place a great sum of money into the system of adversary analysis, more money than has ever been seen. And though I am not an advocate of throwing money at a problem per se, since this would be so new and, we hope, so salutary, that maybe having a large funding base would permit it. Even if we were half wrong, we would still get half the people who have been thinking like yourself and others we have seen, who are out in the desert just scratching for paltry pennies to do their work. They would be more than funded; they could really have an impact in getting knowledge abroad on the subject, and hoping that democracy works, this knowledge itself would be utilized by others.

Mr. HERONEMUS. There is one other thought here. There are seven public members proposed on your Commission, and I would suggest that as many of those as possible be men from Government, and particularly men from Government with legal background, and that this could help.

Senator GRAVEL. Former Government or present Government?

Mr. HERONEMUS. Former or present Government; men who have distinguished themselves as being able to weigh evidence and make decisions on the basis of that which is in front of them on this particular issue, and always acting in accordance with their prejudices.

Senator GRAVEL. Yes. I think that I might lean more toward former Government, because, again, in Government, they get all the funding they need, as we see in the AEC.

Another thing—and I really do want to compliment you on the philosophical thrust and, of course, the homework that you have done—concerning such things as the investment in one $6,000 solar plate collector per house, or going to a wind-type individual unit, and also hydrogen gas—and correct me if you disagree with this. But one of the problems is building the infrastructure within our economic system that has a vested interest to do something about these things. But if we did provide some kind of a limited tax incentive for new construction, let's say a $10,000 writeout deduction for *x* number, something that does not leave it open ended, the fear I would have, and maybe it is not grounded, please tell me if you disagree, is that once we started into something like this, giving a tax advantage, we would be spending tons of money in one area, and then when something else came along, perhaps some new broader-based technology that you mentioned, we would get locked in, again, with people who have a prior proprietary interest for that type of expenditure, and that would perpetuate more tax aberrations that we have enough of already.

So I would be ill-inclined in law into putting in, say, a tax incentive deductible up to $10,000. Let's say the IRS would grant it if they have an approval certificate from the Federal Energy Administration before the fact, not after the fact. So all they have to do is get a certificate; builders would have to get a certificate from the Federal Energy Administration. They would then present this to IRS, which would give them a total writeoff of that, and we would do it to a specific number and limit it to a specific time frame, like, let's say, we are going to take a million, or permit 2 million solar, 2 million wind-power 2 million hydrogen home-size units.

That demand out in the economy would cause somebody to start manufacturing these, and that is where the benefits will come when somebody starts manufacturing that. Would that make sense?

Mr. HERONEMUS. I think that makes a great deal of sense. You have to put limits on this.

What I was speaking about here is exactly what your last comment said, is that you want to get something started, we all want to get something started. The people who are willing to step up and take the risks, in the beginning have got to be looked out for, for awhile, and you have to be fair. The definition of fair is something that can be worked upon.

Surely, 30 or 40 years from now, despite the brilliance that we built into this particular piece of legislation, it might be outdated by something new.

Senator GRAVEL. So we would say, as part of an R. & D. effort, that we could provide tax credits, let's say, a million—well, what do you think, just off the top of your head, now, for computation. Would a million plates generate enough economic demand for something to make it attractive?

Mr. HERONEMUS. Well, a market for 1 million new low-temperature photothermal process devices would be an excellent market, if they knew that they were in the offing.

Senator GRAVEL. Would that be quantities enough?

Mr. HERONEMUS. Yes, that would get it started. That would certainly get it started. Big business would certainly be interested in that.

Senator GRAVEL. Then the same thing with the wind deal, and so on—and on the first-come, first-served basis, they get the tax writeoff, and then it ends. Then we can cause the Federal Energy Administration and the IRS to give us a report at the end of that period when this expenditure expires. That is something—we can compute out what the loss would be. And this would be a direct investment by the private sector where they exercise their free choices without a great deal of Government intervention?

Mr. HERONEMUS. Yes.

Senator GRAVEL. All you would have would be the Federal Energy Administration—well, should it be the Federal Energy Administration that should approve the certificates, or should it be a group of scientists?

Mr. HERONEMUS. Well, the group of scientists, as I see it here, are always in an advisory role to the Federal Energy Administration.

Senator GRAVEL. We will work that out. I think that is an excellent suggestion. When you see that in the next copy of the bill, you can take a proprietary interest in it.

How difficult would it be, if we had a million houses that would utilize hydrogen gas, is that sufficient to develop the capital infrastructure, attract the capital infrastructure, to get into some "hydrogen gas cells"?

Mr. HERONEMUS. Well, I am not quite sure, Mr. Chairman, what you mean by the hydrogen gas.

Senator GRAVEL. The heating of homes with centrally distributed electricity or hydrogen gas.

Mr. HERONEMUS. Well, there we are talking about something like the offshore wind power system or the ocean thermal differences system producing hydrogen gas. This is the large central system. The size of market here, now, that is required, you are talking about encouraging a new industry that would be of the size of, say, Con Edison or Boston Edison. That is what I am talking about here.

Senator GRAVEL. Hydrogen gas—how would that work in the home? Let's take my home. I have a gas plant that heats it and brings my air-conditioning.

Now, how would I convert? What does this mean to convert to hydrogen gas? What is involved?

Mr. HERONEMUS. The hydrogen gas can and will be used in the homes by catalytic burning to take the place of the electric range, to take the place of the heater, to do all of your heating processes.

Now, it is possible that that hydrogen gas at the individual residence level might also be converted in the individual residence fuel cell to give you electricity, but I am not so sure any more that that is probable. I think that you will still have a gas line coming into the house, and you will have the electricity line coming into the house.

Now, having so stated, I would go one step farther, though and indicate that probably the most desirable way is the one in which the hydrogen gas really never comes into the individual home, that the hydrogen gas comes to the minisubstation at the town level, at about every 10,000 homes. The hydrogen gas would reach there, and there it would be converted to electricity, and your entire economy would become an all-electric economy with hydrogen gas being used as your energy transmitter, the hydrogen gas having been produced for you by renewable solar energy processes. That is really the one that I think has the greatest efficacy.

Senator GRAVEL. We have seen in an energy model where the inefficiency increases the more we go to all electricity. In other words, considering the productivity of a unit of heating oil, compared to taking that same fuel and burning it in a central plant to run a generator and then heat my house with electricity, it is more inefficient that way. We get more out by dealing directly with the heating oil. The factor, as I recall, was about 60 percent waste, as opposed to 40 percent use, with an electrical part in it.

So would not that also be compounded; would not the use of hydrogen gas in the system, add to or continue that increase in inefficiency?

Mr. HERONEMUS. Well, your point is absolutely correct, that once you interpose this additional conversion from hydrogen gas to electricity before you then use the electricity for heating, you are going to suffer some degradation. In fact, it is a significant one.

The question then becomes—you have got to look at all the factors, really—is it safer? Is the total system more efficient? Is the total system more effective to end up delivering the energy to the individual user as electricity or as a combination of hydrogen and electricity?

I am sure that we are going to continue to deliver electricity to everybody. There is no question about that. Now, we can go to the all-electric economy, and it can be based on renewable solar energy processes, and it is probably the cleanest and the safest and the easiest system for the entire country. But there will be an additional loss of efficiency, as you pointed out.

Senator GRAVEL. Someobdy should make the tradeoff study and make an assessment as to what would be in the large policy interests.

Mr. HERONEMUS. You are absolutely right. That should be made.

Now, Derek Gregory out at the Institute for Gas Technology, is very much against this concept, at least in our conversations, against this idea of converting all of the hydrogen into electricity. He thinks we should go two ways: You should sell hydrogen and you should sell electricity, and his economics are pretty convincing.

Senator GRAVEL. I am still lost. Maybe we could take a step backward here.

How, actually, would I use hydrogen in my home? I would burn it?

Mr. HERONEMUS. You would burn it.

Senator GRAVEL. You would have a hydrogen furnace?

Mr. HERONEMUS. You would have a hydrogen furnace. The hydrogen furnace might look like wallpaper, incidentally. It would be a catalytic burner. You would be able to put your hand on it. It would produce nothing but moisture in your room, and would take care of the humidification job magnificently. You would burn it in your stove, the catalytic burner in the stove. It would be a very fine economy.

Senator GRAVEL. It would be a gas?

Mr. HERONEMUS. That is right.

Senator GRAVEL. You would buy it in propane bottles?

Mr. HERONEMUS. No. You would probably have it piped into your house. It would be piped in like you get gas now.

Senator GRAVEL. So we would have to set up a hydrogen gas system much like we have a natural gas system?

Mr. HERONEMUS. Yes, you would.

Senator GRAVEL. You have got some opposition right there.

Mr. HERONEMUS. Well, I think that the natural gas people might not oppose this because, you know, they are running out of a product. In fact, they should be the people who are running around most looking for this hydrogen to take the place of their natural gas.

Now, their existing gas mains could possibly not cope with the hydrogen economy, but with some updating or upgrading, it probably could.

Senator GRAVEL. Well, is hydrogen more flammable than natural gas? Would it be more dangerous? Would it be a more difficult product to handle than natural gas?

Mr. HERONEMUS. Hydrogen is, indeed, more flammable. In fact, the energy required to light off hydrogen as compared to natural gas is only one-tenth of that to natural gas, so it will catch fire quickly.

Senator GRAVEL. Does that mean that in the pipes that the gas system has that there would be more danger to public safety?

Ever so often we read about a house or an apartment building that had an explosion in it because of a gas leak. Now, would we be more prone toward that danger under a hydrogen gas system than we are under the natural gas system?

Mr. HERONEMUS. No, I do not think we would be more prone. We would be as prone. If we were to exercise the caution and the care that is required in piping hydrogen around, why, it would be all right. There are extensive hydrogen pipelines in Europe today, some 18 to 24 miles long.

Senator GRAVEL. Do you happen to know where they are located?

Mr. HERONEMUS. Yes, they are in the Wuppertal in southern Germany. I guess it is southern Germany, southwestern Germany, in that highly industrialized region.

Senator GRAVEL. Around Munich?

Mr. HERONEMUS. No, Munich is over in the other region; in the Alsace-Lorraine region.

Hydrogen has been moved around there for many years. It has been moved around very efficiently. The hydrogen industry is a very large industry in this country, and it is a rapidly growing industry.

Now, there are things about hydrogen that can alarm you. It will kindle more easily than natural gas. You can blow yourself up with hydrogen just as well as you can blow yourself up with natural gas. There is one other characteristic: it will rise and collect in a high spot. It will not mix as nicely as natural gas. But we can learn to make sure that this material is handled in a way that it does not constitute any more hazard than we have right now.

Senator GRAVEL. Well, of your knowledge of the infrastructure we are talking about now, you approve a tax incentive to utilize a definite quantity of the solar plates, a wind system, and you still feel that we can do the same thing for hydrogen gas?

Mr. HERONEMUS. Yes.

Senator GRAVEL. To include a hydrogen gas system within a house?

Mr. HERONEMUS. Yes, you could. Yes, indeed.

Senator GRAVEL. Maybe in our tax incentive having a total writeoff, we might have to provide for a system which will at some later date, if somebody has to reconvert because the economics do not prove themselves out, provide a recapture or a deduction. Say it has to be changed over 10 or 20 years later, because the technology has not developed but they are locked into it, so maybe you would have to put in a recapture type situation so that somebody could take down the road. I think we will just analyze the economics of that.

Would you just explain to me, when you talk of "fossil fuels, including uranium available, in the United States comprise, along with their advantages, a massive opportunity for massive and probably totally unacceptable pollution if consumed by conversion to heat at too fast a rate"?

Mr. HERONEMUS. This is really the major and fundamental question of physics that is behind all of this, and more people are paying attention to this business in this current year than have before.

Now, the earth in the solar system, is in a position of heat balance with the rest of the whole solar system. We are a part of the solar system, and the temperature on the surface of the earth has been fixed, in a sense, by nature. It has been decreed that the average temperature of the surface of the earth shall be such and such. The energy, the preponderance of the energy that enters into this heat balance is the energy that comes from the sun and goes back into space day in and day out.

Now, as long as man releases additional energy to the surface of the earth that has been created from our fossil stores, as he takes matter, stuff that is there in an inert form right now, petroleum, coal, or uranium, and then he does with it that which is required to create heat, once you release that heat, there is literally nothing you can do about it, or do with it, even, except to degrade it. Finally, it has to move back out into space. The way it gets moved out into space is by radiation.

The law that governs this radiation says that the absolute temperature of the radiating body and the surface area of the radiating body will determine how this energy gets dissipated back to space. Well, now, the surface of the earth is pretty well fixed. There is not much we can do about increasing the size of it. As we release more and more of this heat to the surface of the earth, the average temperature of the earth is going to have to rise. It is the only way in which we can reinstate ourselves into a position of thermal balance. This is going on all the time.

Now, there is one physicist in Britain, for instance, who suggested that since 1860 man has probably increased the average global temperature of the earth—this is the average, now; you know we have cyclical changes, hots and colds—the average has gone up about eight-tenths of a degree Centigrade. If we continue this—we know that we have already created heat islands we can see the effect of it in cities and downwind of cities, where the average temperature has been driven up—if we continue to release heat at the rate we plan to do by converting matter into heat, we are heading for trouble.

Now, a recent paper written by a meteorologist by the name of Wendell Mordy has suggested that a real atmospheric limit to our energy practices, and everything that we are doing, our energy policy——

Senator GRAVEL. What is the paper again?

Mr. HERONEMUS. It is by Dr. Wendell Mordy, and the exact title I cannot recall.

Senator GRAVEL. Do you have easy access to that?

Mr. HERONEMUS. Yes, I do.

Senator GRAVEL. Could you secure it for the record?

Do you know if it is very voluminous?

Mr. HERONEMUS. No, it is not.

Senator GRAVEL. Could you secure it for the record and add it to your testimony?

Mr. HERONEMUS. Yes, I will do so.

[The material referred to follows. Hearing continues on page 1605.]

THE COMMONWEALTH OF MASSACHUSETTS,
UNIVERSITY OF MASSACHUSETTS,
Amherst, Mass., February 13, 1974.

Mr. ROBERT A. BEST,
Chief Economist, Senate Committee on Finance,
Dirksen Senate Office Building,
Washington, D.C.

DEAR BOB: Forwarded herewith is a copy of the paper by Wendell Mordy to which I referred on the 28th of January, and which Senator Gravel asked to be presented for inclusion in the record. Dr. Mordy has given us that permission by telephone. He would very much like copies of the Hearings record when it is published.

Sincerely,

WILLIAM E. HERONEMUS,
Professor.

Enclosure.

ENERGY NEEDS AND THE ATMOSPHERE

(BY WENDELL MORDY, VISITING FELLOW, THE CENTER FOR THE STUDY OF DEMOCRATIC INSTITUTIONS)

A primary constraint on the ultimate extent of man's production of energy is the atmosphere, which therefore deserves early attention in planning for the provision of his future energy needs. To fully appreciate the nature of this constraint, one must consider several factors. Uppermost, all terrestrial life is weather and climate related, having evolved in adaptation to the atmosphere. Beyond this, even though the atmosphere is commonly thought of as so vast that it is entirely on the scale of planetary forces—a huge solar-driven system—nevertheless, the atmosphere and familiar features and details of weather and climate are interdependent with the oceans, ice fields, terrain, natural flora and fauna, and also, now more than in the past, with man's cultivation, settlement, commerce and industry.

Local features produce much of the weather we directly experience; monsoon rains, coastal fogs, orographic wind and cloud; heat islands; desert climates, and much more. In turn, regional or local features and their attendant weather in many cases influence global weather patterns. Although global atmospheric circulation represents huge quantities of energy, local events and features of much smaller energy input can influence these planet-circling patterns in a manner somewhat analogous to a valve or relay system controlling much larger energy flows in hydrologic or electronic networks. On a globa scale, small shifts in the general circulation of the atmopshere can mean large changes in weather or climate for large regions. In terms of *weather*, this occurrence is almost the rule and provides the explanation of weather differences from year to year and the secular changes we observe, such as droughts and floods, excessive heat or cold. If there is or should be a shift in the *average* condition, in characteristic storm tracks, wind patterns, and related weather phenomena, then altered *climate* results. Such climate changes are not infrequent, in terms of geological time, as times of glaciation or ice-free periods attest.

Conceivably, changes which, though now hidden, may in future dramatically manifest themselves as atmospheric limits to man's energy use, could have already occurred and not been recognized. It is difficult to differentiate, in short periods of fime, *climatically* significant shifts from the large normal variations characteristic of weather. Climatic norms require many decades to establish Recognition of man-induced changes on the same scale would at the least require comparable periods of record. Changes induced by man are in a sense superimposed on natural secular weather variability and climatic change, which complicates the determination of human influence.

During the long periods required to establish climatic patterns, great changes in society, production, and related commitments to energy use and systems can occur. If and when large-scale weather influences from these human causes are recognized, it will then be very difficult, as it is locally in Los Angeles now, to correct for undesired consequences. These difficulties will be confounded by the requirement for international accord for correction, as in the case of chemical pollutants in the air and rains of Scandinavia which originate in the heavily industrialized areas of West Germany and Europe. In cases where weather and climate patterns are altered, the problem of determining causes will make agreements far more complex; furthermore, correction, if desired, may be nearly impossible.

The intention here is to affirm that there are compelling reasons to concern ourselves now with the potential impact on the atmospheric environment of the growth of anthropogenic energy, in the context of growing populations and levels of consumption. Some of these reasons are empirical, and some of necessity speculative. A question might be asked at this point: are potential atmospheric constraints something that in fact we need be concerned about right now, in comparison to constraints that seem much more real and immediate, and are in fact creating problems in the present? The answer should be affirmative, in the following perspective.

Potential constraints on future energy production are: (1) limitations in natural resources used for energy sources; (2) limitations of technology; (3) rates of economic growth and available capital for facility construction; (4) constraints effected through social and political structures and values; and (5) limits of tolerance in the bilogical and physical environment to energy injected into the human ecosystem.

Of these, new solutions will no doubt continue to emerge in the first three areas, no matter how vast and poignant the problems are at the present moment. Only the last can *ultimately* constrain energy production. Short of this, constraints can be decided upon and imposed by society, but this can only occur if there is realization that otherwise, environmental tolerance limits will sooner or later overtake us.

There are a variety of ways in which the weather and the general circulation of the atmosphere may be affected by human uses of energy. These range from the direct influence of heat added to the atmosphere, to the secondary influences of industrially produced trace gases and chemicals; particulates; water vapor; changes in terrain and vegetation; and many others. Before considering these effects separately and in some detail, the nature and limitations of energy projections will be noted; the probable futures of various types of energy production will be briefly reviewed, and their primary atmospheric impacts characterized; and the nature of the present evidence that energy production and use may significantly influence future climate will be summarized.

NATURE AND LIMITATIONS OF ENERGY PROJECTIONS

Three types of procedure are commonly followed in energy projection. (1) Trends may be derived from past and present growth rates; (2) predictions may be based on maximum or optimum per capita use and population level; (3) predictions may be based on anticipated technological developments.

Characteristic of the first type is the projection of exponential curves, estimating growth rate or doubling period. Energy growth rates according to such estimates range from about 4.25 percent to 7 percent, with doubling periods from 16 down to 10 years. Based on present energy use figures, in ten doubling periods, human produced energy 100 to 160 years from now would rival the solar energy which now drives the atmosphere. Indefinite growth is thus obviously unthinkable. These projections ignore the context of the phenomenon studied.

The second type of projection multiplies assumed per capita use of energy by an assumed maximum or optimum population estimate. This leads to more conservative judgments of energy needs. Thus, for example, a typical *outside estimate* for the distant future is a global population limited to 20 billion, each person using 15 kilowatts of power, or about twice present U.S.A. per capita capacity. This yields a maximum likely use, and a basis for an estimate of maximum impact on the environment.

For these figures just mentioned, the maximum artificial energy production in future (neglecting efficiency rates) is projected as a significant 2 percent of total available solar radiation falling on land surfaces or 0.6 percent of the solar energy incident on both land and sea. However, the population estimates and per capita use figures built into these estimates don't necessarily represent future reality, as they seem quite high by present standards.

The third type of projection yields even higher estimates, and borders on science fiction. Unlimited available energy by controlled fusion or other technological innovation is anticipated at very low estimated cost. It is estimated that deuterium as a fuel would cost, per unit of energy, less than 1 percent of coal at present prices. In such projections it is argued that abundant energy can serve to replace many natural processes. For example, fresh water can be produced from the sea, fuel can be provided to replace natural fuels, minerals can be recovered from salt water, and food can be synthesized. While such reasoning implies unlimited and rapid future growth of energy production, those who pursue it often turn to conservative projections of likely use, thus minimizing estimates of potential environmental impact. In addition, potential damage to the environment is usually dismissed as negligible or unimportant when compared with likely benefits. In the extreme, a world inhabited only by man and essential bacteria, in a synthetic habitat, is foreseen.

TYPES OF ENERGY PRODUCTION, THEIR FUTURES, AND THEIR PRIMARY ATMOSPHERIC IMPACTS

Existing and proposed energy sources will affect the environment in different ways. It is to be borne in mind that some effects are *directly* related to power production, and some only indirectly. The latter are inevitable and must be considered in the total picture, for it is clear that power is produced to do work and, as it is utilized, it will affect the environment.

Because of differences in impact, it is helpful to try to anticipate the most likely way in which future energy needs will be satisfied. For the near future it seems that fossil fuels will continue to be the dominant energy source. Until about 2000 A.D., world oil production will probably continue to rise, diminishing thereafter. Coal production will rise for possibly a centruy longer. More than 95 percent of the nergy needs of the United States are now met by burning fossil fuels. Less than 5 percent are met by hydroelectric generators, and only a small fraction by nuclear energy plants. But by the *year* 2000, it is estimated that as much as 50 percent of U.S. electrical power will be generated by fission reactors, notably of the new breeder type.

Proposed new means of generating power for the future include primarily controlled fusion processes, solar energy converters, tidal power, hydroelectric plants, windmills, and geothermally powered generators. Of these, it seems to be the concensus that controlled fusion offers the greatest promise of providing sufficient power for future needs. Solar energy conversion requires large outlays in capital, land and equipment, and involves a need for efficient energy storage methods which are as yet unavailable. Nevertheless, since it is the only potential "clean" source, sentiment for research outlays to develop it is growing. Wind energy use is depreciated as not feasible on a large scale, though widespread small-scale use could be significant. Geothermal energy is relatively limited in amount, and involves problems in development such as rapid deteriorization due to corrosion. The maximum available geothermal and tidal energy are each estimated to represent only 2 percent of the total hydroelectric power potential in the world, as yet only 8½ percent developed. Even full development of such potential apparently would fall far short of satisfying fairly immediate estimated needs.

Producing energy from fossil fuels has a variety of environmental effects, most of which are all too familiar. Solid matter is added to the air and water as production waste, or by accident. Water vapor, gaseous emissions, and chemicals are given off to the hydrosphere. Land surface transformations which can affect weather take place, and heat wastes are injected into the atmosphere and waters.

If further needs are to be met primarily by nuclear power, there are several environmental concerns which deserve attention. Often described as a "clean" source of energy, we are also reminded that proposed plants are larger scale than most presently operating. These plants involve huge amounts of waste heat, and water for cooling. Heat and water vapor thus released ultimately find their way into the atmosphere either by way of cooling towers or through evaporation and convection after heating streams, lakes, or coastal waters. Further problems exist in the diffusion of radioactivity into the atmosphere and the disposal of radioactive wastes.

Hydroelectric generating plants involve in most instances the construction of very large artificial lakes, and the creation of even larger areas of irrigated land, changing local climates and producing surprisingly large secondary effects—such as a changed regional radiation balance, and considerable energy given off to the atmosphere as latent heat of evaporation.

Wind and solar energy, utilizing energy already available to or in the atmosphere, have the fewest environmental drawbacks. Large solar energy installations, if ever utilized, will occuply huge land areas and probably be rather ugly, but would occupy arid, remote, and sparsely settled areas.

Tidal power sites would be mostly in estuaries, important locales for marine life which would be disturbed or destroyed.

Geothermal energy development is similar to mining and relatively innocuous environmentally in comparison.

All power development involves landscape changes—pumping, plowing, irrigation, paving, and building—which in turn change the amount of radiation absorbed or reflected from the earth, the amount of evaporation given up to the atmosphere, and local temperatures.

EVIDENCE THAT ENERGY PRODUCTION AND USE MAY INFLUENCE FUTURE CLIMATE

The above facts contain ample reason for concern in the matter of potential climatic change from continually increasing uses of energy. Wastes are produced and physical transformations take place in industrial production, land transformation, city-building, domestic consumption, agriculture, and transportation—all involving the use of large amounts of energy. Some of the effects of these activities on climate have already been measured, though only in limited areas. And other measurements, global in scale, indicate that the composition of the atmosphere as a whole may be changing, though the climatic significance of this has not been determined. A few documented instances of man-induced climatic change will serve as examples.

UNINTENTIONAL WEATHER

Certain kinds of changes in weather and climate have occurred as a result of urbanization and industrialization. (While to some extent this has been recognized for centuries, scientific documentation has only recently been obtained.) In 1970 estimates of average changes in climatic elements over modern urban areas were made by Dr. Helmut Landsberg, who has long been a student of the effect of cities on climate. (SMIC, 169) Recently he has been looking at the changes occurring in the new Washington suburb of Columbia, as the population increases and building proceeds. He estimates that as a result of urbanization, the contaminants in the atmosphere significantly increase. The air contains at least ten times more particulate matter, and five to twenty-five times more gaseous admixtures than before. Cloud cover is increased from five to ten percent. The incidence of fog is 100 percent more in the winter and 30 percent in summer. Rainfall is increased by five to ten percent, and snowfall by five percent. Relative humidity in urban areas decreases from two to eight percent, depending on the season. The duration of sunshine is shortened by five to fifteen percent, and the ultraviolet radiation reaching the surface is up to thirty percent less in winter and five percent less in summer. Temperatures are from a half degree to a degree centigrade higher on a year-round basis, and in winter from one to two degrees warmer. Wind speed is twenty to thirty percent less.

So far, of course, the most obvious and perhaps the most important changes have resulted from air pollution. In addition to unattractive climatic change, unpleasant irritation, and deleterious effects on health, air pollution also has dramatically changed the amount of solar radiation incident on the surface, the amount of cloudiness, and the visibility.

Less well defined but nevertheless observed changes that have occurred as a result of urbanization and industrialization include the downwind effects from cities on clouds and precipitation. Recently, photographs taken from the weather satellites have dramatically shown that on the east coasts of the Asian and American continents, cities produce a long wake of cloud and modified cloud cover extending out over the oceans to the east. The addition of heat, water vapor, and particulate matter all can influence such cloud cover, though the relative importance of each of these factors is still not known.

Rainfall downwind from Gary, Indiana, at LaPorte, has been reported to have increased by a factor of nearly thirty percent. The increase in rainfall since 1920 correlates well with figures showing the increase in steel production. While there has been controversy over such dramatic figures, the reliability of observations recently has been upheld and extended as the data in Table 1 below show.

TABLE 1.—SUMMARY OF URBAN EFFECTS ON SUMMER RAINFALL AT 8 CITIES

City	Effect observed	Maximum change: Inches	Maximum change: Percent	Approximate location
St. Louis	Increase	1.6	15	10 to 12 mi downwind.
Chicago	do	2.0	17	30 to 35 mi downwind.
Cleveland	do	2.5	27	2 to 25 mi downwind.
Indianapolis [1]	Indeterminate			
Washington	Increase	1.1	9	30 to 40 mi downwind.
Houston [2]	do	.7	9	Near city center.
New Orleans [2]	Increase	1.8	10	Northeast side of city.
Tulsa	None			

[1] Sampling density not adequate for reliable evaluation.
[2] Urban effect identified only with air mass storms—apparently little or no effect in frontal storms.

Source: Huff and Chagnon, 1972.

Many more examples of weather change in a relatively limited area could be cited, some involving other types of phenomena, such as even tornado initiation as the result of urbanization and industrial activity.

On a larger scale, there is now firm evidence of increased cloudiness on routes of heavy jet aircraft traffic. The incidence of high cloudiness at Salt Lake City and Denver has increased by as much as fifty percent since the advent of the jet.

Perhaps the oldest and best known influence of man on climate is land surface transformation, expanding since the beginning of history. Thousands of years ago agriculture and grazing probably already had begun to influence climate. Areas of Africa, the Near East, and the Indian subcontinent have been reduced to semi-desert as a result of land usage practices, particularly over-grazing. In India where land has been overused, R. A. Bryson (1967) has estimated that the deserts are growing at a rate of up to a mile a year. The savanna grasslands of the tropics are largely man-made. The forests in the Americas, Asia, and Europe have been cut to increase the amount of arable land, until today approximately twenty percent of the continental land area of the world has been drastically changed. This produces a change in the heat and water budget of such regions.

One of the most discussed potential influences on global climate now well known to all is the increase in atmospheric carbon dioxide that has occurred in the last few decades. In a period of only approximately two centuries, we will burn the bulk of the world's fossil fuel reserves. Since 1900 the carbon dioxide content of the atmosphere has increased by 17 percent as a result. In theory, as carbon dioxide absorbs outgoing heat radiation from the earth's surface (as does water vapor) an increased amount of carbon dioxide in the atmosphere should warm it in the manner of an extra bed blanket. However, in actuality the effects of carbon dioxide accumulation in the atmosphere are yet to be determined. At the same time that carbon dioxide is being given off, so is particulate matter, to an extent that it is measurable over broad areas of the earth, and the increase in particulate matter in the atmosphere tends to cool the atmosphere by shutting out the incident radiation of the sun to some extent. In view of the fact that over the past three decades the temperature of the earth has been cooling rather than warming, the effect of carbon dioxide accumulation in the atmosphere is still obscure.

Another possible large-scale atmospheric effect could result from supersonic aircraft travelling the stratosphere. Exhaust materials from them are left in a zone of the atmosphere where they may have a residence time of from one to two years, and thus will tend to accumulate. Many of the routes for such aircraft will be over polar regions, where increased cloudiness from condensation trails, increased particulate matter, or increased amounts of gases, may influence the radiative balance of the region.

Probably of much greater concern, however, is the possibility that the exhausts of large numbers of supersonic transports in the high atmosphere could reduce the ozone content of the air. A naturally occurring ozone layer high in the stratosphere filters out most of the biologically dangerous ultra-violet radiation before it can reach the earth's surface. Because of interactions between exhaust gases (mainly Nitric Oxide) and ozone, and the rapid rate at which they occur, it has been strongly argued that the injection of these gases could cause an appreciable reduction of stratospheric ozone. Among the many undesirable results of this would be an increase in skin cancer.

So it is clear that man is influencing climate, particularly locally but also possibly on a global scale. Projections for future human activities suggest that his influence may rapidly increase.

MODIFICATION FROM NATURAL EVENTS

Meteorology is still too imprecise to determine to what degree local climatic changes affect global weather circulation. But on theoretical grounds alone, it cannot be assumed that even small perturbations in a vast and complex system will not have widespread and significant effects on it. And we have more than theory to go on.

We already possess a modicum of knowledge about influences on weather and climate which have occurred historically from natural causes, although they represent small fluctuations in the total energy available to the atmosphere.

Climatic change and its related discipline, paleoclimatology, has been a source of increasing interest among scientists in the last decade. There is growing evidence that naturally occurring variations in incoming solar radiation incident on the earth throughout the ages, resulting from the changed orbital position and orientation of the earth in orbit around the sun, is responsible for the periods of glaciation on the earth and the intervening periods of ice-free polar caps.

It had been pointed out that the earth has been ice free in the polar regions during more than ninety percent of its existence. Variations in insolation on the earth resulting from the tilting of the northern hemisphere at perihelion toward the sun in summer at one period, or away from the sun in summer as is now the case, have been calculated to be as much as seven percent, that is, plus or minus three and a half percent from the average.

Recent correlations, using the oxygen isotope ratio method of Urey, have produced good correlations between sea-surface temperature in the Caribbean area and the astronomically accounted for variations in incoming solar radiation. In untangling this relationship, a number of factors are involved and the story is complicated. The climatic responses to these changes in incoming sunlight cannot be explained by the variation in insolation alone, but require some understanding of climatic factors and functions as well.

Nevertheless, the point of value here is that only a three percent variation from the average insolation on earth has apparently been sufficient to produce ice ages of the ice free intervals between.

Of particular importance is the fact that high insolation in northern latitudes was the most important factor in producing the warm inter-glacial periods. The relevance of this will become clear below as we look at the probable geographical distribution of man-produced energy.

Since particulate matter is one of the waste products of energy production, it is relevant here to examine the phenomenon of volcanic eruption, which has influenced weather and climate over extended periods, globally. While volcanic heat energy is not thought to be at the root of the eruptions' influences on climate, the injection of particulate matter or gasses into the stratosphere is.

Global pressures and temperatures have been clearly affected by historic volcanic eruptions. The classic case is the eruption of Mount Krakatoa in 1883. The British Royal Society report (Symons, 1888) of that event gives rich detail about influences on pressure and temperature, and describes optical effects in the sky observed around the globe, resulting from the eruption.

More recently, the eruption of Mount Agung in 1963 resulted in an immediate warming of the stratosphere over tropical regions of six degrees Celsius, and a measurable increase in the stratospheric temperatures *over a period of several years.* As of this date, however, it has not been determined whether surface temperatures throughout the world were influenced by this eruption. Particulate matter sampled in the stratosphere in recent years, following the Mount Agung eruption, has been found to be largely sulfuric acid, presumably from the oxidation of sulfur dioxide gas by photochemical reactions with O_3 and O. The SO_3 thus formed hydrolizes, forming H_2SO_4. Since a considerable amount of sulfur dioxide is produced in burning fossil fuels for energy production, there is considerable speculation about the importance of man-made particles from the burning of sulfur rich coal. At present, man-made sulfates in the atmosphere are estimated to be about a third to half of nature's production and by the end of the century it is believed they may equal nature's production.

Thus, we see that changes of a few percent in solar radiation reaching the earth's surface have had a dramatic influence on weather and climate for extended periods of time. Both in the case of natural astronomically related variations in incident solar radiation of a few percent, and in the case of dust in the atmosphere produced by volcanic eruptions shutting out incident solar radiation to the extent of a few percent, the atmosphere has responded in dramatic ways.

COMPARISONS OF SCALE BETWEEN ANTHROPOGENIC ENERGY SOURCES, WEATHER PHENOMENA, AND TOTAL AVAILABLE SOLAR ENERGY

For a first impression of energy production impact on the atmosphere, it may be helpful to directly compare the quantities of man-made energy with various scale atmospheric phenomena, and with available and absorbed solar radiation. In this, it will be important to look at the ratio of man-made to solar energy as a world-wide average, and also, this ratio in areas of intensive human activity, as relatively small heat sources can affect weather and climate patterns down stream.

If it can be shown that man's potential contribution is or will be large enough to affect the general circulation of the atmosphere and oceans, such man-caused climatic change presumably will be cause for concern, on ecological, economic, social and political grounds.

Heat is the most direct effect of energy production on the hydrosphere. It is only very recently that meteorologists and oceanographers have begun to turn their attention to man-made heat sources as possibly significant in the scale of phenomena that weather and ocean currents represent. Until now, human-produced energy has been miniscule in relation to the amounts of energy represented by the sunshine incident on the earth's surface (0.015 percent in 1963), by the heat energy stored in the seas, or by the energy released in storms.

Today, however, we are approaching a point in the history of industrialization where man-made energy production may have a significant effect on the functions of the atmosphere and oceans.

TABLE 2.—POWER COMPARISONS

Anthropogenic*	Power (watts)	Area (1,000 km^2)	Power/unit area (watts/m^2)
Largest single powerplant	$\sim 10^9$		
U.S. energy production	1.6×10^{12}	7,760	0.24
Eastern United States, 14 States	1.0×10^{12}	932	1.11
U.S.S.R	1.4×10^{12}	22,400	.05
Central Russia	2.2×10^{11}	256	.85
Central Western Europe	1.1×10^{12}	1,665	.74
Federal Republic of Germany	3.3×10^{11}	246	1.36
Japan	2.6×10^{11}	366	.71
Benelux	1.2×10^{11}	73	1.66
World	8×10^{12}	500×10^6	.016
New York—Manhattan Island	36×10^6	0.059	630
Moscow	100×10^6	0.878	127
Cincinnati	5.0×10^6	0.200	26
West Berlin	4.6×10^6	0.234	21.3
Los Angeles	72×10^6	3.5	21
Los Angeles County	72×10^6	10.000	7.5
Nordheim-Westfalen industrial area	100×10^6	10.296	10.2
Nordheim-Westfalen	134×10^6	34.039	4.2
Weather phenomena:			
Tornado	10^8	0.02	10,000
Thunderstorm	10^{10}	0.10	100
Great Lakes snowsquall	10^{13}	10.00	1,000
Cyclone (latent heat 1 cm H_2O/day)	2×10^{14}	1,000.00	200
			200
Solar energy (global average):			
Incoming flux	1.75×10^{17}	500,000.00	350
Net solar radiation at surface	5.0×10^{16}	500,000.00	100

*Efficiency of generating systems not taken into account. Actual energy released to atmosphere therefore 2 or 3 times higher.

Sources: Hanna 1971; SMIC: Flohn, Lydolf, OECD 1969.

For some isolated areas, this is already the case. (See Table 2) From the small island of Manhattan, more than six times as much energy (630 watts/m^2) is given off to the atmosphere and waters thereabout than is received from the sun (93 watts/m^2). While Manhattan is a very small area, there are other areas that we can point to as well. Moscow, with an area of 13 times that of Manhattan, now gives off approximately four times (127 watts/m^2) the incident solar radiation for that area (42 watts/m^2). The Nordheim-Westfalen area, which consists of over 34,000 square kilometers, gives off approximately 8½ percent of the incident solar radiation. If we confine that area to the industrial zone itself of 10,000 square kilometers, it gives off nearly 18 percent. Los Angeles County, with an area of 10,000 square kilometers, gives off about 7 percent and Hamburg, with an area of 747 square kilometers, gives off about 25 percent.

Some recent projections for Western and Central Europe show that with an assumed growth rate there of about 5.5 percent, the human input to the energy budget of that region would rise to about 4 percent of the solar input by the end of this century, and about half of the solar input by half way into the next century. Similar figures worked out for the United States indicate that our present insignificant contribution (0.24 watts/m^2) may become over one percent of the incident solar radiation of the continent in about 30 years, and ten percent within a century, based on a continuous 5.5 percent growth rate. Worldwide, it may approach five percent of land-received sunshine within a century. This growth rate could be slowed due to scarce resources or economic, political, or social constraints, or could be greater if fusion produces energy cheaply.

But it is important to note that most man-made energy is emitted to the atmosphere now from "hot spots" on the globe. Industrial activities are now focused in mid and northern latitudes, and thus most waste heat and other emissions are given off in rather limited areas. These hot spots may play an increasing role in influencing atmospheric flow patterns and resulting weather and climate both locally and broad scale.

In some countries, the growth of energy demand at the present time is much more rapid than for the world as a whole. Thus Italy and Japan, for example, have an annual growth rate which already reaches ten percent with a doubling time of about seven years. Of course, the size and distribution of future populations, and the dominant future types and distribution of energy production, will alter the present picture. Nevertheless, in the near future, however rapidly energy use expands in tropical to sub-tropical latitudes, it is likely to expand significantly in temperate zones.

WAYS THAT ENERGY USE MAY INFLUENCE WEATHER AND CLIMATE

Let us now turn our attention to specifically meteorological considerations—to several ways that the projected future uses of energy may influence weather and climate, and ecological balances. There are five primary factors involved in climate change—*heat, particulate matter, water vapor, chemicals and gaseous emissions,* and *land and water surface changes.* Heat is added directly to the atmosphere from the burning of fossil fuels and is dissipated from nuclear power plants. Second, the addition of particulate matter is introduced to the atmosphere from industrial sources, internal combustion engines, fires, and so forth, and such particles have an effect on the radiation balance in the atmosphere. Third, water vapor is added to the atmosphere by cooling towers, by artificial evaporation in cities, by evaporation due to heat added to bodies of water from industrial processes, and by agricultural uses of water involving power; fourth, chemical pollutants and gaseous material are released to the air from industrial uses of power; and fifth, climate can be affected by changes in vegetation of land surfaces, and by man-made lakes or large irrigation projects.

HEAT ADDED TO THE ATMOSPHERE FROM ENERGY USES

Of the various possible influences on weather and climate, the most difficult to appraise is the addition of heat to the atmosphere from human activity, to the extent now projected. This amounts to as much as a few percent of the incident solar radiation on continents: regionally it amounts to much more. The best method for assessing effects is that of computer simulation, putting assumed heat sources into theoretical models, to see what the additional energy may produce in changing weather patterns. At the present time, our knowledge of the natural workings of the atmosphere is insecure, and such models, though constantly being improved, are somewhat crude. Thus, a firm analysis of added effects is difficult. This is not surprising for only in the last decade or so have meteorologists begun to utilize theoretical computations in the preparation of routine weather forecasts and experimental simulation with models is still in an early stage. The models first developed for this purpose approximated the atmosphere in such a crude way that it is surprising that useful results were obtained.

The earliest models envisaged a friction free atmosphere with no sources or sinks of energy. The atmosphere was considered as a single layer, so observations taken about a third of the way up into it were assumed to be representative of the entire atmosphere. More recent theoretical models slice the atmosphere into several horizontal layers, and incorporate certain natural energy sources and sinks, such as the warm water lying off the east coasts of the Asian and American continents, and regions of heavy precipitation, where heat is added to the atmosphere by condensation.

These models have succeeded in giving a fair representation of the changes in atmospheric circulation for periods under 72 hours. Analyses of what will happen in the atmosphere are generally better now than they were prior to the introduction of numerical weather forecasts. But they have serious shortcomings when it comes to using them for appraisals such as the one under discussion.

Nevertheless, a project of this type was recently undertaken at the National Center for Atmospheric Research in Boulder, Colorado, by Dr. Warren Washington. Not all results have been published, but in private communication with Dr. Washington, he indicated the following:

> The effects of man's energy output on the global atomspheric circulation are being studied by us and by scientists at the National Center for Atmospheric Research (NCAR) using their global circulation model. The patterns of energy input are those suggested by R. P. Hammond of Oak Ridge National Laboratory. A few preliminary studies have been completed. In the first experiment, man's expected energy output of 3×10^{11} kilowatts is assumed to be emitted from the continents in proportion to a pattern of expected future population density. In a later study, the same energy output will be distributed over the oceans.
>
> The predictions of the model represent averages of various meteorological parameters for the month of January. The average increase in global January surface temperature due to man's energy input is .28°C, which is almost a factor of two greater than the value, .15°C, calculated by the simple Stefan-Boltzmann law. In the thermal energy experiment, average January surface temperatures in 10° latitude belts are about 2°C warmer at 30°N lat. and 2°C cooler at 60°N lat. than temperatures in the control experiment. However, these differences are not significant, for variations of this magnitude often occur in monthly average surface temperatures in zonal belts.
>
> Differences between monthly average surface temperatures in thermal and control experiments are as much as ± 10°C over small areas of the globe. The locations of these maximum deviations are not well-correlated with the locations of the energy inputs. Furthermore, since the standard deviation of observed monthly average surface temperature is about 4°C, these differences are generated by this global circulation model when the initial conditions are slightly altered.

The caution which is expressed at the end of this quotation is a natural caution of empiricists who are unsure of their results. I believe we will see an increasing number of studies in the near future using models to simulate experiments. We can expect a wide range of conclusions which reaches from little or no effect as a result of man injected heat to the atmosphere, to some rather startling predictions, depending upon the limitations of the model used and on the assumptions that are made. It will no doubt be difficult to sort out the truth in the near future.

It should be emphasized that the best available means for evaluating the effects of inputs to the atmosphere such as projections of heat from human activities are the rather imperfect methods which we presently utilize for weather prediction. Because of the complexity of the problem, progress in the refinement of theoretical models for prediction of atmospheric motions has been and probably will be slow. It can be expected that the reliability of the results of such analysis will continually be questioned, and controversies can be expected to continue for at least a decade or two. Improvement will come from better theoretical constructions, from larger capacity electronic computers, and from improved observational techniques in meteorology, but we can only speculate about the rate of progress.

THE EFFECT OF PARTICULATE MATTER IN THE ATMOSPHERE

A corollary of energy production, particularly in the use of fossil fuels, and also in the industrial uses of electrical energy in the chemical industry, is the ejection of particulate matter into the atmosphere. Particles suspended in the air affect the formation of clouds and precipitation. They intercept, absorb, and re-radiate energy. Because of their role in determining the number of droplets in the cloud formation process, they affect the reflectivity and radiation characteristics of clouds.

Only particles smaller than 20 microns in radius have a long enough suspension time to be important in this process. Estimates of the amount of such particulate matter entering the air each year range from about 900 million to 2,600 million metric tons. Of this, about 35 percent is estimated to originate from man's activities. Other sources include soil and rock debris; smoke from forest fires; sea salt particles blown from the sea surface or ejected from bursting bubbles; volcanic ash particles formed from gaseous emissions from hydrogen sulfide; and ammonia, nitrates, and volatile hydrocarbons given off by plant life. Much of this material is subsequently oxidized in the atmosphere to form particulate matter.

Particles on which water has condensed are precipitated; the air beneath clouds which are raining or snowing is washed out, and particles combine and settle to the surface. But these mechanisms for particle removal are apparently insufficient to prevent the recently detected regional increases in atmospheric particle number.

The trend in *atmospheric turbidity* shows a systematic increase over the past 25 years. This is inferred from measurements of direct solar radiation at several remote places in the USSR and Japan and the United States, and indirectly by measurements of electrical conductivity in the atmosphere. There is a five percent reduction in solar radiation indicated at a sun height of about 30 degrees. An increase of up to 50 percent in the atmospheric turbidity coefficient in remote areas of the northern hemisphere has been noted.

Because particle measurements are sparse, and because they are generally confined to higher latitudes, it is difficult to speculate on global change. Particle counters that have been in use for the last ten years or so will probably soon resolve some difficulties, though results to date are inconclusive.

To assess the effects particles have on weather and climate, two predominant influences must be considered. First is the role that atmospheric particles play in the *radiative balance* in the atmosphere. Second, particles are a dominant consideration in the *formation of clouds* and precipitation.

Particles suspended in the atmosphere *reflect incoming solar radiation* back out to space. They also *influence the internal radiative processes* which distribute, within the atmosphere and to the earth's surface, energy received from the sun. In addition, the *reflectivity of clouds* formed is altered by atmospheric particle concentration. They also potentially can affect the *geographic distribution* of absorbed radiation from the sun, due to their concentration in the northern latitudes, and lower sun angle in high latitudes.

Recent studies indicate that the albedo of the earth, or its reflectivity, may be increased by several percent as a direct result of particle suspension in the air. Because there is very little data at present concerning the refractive index of particles in the air, these studies are yet uncertain. But the best estimates available suggest this is true.

Clouds over continents characteristically include 10 to 100 times more droplets per unit volume than oceanic clouds. This is due to the increased concentration of particles over land on which the droplets form during the initial condensation phase. Since the condensation level in clouds is relatively low, the concentration of particles at low levels plays a more important role than in the higher altitudes to which the clouds ultimately extend themselves.

Where more particles are present in clouds, they scatter light more effectively, and more reflection occurs. The global importance of this influence is still unassessed. Scientists concerned with the effects of atmospheric particles are careful in underlining the caveats which go along with such speculation.

One additional factor remains in terms of assessing the effects of particulate matter on atmospheric processes. As indicated, particulates are important in the formation of clouds and rain. Condensation in clouds occurs first on larger particles such as sea salts which are hygroscopic. As the humidity rises to the point where these particles absorb water from the atmosphere at a rate as fast or faster than it is being made available by cooling, condensation occurs on smaller particles until near balance is struck.

Two factors are important here. First is the size distribution of particles suspended in the air when condensation begins. Second, the rate of cooling, as represented usually by the rate of the cloud updraft, also determines the number of cloud droplets formed. In recent years scientists have shown that the effect of cooling is comparable to the effect of the particle size distributions. Thus, for a given cooling rate, particle distribution characteristic of relatively clean air will result in one concentration of cloud droplets. For polluted air as many as a thousand times more cloud droplets may form at the same rate of cooling.

Because of this, atmospheric pollution has a real influence on the depth of cloud required (up to 10 times) before the onset of snow or rain due to the smaller droplet size in the denser clouds.

Particles also play a role in the formation of snow or rain by the Bergeron-Findeisen process. This process, which has been exploited in weather modification research, functions as a result of the difference in vapor pressure over ice and water at temperatures just below freezing. Thus, at temperatures just below freezing, if ice crystals and water drops exist together in clouds, water droplets evaporate while ice crystals grow rapidly and fall out as snow or rain.

The first ice crystals form on "freezing nuclei" which may be particles of clay or dust, the geometry of which helps form the first ice crystal lattice. These particles may form ice only at temperatures considerably below 0° C. The addition of better or more numerous freezing nuclei, as in weather modification experiments, may initiate the freezing in clouds and start the precipitation process.

Pollution is a potential source for artificial freezing nuclei. Lead iodide, because of its crystal structure, serves as a very good cloud-seeding substance. Recent discoveries indicate that very substantial amounts of lead iodide are formed in the atmosphere as a result of the combination of lead, released in burning automobile fuel, with iodine from natural and industrial sources. The importance of this influence has not yet been fully determined, but it is extensive. Because the particles are extremely small and are thus suspended for long duration in the atmosphere before settling out, lead iodide soon, if not already, could be globally pervasive. The effects of such pollution-produced artificial freezing nuclei are yet to be assessed properly.

It is an interesting commentary on public attitudes today to note the relatively high level of concern about the scattered, and miniscule efforts to modify the weather intentionally while *uncounted tons of meteorologically active particles* are emitted along with heat and water vapor from generating plants, factories, and cities without comparable concern and anxiety.

THE EFFECT OF WATER VAPOR ADDED BY ENERGY USE

Water vapor in the atmosphere plays several roles. Evaporation from water surfaces adds latent energy to the atmosphere, in the form of water vapor, which is released as heat when the water condenses. Such energy is stored in the atmosphere in the tropics, and then transported northward. At higher latitudes, the latent heat of condensation and sublimation is released to the atmo phere, thus fueling clouds and storms with energy from a distant source.

In addition, water vapor, as it condenses and forms clouds and snow, affects the reflective characteristics of the earth, reflecting incoming solar radiation back to space. Outgoing radiation from the surface of the earth is retarded by water vapor which acts like a blanket to keep the earth's surface warm.

On a local basis, of course, water vapor in the atmosphere is important not only in terms of cloudiness and precipitation, but also of visibility and fog. But above all other considerations, water is a controlling factor in all life processes. In assessing the impact of man's growing energy requirements on the atmosphere, some perspective in terms of these processes is required. Most of the large power generating plants in use or planned involve the disposal of waste heat into water which is then either returned to lakes or streams or evaporated to the atmosphere as water vapor. In fact, almost all of the sensible heat put into the water will ultimately find its way to the atmosphere as evaporated water vapor.

How significant on a global scale, or on a local scale, is the water vapor which will be given off by anticipated nuclear plants, or from the accelerated burning of fossil fuels? To gain a quick feel for the importance of energy transfer by water vapor in the atmosphere, it can be noted (Table 2) that a rain of about 1 cm is equivalent in its release of latent heat to the atmosphere to the energy released in two days of sunlight on the land. Yet such a rain can occur in an hour or less, so that much more energy than is being received from the sun can be injected into the atmosphere in the locale of storms.

We can also compare the magnitude of energy inputs to the atmosphere by evaporation from the sea surface or other bodies of water, with artificial sources of heat from present or projected power sources. Cold air flowing off Siberia over the Sea of Japan, and similarly, cold air from North America flowing over the Great Lakes in the fall, or out over the warmer Gulf Stream, has a significant effect on weather processes, for it gathers large amounts of heat and water vapor. Such flows distort the weather patterns and create low pressure areas. In these instances, the heat added to the atmosphere both as sensible heat and as the latent heat of condensation and sublimation, is as much as 500 watts per square meter (insolation averages 100 watts/m²). The energy transfer occurs over quite wide areas, in these instances—much more extensive than urban and industrial areas today—and the transferred energies involved are many times greater also. If we compare this with the heat given off by the multi-city industrial areas of the world, such as the area between Boston and Washington or the Nordheim-Westfalen District (Table 2), the comparison figure is from 2½ to 10 watts per square meter in excess of local sunlight.

One way to assess the importance of water evaporated in energy production is by comparing the water evaporated to the atmosphere annually by present power production with the water vapor resident in the atmosphere at any one time, which is of the order of one to three percent. However, since the water vapor in the atmosphere turns over about 35 times a year, this figure is reduced by that factor, reducing it to something under a tenth of one percent on an annual basis. Depending, then, on the growth projections that we make for worldwide energy production and the cooling system anticipated, this figure takes on more or less significance. Nevertheless since much of this water vapor would be released to the atmosphere at mid or higher latitudes, and over contingents, evaporation by power use could assume much more significance climatically at future levels of energy use than it now has.

Locally, however, the addition of water vapor to the atmosphere is already quite significant. As planners for power plants project larger and larger power facilities, producing as much as perhaps 40 times 10^6 kilowatts each, the amount of water evaporated to the atmosphere affects local weather to a considerable extent. Already in Pennsylvania, the 1,000 megawatt nuclear plants evaporate millions of liters of water daily to the atmosphere, and depending on the ambient weather, affect local precipitation and fog for a considerable distance downwind, just as cities do.

In general, these local effects tend to amplify the local weather circumstances. Thus, if fog is a natural occurrence in a region where a power plant is situated, the incidence of fog will increase and the area affected will also be extended. If thunderstorms are characteristic of an area, the amount of heat and water vapor added from nuclear power plants should serve to trigger thunderstorms downwind of the source. Charles Hosler of Pennsylvania State University has documented examples of extensive fogs and cloud banks already generated by the existing power plants in Pennsylvania (Hosler, 1971).

It should be noted that local perturbations of the heat and water vapor balance of a region may have a larger effect on the atmosphere than is implied by the figures just given. Since these heat sources tend to establish a heat island which can serve as a barrier to the natural flow of winds in the atmosphere, it is entirely possible that at some time in future we will find that we can detect large-scale perturbations in the atmosphere which have their origin in localized man-injected water vapor and heat. Our knowledge of the circulation of the atmosphere and the precision with which we can identify cause and effect is still insufficient to say what the exact effects of such influences will be.

EFFECTS ON THE ATMOSPHERE OF GASEOUS EMISSIONS FROM BURNING OF FOSSIL FUELS AND FROM INDUSTRIAL PROCESSES REQUIRING ENERGY PRODUCTION

The most notable example of gaseous emission to the atmosphere is carbon dioxide. It is accumulating, and the amount resident in the atmosphere has increased by about three percent since 1958. There has, of course, been much speculation on the possible or probable influence of continued accumulation.

Carbon dioxide absorbs outgoing longwave infrared radiation from the surface, just as water vapor in the atmosphere does. The absorbed outgoing radiation then is re-radiated in all directions, and contributes to increasing the temperature of the surface layers of the atmosphere. Thus, it contributes to the so-called "greenhouse" effect.

By the year 2000 it has been estimated that the concentration of carbon dioxide in the atmosphere will be on the order of 380 parts per million. In 1958 it was 312 parts per million. This is based on its present rate of increase, the residence time for carbon dioxide in the atmosphere, its exchange rates with the ocean and with the biosphere, and projections of the rate at which fossil fuels will be used. Present data indicates that about half of the carbon dioxide given off to the atmosphere by combustion appears to remain in it. Since 1940 the amount has increased by about 2.8 percent. Various estimates of the atmospheric effect of this have been made. Perhaps the most reliable one was made several years ago (Manabe and Wetherald, 1967), which indicated that a doubling of the carbon dioxide concentration in the atmosphere would result in a surface temperature increase of about two degrees Celsius. Thus, the three percent increase since 1940 might be expected to have increased the surface layer of the atmosphere temperature by about 0.6°C. But this would not just be a simple and uniform effect, with an overall temperature increase. (In fact, the temperature has fallen during this interval.) According to the best estimates, the distribution of temperature in the atmosphere would also be affected. Manabe (1971) very recently indicated that the warming might ultimately be greater as a secondary effect of a reduction in snow cover from the initial warming. Also, there would be a marked geographical variability in temperature changes, with the higher latitudes warming more on the average than the global average.

None of the estimates to date take into account the possible changes of cloudiness which might occur from increased evaporation and warming. An increase in cloudiness of only one or two percent would compensate for the increased temperatures resulting from carbon dioxide warming.

All in all, it is clear that for some time to come meteorologists will find it very difficult to detect whether or not there are significant effects of increased carbon dioxide on the atmosphere. Many factors in interaction control the radiative balance in the atmosphere, such as cloudiness, ice cover, water vapor content, carbon dioxide, particulates, and ocean and atmosphere circulation, so that the relative importance of any single one will not be easy to sort out.

Other gases given off to the atmosphere may be of significance also. Notable among these is sulfur dioxide. Most of the sulfur dioxide in the atmosphere is believed to come from man-made sources. Its importance in the atmosphere is that in combination with other trace gases it forms particles in the stratosphere, and these particles play a role in that layer in radiative transfer. Much of the material given off from volcanic eruptions shows up as particulate matter which has originated as sulfur dioxide. Since we know that volcanic eruptions have had a profound influence on the temperature of the stratosphere, it can be assumed that man-made sulfur dioxide may contribute significantly to the stratospheric particle content and, as a result, play a role in the radiation budget of the atmosphere.

LAND AND WATER SURFACE TRANSFORMATIONS

Energy is extensively used to change land and water surfaces. Plowing, filling, pumping, irrigating, paving, and digging all are increasing as a result of the greater availability of energy. An extension of our needs for sand and gravel alone, based on their present exponential growth, leads us to the ridiculous conclusion that after a century we will scrape the continents clean. New requirements for energy also motivate more dam building, hydro-electric plants, and artificial lakes, thus further altering the landscape. To what extent do these activities threaten to alter existing weather and climate?

For thousands of years now, man has been altering his environment in ways which have an effect on the atmosphere. We are accustomed to thinking in terms of industrial activity, but agricultural practices have made dramatic changes in the landscape and thus the local energy balances of large regions. Vast areas of Euorpe, North America, Africa, the Near East and Mediterranean have been deforested to provide agricultural land. Approximately 20 percent of the total land area of the continents has been thus changed, causing changes in heat and water budgets. Considering the number of people now alive and the energy at their disposal, additional land surface change can be expected to occur very rapidly. Moreover, water surfaces created as man-made lakes and reservoirs are now estimated to be as much as 300,000 km^2 or about 0.20 percent of total world land area. Irrigated land is now estimated to be 2×10^6 km^2 or 1.33 percent of land surface.

Such large undertakings cause changes in energy injected to the atmosphere many times the present direct inputs of heat and water vapor from industry and power production. Remembering that one centimeter of water evaporated into the atmosphere is the equivalent of about two days of net solar radiation at the *global* average of 100 watts/m^2, we can judge the significance of the atmospheric energy input changes resulting from land manipulation.

Present estimates for *Europe* indicate that man-made additional evaporation from water usage at present is about 9 cm/yr. or the equivalent of 24 days or more of sunlight, about 7½ percent of 7½ watts/m^2 per annum. This figure is much larger than any we considered for urbanization or industry. For Germany alone, an independent estimate is 8 cm/yr. Because of the high evaporation rate, large irrigated desert areas would produce even more startling figures.

Projecting population and per capita use of water to the year 2000, meteorologists estimate that a European average of approximately 21 cm/yr. (63 days sunlight, 17 watts/m^2) may be reached representing about half the natural evaporation which now takes place. Globally by the year 2000 A.D. the estimate is about 3.5 cm.

The limits on such use are placed by the fact that there is only so much solar radiation to accomplish additional evaporation.

With such large energy or evaporation changes due to water and land use, we should now be able to point to clear evidence of resulting climatic change. However, because these changes have taken place gradually, over many centuries without adequate records, we cannot. However, there is evidence of change in land *use* possibly related to climate change in Africa, India, and the Middle East. Land once tilled is now desert or semi-desert. The fact that attempts to correlate climatic change with astronomical data work well up to recorded history, but not so well since, suggest that additional factors may now be at work. Our evidence is incomplete, but there is ample reason for concern.

WHAT ARE THE IMPLICATIONS?

Weather and climate modification are probable corollaries, in the long run, to increasing anthropogenic energy. Will it be inadvertent, or will it be anticipated, and managed through comprehensive planning in connection with production plans? During the next few decades, very large enterprises will be undertaken which well may profoundly affect weather, ocean currents, temperatures, and climate. Such changes could be irreversible. In view of this, there is great need for caution and restraint, at the very least.

Climate modification, intentional or not, will have appreciable demographic and economic impact, such as population dislocation due to changes in liveable climates, and in suitable locales for agriculture, recreation and other activities. In turn, unemployment and other social ills could follow.

Since weather is a dynamic system, changes originating in one location can have far-flung effects. Legal disputes, and international controversies, can be expected, involving attempts to fix responsibility for undesirable weather transformations. This can happen whether or not the initial change was intentional. Perhaps we will be forced to reconsider our concepts of property rights. And it is likely that present international arrangements will be inadequate for dealing with such problems.

If we even try to conceive of managing the vast and complex atmosphere-ocean system, a host of considerations come to mind. Some are technical, of course. But others are economic, social, and political. Will our present structures and institutions permit the development of the kind of environmental planning and management on the breadth of scale that seems required? The alternative to deliberate planning is as we must realize planning by default which is what we have had so far.

At present no planning body exists which would have a broad enough purview to undertake the planning task which should be faced as soon as possible. This is a political challenge of the highest order. The reward would be mankinds.

Mr. HERONEMUS. The relative magnitude of the heat released by man, say 1 percent, 10 percent, or 50 percent of the sun's heat energy, is the number we have to look at.

Now, just exactly what the limit to this is the thing that people are talking about. But we can say this: If the entire earth does reach a total energy release budget by the year 2000 of 1 quintillion Btu's, which we think is going to be the case, and then if the entire earth continues to allow its energy demand to grow exponentially, as we are planning to do, so that there is a doubling period on the order of 20 years, it is going to be fewer than 150 years before the entire earth would be releasing heat to the surface of the earth in the amount equivalent to that received from the sun.

Well, this is just not going to work. It just is not going to work. We will have driven the global temperature up to a point where we will have some significant weather modifications.

Now, how far along that path we can go is the question for debate and study.

Senator GRAVEL. Is that part of the problem of melting of the ice?

Mr. HERONEMUS. Yes, it certainly is.

Senator GRAVEL. And that would change the level of the oceans and the rivers, and all the land that is marginal where human beings are living, that would be the first thing to be threatened because of the increased water levels?

Mr. HERONEMUS. Yes, it is.

Dr. Mordy has pointed out there is rather excellent evidence now to suggest that the difference between a non-ice age and the kind of a period we are living in right now might represent as few as 3 degrees Centigrade difference in average temperature. It might be as little as 2 degrees Centigrade.

Now, if we have already gone eight-tenths of a degree toward having——

Senator GRAVEL. Eight-tenths represents what time frame?

Mr. HERONEMUS. That is from 1850 up to about 1968, this particular figure. So let us pose the question, what have we done since the Industrial Revolution since we started burning coal.

This is another rather interesting statistic. If you take the total amount of heat that man has released on earth since the start of time up to the year 1970, and then you compare that against what we are planning to do between the year 1970 and the year 2000, you find that the latter amount is greater by far.

Senator GRAVEL. Staff was just telling me that apparently you were talking about a 300-foot sea level change.

Mr. HERONEMUS. I do not think 300 is the right number, but it is a huge number. I think 175 may be a good number. It would bring about the largest urban renewal program ever. [General laughter.]

Senator GRAVEL. And we think we have got an energy crisis now.

I would only like to close, Doctor, by asking your comments. We had Mr. Anderson here Friday, who gave us what I thought was very interesting and exciting testimony on the sea solar power, and he had a unit with a reasonable price to it.

Would you comment on that?

I understand you have done some research in that area.

Mr. HERONEMUS. Well, our team at the University of Massachusetts has been funded now for 18 months by the National Science Foundation, in the RANN program, to examine the technical and economic feasibility of this process. We are convinced that it is a winner. There is just no doubt about it in our minds. We have restricted ourselves to one configuration for this study, and that is a configuration that would work in the Gulf Stream off our southeast coast. There are at least two other configurations that we want to do. One would be a fully afloat underway system in the Gulf of Mexico, and still another one would be the system that is afloat and underway down closer to the equator in international waters.

The basic concept of this, of course, is a matter of geography. If you look at the globe and center your eyes on the equator and then let them go to the two tropics, you will see that that very huge zone on the surface of the earth is 90 percent ocean, and it is in that particular region that the majority of the incoming solar energy lands. So a tremendous portion of this incoming solar energy goes to heating the surface of the waters of the oceans, and it warms them up. You go anywhere in the tropic seas and you are 80 to 85 degrees Farenheit, and this, of course, persists day and night. The old darkness and lightness dichotomy in the solar energy process is immediately lost.

Now, almost anywhere underneath those tropical waters where you have at least 1,200 feet of depth, you find cold water in huge quantity that is almost freezing. This constitutes a thermal difference, the ocean thermal difference. There is a huge reservoir in the surface of the oceans at the high temperature, and there is this huge heat sink or reservoir of cold water in the cold water mass of the oceans.

Now, across that rather small thermal difference we can build a heat engine, a heat engine that will do useful work and turn an electricity generator. In our case we have restricted ourselves pretty much to the closed Rankine cycle, and we have either ammonia or propane as the working fluid. This particular cycle would drive a turbine and the turbine would turn a generator, and there you have electricity to sell if you are within reach of your market by cable. If you are not, you can use that electricity to distill sea water, electrolyze the pure water, create the hydrogen, liquefy the hydrogen, pump it to tankers, that would be following astern of you, and bring those tankers back to the market. It is the exact equivalent of the LNG business except that it is a renewable process, solar energy driven, and the temperature required for the tankers is considerably lower. It is going to cost more than the LNG tankers. That is the total system concept. It looks like the resource is huge, and that the cost is going to be right.

We have not completed our work——

Senator GRAVEL. What is the time frame for your study?

Mr. HERONEMUS. We are now working on another 12 months of tidying up this research. If this process, if you really wanted to see this process developed and put into being, you could have a pilot plant working in the near term. Anderson says 4 years. I think 6 to 8 years might be a better time base.

Senator GRAVEL. But do we have enough knowledge at this point in time to warrant the expenditure for a pilot plant?

Mr. HERONEMUS. Yes; unequivocally, yes.

Senator GRAVEL. So what are we talking about, a pilot plant, $20 million?

Mr. HERONEMUS. No; we are talking a lot more than that. If you want to talk, a good 6-year program to do this right, and my idea of a pilot plant is much larger than his idea of a pilot plant, because I feel you have to demonstrate the thing big enough to know whether or not you can then replicate it, I am talking about a 6-year program, the total of which would be about $800 million, and for that you would end up with a 400-megawatt electrical production-line plant on station.

Senator GRAVEL. 400 megawatts would take care of what size community, would you say?

Mr. HERONEMUS. Well, in all of New England today we have on line just about 13,000 megawatts electrical, so 400 megawatts is pretty close to about 4 percent of all New England. It is a big powerplant. Four hundred megawatts electrical is a big powerplant.

Senator GRAVEL. Very good.

And that, of course, could be funded right out of our trust fund.

Mr. HERONEMUS. That would be great.

Senator GRAVEL. Very good.

Well, we will make note of that and give extra emphasis.

Doctor, again I know you have a time constraint, and I want to thank you for your presence and for your participation, and I think you have added something to the legislation. Thank you very much.

Mr. HERONEMUS. Thank you very much.

Senator GRAVEL. Dr. Lindmayer, would you please proceed and give your paper?

Dr. LINDMAYER. Thank you, Mr. Chairman.

STATEMENT OF DR. JOSEPH LINDMAYER, PRESIDENT, SOLAREX CORP.

My name is Joseph Lindmayer and I am the president of a recently formed corporation called Solarex in Rockville, Md. This corporation was formed about 6 months ago with the explicit purpose of developing, manufacturing, and in general advancing the cause of solar energy. Prior to becoming involved with Solarex, I was a scientist in the solid state field. About 3 years ago I became interested in solar cells, devices that convert light directly into electricity, and while director of the physics laboratory at Comsat, developed a superior solar cell for space use. When this cell was measured for conversion efficiency on the roof the efficiency was as high as 18 percent, instead of the usual 10 to 12 percent. Solarex, which is committed to terrestrial applications, will raise the conversion efficiency to the 20 percent mark or higher.

As we all rediscovered, radiation by the sun supplies the energy for our planet on a large scale. Modern industrial society derives its energy needs from sources that represent stored solar energy, such as oil, gas, and coal. These sources are finite and the time of depletion of these sources is within sight. In addition to these limitations, the desire to industrialize is spreading throughout the world; this trend further increases the demand for the limited supply. Clearly, an industrialized world could not be supported very long from conventional energy sources. In such a setting, it will become unavoidable to take advantage of the instantaneous solar input provided by the sun.

Instantaneous solar energy may be collected in the form of heat or electricity, among other things. The technology for heat collection is relatively simple, but interestingly, there is no industry to supply the required panels. Conversion to electricity is extremely attractive because as soon as electricity is at hand, it can be used or stored in many ways. Due to the space program, a small solar cell industry actually exists, supplying solar cells for satellites. Solar electric panels used on satellites are quite expensive: the cost may run from $200 per watt to $600 per watt. When this cost level is related to the cost of power delivered by the electric companies, we find that solar electricity is 100 or 300 times more expensive than conventional power.

At this point we find a group of experts who declare that solar energy is far too expensive and a new technological breakthrough is needed for cost reduction. This is an argument that is being repeated with increasing frequency; reports and studies have been written for years concluding the same. On the other hand, advocates of solar energy frequently declare that no new breakthrough is needed, it is only a matter of commitment. While there is not much action in the field, someone wrote on a blackboard sarcastically: "If we would burn all the papers written about solar energy, the energy crisis would be over." The above static positions must be repealed with a more dynamic functional approach to the problem.

Senator GRAVEL. How much could we heat with all the paper that went into breeder reactors?

Dr. LINDMAYER. That was actually an internal joke.

The use of silicon solar cells for electric power generation is an approach that is very satisfying scientifically and intellectually. Nature provided us with a phenomenon, known as the photovoltaic effect, which allows easy conversion of light into electricity. Nature also provided us an abundant amount of silicon, it is the second most abundant element on earth next to oxygen, and with plenty of light. Between the abundant resources of silicon and light, we have only technological difficulties in making the system work economically. The connecting link is an underdeveloped technology that could be improved rapidly.

It was the above-described philosophy which formed the basis for Solarex Corp. Individual investors, who believed in the future of solar energy and in our functional approach, provided a working capital. We have built up complete facilities in about 3 months, and based on a series of ideas, developed a new, much less expensive technology. There is a small production line running every day, utilizing and refining this new technology. In spite of our limited resources available, the cost of solar electricity has been reduced by a factor of 10 below space costs. At this point we can state that solar electricity is only a factor of 10, and not hundreds, more expensive than conventional electricity. We can see clearly that further cost reductions are possible by continued examinations of new ideas and by utilizing those that prove themselves practical.

Solar electric panels are used today by institutions, such as the Forest Service and Bureau of Land Management, private companies, and individuals who have immediate uses for solar power in remote areas. These people have learned to appreciate the practicality of the durable, maintenance-free, fuel-free solar electric panel which provides electricity every day. There are many smaller systems in operation now, supporting the power needs of remote area transmitters and providing light on offshore oil platforms. While these small systems provide negligible energy in terms of the energy needs of the country, the installations do prove the feasibility of solar electric energy.

Solar energy development is in great need of serious support. Significant support in certain selected research and development areas is needed now, and monetary support should be given to demonstration projects which will unquestionably lead to a major impact. In order to bracket the size of budgets available for solar energy work, I would like to cite that in my own area, the breakthrough in solar cell efficiency was accomplished on a total budget of less than $400,000, and the breakthrough in cost reduction through new technology was accomplished for approximately $200,000. While all these supports came from private sources, the Government is also supporting projects in the different solar areas at similar levels or lower. As we all know, there is a certain threshold level required for an impact program with measurable results, and the present support that can be raised for any of the projects is either at or below this threshold level. The net result is that we have isolated instances of results and an abundance of paper reports. But it can be said that even under these monetary constraints, significant new developments are taking place, indicating clearly that solar energy has a great practical potential.

In order to clear the air of misconceptions, of confusion, and of fruitless arguments on certain details, I believe that selected projects should be supported. In order to illustrate this, let me propose a very specific project which could in a few years clear the air concerning solar energy and at the same time would have a major impact in the energy field. In building solar cells every day, we are using, of course, electrical energy. At the same time, we have test panels on the roof to monitor the amount of energy available every day and the durability of differently constructed solar panels. This electrical input is collected in batteries, and of course, the energy must be used up or else the batteries would be hopelessly overcharged. Rather than dumping the energy into dummy loads, we are in the process of introducing this solar energy into the actual manufacturing process. If we would be putting enough solar panels on the roof, an increasing amount of the solar panel manufacturing could become solar-energy operated. Based on our new technology which is simple and energy conserving, we could solarize the entire manufacturing process. The next result of increased solarization of the process would be an energy-independent, energy-manufacturing plant.

At this point, we will have created, in lieu of a better word, a solar breeder. The output of such a solar breeder may be expressed in terms of x number of kilowatts per year, and every solar panel manufactured will continue to produce energy over the life of that panel, which is at least 20 years. This proposition may remind some people today of the perpetual motion machine, but we are not violating any of the physical laws of nature; the solar breeder indeed would produce energy for homes, factories, and so forth, without requiring any artificial energy input except, of course, the sun.

I believe that we could build such a solar breeder within a few years, say 5 years. The total expenditure for such a project could run in the range of $10 to $15 million. At first, the solar breeder factory would, of course, use conventional energy, but all of its output would be used to disconnect itself from the electrical network. This would be taking place gradually and by the end of 5 years the factory would be nearly energy independent. From that point on the output of the factory will be available for installation elsewhere.

The completion of this solar breeder would decisively lessen the confusion surrounding solar energy. The results would dispel any misgivings about feasibility, practicality, energy recovery cycle, and enumerable other points that certain critics raise. This first solar breeder may produce power as much as one-half a megawatt which would be large enough to give the sensation of real power. Following this prototype building of the solar breeder, the plan can be repeated on larger scales providing a gradual way of introducing increased amounts of solar electricity for general use.

I am sure you will realize that we cannot build this solar breeder from our own resources. We cannot possibly attract investors and tell them that all of our output will end upon the roof. In order to maintain our pioneering enterprise we are, of course, forced to sell practically every panel we make. I think that the proposed solar breeder points out a very clear way in which the Government or some institution could advance the implementation and introduction of solar energy in a serious manner.

Without further elaboration on the pros and cons of solar energy, I wish to call special attention to this unique opportunity to implement an unusual plan and help to introduce this natural energy into our everyday life. The technology is available, the time is right, and the decision may be in your hands.

At this point I wish to express my deep appreciation for the opportunity to present our views on the important matters of solar energy.

Senator GRAVEL. Doctor, you have said something very interesting here and I did make a right decision in putting you in tandem with Dr. Heronemus.

Let me ask you one question.

Do you have any concept of or knowledge of what the total solar effort is in this country today, dollarwise?

Dr. LINDMAYER. As far as I know, the National Science Foundation has the solar energy projects under its control, and it runs around $13 million, roughly.

Senator GRAVEL. $13 million being spent?

Dr. LINDMAYER. Yes. But it is subdivided for all sources of solar energy. For example, the photovoltaic area, converting to electricity, has a budget of $2.4 million.

Senator GRAVEL. Now, the solar breeder that you talk of here, putting it on a manufacturing first, how large would be the sales, how big an area will this cover?

Will it alter appreciably occupation of the factories or homes?

Dr. LINDMAYER. Preferably this would be a one-story building with a fairly large roof, and the roof would be used, maybe areas above the parking lot and places like that.

Senator GRAVEL. Would be used for solar cells?

Dr. LINDMAYER. Yes.

Senator GRAVEL. So what you do is you make a lot of carports?

Dr. Lindmayer. Right.

Senator GRAVEL. Well, if you took the Pentagon with all the massive parking that we have there, if you just put that carport over all the parking lot, would that in your mind give you enough power to power the Pentagon?

Dr. LINDMAYER. I would not have numbers at this point, but I assume a large part of it would be collected. At this point I would just like to mention how I got converted to the practicality of solar energy. It occurred when I built some of these panels and put them on my own house; at first a small one and then a little bigger, and then something like a square yard, maybe, and then you certainly begin to see the power. That is the turning point, when you have a large enough area to get the amperes flowing.

Senator Gravel. Is it conceivable that we could take the area of a present roof of a present home and attach to that and in the same direction and the same pitch and all of that, so you do not alter the architectural appearance, could we put on solar panels and would that generate enough electricity to take care of the electrical needs of the house?

Dr. LINDMAYER. This is in an average home?

Senator GRAVEL. Yes.

Dr. LINDMAYER. Yes. I have calculated this in great detail and of course related these results to the data obtained from the experimental panels on my own home. While I had a modest size panel, I could easily extrapolate what kind of power I would get if I would cover the whole roof. According to Pepco, the average home in Washington uses 750-kilowatt-hours a month, and with a 10-percent conversion efficiency of solar cells, even allowing it to be that low, we could make the fully independent home using less than 1,000 square feet of roof area.

Senator GRAVEL. You are kidding.

OK, 1,000 square feet of roof.

Dr. LINDMAYER. It actually comes out to 500.

Senator GRAVEL. And that 750-kilowatt hour represents probably a 2,000 square foot home on the average.

Dr. LINDMAYER. That is correct. It turns out there is a complete harmony between the electrical needs of the building and the amount of roof area available.

Senator GRAVEL. Very much harmony. You have got half the area you can utilize. Does that provide enough energy for that? What would be the capital investment of putting solar cells on the roof?

Dr. LINDMAYER. Well, I am going to go to the major economical problems that we have to face. If we were to use space solar cells and space panels, using the same technology that was used in space, that installation would cost up to $500,000 for a house.

Senator GRAVEL. So that house roof would cost $500,000?

Dr. LINDMAYER. Yes. But with the cost reduction newly achieved, we are now at less than $50,000.

Senator GRAVEL. So $50,000 would be a capital investment for that roof.?

Dr. LINDMAYER. Of course, at that point it can be nicely calculated that one is running at roughly 30-cents per-kilowatt-hour, which is almost 10 times what Pepco charges today. At a $5,000 or $6,000 installation cost, one would be directly competing with present prices.

Senator GRAVEL. If you could bring it down by another factor of 10.

Dr. LINDMAYER. That is right.

Senator GRAVEL. If, again, we provided a tax incentive or a total deductability for let's say 1 million homes, do you think that that would provide sufficient impetus into the industry so that they might have enough research or manufacturing expertise to make it lowered by another factor of 10?

Dr. LINDMAYER. I have no doubt in my mind that technically the solution is there. In fact, we have a fairly good theoretical background worked out here where we know that this could be done. Another factor of 10 cost reduction is possible.

Senator GRAVEL. Do you feel that you could put together some figures if, supposing we provided in the law a tax deduction and a recovery, if a person chooses to change over after *x* number of years, we could compute out what that cost would be, if you could then turn around and give us projections as to what you think those costs would be?

Dr. LINDMAYER. I would be glad to do that.

Senator GRAVEL. Okay.

Would you submit it in an additional paper for us, computing out the case if we provide the total write-off on a million homes and translate that into impact on the economy, and then what you think the conversion and cost would come to, so that by the time that million home program is accomplished, what do you think these units would be selling for on the open market.

Dr. LINDMAYER. Yes; and the 1 million homes, of course, represents a tremendous market. The size of the industry to solarize 1 million homes must be on the order of $1 billion or more, and maybe it would be also possible to give some tax incentive to potential investors who would invest in the selected industries, not just to the customer.

[The information referred to follows:]

ADDENDUM TO STATEMENT BY DR. JOSEPH LINDMAYER, PRESIDENT OF SOLAREX CORP.

THE PROBLEMS OF SUPPLYING SOLAR ELECTRICITY TO ONE MILLION HOMES

At this point of time the solar cell industry is very small, generating an output of approximately 60 kW/year. If all solar cells manufactured today were used for home installation, approximately ten homes could be solarized every year. In order to solarize 1,000,000 homes within ten years the production capability of the industry should be expanded 10,000 times. Since production capability could only expand gradually, by the end of the 10-year period the solar electric industry must be multi-billion dollars strong.

If it is assumed that electricity will rise in cost from the present 3–4¢/kWh to about 8¢/kWh in ten years, the average homeowner will pay an electric bill of $720 per year. This is based on an average use of 750 kWh/month. Using the 8¢/kWh figure, electricity costs then about $18,000 in 25 years.

At the present time solar electricity can be bought for as low as $20/watt (peak)—a great reduction recently accomplished. Further cost reductions will inevitably occur with the expansion of the market. Assuming that the price will have dropped to the level of $3.00/W installed, the 25-year cost would be $17,500. With a 50% tax credit, the installation cost is $8,750 on which the interest for the first year runs at $787.00. This cost then is very comparable to the cost of electricity generated from fossil fuels

The projected cost of $3.00/W (peak) requires a silicon cost of 50¢/W approximately a four-fold cost reduction) and an automated production line producing the cells and panels at not more than $1.50/W. The remaining $1.00/W is allocated to installation and sale costs.

The above-described guide numbers outline the following problem areas requiring solution:

(*a*) The cost of silicon must be reduced by using low grade silicon or thin film.

(*b*) Support is needed to establish an automatic production plant for solar cells and panels.

(*c*) Investment capital support is required.

(*d*) Training of personnel for installation is also required.

Senator GRAVEL. Well, we have that in the bill. We have 7-percent investment tax credit recommendation, an investment tax credit which no other part of American industry would have. So that in itself would draw into anything. Also, there would be the economics at the other end, a guaranteed sale of 1 million units, several people could go into that business and compete for it.

Dr. LINDMAYER. I would be very happy to support that. I think it is a very important point because the investor must be attracted.

Senator GRAVEL. So in point of fact, when you say $1 billion that is a bagatelle in the total cost to the Nation of the problem if left unattended. This year we are going to expand our exports by $10 billion just for the purchase of this foreign energy. So that is only 10 percent of 1 year's expansion. We will be bankrupt in about 10 years if we do not move into areas like this.

Do you know anything about the windpower?

I failed to ask Dr. Heronemus.

Dr. LINDMAYER. It is not my specialty.

Senator GRAVEL. I have received a paper from some scientists at the University of Alaska talking about the windpower potential. Apparently some of the most consistent and best winds in the world are there. They also talk of a hydrogen system, creating hydrogen and exporting it.

Do you know anything of that?

Dr. LINDMAYER. Of course, this points to the hydrogen economy, that may be common to all systems, whether the energy is generated by windpower or ocean thermal gradients, as we heard a few minutes ago. Along the same lines, of course, solar cells could do the same.

Senator GRAVEL. So it would be a race to see who produced it most economically.

Dr. LINDMAYER. Well, I think it is fine. Maybe they will not be really competitive systems, but rather complementary systems.

Senator GRAVEL. Very good.

Well, Doctor, I want to thank you very much for your presentations and we will expect your computations, because it will be your computations that we will base our tax deduction on, or the feasibility of it. We will need as precise information as you can give us to sell this to Congress.

Dr. LINDMAYER. Thank you very much.

Senator GRAVEL. Our next witness is Dr. Krajcovic-Ilok.

Doctor, would you please introduce your colleague with you and proceed at your own pace?

STATEMENT OF DR. V. STEPHEN KRAJCOVIC-ILOK, PRESIDENT, ILOK POWDER CO., ACCOMPANIED BY WILLIAM L. TALBERT

Dr. KRAJCOVIC-ILOK. I thank you very much for the great honor you have given me in inviting me to this hearing on energy.

Senator GRAVEL. Thank you.

Dr. KRAJCOVIC-ILOK. My name is V. Stephen Krajcovic-Ilok, president of Ilok Powder Co., Inc. With me is my staff engineer, Mr. William Talbert.

I am here to present and persuade you of an extraordinary claim—that my company now has the technology to win the energy war promptly. We are only money away from that goal.

The Energy Revenue and Development Act, pending as S. 2806, is legislation that would open up a source of funds. So I am here to support it. If the Government would place orders for the supply of Ilok energy, and if loans were obtained under that act, we could build plants across America to put to use a technology, now lying dormant. for energy output that would be the reward of every American.

The answer to the energy crisis is 4 micron coal. Let me explain.

The United States of America already has a vast reservoir of energy in both oil and coal. But in their present form, these two sources of energy cannot be adequately tapped. With about 50 billion barrels of oil reserves, and with about 2 trillion tons of recoverable coal there should not be any energy crisis. Yet a crisis there is because our own reserves of oil can last at best only some 30 years. And our supply of coal, which would be good for 400 years of energy, is too dirty to be used for that purpose.

In addition to being dirty, coal is also too large in size, and there is no technology to reduce it commercially to less than 74 micron. As a result, much of the energy in coal is lost, hence unexploited, both during the combustion processes now in use and also in the coal-to-oil and coal-to-gas conversion processes that are being developed in America.

Senator GRAVEL. Excuse me, Doctor.

What is a 4 micron?

Dr. KRAJCOVIC-ILOK. A 4 micron is 0.00016 of an inch. To elaborate further, 1 micron would be around 105 million times larger than an atom of carbon; 1 micron, divided by 300, is about 7,000 times larger than an atom of carbon; 1 by 500 of a micron is only 4,000 times larger than the atom of carbon.

Mr. TALBERT. I might state here that the 4 micron is a microscopic particle. In other words, it is not visible to the naked eye.

Senator GRAVEL. So what you are talking about is changing the size of the particle within powdered coal, change its size from 74 microns down to 4 microns?

Dr. KRAJCOVIC-ILOK. To make it more instructive, I would say this. With the naked eye, Mr. Chairman, you can see 74 microns. If you have 40 microns, you can still see it. But down below 40 microns, you cannot see it. It is too small.

Senator GRAVEL. Below 40 microns?

Dr. KRAJCOVIC-ILOK. Yes, below 40 microns you cannot see with the naked eye.

Senator GRAVEL. Are you going to go into more technical explanation of that?

Dr. KRAJCOVIC-ILOK. Yes, I will.

Ilok Powder Co. states that it has the technology that remedies both these basic deficiencies in coal. Ilok coal is not only clean, but it is also small in size. It has surface areas, available for the first time in our economy of energy, which by the generation of electricity attain thermal efficiencies of 50 to 63 percent. These efficiencies are superior to even those attained by the atomic energy in the production of electricity.

Ilok Powder Co. has a solid record of achievement in the field of coal and of substitute energy production from coal. It shows that the conversion of our vast coal resources into clean fuels more effective than oil itself is not only possible, but easily achievable, and that all necessary experimentation and demonstration has been done and is ready for large-scale commercial applications.

On the basis and to fulfill President Nixon's plan for self-sufficiency in what he calls Project Independence, I am prompted to propose five individual solutions to our energy crisis in America.

First solution: Dr. Ing. Hans Rohrbach, now Ilok's director of research, discovered in 1936 that coal, when reduced to uniform 4 micron sizes, could be burned in diesel engines in lieu of diesel fuel without leaving any damaging residue. The diesel engines that he developed used the 4-micron coal to generate electricity for years in the city of Bochum, Germany.

The technology that is known as the Ilok coal powder technology is based primarily on this first and most important discovery regarding coal. With the 4-micron coal powders at our disposal, this Nation does not need any longer the huge quantities of costly diesel oil, since our diesels can now be powdered with the bountiful coal, of which America has about 2 trillion tons.

Not only that. This 4-micron coal can be used more effectively than the diesel oil, because from 1 ton of the 4-micron coal, we obtain about 4,100 kilowatt-hours, instead of 2,700 kilowatt-hours obtained from conventional coal.

Senator GRAVEL. What is the comparison with diesel?

Dr. KRAJCOVIC-ILOK. In diesel, we get—from 1 barrel of diesel oil, we get about 600 kilowatt-hours, so you would need about 5 barrels of diesel oil to match this. Diesel costs you, however, very much money, and it does not obtain these kilowatt-hours which I have cited here.

Why is that? Because of the surface areas of the ultrafine coal that the Ilok technology opens up, and that up to now were never available for a more perfect combustion. It therefore follows that since we have a more rapid combustion as a result of the doubling and tripling of the surface areas of coal, we also obtain a doubling and tripling of the combustion pressures. Thus, we also achieve a greater velocity of the pistons that are responsible for a greater number of revolutions of the engines, and therefore, for a much greater performance than was possible up to now.

In practice, this means that the burning of 4-micron coal in diesel machines outperforms the burning of the costly diesel oil. On this basis, energy derived from the 4-micron coal is more economical and more competitive than oil. Therefore, America must switch to coal.

Senator GRAVEL. What form is it in?

Is it a powder that you blow into the engine?

Dr. KRAJCOVIC-ILOK. Yes, it is a powder.

Senator GRAVEL. It is not a liquid?

Dr. KRAJCOVIC-ILOK. No.

Senator GRAVEL. How does it flow?

Dr. KRAJCOVIC-ILOK. We have a special transportation system from the reductor mills to the diesels.

Senator GRAVEL. No, I mean in the engine itself.

What causes it to move around?

Dr. KRAJCOVIC-ILOK. It falls centrally into the system itself, so the diesel has to be slightly modified, and any diesels can be used. This applies especially for the huge diesels.

Second solution: The second feature of the 4-micron coal particles is the fact that such particles have capillaries which contribute up to 50 percent to their total internal volume. For this reason, the 4-micron coal particles can be readily blended with oil without any fixateur agent that must be used when 74-micron coal particles are used which lack the capillary structure totally. The 4-micron coal particles can also be blended with our dwindling quantities of natural gas.

May I make a diversion, Mr. Chairman?

During the Second World War, when this country was facing the same kind of energy shortages as we are now, the U.S. Government tried to develop colloidal fuels. But since they had only those visible particles, 74 micron, which do not have capillaries, which you have and I have in our bodies, they could not blend oil or gas totally.

Whenever they blended it, it separated from each other. Hence, you could not send it through your pipelines because it would make sediments, and also sediments in machinery, because it was dirty. It had ash and sulfur. All this is removed now, because only the 4 micron has capillaries. When you have capillaries, it is like a sponge which absorbs all the gas and all the oil.

Senator GRAVEL. Let me see if I understand you. Just from my personal point of view, we have a great deal of coal in Alaska, as you know.

Can that coal be brought down to 4 microns, and then we can build pipelines to ship that coal?

Is that what we can have?

Dr. KRAJCOVIC-ILOK. Correct. Exactly.

When we reduce it to 4-micron size, while we are reducing it, at the same time and at no cost whatsoever we are removing all the ash and all the pyrites from coal. For this reason, we call it clean coal, and if it would be sent through the pipelines we would use an inert gas system with it, like nitrogen. Then, at the end of the pipeline, the nitrogen or any other inert gas would be removed and the pure coal would be burned either in your boilers or in your diesels, or it could be blended again with the existing quantities of fuel or gasoline, diesel oil, or natural gas as colloidal fuels.

Senator GRAVEL. Now, you have plants right now that can do this?

Dr. KRAJCOVIC-ILOK. This was done in Europe for about 18 to 20 years, both in East Germany, West Germany, and Switzerland. And once this was discovered, this basic 4 micron, from then on it became a secret industrial endeavor, because of implications to which we will come later.

Senator GRAVEL. Is it still a secret process?

Dr. KRAJCOVIC-ILOK. It is, except because of my company which has all these secrets, and makes it available to the U.S. Government.

Senator GRAVEL. You have a patent on this process?

Dr. KRAJCOVIC-ILOK. Yes, it is a protected process.

Senator GRAVEL. How long will your patents last?

Dr. KRAJCOVIC-ILOK. The basic patents will run out in about 1977. But since those patents have been approved and issued, we have made many basic improvements on the system, so that once we go into the production here in the United States to alleviate the fuel crisis, we will apply for the improved patents.

Senator GRAVEL. The point I am making, though, can you lock up all of this technology, or can we broaden it into a larger national effort without making you king of micron 4?

Dr. KRAJCOVIC-ILOK. That is correct. We can make a very great national effort on this. We can make a Comsat-type of an arrangement between the Government and Ilok Corp.—we can also make the use of this technology royalty free to the U.S. Government. That we are prepared to do.

At the same time, we can also develop our own activities. For instance, Government would probably not be interested in building a string of coal plants across the country. But the Government probably would be interested to give us a helping hand in securing low interest loans, because it would be advantagous to the Government.

Senator GRAVEL. This bill that I have would do that?

Dr. KRAJCOVIC-ILOK. Yes. That is exactly right. We are supporting it. It is a great bill.

This technical statement means that the gloom that has enveloped the industrialized West since the oil-producing nations unsheathed their oil weapon can now be effectively removed without waiting for the magic year 1980 or the year 2000 because Ilok is able and ready to go to produce a whole line of new colloidal fuel immediately. Here are the dimensions of the project.

The Federal Energy Office said on January 10, 1974, that the shortfall on oil for the week that ended in December 28, 1973, was 1.5 million barrels a day. Since each 10,000 long tons of 4 micron coal can be blended in one single Ilok plant with 100,000 barrels of oil—fuel oil, diesel oil—daily to obtain 150,796 barrels of Ilok colloidal oil, it follows that to produce the equivalent of the missing 1.5 million barrels of oil, Ilok must produce each day about 300,000 long tons of the 4 micron coal.

Once the 300,000 tons of the 4 micron coal are blended daily with 3 million barrels of oil, the Nation will have at its disposal 4.5 million barrels of colloidal oil, which in 1 year represents a total output of 1,642,500,000 barrels of colloidal oil.

To reach this yearly output, 30 Ilok plants must be built at a cost of about $100 million each, which is a small price to pay to help make America energy self-sufficient.

As to any possible shortages of natural gas——

Senator GRAVEL. Now, that is just the capital cost of those plants?

Dr. KRAJCOVIC-ILOK. And also the first year operating expenses.

Senator GRAVEL. Is that the cost of the coal too?

Dr. KRAJCOVIC-ILOK. That is not the cost of the coal or oil included in it, because for coal and oil we can set up separate corporations and people can participate in this technology.

Senator GRAVEL. Yes, I have got some ready figures in my mind, which is that the Alaska pipeline is about a $3 billion project—similar to this. It would produce 2 million barrels a day. You are talking about an equivalency here of 1.5 million, and so you have got to purchase the oil, you have got to purchase the coal.

Now, I am just wondering, once the oil is discovered and once the coal is discovered, the cost of the production of the coal, either through strip mining, or the cost of oil through deep wells would be the item of comparison at that point in time.

Dr. KRAJCOVIC-ILOK. Yes, but even so, it would be cheaper for this reason, Senator.

If you take one barrel of oil at $7, if you roll back the price to $7, you will have $700,000 each day representing 100,000 barrels of fuel oil. To that, add 10,000 long tons of 4 micron coal, which will cost you on the long-term contract for coal—you do not pay more than $3 or $4, at the most $5 per ton. Now, from 1 ton of coal I am making an equivalent of five barrels. So when you divide $10 with five barrels, it is $2 per barrel combining with the $700,000. Your ultimate price for the one barrel of colloidal fuel will be at least $1 or $2 less than what we now pay for one barrel of fuel oil.

Thus, as an economist, you may strengthen your dollar, you improve your balance of payments, and we create the employment, and nobody can do this.

I can do it without a rollback.

Now, let us talk about natural gas. As to any possible shortages of natural gas, the 4-micron coal particles can be blended with natural gas at a ratio of about 23 pounds for 4-micron coal and 1,000 cubic feet of natural gas. This colloidal natural gas can well feed America's industries, while the pure natural gas would be reserved for hospitals, schools and residences.

Third solution:

As an alternative source of energy, different Ilok plants can be built for the reduction to a 4-micron size of the 520 million tons of now discarded dried vegetable residues, such as soybean, rice, wheat, barley, sawdust, dried feedlots, straw, and other similar substances.

In a 4-micron form, they can be used also in diesels, because our operation in Bochum, Germany, proved conclusively that these substances yield up to 7,000 Btu per pound due to their enlarged surface areas, and replace both the oil and coal in diesels.

This alternative energy source, when fully utilized, can represent an equivalent of 1,166 million barrels of oil. This energy can still be further increased if the U.S. farmers utilize the 40 percent of available cropland that is now idle to raise grain.

Since the use of the 4-micron coal in diesels in lieu of oil, the use of colloidal oil fuels and colloidal gas and the use of dried vegetable residues have all been commercially developed, the success of project independence is indicated already on this basis. And, I wish to emphasize not by the year 1980, but within a few years, when the energy crisis will be effectively wiped out, provided we have the vision for a meaningful implementation of the Ilok coal powder technology on a scale similar only to the Apollo program.

Fourth solution:

Turning to the problem of coal-to-oil and coal-to-gas conversion processes, our experience with the burning of the 4-micron coal in diesels demonstrated without a shadow of a doubt that in the hierarchy of coal sizes the 4-micron size represents a value that technologically, economically and even politically makes a vitally important difference: Only the 4-micron coal sizes and sizes below 4-micron gasify completely. That is, without any residue, which means without any char. All the sizes of coal above the 4-micron size do not gasify completely and invariably yield char, sometimes up to 60 percent from the weight of coal used in the coal-to-oil or coal-to-gas conversion processes.

The practical implications of this statement are enormous. At the present time all our coal-to-gas and coal-to-oil conversion processes that are being developed with the assistance of government funds use coal in sizes above the 4-micron level. Thus they are not only prohibitively costly, but also very wasteful.

By pulverizing coal and mixing it under pressure with hydrogen, the Germans were able to produce oil and gasoline to keep their Wehrmacht going.

But at what price?

Just in their one plant in Scholven, Germans produced 168,000 tons of fuel for their aircraft and 48,000 tons of other fuels. They consumed for that purpose up to 481,000 tons of coal and 292,000 tons of coke.

Today, the FMC coal-to-oil process does no better. From 1 ton of coal it obtains 1 barrel of oil, 9,000 cubic feet of gas, but one-half ton of char.

For this reason of wastefulness with our coal, Dr. Dixie Lee Ray rightly advised in her report to the President that a workable desulfurization of coal and a breakthrough in the production of hydrogen are required to achieve energy independence for the United States.

But even this is not enough. A third, vitally important element must be added to the program: reduction of coal to at least the 4-micron size.

Senator GRAVEL. When you reduce it to 4 microns, do you do away with the problem of sulfur?

Dr. KRAJCOVIC-ILOK. Yes; we remove the inorganic ash, we remove the pyrites. Now, we have demonstrated in the diesel, when you put it into that cylinder, it burns there without any char, without any residual, none whatsoever.

Senator GRAVEL. The char is the pollutant?

Dr. KRAJCOVIC-ILOK. Sure. It is not only the pollutant, but it would clog the machinery, and for that reason we remove all the impurities, so that creates clean coal.

Second, we reduce it to such a size that it gasifies completely without char. And all of our gasification of coal-to-oil processes are built on the obsolete technology which at one time Mr. Carl Bagge, president of the coal association, called, as science using total senility standards.

We cannot overcome this crisis quickly, for that reason. Dr. Ray put her finger on it. First we have to clean it. And I put my second finger, we must make it small. That is the whole problem. If we solve these two problems, we have got it made.

Now, Mr. Chairman, I do not want to mislead you. When I say that we make clean coal, now what is clean coal? Clean coal is the coal which mechanically we can clean in such a manner that we remove all the inorganic ash and inorganic sulfur. The little tiny piece of organic ash and organic sulfur which was there when the coal was formed before millions of years is still in the matrix of coal. We clean that at a later state, to which I am coming, by my ultimate solution.

Only Ilok's 4-micron coal particles, free of moisture, free of pyrites, and free of ash, gasify completely. This means that only when we use the 4-micron coal in all our coal-to-oil and coal-to-gas conversion processes, one form of energy is fully converted, that is, 100 percent, into any other form of energy, be it gas or oil, without any loss. With such clean coal as Ilok's at America's disposal, it is then not only simple but also economical to just vary the amount of hydrogen, heat, and pressure to produce the kind of fuel the Nation needs.

It is therefore absolutely important, before undertaking the task of producing synthetic oil or synthetic gas, to reduce coal to 4 micron sizes and to remove from it at the same time moisture, pyrites, and ash, to so insure the more balanced coal conversion processes without getting any of the wasteful char.

In short, only when the Ilok coal powder technology is fully applied in all our coal-to-oil and coal-to-gas conversion processes, America will become energy independent also in respect to synthetic oil and synthetic gas. If utilized, we can produce from 1 ton of average bituminous coal not 16,000 cubic feet of pipeline quality gas, but 26,000 cubic feet at least, and definitely not 1 barrel of synthetic oil, but at least 4 barrels of oil, depending on the techniques applied, that is, the amount of hydrogen added, heat, and pressures used.

The basic point is that Ilok's 4-micron coal can eliminate the energy crisis promptly. It can: burn in diesels in lieu of oil; it can be blended with oil and gas, and in combination with hydrogen, under certain heat and pressure it can produce any fuels this Nation needs without any steam, without oxygen, without the wasteful char and without methanation.

This is particularly important, Mr. Chairman, for the Western States, which do not have water. For that reason, you cannot use the processes, No. 1, which are wasteful, which give you much char, and which need your steam and oxygen. You must do it without these elements.

Fifth solution:

Indeed, the Ilok technology has also a fifth solution, which is the ultimate in the coal science. By an additional thermal processing of 4-micron coal, this technology can separate the carbon in coal from the product gas derived from all the volatiles in coal.

Thus, from 15,000 tons of the bituminous coal Ilok can obtain about 8,500 tons of pure carbon in a size of 1:000 micron, and about 125 million cubic feet of pipeline quality gas by an additional processing of the product gas. This achievement represents the ultimate solution of the energy crisis because it also shows the classical example of a complete conversion of coal into two forms of clean energy: carbon and pipeline quality gas.

Having the absolutely pure carbon in the size of 1:300 micron at our disposal, we can do very many things. But since we are concerned about the energy crisis, we can:

One, burn the 1:300-micron carbon in both diesels and turbines to obtain thermal efficiencies of 60 to 63 percent;

Two, blend the 1:300-micron pure carbon with any type of oil or gas to form absolute collodial fuels; and

Three, react the 1:300-micron carbon with hydrogen to get any fuels desired, depending on the amount of hydrogen added and heat and pressures used.

For the past, 25 years, America has led the world in developing new technologies. The project I am here to recommend is comparable in scope and scale to the computer, television, and space technologies.

Furthermore, what I have discussed here today is only the tip of a huge iceberg regarding the technology of energy and the closing of the energy crisis promptly. It has many other applications, like the atom, for the limitless benefits of mankind. Now is the time to get America moving again and to announce that a new age—the age of clean coal and pure carbon—has dawned.

To get American moving again, and to open the new age of coal and pure carbon, I wish to say in conclusion that Ilok Powder Co. is prepared to offer what it has not done so far to any agency—a fully detailed technical disclosure of this technology to government agencies or qualified investors, utilities or corporations wishing to secure for themselves a guaranteed daily flow of Ilok clean fuels. Naturally, such technical disclosure has to be made under the normal disclosure practices through Ilok's attorneys, and not for purposes of curiosity or research, but commercial production of such clean fuels only.

As to the economics involved in this process; to reduce 1 ton of coal to 4 micron ash-free, pyrites-free and moisture-free particles will cost only about $3. To further reduce one ton of 4 micron coal to a

1:300 micron pure carbon will cost an additional $3. The capital cost of one powder plant reducing 10,000 tons of coal to 4 micron size is about $65 million; the capital cost of one powder plant and one colloidal fuel plant, including in that first year operating cost, is $100 million to produce daily 150,000 barrels of colloidal fuels. The estimated capital cost for one coal gasification plant producing daily 250 million standard cubic feet of pipeline quality gas is $70 million. The estimated capital cost for a hydrogen plant producing daily quantities of hydrogen to feed about 9 Ilok gasification plants for purposes of producing in each 250 million standard cubic feet of pipeline quality gas is only $70 million.

Since the energy project of this dimension must lean heavily on the assistance and loans from the Government, in the absence of any legislation dealing with financial assistance to proven energy technologies, such as Ilok's, it is in the interest of this Nation to either renew the World War II act known as the Army and Economic Mobilization, for setting up of new energy plants using proven technologies, or to establish the now-proposed Energy Trust Fund.

I therefore respectfully recommend passage of S. 2806 as the first step on the road toward the new age of clean coal and pure carbon.

Senator GRAVEL. Sir, I wonder if you could not prepare something for our committee. We have some comparative economic data, but it is not prepared in a form to make some judgments. So I wonder if you would not go back through, and I know you have the source material just by seeing the figures you have given us, if you could go through and prepare some charts giving us some comparisons from, let's say, the cost of coal; the market cost of coal right now, the cost of the Ilok process, and then the added cost of gasification or mixing it with oil, either one; and the product, either on a Btu basis or on another type of energy measure basis. I think the Btu basis would probably be best. And also a barrel equivalent. Then take the information you have at your disposal as to what it costs up to this time, and what the market pays for these barrels. Then we can see comparatively as to what the benefit of your process would be, and how it could be integrated into the economic system as a viable force. I think what you glean from this is your statement says that it is the case, and gives some economic data to whet the appetite, but not enough economic data to totally prove your case.

Dr. KRAJCOVIC-ILOK. Mr. Chairman, we have had three engineering companies making for us commercial feasibility studies, and it would be very easy for me to supply all the pertinent information.

Senator GRAVEL. I think that is what is needed at this point.

Dr. KRAJCOVIC-ILOK. And then we can include it in the record.

Senator GRAVEL. Your process is a process that is presently used in Europe?

Dr. KRAJCOVIC-ILOK. They have discontinued it, because I transferred the whole technology into the United States and made out of it an American technology. And now we are negotiating with several potential partners who would be willing to put up the first money, but of course to put up 30 or 100 such plants it would require so much capital that there is no one financial institution in the United States that can undertake such a vast undertaking, except the Government itself.

For this reason we are really wholeheartedly endorsing and recommending your bill.

Senator GRAVEL. So your processes are nowhere being employed in Europe at the time? Do you have a plant now in existence?

Dr. KRAJCOVIC-ILOK. The last one was dismantled in 1959, in Switzerland, because it was using the carbon 1:300 for military purposes; for explosives, for instance. These explosives can be used to stimulate natural gas, and for various mining purposes, and for rockets. For instance, when you use this powder as solid fuel for space, you have over 1,000 or 1,200 impulse/second. So all of this has been developed, and for this very reason it has been kept very secret.

Senator GRAVEL. But do you have a plant now in operation?

Dr. KRAJCOVIC-ILOK. No, not now. We have the blueprints to start building tomorrow, so that one commercial plant can be operating within 24 months.

Senator GRAVEL. But, in point of fact, since there is no operating plant, you would have to build a prototype plant.

Dr. KRAJCOVIC-ILOK. Well, we would have to build 2 prototype American reductor mills, which we would multiply by 10,000 times, that is correct. And furthermore, in Europe, it was not computerized; the production was not computerized. Now, in the United States, everything has been pushbutton.

Senator GRAVEL. But the point I am making is that you would have to prove the efficacy of this by actually doing it. It has not been done yet, the process you are talking about.

Dr. KRAJCOVIC-ILOK. Yes, not in America, but it was done in three countries in Europe.

Senator GRAVEL. But the point is that the energy crisis has been much more severe in Europe than in the United States, and so if you are using logic, this statement that it was done in Europe—well, they have got a worse problem than we have, then why has it not been pursued further in Europe?

Dr. KRAJCOVIC-ILOK. I will tell you, Mr. Chairman. Because in Europe, they recognized several other values of this technology, like water pollution, like the making of human bones from it, like these rockets and explosives, and they concentrated mostly on the military applications. In those years, nobody spoke about pollution, and nobody suffered any energy shortages. So now we are switching back to energy.

Senator GRAVEL. So, basically, this activity has been under a shroud of military secrecy.

Is that what you are saying?

Dr. KRAJCOVIC-ILOK. Yes.

Senator GRAVEL. Is that why Europe has not availed itself of this?

Dr. KRAJCOVIC-ILOK. Yes; but I must also say, Mr. Chairman, that the European governments are in touch with me; four cabinet ministers, and they are inviting us to negotiate with them to assist them in developing plants. And there are also other foreign countries interested in this, including Canada.

Senator GRAVEL. I think the key to it, to make your case here, and this provides a forum for it, is to supply us with this comparative economic data to make your case more cogent in economic terms. I think, on that basis, you will have them beating down your doors, plus we will provide a system of guaranteed loans.

Dr. KRAJCOVIC-ILOK. Thank you very much, Mr. Chairman. This is most generous.

Senator GRAVEL. Thank you.

[The following material was subsequently provided by Dr. Krajcovic-Ilok; hearing continues on p. 1649.]

ILOK RESOURCES SUPPLY CO. PRO FORMA INCOME STATEMENT: COAL AND OIL SUPPLIES FOR 1 ILOK FUEL PLANT

[Dollar amount in thousands]

	Income	Percent sales	Income	Percent sales
Net sales:				
Oil	$146,000.0		$146,000.0	
Coal	31,225.0		31,225.0	
Total net sales	117,225.0	100.0	177,225.0	100.0
Less cost of goods sold:				
Oil	91,250.0		109,500.0	
Coal	18,615.0		21,717.5	
Total cost of goods sold	109,865.0	61.9	131,217.5	74.0
Gross profit:				
Oil	54,750.0		36,500.0	
Coal	12,610.0		9,507.5	
Total gross profit	67,360.0	38.1	46,007.5	26.0
Selling/administration/general expenses:				
Oil	7,300.0		7,300.0	
Coal	611.5		611.5	
Total selling/administration/general expenses	7,911.5	4.4	7,911.5	4.4
Pretax profit:				
Oil	47,450.0		29,200.0	
Coal	11,998.5		8,896.0	
Total pretax profit	59,448.5	33.7	38,096.0	21.6
Taxes	29,724.0	16.8	19,048.0	10.8
Net profit	[1] 29,724.0	16.8	[2] 19,048.0	10.8

[1] Assumes oil cost price $2.50 per bbl and selling price to Ilok Fuel $4 per barrel. Assumes coal cost price $3 per ton and selling price to Ilk Fuel $5 per ton.

[2] Assumes oil cost price $3 per barrel and selling price to Ilok Fuel $4 per barrel. Assumes coal cost price $3.50 per ton and selling price to Ilok Fuel $5 per ton.

Note: Based on an independent engineering feasibility study and Ilok Powder Co. estimates, as of Sept. 10, 1973.

ILOK SUPPLY AND DISTRIBUTION, PRO FORMA INCOME STATEMENT SALES OF ILOK COLLODIAL FUEL PRODUCED BY 1 ILOK FUEL CO. PLANT

	Income	Percent sales	Income	Percent sales	Income	Percent sales
Net sales	$246,375,000	100.0	$273,750,000	100.0	$301,125,000	100.0
Less cost of goods sold	180,967,000	73.4	180,967,000	66.1	180,967,000	60.0
Gross profit	65,408,000	26.6	92,783,000	33.9	120,158,000	40.0
Selling/administrative general expenses	2,180,000	.9	2,463,000	.9	2,710,000	.9
Net profit before taxes	63,228,000	25.7	90,320,000	33.0	117,448,000	39.1
Taxes	31,614,000	12.85	45,160,000	16.5	58,724,000	19.55
Net profit	31,614,000	12.85	45,160,000	16.5	58,724,000	19.55
Selling per barrel	4.50		5		5.50	

Note: Based on an independent engineering feasibility study and Ilok Powder Co. estimates, as of Sept. 10, 1973.

ILOK COAL POWDER TECHNOLOGY: ECONOMIC CONSIDERATIONS

TABLE I.—PRODUCTION OF 4-MICRON COAL (YEARLY OUTPUT IN 1 PLANT 3,650,000 TONS OF 4-MICRON, MOISTURE-, ASH-, PYRITE-FREE COAL)

Estimated total cost per ton of coal processed to 4-micron MAPF particles

	Per ton
Coal feed to plant—commodity charge	$6.00
Operating cost, fixed charges and profit	4.00
Selling price, 4-micron MASPF coal particles (2,000 lbs)	10.00

Estimated cost per MMBtu when West Kentucky No. 11 coal is processed

$10.00 per ton (2,000 lbs=29 MMBtu 4 u MAPF)	$0.345
1 lb	0.005

TABLE II.—PRODUCTION OF COLLOIDAL FUELS

Yearly output in 1 plant of 55,040,540 barrels of Ilok colloidal fuel oil.

100,000 barrels of No. 6 oil+11,500 tons 4-micron MAPF coal=150,796 barrels colloidal oil

Estimated total cost daily for blending:	
620,000,000,000 Btu+333,500,000,000	953,500,000,000
Cost per barrel of No. 6 fuel oil having 6,200,000 Btu	$10.00
Cost of 1 MMBtu of No. 6 fuel oil	1.61
Cost of 100,000 barrels of No. 6 fuel oil to plant	1,000,000
Cost of 11,500 tons of 4-micron MAPF coal to plant	115,000
Cost of blending, fixed charges and profit	100,000
Total cost daily	1,215,000
Selling price per barrel of Ilok colloidal fuel oil having 6,350,000 Btu	8.06
Estimated cost per 1 MMBtu of Ilok colloidal fuel oil	1.17

TABLE III.—PRODUCTION OF PIPELINE QUALITY GAS

Yearly production of 91,250,000,000 cubic feet of pipeline quality gas [1]

Estimated total yearly cost:	
Coal feed to plant 3,650,000 tons 4-micron MAPF	$36,500,000
Hydrogen, operating cost, fixed charges and profit	38,500,000
Total cost	75,000,000

Estimated cost per 1 MMBtu of pipeline quality gas—$0.82.

[1] Co-production of about *6 million* barrels of synthetic oil with the addition of more hydrogen, yearly, is feasible, besides the above 91,250,000,000 cubic feet of pipeline quality gas, at the same time.

TABLE IVa.—PRODUCTION OF SUBMICRON POWDERS

Estimated total cost for the comminution of 4-micron MAPF coal particles to a size of 1:300 micron of pure carbon+product gas

Estimated daily production of 8,020 tons of 1:300 micron pure carbon and 675,496,680 cubic feet of gas, 302 Btu per cubic foot:	
15,000 tons of 4 micron MAPF coal feed to plant daily	$150,000
Operating cost and fixed charges and profit	56,000
Total cost	206,000
Selling price of 1 MMBtu gas	0.60
Selling price of 1 MMBtu pure carbon 1:300 micron for direct use in diesels and turbines	0.69

TABLE IVb.—DIRECT HYDROGENATION OF PURE CARBON

C—8,000 tons 1:300-micron pure carbon
H_2—2,667 tons
CH_4—10,667=477,781,600 SCF CH_4
Estimated daily cost:

8,000 tons of 1:300-micron pure carbon	$160, 000
2,667 tons H_2, at $0.30 per 1,000 SCF	300, 837
Operating cost, fixed charges and profit	60, 000
Total cost	520, 837
Estimated cost per 1 MMBtu pipeline gas	1. 09

[1] Cost of hydrogen will be lower, when produced by Ilok Powder Company.
[2] $1.09 for 1 MM Btu Ilok gas compares favorably with the imported LNG gas, which sells for $1.50 for 1 MMBtu.

TABLE IVc.—ILOK COLLOIDAL GASOLINE

I. Estimated total daily cost for blending:
62,902 barrels of gasoline+8020 tons of 1:300 carbon=125,803.92 barrels coll. gasoline.
16,040,000 lbs gasoline+16,040,000 lbs carbon=32,080,000 lbs colloidal gasoline.
352,251,200,000 Btu+232,580,000,000 Btu=584,831,200,000 Btu.

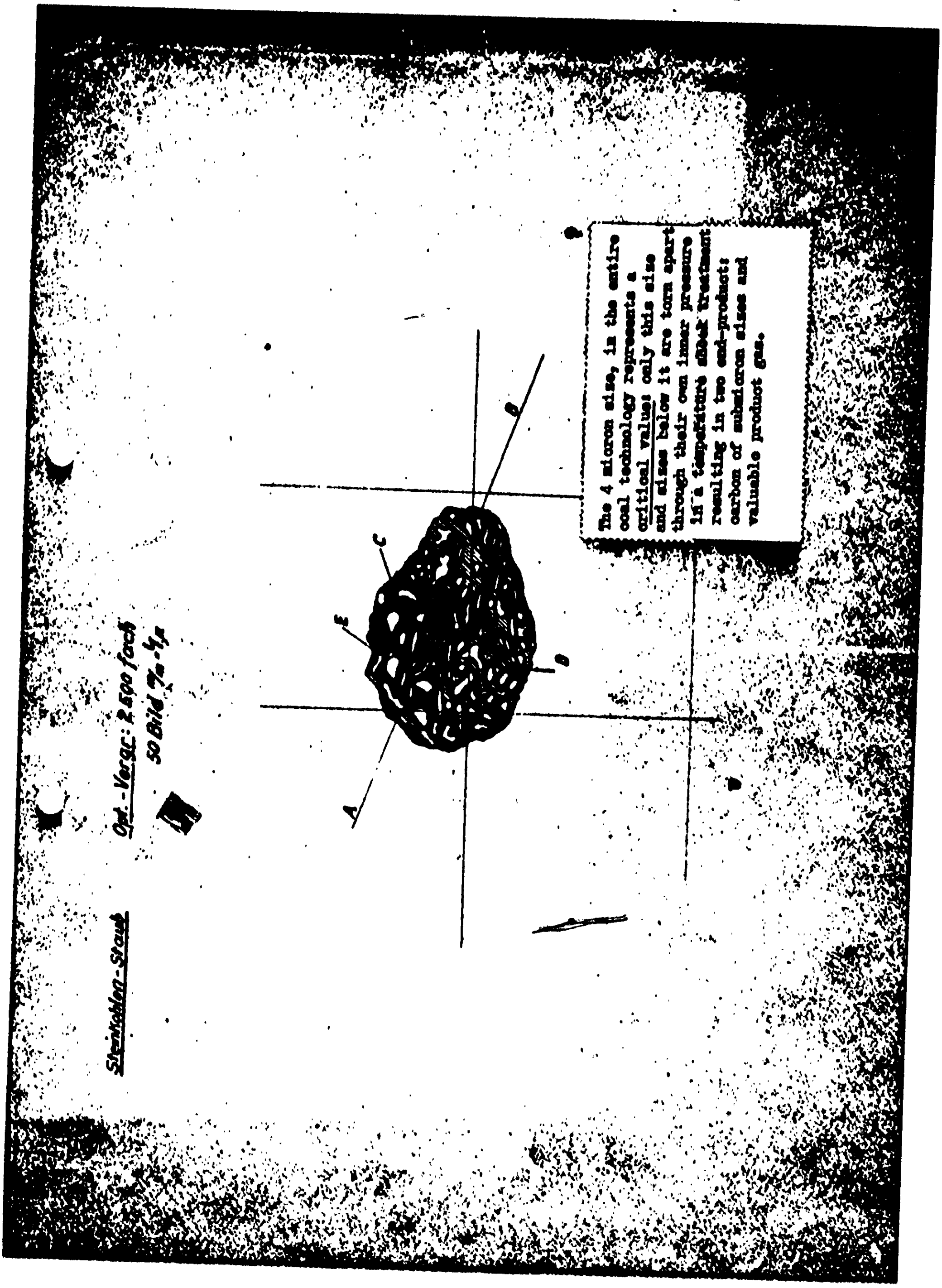
Cost per barrel of gasoline having 5,600,000 Btu	$15
Cost per 1 MMBtu of gasoline	$2. 67
Cost of 62,902 barrels of gasoline at $15 to plant	$943, 530
Cost of 8020 tons of pure carbon of 1:300 micron size	160, 400
Cost of blending, fixed charges and profit	100, 000
Total cost	1, 203, 930
Selling price per 1 barrel of Ilok colloidal gasoline (225 lbs per barrel having 4,648,747 Btu)	$9. 56
Selling price of 1 MMBtu of Ilok colloidal gasoline	$2. 06

II. 41,532.3 barrels of gasoline+8020 tons of 1:300 micron C=104,434.18 barrels coll. gasoline.
10,590,716 lbs of gasoline+16,040,000 lbs C=26,630,716 lbs colloidal gasoline.
232,580,000,000 Btu+232,580,000,000 Btu=465,160,000,000 Btu.

Cost of 41,532.3 barrels of gasoline at $15 to plant	$622, 984. 50
Cost of 8020 tons of C	160, 400. 00
Cost of blending, fixed charges and profit	84, 000. 00
Total cost	767, 384. 50
Selling price per 1 barrel of Ilok colloidal gasoline (225 lbs per barrel having 4,454,105 Btu)	$7. 35
Selling price of 1 MMBtu of Ilok colloidal gasoline	$1. 65

TABLE IVd.—REFINEMENT OF PURE CARBON AND USES

A. Carbon black:
Daily output of 8020 tons of 1:300 micron pure carbon is further processed to acquire properties of carbon black.
Estimated selling price per ton—$75.00; present price per ton is $150.
B. Water pollution applications:
Daily output of 8020 tons of 1:300 micron represents the availability of an absolute filter.
Estimated selling price per 1 ton—$75.00; present price for activated 74-micron coal is $0.35 per pound or $700 per ton.
C. Medical applications:
By an additional refinement the pure carbon at a size of 1:300 micron or at a size of 1:500 micron will find innumerable medical applications to benefit all mankind.
Estimated selling price per ton—$150.00



REPUBLICAN TASK FORCE

Energy and resources

HOUSE REPUBLICAN CONFERENCE, REPUBLICAN RESEARCH COMMITTEE

ILOK COAL POWDER TECHNOLOGY—CLEANING HIGH-SULPHUR COAL

WASHINGTON, D.C.—The House Republican Task Force on Energy and Resources has concluded a two-month investigation of a combination mechanical/thermal process for removing sulphur and other pollutants from coal, according to Michael D. Hathaway, Task Force Director.

Based on the work of Dr. Ing. Hans Rohrbach, spanning over 35 years, the process was under investigation as a possible solution for the problem of low-sulphur fuel shortages in the U.S. today.

At a special Task Force meeting, held in October of this year, Dr. V. Stephen Krajcovic explained the background of Dr. Rohrbach's work, together with possible applications to today's energy problems.

According to Dr. Krajcovic, who is President of Ilok Powder Co., Inc., the mechanical segment of the process, wherein coal is reduced to a size of 4-micron (approximately equal to 0.00016-inch), removes the inorganic sulphur and ash present in the coal. The thermal process, which reduces the 4-micron particles to a submicron range (1/300-micron, or less), removes the remaining sulphur, which is in organic form.

Dr. KRAJCOVIC also explained the possible application of these ultrafine and submicron powders to problems in other fields, such as medicine and pollution control.

Based on the October meeting and subsequent analysis, the Task Force staff formulated several conclusions and recommendations. Among these are:

1. Available literature confirms that the technology involved was proven feasible in Germany, before World War II.
2. There unquestionably exists within the U.S. today, particularly east of the Mississippi River, a serious shortage of low-sulphur fuels.
3. The work of Dr. Rohrbach offers a possible solution to this problem and could, based on the information available, be available within a time frame either equal to or shorter than other possible solutions.
4. Large scale application of the process might prevent the further closings of high-sulphur coal mines and allow utilization of the substantial reserves east of the Mississippi River.
5. A commercial plant should be constructed as soon as possible in order to: (a) Adapt the already established production procedures to electronic controls and automation of the production of sulphur-free fuel; (b) establish the most economical method for both short and long distance transportation of ultrafine and submicron powders and their combustion in the existing steam-electric generating plants.
6. The Task Force should continue investigation during the 93rd Congress.

[From the Indianapolis News, Dec. 8, 1973]

TIME FOR ACTION—START CONVERTING COAL INTO OIL

(Ralph de Toledano)

In typical bureaucratic reaction to the fuel shortage, the Atomic Energy Commission has recommended that $11 billion be spent on an energy search.

The approach to any problem in Washington is to spend a lot of money, hoping that something will happen. The fact that the job can be done for a small fraction of what AEC seeks—and that probably no "search" is necessary—is one that shocks the bureaucrats.

What the administration will not face up to is that there is a solid record of achievement in the field of substitute energy production which a few prescient people in this country have futilely attempted to bring to the attention of government and industry.

One such person is Dr. Stephen Krajcovic who has argued for long that the conversion of our vast coal resources into clean fuel, more effective than oil, is not only possible but easily achievable—and that all the necessary experimentation has been done and is ready for application.

I am not a scientist, but I have carefully studied a paper which Krajcovic read, more than 13 months ago, to the Republican Research Committee's Task Force on Energy and Resources. That little has come of it makes me wonder what special interests have blocked any action.

The Ilok plan which he outlined is based on the successful experience of Germany in the 1930s, when the Nazis were preparing for war and realized that they would need a substitute for oil to power their industry. The problem was to give coal the properties of oil and natural gas so that it could be used directly in diesels and turbines.

Hans Rohrbach, a German scientist, discovered that coal, when reduced to micron size, could be burned directly in diesel engines without leaving damaging residue.

It took Rohrbach two years of research to create a reductor which at low cost removed the impurities from coal and reduced it to a microscopic 4 micron size. This ultra-fine coal powder was used successfully for four years to produce electricity in Hanover. The Rohrbach process also resulted in the production of other valuable by-products.

The details of the Rohrbach-ILOK process, obstinately ignored by American scientists, are highly technical. But they are such that America's clamoring environmentalists should be satisfied, for the process will allow this country to make use of its 2 trillion tons of recoverable coal without polluting the atmosphere. Of prime importance, it will free the United States and other countries with plentiful coal from their dependence on oil.

Krajcovic maintains that the carbon produced by his ILOK process can be moved through pipelines or combined with hydrogen to produce oil and natural gas. It can also be used as an absolute filter to remove pollutants from industrially-used water—and it has important medical and military applications. In the latter application it can serve as a highly potent explosive without the radiation of nuclear weapons.

For years, Dr. Krajcovic has sought to interest others in his process—not only pleading before the Republican Research Committee and other groups but writing to newspapers and buttonholing industrialists. Before our present energy crunch, it was perhaps understandable that he should have been brushed aside. Our economy is geared to oil which seemed inexhaustible. We know now that America cannot rely on the rest of the world for its energy. Not only does this leave us perpetually vulnerable, but it puts unbearable strain on the dollar.

The powerful oil industry, however, would like us to submit to Arab blackmail in order to get back our Middle East oil. But even should the Arabs relent, they would still be holding a Damoclean sword over our heads. And we would still be exporting precious dollars. The ILOK technology might well be the answer to this double problem. Certainly the Congress and the administration should give it careful consideration before it tosses out $11 billion for a "search" that may be unnecessary.

[From the Chementator, Dec. 24, 1973]

Fuels technology based on extremely fine and clean coal particles is awakening interest in U.S. energy circles. Offered by Ilok Powder Co., Washington, D.C., the knowhow was developed to commercial scale in Europe but has been dormant there since the mid-1950s, when its developers came to the United States.

At the heart of the processing concept is a conical, four-stage impact-attrition mill that reduces coal to uniform 4-micron particles, at a power input of about 25 kwh./ton. The mill can take out pyrites and ash centrifugally, or they can be removed magnetically. The coal particles can be blended with oil or gas to make colloidal fuels, or can serve as high-quality feed for coal gasification or liquefaction, or can be fed as-is to turbines or specially designed diesel engines. In another option, the particles can be further reduced thermally to yield 1/300-micron carbon fines (plus byproduct fuel gas), suitable not only as fuel but for carbon black, filter media, or explosives manufacture.

Brokerage firm Merrill Lynch, Pierce, Fenner & Smith issued a prospectus in September; among the firms that have responded are a "large utility in the Southwestern United States." Several government officials have also shown interest; one of the most recent is Sen. Hugh Scott (R.-Pa.), who has requested the Library of Congress to study German literature on the process.

The Age of Clean Coal

ILOK POWDER COMPANY, INC., WASHINGTON, D.C.

Abstract

Energy supply requires the same kind of national concern that is now being shown for the problems of peace and war, national security, prosperity, and the environment.

Since the world consumption of energy is rising rapidly and the reserves of oil and gas may be virtually depleted in a few decades, man must turn to the fantastically abundant coal.

To bridge the energy gap, coal must be "cleaned up." When that is done, the United States with its estimated total of 1.6 trillion tons of coal, will again become

self-sufficient in the field of energy. "Clean coal" will not only be used directly as a clean fuel but will be easily converted into gas or oil.

The Ilok process, which cleans coal completely, offers a high potential for an economic and technical closing of the energy gap.

The age of clean coal

Not long ago—April 25, 1972—some 31 scientists and other professional persons urged Congress to deny the Nixon Administration's request for funds to start building a $500 million demonstration model of a nuclear breeder reactor to generate electricity, on the grounds that too many serious questions as to the safety and environmental impact stood in the way of commercial development of this technology.

The signers—among them Dr. Linus Pauling, Dr. Harold C. Urey, and Dr. Paul Ehrlich—raised questions about the safety of three aspects of the breeder reactors: namely, the plants themselves, the handling of plutonium, and the disposal of plutonium waste products. The signers also suggested that with large quantities of plutonium in use, some of it might be clandestinely diverted to the manufacture of nuclear weapons.

On the positive side, the scientists said the money should be channeled into reactor safety research and into development of other energy sources, notably solar energy and coal. Dr. George L. Weil, a nuclear energy consultant, speaking for the group, stated: "*We should concentrate on coal. It can be cleaned up.*"

Dr. Weil is right. Coal can indeed be cleaned up and is already being cleaned up by the Washington, D.C. based firm, Ilok Powder Company, Inc.

At a time when natural gas distributors across the country are warning their customers of possible curtailments of gas in the immediate future—and in some instances gas companies are already refusing to take on large new users and even some private residences—it is high time for the United States to concentrate on the development of new sources of clean energy, particularly from coal, simply because the United States has enormous coal reserves and because there is no practical way at the present time to avert an energy crisis of enormous proportions.

Former Rep. Wayne N. Aspinall, Chairman of the House Interior Committee, has stated: "Under present circumstances, we just do not have the domestic capacity to produce the gas and the liquid fuels in the amounts that will be required." If this is so, we have an overriding responsibility to develop not only "clean coal" in its solid form but also to develop and produce liquid fuels and gas from such clean coal.

Definition of clean coal

What is clean coal? How do we get clean coal? Is the very term "clean coal" a misnomer? What exactly do we understand by that term? Coal has no fixed chemical formula. Geologists classify it merely as a sedimentary rock which, by heating. is decomposed into combustible gases, steam and coke residue.

Since coal compositions vary widely and no two pieces of coal, even from the same seam, are identical from both the purchasing and combusting viewpoint, proximate and ultimate analysis is used. While the proximate analysis determines the percentage of moisture, volatiles, ash, and fixed carbon in coal, the ultimate analysis is more accurate in indicating the percentages of carbon, hydrogen, sulfur, oxygen, nitrogen, and ash. From the point of view of the ultimate analysis of coal, it is obvious that in a *general term* a "clean coal" would be a coal from which all the ash—both organic and inorganic—and all the sulfur—organic and inorganic—would be removed completely.

Specifically, an absolutely clean coal would not only be free from all the ash and all the sulfur, but in addition would show separation of all the volatiles in coal from carbon in coal. But then "clean coal" would be a misnomer indeed, for in this instance we would have to talk about a "clean carbon." If this can be accomplished, it would be a technological breakthrough of such magnitude that the United States and, in fact, the whole world would enter the Coal Age or the Age of Carbon.

Both the general and the specific definitions of "clean coal" and respectively of "clean carbon" show that we do not get a clean coal by removing from it the inorganic sulfur and inorganic ash. *Nor can we have a clean coal by coal gasification processes*, during which ash turns into slag and sulfur is converted into H_2S, because in the process the coal itself is converted into various gases so that the *solid form* of coal is not there any longer.

Present technology

Present technology seems to pursue limited objectives based largely on the efforts to reach an economic abatement of sulfur oxide pollution. In the absence of a proven desulfurizing method, the most modern coal preparation plants include steps to upgrade coal in terms of BTU content. For example, prior to crushing for delivery, most run-of-mine coal is hand classified to remove gross impurities. In addition, most coal pulverization operations usually incorporate some type of air classification for further ugrading of the product. Most of these steps remove some ash, and some reduction in pyritic sulfur also occurs.

In addition, there are several coal washing techniques. Most of them involve grinding coal to desired sizes and classifying the coal on the basis of particle size and specific gravity. Since all non-coal impurities have a heavier specific gravity, the density of coal particle is a direct measure of its purity. With these methods, some ash ~~and~~ some pyritic sulfur is removed but not all.

To remove pyrites chemically has been proposed on the basis of a selective oxidation of pyritic sulfur under controlled conditions, with suitable oxidants such as air, oxygen, or carbon dioxide and with the expected lowering of sulfur in coal by 50 percent.

Another chemical removal of pyrites is advocated by the Environmental Protection Agency for a process developed by the TWR, Inc., called the Meyers process. The coal is contacted with ferric sulfate solution at about 100 degrees C. The solution selectively oxidizes the pyritic sulfur to form free sulfur, without oxidizing the organic sulfur which is in the matrix of coal. The freed pyritic sulfur is removed from coal by vaporization or by solvent extraction. For the removal of at least this one type of sulfur, this method seems to be the best one, while the process cost amounts to only about $2 per ton of coal processed.

As to the organic sulfur, its removal is more difficult without changing the solid form of coal itself. The U.S. Bureau of Mines' method involves a mild oxidation of pyrite-free sulfur, with air causing the organic sulfur-containing molecules to form sulfones which can be taken out by an alkali treatment.

Another approach of the Bureau is the slurrying of coal in tar or in heavy oil, then passing the slurry rapidly through a fixed bed of ammonium molybdate in the presence of hydrogen. The sulfur content converts to H_2S, which is separated from coal by allowing it to go into aqueous solution in a quench tank. This method lowers sulfur to about 0.3 percent, however the coal is not only desulfurized but a pitch-like semi-solid substance is formed as well.

In the private industrial sector, the Pittsburgh & Midway Coal Mining Company uses a highly aromatic solvent to dissolve and depolymerize the coal in the presence of hyrogen at about 850 degrees F. and up to a pressure of 2,000 psi. This product can be used as a solid fuel or at higher temperatures as a liquid, but it is a product distinct from coal.

On the other hand, the Consolidation Coal Company's process produces not what we call a clean coal but a pitchblende that melts at around 400 degrees C., containing none of the pyrites but only half of the organic sulfur.

Other processes to remove organic sulfur from coal are also being developed, however, they all offer only a partial answer to the problem as defined earlier.

Ilok Technology

In contrast to the above enumerated methods of de-ashing and desulfurizing coal, the Ilok process is the only proven technology that obtains an absolutely clean coal as defined. This statement is *based* on the fact that the Ilok process has been used over a period of eight years by the Bochumer Verein in Germany and later over 8 years in Switzerland. The process was primarily developed by Dr. Ing. Hans Rohrbach, now Director of Research of Ilok Powder Company, Inc., for purposes of substituting diesel oil with ultrafine coal powders for the operation of diesel engines—a problem which he solved most successfully and whose solution was denied, as is well known to Rudolf Diesel himself and to his several followers, among whom were such noted scientists as Dr. Pawlikovsky and Dr. Schickau of I. G. Farben. To achieve a perfect burning of coal particles in diesel engines and to eliminate the wear problem of the engines resulting from ash and sulfur, their removal from the ultrafine coal particles before their combustion in the diesels became unavoidable. It was only then therefore that the Diesels were running on coal smoothly, evenly and without interruption for a period of 8 years.

Although this was a proven technology its translation into a commercial production in the United States had to be confirmed by U.S. engineering companies. Three such engineering companies recently not only confirmed this proven technology of coal comminution and of de-ashing and desulfurizing of coal, but also worked out its adjustment to a commercial production of such clean coal in the United States.

In the light of the above statement it can now be said that without changing the solid form of coal, *Ilok process at first removes pyritic sulfur and inorganic ash* and then in a subsequent step, *organic ash* and *organic sulfur*, while at the same time separating carbon in coal from the volatiles. In essence, this great leap forward in coal technology is carried out in two stages, a mechanical and a thermal.

During the mechanical stage coal is comminuted to 4 micron size in a special reductor mill. It is during this mechanical comminution of coal to 4 u size that pyrites and inorganic ash are removed; while it is during the subsequent thermal treatment of 4 u size coal that the organic sulfur and organic ash are removed, and at the same time the volatiles are separated from the carbon in coal. All this is accomplished within one hour's time.

Ilok Mechnical Process

Before the conventional coal of any type is subjected to mechanical comminution, it must first go through a metal control to remove any metal particles from the coal feed. Then the coal designated as nutcoal enters the reductor mill proper, which is an impact-attrition reductor. It is built conically and is divided into four individual grinding chambers through which the coal has to pass in succession. Each of the chambers contains a number of grinding plates which are radially exposed. The coal feed enters the reductor's first chamber of the smallest diameter. It leaves the reductor chamber of the largest diameter. The speed of the mill wheel is 10,000 RPM. As the successive stages of the reductor mill increase in diameter, the centrifugal force becomes greater as coal travels towards the exit from the reductor. With the larger cross-section, air velocity becomes lower, causing the coal particles to remain in suspension in the successive stages, until reduced to a size which will enable the pull of the air current toward the fan to exceed the centrifugal force thus forcing the end product—4 micron particle—out of the mill.

This unique Ilok/Rohrbach mill attains supersonic velocities of between 475 to 500 m/s in the fourth chamber of the reductor mill. Inert gas is used to dilute the amount of oxygen present as a precaution against explosion.

The capacity of the original Ilok/Rohrbach reductor mill has been 1,000 kg/hr but mills with a capacity of 10,000 kg/hr are now proposed by the Ilok Powder Company for the processing of 15,000 tons of coal daily. From the coal fed to these units 97, 3% is reduced to 4 micron and lesser sizes based on the the European experience and at a cost of 33 HP/hr per each one ton of coal.

Naturally, if sizes larger than 4 micron were the objective, the European experience demonstrated that the reductor mill was easily adjustable: with only three individual grinding chambers, the Ilok reductor mill yielded sizes of 15 micron; on the other hand, when sizes of 74 micron have been available as feed, Ilok reductor mill was reduced to its last two grinding chambers turning out ultrafine particles in the 4 micron and lesser sizes with the greatest ease.

For the removal of inorganic ash and pyrites from the mass of the ultrafine coal particles, an ejector is incorporated into the reductor, which allows the coal particles having 1.3 to 1.8 specific weight to leave the ejector axially, while anything in coal with a higher specific weight, such as pyrites and ash, to leave the ejector radially. Since a very small fraction of the original feed could be lost by this cheapest and most economical method of ash and pyrites removal, Ilok has another method. It is the magnetic method which, as the independent feasibility studies show, works as follows: As the Ilok/Rohrbach reductor mill develops dielectric heat, the non-magnetic pyrites are converted into ferro-magnetic pyrrhotites, Fe_7S_8, which during coal's comminution are automatically discarded from the reductor without any loss of the fine coal particles, through special devices built into the reductor mill.

The end product of the Ilok mechanical processing of coal is the moisture-, ash-, and pyrite free ultrafine coal in 4 micron size. This by itself is not only a 60 to 70 percent desulfurized and de-ashed coal but is also a greatly upgraded coal product.

Furthermore, this product will burn in Diesel engines without residue. This was demonstrated as stated earlier over an 8 year period by the Bochumer Verein in Germany and corresponding patents have been granted. This accomplishment stands in contrast to a study by the Haward University under contract to Office of Research, which failed to solve this problem (SEE: R & D Report No. 46 Final Report, OCR Contract No. 14-01-0001-491, Catalog No. 163.10:45). Of course, to bring the ultrafine coal powder into the diesel engine required building of special feeding devices. These devices were built to bring the fine coal powders into the combustion chamber of the engine in exactly measured dosages for each individual ignition. These adjustments, however, were small and therefore any existing diesel engine can be modified.

The operation of the diesels on the ultrafine coal powders and also their modification is based on the following principles:

(a) Coal powder must be brought into the center of the cylinder head;

(b) The coal powder diesel motors must always be built with the greatest possible caliber and without any anteroom;

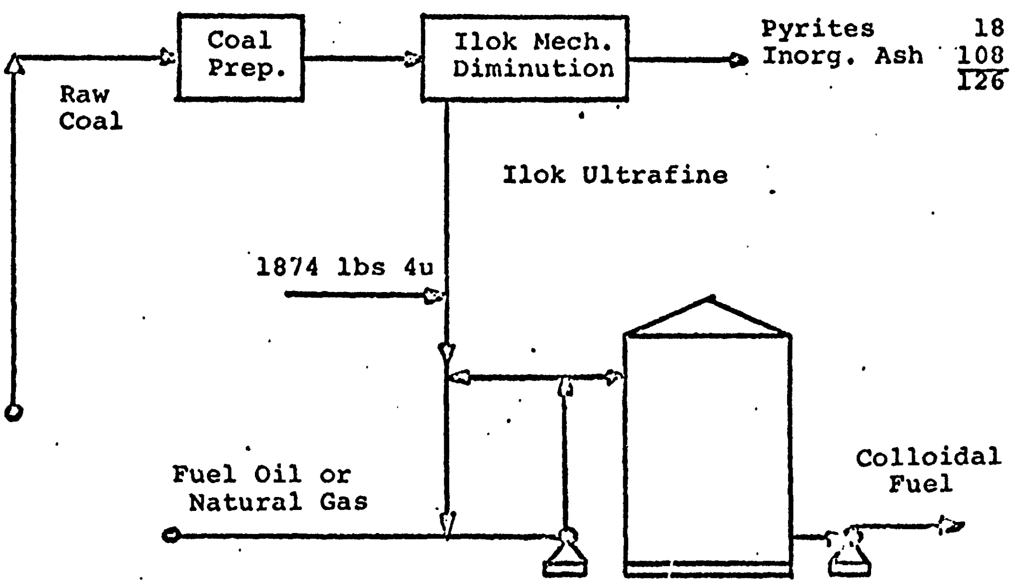
(c) The coal powders to be used must not be larger than 4 micron;

(d) The ignition point must be at or immediately above the dead point;

(e) An exact dosage mechanical device proportioning the coal powders per each stroke must be achieved.

The use of the ultrafine clean coal powders in diesels is therefore a great technical and economical breakthrough. But for a mass use of such clean ultrafine coal powders the production of colloidal fuels is recommended. These powders can be belnded with either the gasoline or natural gas to form colloidal fuels which do not separate after having been formed. This is due to the *capilaries* in the 4 micron coal particles which in sizes above 20 micron do not exist at all. This new family of Ilok colloidal fuels as it is obvious will lower our dependence on the foreign energy imports without any need for the costly and so far unproven coal gasification processes if a prompt closing of the energy gap is truly a matter of national concern.

FIGURE 1.—Ilok collodial fuels based on 4 u coal particles.



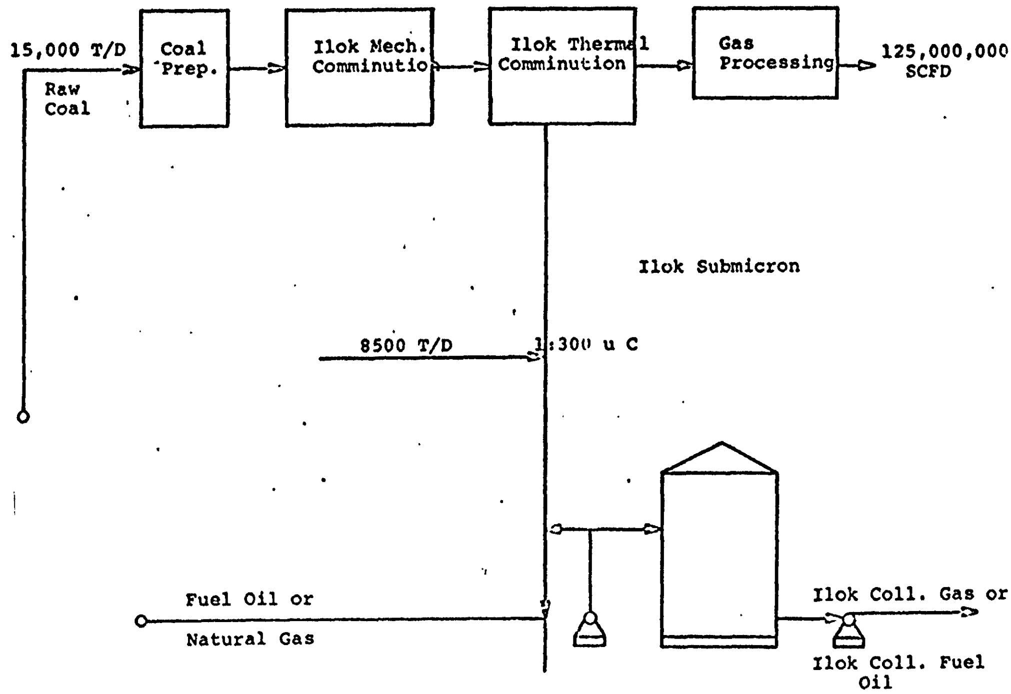
Ilok thermal processing of coal

Even if the Ilok mechanical process represents a tremdnous technological breakthrough in coal powder science the ultimate in the reaching of an absolutely clean coal as defined which is obtained when the 4 micron ultrafine coal particles are additionally processed in a specially designed Ilok/Rohrbach reactor in which the ultrafine coal particles expand and explode. This thermal treatment of the ultrafine coal particles results in splitting of the particles into submicron sizes of 1:300 micron and in the actual separation of all the volatiles in coal from the carbon in coal.

If an average bituminous coal has been so treated 15,000 tons of such coal would yield about 125 million SCF of pipeline gas due to the *additional processing of the product gas* which is obtained from the splitting and devolatization of the 4 micron coal particles and which contains mostly hydrogen, carbon monoxide and methane. Besides the pipeline gas the main product is 8,500 tons of pure carbon in the size of 1:300 micron. Organic ash and organic sulfur are also removed at this stage.

The technological and economic implications of this proven Ilok technology are staggering because an ultimate clean coal fuel has been arrived at which can be used directly in the Diesels boilers and turbines and can be combined with natural gas liquid fuels.

FIGURE 2.—Ilok colloidal fuels based on 1:300 u carbon particles



As vast quantities of pure carbon are made available, the new Ilok tech, nologies for the production of pipleine quality gas, and in fact for any other clean fuels, are at the disposal of the United States and the world, provided that the Government or Ilok Powder Company, Inc. can develop an economical method for production of hydrogen as well.

An economic method for the production of hydrogen can be obtained simply, because if electrolysis is employed to obtain hydrogen from water, Ilok clean coal or carbon in the production of electricity will be more economical—should diesels be used, or turbines or boilers—than if natural gas or gasoline were used instead. If on the other hand heat as such should be used directly for the decomposition of water into oxygen and hydrogen—as proposed by the Marchetti process who wants to use atomic reactor for the production of heat instead of electricity—then Ilok submicron powders which burn in 1/7000 second and develop a heat of up to 7,000 degrees centigrade—can be applied for the generation of heat needed for the decomposition of water.

As to the other clean fuels that can also be produced let us mention at least the production of synthetic natural gas, which without any need of methanation (which technical step was not yet proved commercially) can be produced directly in a *chemical* reaction of Ilok submicron carbon with hydrogen according to formula

$$C+2H_2=CH_4$$

Now let us also speak of clean solid fuels which will result from the purely *physical* bonding of Ilok submicron carbon powders with hydrogen and oxygen, a feat which also has been carried out in practice during long years of development of the Ilok technology.

In view of the advanced Ilok technology, the energy gap in the United States can be considered as nearing its end, thanks to the untiring efforts of the Ilok Powder Company, which stands in the forefront of developing superior technologies for the development of alternate domestic supplies of energy, ranging from the described clean coal to colloidal fuels, synthetic gas, synthetic oil, and even other sophisticated fuels of the future that are based on carbon and hydrogen.

Ilok clean coal fuels

Without going more fully into the production of colloidal gas and colloidal fuels, which the Ilok accomplishment now makes possible for the closing of the energy gap, Ilok carbon in the size of 1: 300 *u* already represents a fuel that can well replace the use of gasoline and of natural gas in applications concerning the utilities and the industrial sector. Both types of clean coal, whether the 4 micron or the 1: 300 micron size, have enormously large surface areas that have now been made available for such rapid combustion reactions that are superior to the combustion reactions of gasoline and natural gas.

Since Ilok clean coals are economical, it is obvious that the utilities and industrial sector will prefer to use them over the scarce natural gas and gasoline. The engineering feasibility studies for the commercial production of Ilok clean coal show that one million BTU of 4 micron carbon will cost only 45 to 50 cents. This cost is more economical than the projected cost of the synthetic pipeline quality gas at 75 cents per 1,000 SCF, or at about $1 or more for the imported liquified natural gas from Algeria.

As to the objection against the rapid combustion velocity of the Ilok Clean Coal Fuels, it must be stated that the combustion velocity is controlled through a mathematical regulation of the coal mixture entry into the burner or into the combustion chamber and through maintenance of a selected and necessary chamber pressure. This is accomplished without any major changes of equipment or machinery that is now being used for the same purpose in coal-fired power plants. The conversion of conventional coal burning boilers consist of the following:

(1) Seal combustion chamber with controlled gas outlet.

(2) Install proportioning coal power burner.

(3) Install ceramic membrane in combustion chamber to protect water pipes.

(4) Install electronic controls.

This was demonstrated in Europe in a small boiler.

This slowdown of the combustion reactions of clean coal fuels is in line with the practical uses of atomic energy, which too became important to the economy of energy only when our scientists were able to slow down the reaction of U–235 for beneficial uses in the generation of electricity. The practical harnessing of the rapid combustion reactions of the fuels through slowdown, as indicated, means that the age of coal has truly arrived and is here to stay, since the thermal efficiencies of coal from now on will become competitive, as the efficiencies will be much greater than in the best operated power plants today, which register thermal efficiencies of only 30 to 40 percent.

Both the increased thermal efficiencies and the cleanliness of the Ilok fuels are ushering in a new age for the energy self-sufficiency and clean environment of the United States.

Economic criteria

It is not difficult to establish economic criteria for allowable cost connected with the production of Ilok clean coal. One of the guides for a fair value would be, of course, President Nixon's Environmental Message to Congress, which proposes a tax of 10 to 15 cents per pound of sulfur emitted into the atmosphere. On this basis, a ton of hypothetical high-sulfur coal from which four percent of pyritic and organic sulfur had been removed—i.e. 80 pounds of S— would represent a tax savings of eight to twelve dollars.

Yet a complete removal of both types of sulfur from coal is only one, through certainly the most important, consideration in evaluating the Ilok processing of coal. Such complete removal of sulfur from coal means not only the reopening of coal mines with high-sulfur content coal, but implies new employment for many thousands of men.

Quite another consideration in the establishment of a fair value of the Ilok product is the comminution of coal to ultrafine size of 4 micron and to submicron size of 1:300 micron.

Still another criterion is the increase in the efficiencies of combustion reactions of clean coal in the generation of electricity, which will certainly offset the cost of Ilok's comminution of coal and the cost of the ash and sulfur removal.

Now we should consider what should be the fair market value of Ilok's carbon as a basis for a new family of synthetic pipeline quality gas and of other synthetic fuels that will make the United States self-sufficient in the field of energy and that will remove any strain on the value of the dollar which would be imposed by increased energy imports.

The Ilok process, which costs no more than about $3 for the conversion of each ton of coal into a clean coal, is a very special process indeed. It is this process that will make the United States of America move forward again, once we realize that below the earth's crust lie 1.6 trillion tons of coal that the Ilok process can convert into carbon.

SUMMARY

The technology for a complete cleaning of coal—America's most abundant source of energy—exists. The Ilok process has been successfully demonstrated in three separate European operations over a number of years.

In addition, three independent American engineering technical and economic evaluations of the process are available.

At a time when the U.S. Government is prepared to subsidize the construction of super tankers for bringing liquified natural gas to America's shores from foreign countries and is even contemplating the exploitation of Siberian natural gas resources that will require as much as ten to fourteen billion dollars of U.S. development capital—which private financing will not be able to shoulder alone without the need of some new form of Government financing—it is in the interest of the United States to consider reversing its policies of dependence on foreign energy sources in favor of a meaningful implementation of the Ilok process and its clean coal and clean carbon. The policy of self-sufficiency in energy, especially of clean energy, is a matter of national economical concern and of national security.

REFERENCES

"A Study of Ultrafine Coal Pulverization and Its Application," by R. A. Glenn and R. J. Grace, Final Contract Report, Bituminous Coal Research, Inc., Contract No. 14-01-0001-226, OCR, Department of the Interior.

"General Literature Survey of the Ultrafine Grinding of Coals," Report to the OCR, Department of the Interior, Contract No.14-01-0001-390, Pennsylvania State University.

"Basic Methods of Removing Sulfur from Coal," by J. W. Leonard and Charles F. Cockrell, Coal Research Bureau, School of Mines, West Virginia University, Mining Congress Journal, December, 1971.

"Taking Coal's Sulfur Out," by Nicholas P. Chopey, Chemical Engineering, July 24, 1972.

"Sulfur Codes Pose Dilemma for Coal," Environmental Science and Technology, December, 1970.

"Desulfurization of Coal," by R. A. Meyers, J. W. Hamersma, J. S. Land, and M. L. Kraft, Science, 1972.

"Energy Sources for the Future," by Earl Cook, The Futurist, August, 1972.

"Energy: 2000 A.D.," by F. C. Olds, Power Engineering, August, 1972.

"The Sources of Air Pollution and Their Control," Public Health Service Publication No. 1548, Government Printing Office, Washington, D.C., 1966.

Annual Report 1972, Office of Coal Research, U.S. Department of the Interior.

Statement of George H. Lawrence, American Gas Association, Hearings on Research and Development of Energy Production, Transmission, and Utilization, Committee on Merchant Marine and Fisheries, U.S. House of Representatives, May 10, 1972.

ESTIMATED REMAINING COAL RESERVES OF THE UNITED STATES BY TYPE, SULFUR CONTENT, AND STATE, ON JAN. 1. 1965[1]

[Millions of short tons]

Coal type and State	Sulfur content, percent: 0.7 or less	0.8 to 1.0	1.1 to 1.5	Over 1.5	Total
Bituminous coal:					
Alabama	889.2	1,189.3	5,421.7	6,077.6	13,577.8
Alaska	20,287.4	1,100.0			21,387.4
Arkansas			1,128.4	487.4	1,615.8
Colorado	25,178.3	37,237.2			62,415.5
Georgia		76.0			76.0
Illinois [2]			1,808.0	137,948.0	139,756.0
Indiana	197.5	173.0	3,645.2	30,825.4	34,841.1
Iowa				6,522.5	6,522.5
Kansas			519.9	20,218.1	20,738.0
Kentucky:					
West			1,119.6	35,775.8	36,895.4
East	13,639.9	8,491.9	2,286.8	4,996.2	29,414.8
Maryland				1,180.0	1,180.0
Michigan				205.0	205.0
Missouri				78,760.0	78,760.0
Montana	51.2	218.2	205.0	1,630.2	2,104.6
New Mexico	5,212.0	5,474.0			10,680.0
North Carolina				110.0	110.0
Ohio		611.0	369.0	41,044.0	42,024.0
Oklahoma	250.6	772.2	825.0	1,455.0	3,302.8
Oregon		14.0			14.0
Pennsylvania	44.0	1,154.4	7,624.4	49,128.7	57,951.5
Tennessee	3.3	160.9	715.9	959.4	1,839.5
Texas				7,978.0	7,978.0
Utah	8,551.4	13,584.0		5,522.6	27,658.0
Virginia	1,981.5	6,077.5	1,637.1	123.9	9,820.0
Washington	898.9	672.1			1,571.0
West Virginia	20,761.0	26,710.6	21,819.7	33,375.1	102,666.4
Wyoming	6,222.2	6,596.6		1.1	12,819.9
Other States		616.0			616.0
Total	104,168.4	110,928.9	49,125.7	464,324.0	728,547.0
Percent of total	14.3	15.2	6.7	63.8	100.0
Subbituminous coal: [3]					
Total	256,616.3	130,586.3	150.5	1,312.3	388,665.4
Percent of total	66.0	33.6	.1	.3	100.0
Lignite: [4]					
Total	344,623.6	61,388.5	41,164.5	464.7	447,641.3
Percent of total	77.0	13.7	9.2	.1	100.0
Anthracite: [5]					
Total	14,652.0	96.0		431.8	15,179.8
Percent of total	96.5	.6		2.9	100.0
Grand total	720,060.3	302,999.7	90,440.7	466,532.8	[6] 1,580,033.5
Percent of total	45.6	19.2	5.7	29.5	100.0

[1] Data is from U.S. Bureau of Mines' Circular 8312 dated 1966 except for Illinois. The table includes coal in seams at least 14 in thick and less than 3,000 ft deep in explored areas. Approximately ½ of these reserves are considered recoverable.
[2] Data from Illinois State Geological Survey Circular 432 dated 1968. 1966 data.
[3] Nearly 80 percent in the Rocky Mountain area and most of the remainder in Alaska.
[4] Practically all in North Dakota and Montana.
[5] Over 80 percent in Pennsylvania and most of the remainder in Alaska.
[6] Revised in 1967 by the U.S. Geological Survey to 1,559,875,000,000 tons.

Source: Federal Power Commission, based on U.S. Bureau of Mines data.

Present State of Coal Grinding in the U.S.A.—Excerpts From General Literature Survey of the Ultra-fine Grinding of Coals, Part II

PRESENT STATE OF FINE COAL GRINDING

Ilok Technology reduced one tonne of coal in 60 minutes and at a cost of 24.58 Kw yielding 97% of 4 micron sizes.

To properly appraise this technological achievement of Ilok Powder Company, the reading of the following chapter written under contract for the U.S. Government by the Pennsylvania State University is recommended.

V. FINE COAL GRINDING

1. *Coal petrography*

The petrography of coal is an important aspect in the crushing and grinding of coal. If the goal is to reduce the size of the coal particles to the ultrafine range, it becomes a necessity to know the constituents of the coal particles. Since the property of coal varies considerably from one place to another, the specimen should be carefully analyzed before being tested upon. Several terminologies have been developed for the classification of coal. The classification most frequently used, is that one developed by Stopes-Herleen and Thiessen. The classification used by Dr. Spackman at The Pennsylvania State University, has become very popular in recent years. The classification developed by Stopes-Herleen, was originally applied to bituminous coals, however it is also applied to higher ranks of coal such as anthracite. The Stopes-Herleen terminology recognizes four types of coal materials.

Vitrain a jet like coal, with glossy luster and conchoidal fracture, which when analyzed in thin sections, yields deep red to yellow color. It is usually translucent in appearance, structure-less or with traces of cell structures, equivalent to translucent attritus with some anthaxylon.

Fusain as mineral charcoal is similar to charcoal in appearance, being porous and crumbly. In thin sections it is black and opaque with cellular structure. Often the cells are filled with secondary minerals.

Clarain consists of rather silky, lustrous, laminated coal. In thin sections it is composed of anthaxylon with spores and resins.

Durain is the name applied to layers that have a dull luster and gray to black color, usually lacking lamination. In thin sections it consists primarily of opaque attritus with spores and resins associated.

The terminology as developed by Thiessen, recognizes three types of coal. They are: anthaxylon, which is translucent plant tissue with recognizable structure, and attritus which is a broken down fragmental plant material, in part opaque and in part translucent. The third type in Thiessen's terminology is fusain. This terminology mentioned above, does not apply to specific varieties of coal but to macroscopically distinguishable bands within normal coals. Thus, a normal anthracite may contain layers of several or all varieties mentioned, in a single laboratory specimen or in a single coal seam. Cellular structures of the original woody tissue is visible particularly in the clarain and fusain. Spore cases are perhaps the most prominent structure visible and include both microspores and the large megaspores. Resins appear as small lenticular and drop-shaped masses. Pyrite and marcasite also form concretionary masses. Anthracite is one kind of coal of the different varieties. It is a hard coal, difficult to ignite because of the low content of volatile hydro-carbons. Some types of anthracite have a banded structure, others are quite massive in appearance. Coal contains varying amounts of minerals, of which the most frequently occurring are quartz, carbonate, pyrite, and marcasite. Spackman has identified the minerals most commonly occurring in anthracite coal. Macerals, as developed by Stopes in 1935, designate the elementary microscopic constituents of coal. Macerals vary in their physical and chemical properties. The composition may vary within particular bands of a seam and almost always between seams of different locations. Spackman and Mansfield in their study of the composition of coal beds, point out that the physical composition from point to point vertically can change drastically. However, laterally the coal beds seem to be much more uniform. Macerals occur together in very fine mixtures and can only be separated if the sample is crushed to less than twenty-five microns. When considering the crushing characteristics of coals, it should be noted that assemblages of macerals occur commonly and they vary in their individual strengths.

The various ranks of coals result from different stages of metamorphism. The rank of the coal has therefore to be studied by determining the degree of coalification. This can be done by: (1) On basis of reflectance of the vitrinite on a highly polished surface; (2) reflectance measurement in general.

When making maceral analysis; samples should be cut vertically to the bedding plane, representing columnar sections of the seam. Microlithetypes are used to determine maceral assemblages present in coals.

The element composition of coal varies from one stratigraphic level to another, however varieties are best pronounced in coal of different ranks. As earlier mentioned, the various ranks of coal result from different stages of metamorphism. Thus, the type of coal that occurs is directly dependent on the environment of deposition. To fully understand the petrography of coal, it becomes a necessity to know the geology of coal. Stutzer, in his Geology of Coal has done an excellent contribution in this field. Coal is a brittle material. In studying the structure of coal, a distinction can be made between gross and mino structures. Gross structures include visible cracks and weaknesses, which are normally invisible but can be detected with the help of a radiograph. Brown has shown, that the weaknesses in coal will depend on the rank of that particular coal sample. It was also shown that when coal is heated to higher temperatures (say 1300 C), to drive off the moisture, and then cooled, breakage occurs much easier than for unheated coal. Several studies on the ultrafine structure of coal have been performed. McCartney found that there appear to be two general ranges of the ultrafine structure in a number of components, one in the order of hundreds of Angstroms, the other less than 100 Angstroms. The particles appear to have general forms of spheroids, curved cylinders and round and polygonal platelets were observed.

2. Grindability of coals

The stand method widely accepted in testing the relative grindability or case of grinding of coals is the Hardgrove-Machine method. The method is based on Rittinger's Law. A grindability machine, shown in Fig. 18, is required for this test. The eight 1-inch balls roll on a stationary ring and are driven from above by a rotating ring to a standard weight. Fifty grams of a closely sized sample of coal, 1190 by 595 microns, are ground under a load of 64 pounds for 60 revolutions. The grindability index is calculated by

$$\text{Hardgrove grindability index} = 13 + 6.54\ W \qquad (7)$$

where W is the weight of material passing the 74-micron (No. 200) sieve, determined from the weight of the original sample minus the weight of the material retained on the 74-micron sieve.

A general relationship exists between grindability and rank. Coals that are easiest to grind are found in the medium-volatile and low-volatile groups. They are decidedly easier to grind than coal of the high-volatile bituminous, subbituminous, and anthracite ranks. It has also been established, for example, that the higher the amount of vitrinite present, the higher the Hardgrove grindability index. Table 12 shows grindability index of some representative American coals.

3. Ball mill grinding

Although the attempts have been made using ball mills or other mechanical mills in ultrafine grinding of coal, little information on practical grinding is available. Fischer and co-workers have ground coal to less than 10 microns in a ball mill. The mill contained six 1½-inch steel balls moving centrifugally in the shaped periphery and operating under vacuum at 1 to 3 mm Hg. (See Fig. 19). In 16 hours' grinding coal was reduced to less than 10 microns; but at a lower pressure, 0.1 to 1.0 mm Hg, the time was reduced to 8 hours. The vacuum in this case has a decided influence on the fineness attainable by grinding.

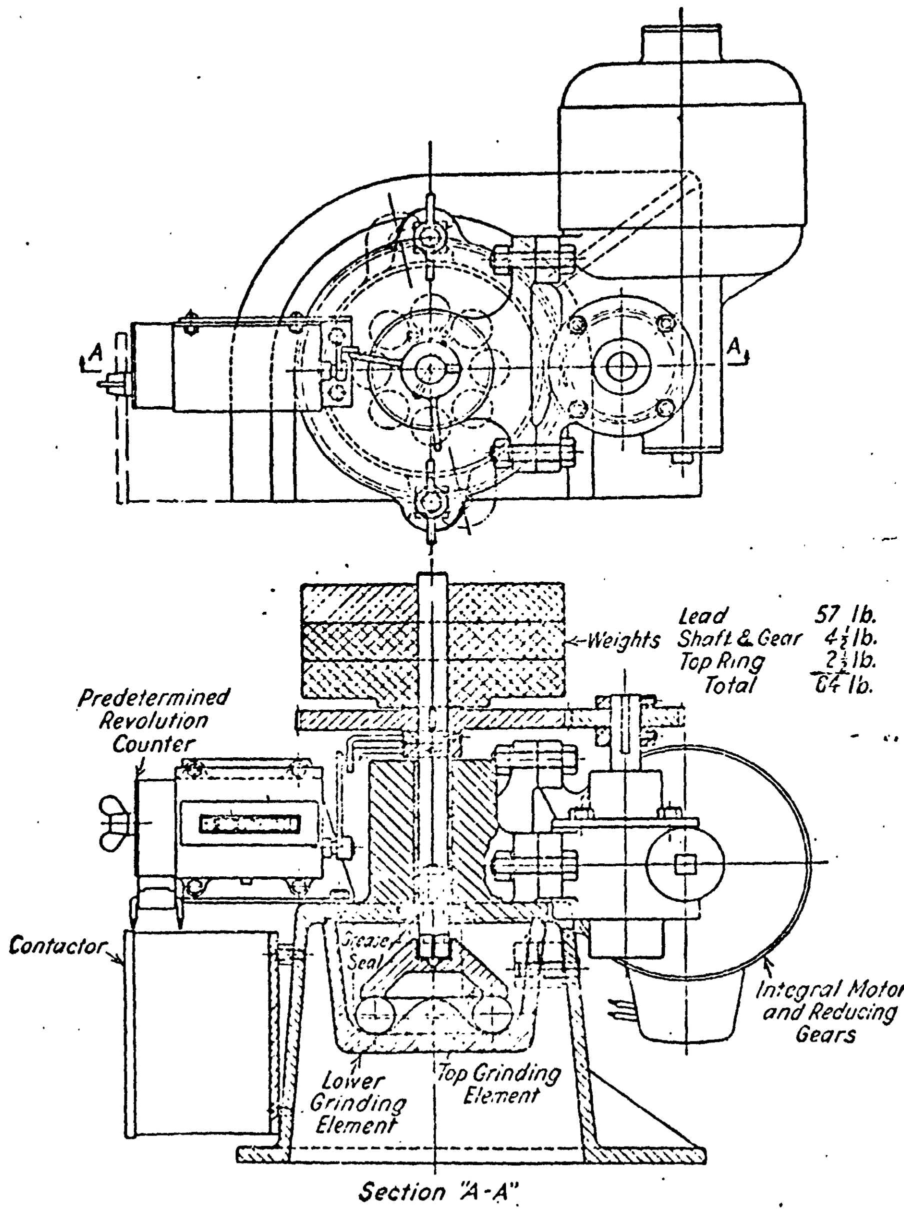


Figure 18 HARDGROVE GRINDABILITY MACHINE

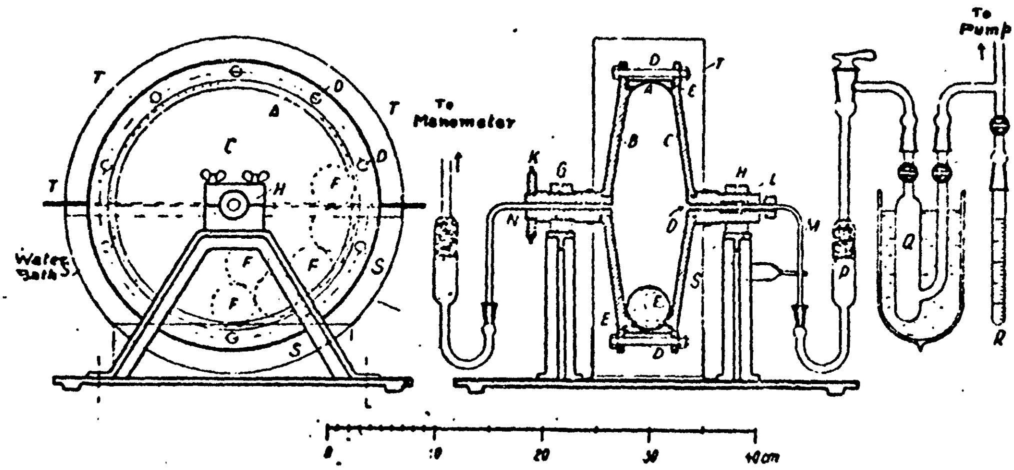


Figure 19 VACUUM BALL MILL

TABLE 12.—GRINDABILITY INDEX OF SOME AMERICAN COALS

State and county	Bed	Hardgrove grindability index
Pennsylvania:		
Cambria	Lower Kittanning	109
Indiana	Lower Freeport	92
Washington	Pittsburgh	55
Westmoreland	Upper Freeport	65
West Virginia:		
Fayette	Sewell	86
McDowell	Pocahontas No. 3	96
Wyoming	Powellton	58
Do	No. 2 Gas	70
Virginia:		
Wise	Morris	43
Do	Taggart	62
Dickenson	Upper Banner	84
Buchanan	Raven	98
Illinois:		
Sangamon	No. 6	55
Williamson	No. 6	57
Fulton	No. 5	63
Vermillion	No. 7	56
Kentucky:		
Pike	Elkhorn Nos. 1 and 2	42
Bell	Hight Splint	40
Muhlenburg	No. 12	55
Ohio:		
Harrison	No. 8	51
Belmont	No. 9	50
Indiana: Sullivan	No. V	55
Alabama: Walker	Black Creek	44
Utah: Carbon	Castle Gate	47
Pennsylvania: Schuylkill	Various	38

However, it was described that a vacuum had practically no effect on the grinding efficiency of ball mills using either the dry or wet method.

Bremner and Colpitts have ground gas-coals to 2.5 microns, anthracite to 0.75 microns and pitch coke to 0.15 microns, using 42.5% filling of ¾-inch cast iron balls for 1 to 5 days. The most of the grinding was effected in the first 24 hours. The ultimate particle size was little influenced by dry or wet grinding, aids such as stearic acid, naphthalene, S, and BzH, the gaseous atmosphere (N_2 CO_2 and C_2H_2) or the pressure (vacuum to 100 psi of CO_2). The particle size depended primarily on the raw materials. However, the lower the volatile or hydrogen content of the raw material, the smaller the particle size is after grinding. This general relationship broke down below 0.4% hydrogen.

Dry grinding of coals using a 8½-inch ball mill has been described by Mott. With 3/16-inch steel balls, the mean size of coal was reduced to 2 microns in one hour and to 1.5 microns in eight hours, after which grinding ceased because the coal was caked on the sides of the mill. The feeds used in the experiments were minus 72 B. S. meshes (210 microns). In one experiment, S. W. anthracite was tested.

Glen and Grace have conducted a series of experiments using an experimental pilot-scale ball mill manufactured by The Patterson Foundry and Machine Company. The experimental conditions covered the concentrations ranging from 10 to 60% by weight of coal in water; of these, a 40% by weight concentration was found to be the most efficient, the capacity being 39 lb/hr of product with an average Fisher Subsieve Sizer diameter of 3.5 microns. The tests were also conducted for a dry closed circuit. Although the feasibility of producing ultrafine coal by dry ball milling has been re-established, the factors affecting the capacity of the mill have not been adequately evaluated.

4. Vibratory ball mill grinding

The grinding tests of coal by Southwestern Engineering Company (SWECO) have been reported by Glenn and Grace. The equipment employed was the SWECO M45 Vibor-Energy Mill and is described below:

Maximum working capacity gal	20
Motor hp	5
Stainless Steel Lining	----
Grinding Media ½ x ½	----
Steel Cylinders lb	3200

Initial tests were conducted with a slurry containing 42 weight percent of coal in No. 2 fuel oil. However, after three hours of grinding an extremely viscous slurry formed that inhibited further efficient grinding action in the mill. Subsequent tests were conducted for periods up to four hours with 35 weight percent coal in oil slurry. Microscopic evaluations of the products made after 0.50, 1.58, and 4.00 hours operation showed the average particle size to be less then 44 microns, less than 20 microns, and less than 5 microns; respectively. The feed used in the tests was 60% minimum 200 mesh.

The grinding test of coal by Allis-Chalmers Model 1518D Vibro-Ball Mill has also been reported by Glenn and Grace. Batch operation was employed for the single test conducted, but the results were unsatisfactory and no conclusion was made as to the capacity of the mill. The mill was filled with a sufficient amount of steel balls to cover the central tube. The balls varied in diameter from 1 inch to ¼ inch. Twenty-four pounds of ⅛ inch x 0 test coal were added to the mill to fill the voids between the balls.

During the batch operation the mill was run for a total period of two hours. The mill was stopped at 0.25, 0.50, 1.00, and 2.00 hours for the extraction of samples through the top opening of the mill. During the run, the power input to the two 7½ hp motors which drive the unit varied between 9.25 and 9.75 kw.

Table 13 presents the results of the series of products obtained during the single test operation. The data shows that after 0.25 hour operation, further reduction in size was not accomplished.

5. Fluid energy mill grinding

(a) *Micronizer.*—Three tests, at three different feed rates, were reported by Glenn and Grace. These tests were made with an eight inch, rubber lined, Sturtevant Micronizer. Air, 130–135 scfm, at 115 psig and 65°F with an injector pressure of 64 psig, was employed in all tests. The coal feed of 60% minus 200 mesh was employed. Results of the tests are shown in Table 14.

The production rate of 55 lb/hr was considered too low for economic reasons. Through the use of the largest Micronizer, a 36-inch diameter unit, the production rate would be increased to about 22.5 times that for the 8-inch unit, or to about 1,240 lb/hr. It was concluded that the Micronizer could not be economically justified as a production unit for preparing coal in ultrafine sizes.

TABLE 13.—TEST RESULTS FROM BATCH GRINDING OF ALLIS-CHALMERS CO. VIBRO BALL MILL

	Fisher subsieve average microns	Sizer porosity
Grinding time, hours:		
0	43.0	0.41
0.25	7.38	.41
0.50	8.27	.41
1	8.88	.40
2	7.75	.41

TABLE 14.—MICRONIZER TEST RESULTS

[Feed: 60 percent minus 200 mesh]

Test	Feed rate, pounds per hour	Product, percent −325M (wet)	Fisher value, average microns
1	30	99.96	2.85
2	22	99.93	2.90
3	55	98.44	4.90

(b) *Jet-O-Mizer.*—Fig. 20 shows a typical installation of the 0405 Jet-O-Mizer and accessories such as were used for the custom grinding tests described by Glenn and Grace. Two 13-inch Jet-O-Clone collectors in series were employed. A series of tests were conducted using ⅛″ x 0 coal as feed. Table 15 shows the operating conditions, product size distribution and steam costs for the tests. As shown in this table, steam costs for grinding to about 98% minus 10 microns range from $5.19 to $2.27 per ton, decreasing progressively in Tests 2, 1, 6, and 3, respectively. The products varied in size from 95 to 98% minus 10 microns.

* * * * * * *

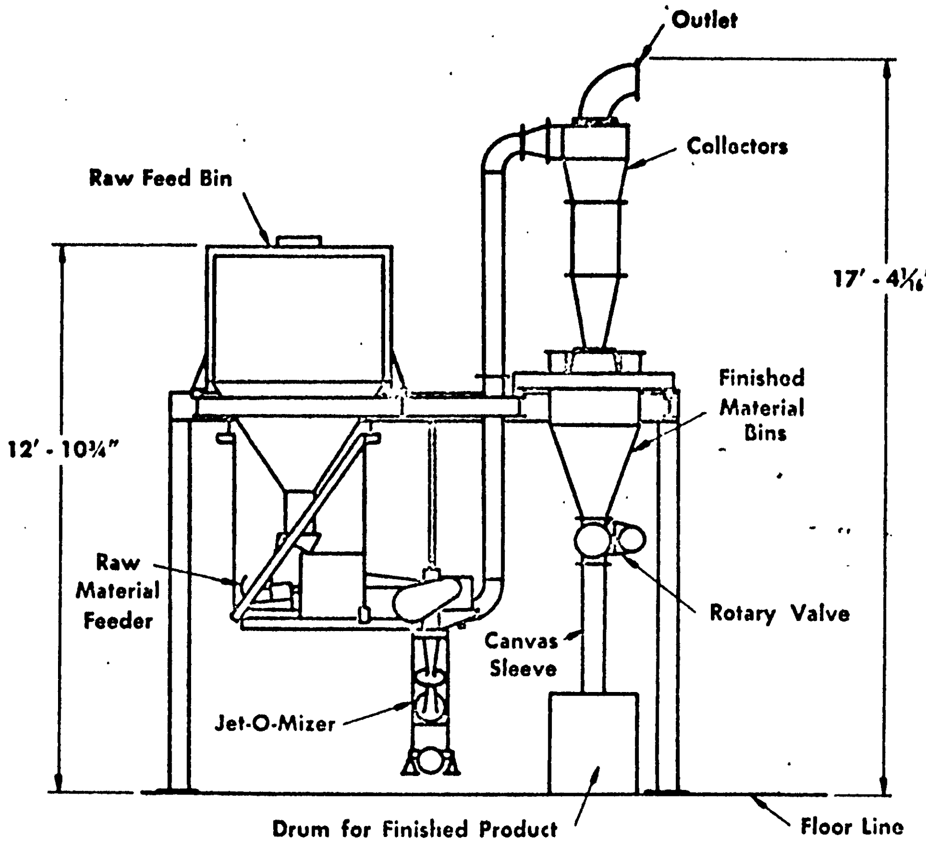


Figure 20 TYPICAL INSTALLATION 0405 JET-O-MIZER MILL WITH 13 INCH JET-O-CLONE COLLECTORS

TABLE 15.—OPERATING CONDITIONS, PRODUCT SIZE DISTRIBUTION AND STEAM COSTS FOR GRINDING TESTS WITH A JET-O-MIZER

[585–41 through 47 equals 1st collector. 585–41A,[1] 585–44A through 47A equals second collector (sample)]

F.E.P. & E. Co. test No.	BCR sample No.	Collector No.	Steam: Pressure, psig.	Steam: Rates, lb/hr: Grind.	Steam: Rates, lb/hr: feed	Steam: Rates, lb/hr: Total	Coal, rate, lb/hr	Steam/coal, lb/hr	Steam[2] cost, dollars per ton	Product size: Percent retained on—: 74 200 M	Product size: Percent retained on—: 44 325 M	Product size: Fisher Subsieve, average μ	Product size: −325 M micro range 70μ (percent)
1	585–41	1	200	900	188	1,088	250	4.36	4.36	0	0	2.65	[3] 98–99
	[1] –41A	2								0	0	1.82	[4] 69–80
2	585–42	1	150	720	188	908	175	5.19	5.19		(5)	2.40	[3] 96–98
	[1] –41A	2											
3	585–43	1	150	720	188	908	400	2.27	2.27		(6)	2.40	[3] 97–99
	[1] –41A	2											
4	585–44	1	150	720	188	908	650	1.40	1.40	3.3	1.9	3.35	[3] 93–97
	–44A	2								(7)	(7)	2.25	
5	585–45	1	150	720	188	908	800	1.14	1.14	10.2	4.8	4.15	[3] 92–96
	–45A	2								(8)	(9)	2.35	
6	585–46	1	110	530	110	640	150	4.27	4.27	Trace	0.12	2.62	[3] 95–98
	–46A	2								(5)	(9)	1.95	
7	585–47	1	110	530	110	640	400	1.60	1.60	1.94	2.10	3.38	[3] 94–98
	–47A	2								0	(8)	1.60	[3] 98–99

[1] Second collector products of 41, 42, and 43 combined.
[2] Steam at $0.50/1,000 lb.
[3] Minus 10.
[4] Minus 2.
[5] Very slight trace.
[6] Few pieces.
[7] Trace plus.
[8] Slight trace.
[9] Trace.

VII. SUMMARY AND FUTURE WORK

1. Summary

A review of the literature on fine and ultrafine grinding of coal as well as mills for novel method of grinding is presented. The conventional crushing and grinding processes, which are not included in the present report, were presented in the previous report.

Contrary to the increasing needs of ultrafine powder in various fields of application, technology of ultrafine grinding has not been competitively developed. Grindings in vibratory mill and fluid energy mill are most promising among the existing methods of communition. While the feasibility of producing ultrafine particles of coal by grinding in ball mills, vibratory ball mills and fluid energy mills has been demonstrated by various investigators, much has left to be explored. Factors which affect the efficiency of the ultrafine grinding employing these mills should be fully studied and extended from the laboratory tests in order to understand the optimum operating conditions for the production mills.

2. Future work

An 8-inch micronizer (Micronizer Co., predecessor of Sturtevant Mill Co.) and a laboratory Point Six vibrating ball mill (Schutz-O'Neill Co.) are available at the Department of Mineral Preparation. It is recommended that the available mills in the present form should be firstly employed in studying ultrafine grinding of anthracite.

Experiments have been planned to investigate the effects of various factors on mill performance. For the Micronizer, the factors to be studied include the feed size, the rate of feed and the pressure of compressed air. For the Point Six vibrating mill, the feed size, the slurry density, the mill charge, the shape and size of grinding balls will be examined in the wet, batch operation. It is hoped that the optimum operating conditions for anthracite with these specific mills will be found.

According to the manufacturer, the 8-inch micronizer requires air supply of 100 SCFM at 100 psig. However, the compressed air line presently available at the writer's laboratory is limited to approximately 65 psig. It is, therefore, suggested that an air compressor which supplies sufficient air pressure and volume should be acquired in order to cover an adequate range of air pressure.

PRESS RELEASE—ILOK POWDER CO., INC., NATIONAL PRESS BUILDING, WASHINGTON, D.C.

An American energy expert told a senate committee today that he has the technology to win the energy war promptly.

Dr. V. Stephen Krajcovic-Ilok, President of the Washington-based Ilok Powder Company, announced the country has the proven technology and the resources to be self-sufficient today without waiting until the year 1980 or even 2000, the target years suggested by Dr. Dixy Lee Ray, Chairman of the Atomic Energy Commission, and Senator Henry M. Jackson in his proposed Manhattan-type crash research program.

The doctor was testifying before the Subcommittee on Energy, chaired by Senator Mike Gravel (D., Alaska), which had earlier listened to Dr. Ray and energy chief William Simon. The secret of his five-point plan to solve not just America's energy problems but those of the entire industrialized western world, is the reduction of coal to uniform four micron size (approximately equal to 0.00016 inch) and well beyond. The United States with about two trillion tons of recoverable coal has a supply that could last up to four hundred years. Meantime much of it cannot be used because it is not clean unless Ilok technology is applied.

He outlined his solutions this way:

First.—Dr. Hans Rohrbach, now Ilok's Director of Research, discovered in 1936 that coal reduced to four micron size could be burned in diesel engines without any damaging residues. This means that no longer would America need the huge quantities of diesel oil because the diesels and utility boilers could be powered by coal.

Second.—The four micron coal particles can readily be blended with oils without an "fixateur agent" that must be employed when 74 micron coal particles are used. They can also be blended with our dwindling quantities of natural gas. And so Ilok technology is able to produce a whole line of new colloidal fuels almost immediately. The daily shortfall on oil for the week ended December 28, 1973 was 1.5 million barrels. One single Ilok plant could blend 10,000 long tons of four micron coal with 100,000 barrels of oil daily and obtain 150,796 barrles of colloidal oil. To make the 1.5 million barrel shortfall Ilok must produce 300,000 long tons of four micron coal and when that was blended daily with 3 million barrels of domestic oil, the country would have available 4.5 million barrels of colloidal fuels. In one year that represents an output of 1,642,500,000 barrels of colloidal fuels. To achieve that goal 30 Ilok plants would have to be built. The four micron coal particles can also be blended with natural gas at a ratio of about 23 pounds for coal and 1000 cubic feet of natural gas that can well feed America's industries while the pure natural gas would be reserved for hospitals, schools and residences.

Third.—As an alternative energy source, different plants could be built for the reduction to four micron size of the 520 million tons of now discarded dried vegetable residues such as soybeans, rice, wheat, barley along with sawdust, dried feedlots, straw and similar substances. In four micron form they can be used in diesels and they represent the equivalent of 1,166,000,000 barrels of oil.

Fourth.—The four micron coal sizes and sizes below that gasify completely, meaning without any residue, without any char. Ilok technology by mixing the particles with hydrogen under certain heat and pressure will provide any fuel the nation wants without any need of oxygen, vast quantities of steam and without any additional processing of char or the costly methanation.

Fifth.—By an additional thermal processing of the four micron coal, Ilok is able to separate the carbon in coal from the product gas derived from the volatiles in coal. This the doctor called the ultimate solution of our energy crisis because the pure carbon in the size of 1:300 micron can react with hydrogen, under certain heat and pressure to give this nation any fuel it needs and it can also be blended with oil and gas to give the nation absolute colloidal fuels. Furthermore, it can burn in diesels and turbines without the erosion of the blades and achieve a 63 percent thermal efficiency. Dr. Krajcovic-Ilok concluded that what he had outlined was just the tip of a huge iceberg. The technology he said has ramifications that stagger the imagination. Like the atom it can provide limitless benefits for mankind.

"I respectfully recommend passage of S. 2806", he concluded, "as the first step on the road towards the new age of clean coal and pure carbon."

PARSONS BRINCKERHOFF, TUDOR, BECHTEL,
GENERAL ENGINEERING CONSULTANTS,
Atlanta, Ga., January 16, 1974.

STATEMENT

I have reviewed the documentation concerning the Ilok Coal Powder Technology for producing clean coal and carbon from coal.

Accordingly, a fuel product can be commercially produced at a competitive price that will materially reduce the national consumption of petroleum and increase the use of coal with a beneficial impact on the national economy. On the basis of those studies we can conclude that:

1. It is now possible to reduce 97% of one ton of coal to 4 micron size at a cost of only 24.58 KWh despite the 10,000 R.P.M. of the rotor of the mill. This is attributable to the ingenious technique for the near complete elimination of the windage losses and the basic theory of design of the mill.
2. It is possible to blend the 4 micron coal powders with oil or gas because of the existance of capillaries in the 4 micron coal particles which contribute up to 50% of the total internal free volume. Such internal capillary structure is nonexistant in our presently produced 74 micron particles. On this basis Ilok can now develop a new line of colloidal fuels that will mitigate and alleviate our present energy shortages.
3. As described in the MTZ Motortechnische Zeitschrift, October issue 1971, the 4 micron coal powders can burn without residue in Diesels and turbines in lieu of oil or gas.
4. From such 4 micron coal powders liquid coal can be made and synthetic gas or oil can be produced with greater yields from 1 ton of coal than hitherto possible, because only the 4 micron coal particles gasify completely without any residue as evidenced with their combustion in Diesels.

The implications of this technology in providing a solution to our energy crisis is indeed interesting particularly due to the low cost of the grinding of coal to 4 micron sizes in your process. The data you provided would suggest a significant marketing situation for the use of 4 micron coal in Diesels and turbines in lieu of oil or gas and for the colloidal fuels utilizing 4 micron coal coupled with an expanded market situation in energy sources once you begin producing also your submicron carbon particles and pipeline quality gas as described in the Feasibility Study by the Scientific Design Company, Inc.

We are particularly intrigued in the applications outside and beyond those related to fuel supplies. Assuming the 4 micron coal from the Ilok process is in the the activated state as a result of utilizing steam, the process should produce an attractive activated powdered carbon for use in waste water treatment. The feasibility of powdered activated carbon treatment has been established. There is, however, a limitation in application due to the requirements for regeneration in order to make this method economically attractive.

At the current cost of $0.30 to $0.35 per pound of activated carbon, the application to wastewater treatment is economically feasible only if the carbon can be regenerated and re-used five to seven times. Your data would indicate that a powdered activated carbon can be produced for less than $0.01 per pound and probably sell for less than $0.06 per pound. Such a product makes activated carbon treatment totally feasible immediately without requiring regeneration. Indeed, a side benefit is obtained when the fuel value of that carbon is utilized when sludge is incinerated. In this regard, we believe the market implications of the Ilok technology in the wastewater treatment field are exciting.

There are, of course, other very interesting applications and markets for pure carbon forms. These include military applications for high-yield explosives, composite structures, and medical applications. As an example, in the latter area, pure sub-micron carbon produced at the cost you project could serve as an absolute filter and replace costly kidney equipment. Small capsules made from submicron carbon could provide an inexpensive alternative to artificial kidneys. There are well known other applications for pure, submicron carbon.

Since the *Ilok Coal Powder Technology* has been proven commercially feasible in numerous years of operation in Europe, we concur with the S 2806 of the 93rd Congress, 1st Session, introduced by U.S. Senator Mike Gravel in the sense of which a series of Ilok Plants could well be financed from the Energy Trust Fund provided by the Gravel Bill cited as the "Energy Revenue and Development Act of 1973".

JOSEF D. CERMAK, P.E.,
Chief Mechanical Engineer.

Senator GRAVEL. The hearings will be in recess until tomorrow morning at 9:30.

[Whereupon, at 12:10 p.m., the subcommittee recessed, to reconvene at 9:30 a.m., Tuesay, January 29, 1974.]

FISCAL POLICY AND THE ENERGY CRISIS

TUESDAY, JANUARY 29, 1974

U.S. SENATE,
SUBCOMMITTEE ON ENERGY
OF THE COMMITTEE ON FINANCE,
Washington, D.C.

The Subcommittee met, pursuant to recess, at 9:40 a.m., in room 2221, Dirksen Senate Office Building, Senator Mike Gravel (chairman of the subcommittee) presiding.

Present: Senators Gravel and Long (chairman of the full committee.)

Senator GRAVEL. The hearings will come back to order.

This is the last day in the 5-day scheduled hearings on the Senate bill we have before us.

Our first witness is professor of political science, Dr. Robert Engler.

Dr. Engler, would you please come forward and make yourself at home?

We are happy to have you before us. Proceed at your own will, and at the end of your statement we can go into a question and answer period and dialogue. I only wish we had more colleagues who could be here, but we have other things pressing. We are developing and have developed a very unusual record with respect to this.

Last November we had testimony primarily from the academic community, and now in the hearings we have primarily representatives from industry. We welcome you from the academic community, since we have had others from there that we found very valuable. We had people like Drs. Pindyck and MacAvoy from MIT and Drs. Cox and Wright from Harvard. So we are glad to add your illustrious views to those.

Please proceed.

STATEMENT OF PROF. ROBERT ENGLER, POLITICAL SCIENCE DEPARTMENT, CITY UNIVERSITY OF NEW YORK

Mr. ENGLER. Thank you very much.

Citizens, the press, and political leaders feel vulnerable, suspicious, resentful, and lost as to analyses and alternatives when confronting the cries of energy crisis. In such vacuums legislation seeking comprehensive public policy for so complex an area merits attention and respect.

I share with the sponsor of the proposed bill the belief that the shortage is not of energy but rather of energy policy. A longrun energy policy and mechanisms for implementing it are central to a healthy and responsible economy.

The legislation before you is ambitious and thorough. Its recognition of the need for public planning for energy development is encouraging, as is its reference to enduse planning. There are a number of interesting and innovative features such as the Commission of Energy Technology Assessment. And the discussion within one framework of reliable information, the research and development of alternative energy models, energy technology review, tax policies, foreign trade, and conservation is indicative of energy's interlocking importance in the political economy and of the need to place it in the broadest context. The bill represents a determination to prevent the Nation from being caught again by shortages.

My testimony, however, parts company with many of the specifics of the bill, as well as with some of its underlying premises and omissions. This despite my respect for Senator Gravel's concern for national and Alaskan development and his record in other fields.

Senator GRAVEL. Thank you.

Mr. ENGLER. My comments shall be general rather than technical and shall be presented essentially in outline form. I shall rely on discussion and questions to spell out the details and more of the reasoning. Not having received your earlier hearings, I am at a loss as to the focus of the other witnesses.

My major reservations center around: One, the faith shown in private enterprise's ability to serve the Nation; two, the inadequate assurances as to responsible government; three, the lack of a sustained, critical appraisal of the lifestyles which make such heavy demands upon energy.

One: There is an implication in the legislation that the rules of a free market have governed the production and distribution of energy—save when interfered with by the clumsy hand of public government—and were we to remove the public impediments the private sector could again serve us well. But the oil industry has been a private planning system which operates on an essentially global scale. It commands extraordinary financial and physical resources greater than those of most industries and many nation states. The major integrated companies have sought effective control of the flow of oil from well to pump. The ability to shift profits from one stage to another has been vital in driving out weaker competitors and avoiding or taking advantage of tax laws. This ability is pertinent to an understanding of the so-called energy crisis. Faced with greater demands from the increasingly sophisticated producing nations, the international oil companies have attempted to increase their profits downstream at the refinery and marketing stages.

Senator GRAVEL. Doctor, would you read just a trifle bit slower? The thoughts you are putting forth are really excellent, and I would like to grasp all of the points.

Mr. ENGLER. My usual experience with Senate committees is that they want me to skip the testimony.

Senator GRAVEL. There is a lot of meat we want to chew on.

Mr. ENGLER. Despite the great number of presumably independent entrepreneurs involved, and the competition for new markets and reserves, in important respects the industry functions as a cartel in setting prices, protecting profits and minimizing competition from intruders or regional independents. The majors account for approximately 70 percent of domestic oil production, 72 percent of natural gas production and reserve ownership, 86 percent of U.S. refinery capacity, 79 percent of gasoline marketing. The top four corporations account for over 30 percent of these operations. The seven worldwide giants have assets whose combined worth, at a minimum, is $85 billion. Their community of interest is guarded through patients, joint ventures in drilling and pipelines, banking ties, regional price leadership, and recognized territorial prerogatives. Brand distinctions are an advertising fiction—gasoline is a standardized commodity which often flows through the same pipelines, refineries and tanks.

Restricting new refinery and pipeline construction, curtailing refinery runs, driving out independent refiners and marketers by cutting off their supplies, and generally doing everything to forestall the nightmare of competition have been central factors in the current shortage. The mechanisms they have created for an orderly flow, that is, for limiting production to effective market demand, have been inadequately responsive to increases in or miscalculations of demand.

Meanwhile, the international oil companies have long anticipated and prepared for the rise of bargaining power by the Middle Eastern producing countries. Indeed, there has been little protest or resistance to the upward spiralling of prices by the Arab nations. All this has increased the worth of their holdings at home and their profits.

They have been mindful of the ultimate limits of nonrenewable fossil fuels and have broadened their operations in coal, gas, tar sands, shale, uranium as well as in the so-called nonconventional fuels. As energy corporations, they now control over 30 percent of domestic coal reserves and 20 percent of domestic coal production, over 50 percent of uranium reserves, and 25 percent of uranium milling capacity. They have helped to push up the price of coal. The insistence that Federal price regulation of natural gas must be ended seems related not to any present unprofitability but to a desire to make gas prices competitive with—that is, up to—coal and oil.

In all of these operations the corporations who dominate energy behave as highly accomplished profit-gatherers, roaming the earth in search of reserves, markets, and profits. Third quarter profits in 1973 increased for the industry as a whole 63 percent over 1972: 81 percent for Exxon, 91 percent for Gulf, 274 percent for Royal Dutch Shell, and 483 percent for British Petroleum. Meanwhile, they shift risk to taxpayers, costs to consumers, and now blame to environmentalists.

Two: Much of what we now call public energy policy is supportive of or subservient to private industry objectives. Conservation laws have protected prices when the key production was domestic. Once supply centers shifted abroad, imports controls were added, without congressional review. This governmental intervention, pushed for by the industry and maintained until last spring, was a price stabilization subsidy which kept oil from abroad in check, while protecting domestic pricing. The cost to consumer and taxpayer has been estimated at a minimum of $5 billion a year. It is scarcely in accord with the tenets of a free market economy.

The Federal Government has provided private industry with tremendous financial incentives through the depletion allowance, depreciation of intangible drilling costs, overseas depletion allowances, and tax credits. All of these help to explain the minuscule Federal income taxes paid. In addition, the corporations have been able to generate vast sums as capital for reinvestment by charging consumers not simply for the cost of production of fuel but for its replacement. Thus consumers have become investors without any rights. The shiny piece of glass or trinket they may have received at the gas station serves to emphasize their status as natives.

The Federal Government has been most responsive to industry definitions of technological readiness of alternative energy sources. The current energy scare and the talk of technological crash programs rip out of historical context the fact that we did have federally run experiments and plants as far back as 50 years ago. Coal-oil laboratories and plants were set up by the Bureau of Mines during World War II. The shale oil pilot plant at Rifle, Colo. and the Laramie, Wyo. laboratory, along with coal to gas plants, were closed down under the Eisenhower administration, not because of technological failures, but because the industry insisted that the next steps—introducing such fuels onto the market, should be a private determination, once the price was right. The energy industry has thus maintained vigorous surveillance and veto power over all forms and sources of energy innovation—whether offshore oil, shale, gasification, ta rsands—which might upset their control over the market.

They have been aided by a sympathetic, innocent, or captive public bureaucracy whose members have come directly from industry, share the premises of industry or have never been offered or been encouraged to think about guidelines for a genuinely public policy. The Federal Government is also honeycombed by a network of advisory bodies, representing the leaders of the major energy corporations and trade associations, along with some independents, who in effect are making public policy in Interior, the Executive offices, and elsewhere while concealed from public view or review.

The Federal Government has also provided immunity from antitrust actions as well as extensive diplomatic, military, and espionage support for the international operations of the oil industry The assumption has been a mutuality of interests. The specific activities have generally been kept secret from the American people, in the name, of course, of national security.

Much of the proposed law presumes the energy corporations are eager actors in search of a script. Their past record and present performance suggest they already know their roles, that of extending operations and maintaining profits and power.

The call for planning and for the coordination of the now scattered and half-hearted Federal efforts could be a step forward. But if the Interior Department has been carved out by coal and oil interests, what assurances do we have that the proposed Federal Energy Administration will have more integrity? The Commission on Energy Technology Assessment could introduce a positive note if it has independence, authority, and backing. Interior's experts generally come from industry and industry-related universities. What assurances will we have in the new agency? I do not believe that the proposals in this bill go far enough to insure genuinely public policy subject to review by the Congress and the citizenry.

Nor do I believe the need is for loans and new subsidies for the private sector; we are not talking about the world of Adam Smith but that of Exxon and Gulf. What provisions are there for newcomers and small business people to enter the scene? Windfall taxes will not help the consumer already facing an uncontrolled inflation. Nor will a tax on Btu's which ultimately will be passed on to the consumer. Excess profits taxes can be a charade if the corporations show they are reinvesting in energy development.

Given the power of the private energy industry, its permeation of political life through its wealth, its controls over resources and skills, its extensive public relations and political activities, its access to the mass media, its leasing of about one-fourth of the land area of the United States and the identification of so many citizens and politicians with its fate, I cannot see how such planning as outlined in the bill will lead in new public directions. Energy planning is too important to be entrusted to the profit considerations of international corporations who dominate so much of the marketplace. The current energy shortage thus provides a dramatic public case study of the failure of this industry to give its first loyalty to the citizenry, and the failure of public government to govern for the public.

Three: There appears to be an uncritical acceptance of many of the fundamental patterns which have contributed to our present difficulties.

(A) There are inadequate provisions for conservation and environmental safeguards. Will the bill encourage its commission and the Government to say no to the development of resources rather than urging maximum efficient recovery when thinking in terms of the future may be more important than present definitions of need?

(B) There is little discussion of present technological factors which foster such insatiable and inequitable consumption patterns. Will the legislation provide means for saying no to big cars and wasteful industrial processes, and yes to mass transit and smaller scale technologies? Will positive end-use planning emerge?

(C) Will this legislation open the door to asking about the inefficiencies and immorality of an industrial system which unabashedly devours a third of the world's resources for its 6 percent of the population? Or does it sanction the mindless pledge of corporate and political leaders to continue to search for more and to use all we can get?

(D) Is energy self-sufficiency by 1985 either a feasible or an appropriate target? Does banding together with other consumer nations while moving to keep imports out assume that there is little hope for a peaceful and cooperative world order, that the best we can do is play off one region against another? And meanwhile will we once more be protecting a high-cost domestic industry from the possibility of lowered foreign prices?

(E) Is there adequate recognition of the impact of corporate-governmental arrangements with the new producer cartels upon the truly poor of the world, the great numbers to whom shortages or rigged prices mean not fewer air-conditioned hours, but no kerosene for warmth or fertilizer for survival? Where has our concern over energy shortages been when the poorer countries have been pressured against developing independent energy bases and when the higher prices of the purchased fuel have canceled out foreign aid and painfully attained growth gains.

(F) A bill cannot do everything. But one cannot ignore the heavy drain on energy by our imperial foreign policy and the permanent mobilization for war. We seem more ready to use the energy shortage as an excuse for curtailing school busing than for ending oil aid to the South Vietnamese Army.

Having been so critical, there is some obligation to suggest the directions of my own counterproposals. These include:

One: The control and development of all energy resources from public lands by a public corporation. This corporation, with access to perhaps half of our fossil fuel, shale, offshore lands, et cetera, could serve as a yardstick. It could also provide minimum protection against an industry whose world power allows it to rig prices charged the military during wartime, cut off supplies to the Armed Forces at the behest of another nation, and generate unemployment at home.

Two: All energy operations should be given a public utility status.

Three: An independent national resources commission, perhaps with a 2-year life, should be appointed with the mandate to appraise the desirability of public ownership of all energy in the United States. After all, the companies did not put these resources in the ground. Nor did they create their value.

The Commission would also be asked to review all intermediate steps for public accountability—regulation, antitrust, Federal chartering , breaking up of the integrated corporations, divestiture of control of competing energy sources. Examining the case for the integrated operation would be valuable. The argument has generally been that only big systems can use big technology and serve big publics. Perhaps this is no longer so. A fresh look not at oil theory or public relations but at the technology and economic practices of the energy industry would be instructive.

I also should have included here that all special privileges, taxes, research, should be examined for public benefit. What does depletion allowance, for example, really accomplish, and for whom?

Senator GRAVEL. Is that an aside there, Doctor?

Mr. ENGLER. Yes.

Senator GRAVEL. No rhetorical question asked?

Mr. ENGLER. What does depletion really accomplish and for whom? I'd say we just need fresh data in this area.

The Commission could be asked to come up with proposals for stimulating local, regional, national and international planning bodies who in turn might seek to place energy in the context of communal goals and development. It would encourage projects which might then receive Federal support. These might include—and this is a small list: regional development of small-scale alternative technologies, experimental energy systems, local producer and marketing energy cooperatives, new towns, local mass transit experiments, new building patterns.

The Commission could be asking what is to be learned from the TVA, the Rural Electrification Administration and from other countries.

Four: A technological review board should be created, not just for energy technology but for all technological innovations. We may not wish to be Luddites. But we must learn how and when we can anticipate social and environmental consequences before we are confronted with them so that we may prepare for their impact or develop the wisdom and the political will to say "No."

Five: One basic function of such a commission would be to generate a great public debate. We need to place in the public record the basic data about energy, natural resources, cost of production, consumption patterns and related issues. Much attention is now being focused on corporate secrecy as to inventories and reserves. I hope we will end the outrageous practices of basing public, domestic, and foreign policies upon trade association figures, and of corporate and governmental bureaucrats defending information about energy as proprietary and masking their moves behind national security.

There are indeed questions about the energy crisis which need public airing. For example, what happened at Tehran in 1971 when oil company leaders met with the oil-producing Nations after receiving support for collective negotiations from the Justice Department? A letter of inquiry which I had sent to the Antitrust Division at that time produced the reply that in its judgment and that of the State Department release of this information at the present time would be contrary to the national interest. Why does our State Department remain publicly so quiet about such negotiations between corporations and governments? What goes on in the meetings of the Emergency Petrolum Supply Committee and the Foreign Petroleum Supply Committee, composed of representatives of the international oil companies, who have been convened as industry advisory bodies within the Interior Department to help resolve the international oil crisis? And how did the Council of Living Council arrive at the special treatment it accords the oil industry under phase 4 regulations? A pass-through of increased costs at all levels on a once-a-month basis is allowed, as contrasted with yearly review in manufacturing.

But we need not go overboard on the information issue. In a larger sense, the issue is not secrecy. We have had abundant warnings over the years of the consequences of our spiralling demand patterns and of the increasing costs of ultimately finite fossil fuels.

It is not secret to the people of Appalachia that their land has been ravaged in the quest for coal. It is no secret to Montanans who fear a similar fate. Nor is it a secret to the people of many oil-producing regions that the great wealth generated can be badly distributed. It is no secret to the people of Latin America and the Middle East that oil companies have enjoyed the political support of the American Government.

Then, too, much of the knowledge about oil and oil policies is not that esoteric. We have had and presumably still do have experts and generalists in the Government who know the score. If we were to create a climate where genuine public servants would no longer be made outcasts for maintaining loyalty to public ideals, the knowledge factor would not be so intimidating to legislators and citizens.

I am thinking, for example, of men like W. B. Watson Snyder who worked almost alone and unsupported in the Antitrust Division for so many years, of economist John Blair in the Federal Trade Commission and then the Senate Antitrust Committee; of geologist-economist David Brooks whose research on imports, coal, shale, and helium caused such discomfort in the Bureau of Mines. He found himself virtually blacklisted in the U.S. Federal Government and moved on to direct energy research for the Canadian Government.

In contrast, the head of Interior's Oil and Gas Division moves to the American Petroleum Institute. And the Assistant Secretary of Interior for Mineral Resources, who defended corporate withholding of data on reserves on public lands as "proprietary" information. ("This Government of ours is a private enterprise government", he explained to a Senate Committee a few years ago) has moved on to head shale operations as vice president for Atlantic Richfield.

Six: Meanwhile, we should do everything to equalize the present shortage pressures. We should keep controls on prices and explore carefully the merits of rationing and also price rollbacks.

Seven: There is no magic in planning or public ownership. We are all aware of the curse of big bureaucracy, private or public. Indeed, our economic system, like our political system, may be toppling under the weight of big technology. But surely there is no gain in extending the power of already irresponsible and bloated corporations.

We need to be talking not just about alternative energy, but alternative economic and political thinking which may yet help us to attain the ideal of peaceful democratic communities. We need to learn to respect the natural environment rather than to loot it. We need to stop assuming that there is always a technological answer when the questions may be moral and social.

This, to me, is the real challenge of the current energy crisis.

Thank you.

Senator GRAVEL. Doctor, I think this is a very fine statement. I think it has a bent and I would like to pursue that bent with you. If I could also recommend for your reading, probably in all of the testimony we have received, the one area that I think would be most interesting to you, judging from your perspective here, would be the October hearings that we had, and we had all that published, and I think Mr. Best could get you a copy, dealing with the MacAvoy and the Pindyck econometric studies on what would be the product of a free market as opposed to the situation we find ourselves in today, and also I would commend to your reading an analysis, and the name of the author escapes me, but an analysis of the effect of the skewness regulating of gas on the total energy situation. One of the interesting factors developed from that skewness is the anomaly that we have, and I think we share the same beliefs in assigning the proper value to scarce resources, but the anomaly we have of finding oil, selling for two or three times cheaper than gas—no, gas selling for two to three times cheaper than oil in markets like Chicago which obviously encourage wastefulness and misuse of a product, and if we are to be in harmony with the environment, we must take the most valuable of the environment's beneficence and treat it with that sense of value. But it is very difficult to do that if you have government policy or public policy that ascribes values that take no cognizance of one of economics, and two, of the chain or of the scale of values that nature has placed on things. That is one small example I think that you might find very interesting in looking to public policy.

Doctor, I can say that philosophically there are many areas of your statement that I personally agree with, but that there are many areas that I feel that I have come away from. I hesitate to use the word evolved away from because that ascribes a sense of maturity to me that you do not have, and I do not think that is entirely the case because I think maturity is a subjective type of situation. You do not know whether or not—you may think you are more mature; I may think I am more mature, but that is really a subjective situation. I think we will let history and the evolution and the actions of human beings and nature and the environment be the judge, and the disciplinarian of these various persuasions.

But I would like to just go through your thesis for a moment, and starting with—and I will have to go through—going from the particular to the general, or going from the general to the particular, I come away with the question very simply, as to what solutions do you seek or do we all seek, because in item 7 on page 11, there is no magic in planning or public ownership, and all of the ills that you described of the oil companies in terms of the growth of profits or their impact on the consumer, I can't help but look to a situation that occurred in Alaska not too long ago where the FAA in remote housing for their employees—now, that is where the employee on the ocean chain or another cold area, remote areas, the only house there is the FAA house, so they live in it. There is no choice. It is either that or go build yourself an igloo. They raised the rents in some cases 150 percent in 1 year.

Now, this was not the private enterprise sector, this was government. These were people in government that somebody made a judgment saying this is what somebody should pay.

Now, I have difficulty making a comparison as to the impact on human beings of going into the worst slumlords of Harlem and seeing how they gouge the people as to what the Government gouged the people.

So, based on that experience, I come away with a certain feeling, my God, really, you know, we are capable of doing anything to ourselves if we give anybody any degree of power to do it.

Can you see any difference between the actions of the FAA in that capricious activity and in some of the capricious activities you defined in or ascribed to the integrated oil companies?

Mr. ENGLER. Well, as an aside, I was in Alaska a couple of years ago and when I was speaking to some of the natives who were complaining about their treatment they told me, it was not too long ago that they were ruled by the Fish and Wildlife Service.

Senator GRAVEL. I have not begun to cite some horror stories of the Fish and Wildlife Service or the BIA. I want to be a little moderate today. I do not want to even get into that, where we still have the BIA in a Department of Natural Resources. We have not had the maturity in Government to put it into HEW. It used to be in the Department of War, but maturity comes very slowly to bureaucracy, as it comes slowly to corporate enterprise.

But do you, from a philosophical point, see any difference in the oppression that takes place?

Mr. ENGLER. Yes, I do; and I think there is enough in this brief statement to reflect my own ambiguities and unease. I do not see how one could grow up in or think about almost any period in history without realizing that most governments have been much if not most of the time tyrannical, let alone stupid, and there is certainly enough data in our present moment of history to suggest much of the same about our own Government.

But there is a difference, and maybe it is a very thin line, and the difference is that we are describing not, as I tried to say earlier, an industry——

Senator GRAVEL. Doctor, could I excuse myself, because I did want to see somebody very quickly here for a moment, and I do not want to lose the thread of the point you are making, to go back to your point.

So I will just absent myself for 3 minutes. I will be right back and then we will continue.

[A brief recess was taken.]

Senator GRAVEL. The hearings will come back to order.

Doctor, now you will have my undivided attention.

Would you pursue the point that you were making?

Mr. ENGLER. You were asking me if we had had enough experience with big government, its stupidities and its failures. I think we could swap stories, and we would not be in disagreement; but I think when you start with that, Senator Gravel, you throw away the ballgame before it begins, because we are not dealing with individuals anymore. We are dealing with giant private world governments.

To give a personal reference, I did a book some years ago called the "Politics of Oil" which described the industry as the first world government, and I tried to document why I thought it was a world government, what it controlled, how it had its own diplomatic corps, how it negotiated with foreign countries, how it dealt with the Nazis, how Esso supplied high-octane refinery plans to Nazi Germany on the eve of World War II, how the United States was denied synthetic rubber because of cartel agreements between I. G. Farben and Jersey Standard.

You talk about oilmen being nervous today. I do not know how nervous they are, but in the early 1940's they really thought they might be nationalized because of public disclosure of some of these practices.

Now, what I am trying to say is, not to review old records, but something else. You are dealing with giant systems here which we have not been able to hold accountable. I have lost count of the number of Senate committees which are now chasing after the energy crisis. This is no disrespect to yours or to my appearance here, obviously, but it seems to me here are all these people pursuing energy questions and not much new has emerged.

It is the same story: everyone is playing with a fragment of the whole. I respect the effort, the concern, but what I am saying is, public government at least gives us a theoretical fighting chance to hold decisions accountable. We do not have the mechanisms yet for holding the corporations accountable, and your bill, as I read it, pretends that either we do or we have little to worry about. And I recognize that you could recreate a new monster while chasing after the old one, there is my own ambiguity, my own, with a small "a," anarchism.

Senator GRAVEL. You see, what I view it as is throwing the water out, and the baby included. I do not particularly view it from that perspective. In fact, I have just gone the other direction where I have now developed a greater faith in the free enterprise system as a system of checks and balances.

Mr. ENGLER. But who is checking oil today in the industry?

Senator GRAVEL. If you are right, that bigness and strength and financial power of oil, domestically and internationally, has co-opted Government, then what would be the difference in your proposal of adding more government to make it more easily co-opted, and you would have what we have in the defense area, a military-industrial complex which develops a syndrome of power and no way to break the situation.

Mr. ENGLER. But you overlook, forgive me, at least one thing that I have said, sir, and that is I think you have passed the point for celebrating this as an area for so-called free enterprise. This must be a public area. I was not sure of that 10 years ago. My conversion did not happen this year because of the energy crisis. I see no justification for natural resources—which were not placed there by Esso or even Royal Dutch Shell—being in private hands, when the consequences are so great.

Senator GRAVEL. What is your definition of public area, and that is what it would hinge upon.

You see, a point you make about information that is being guarded unnecessarily, and adds to the confusion and the lack of knowledge, this bill addresses itself to it. We create an energy model in this bill that will report to the Government, to the industry, and to the American people on a monthly basis exactly where everything is all the time.

What more powerful tool can we have to the exercise of a free society than letting it hang out and then reporting it every single month? That is in this bill.

Mr. ENGLER. The Bureau of Mines reports every month on our inventories, but I do not think it is fireside reading.

Senator GRAVEL. But it is a distinct improvement when you are talking about something like the Bureau of Labor Statistics which in this last 5 years we have had the claims that find they have been manipulated and I do not know whether they have or they have not. I have my suspicions like everybody else. But by the same token, when we moved to putting out the data of the Bureau of Labor Statistics, we did make a step forward, not to perfection, but to substantial improvement.

Mr. ENGLER. As a writer and a teacher, obviously anything that comes into the public domain in terms of information and ideas, I am supportive of because I am still old fashioned enough to believe that there can be no public without the fullest publicity. If there is a ghost of a chance for genuinely public policy, I am convinced it is not going to come from experts or even professors. It has to ultimately be based in the understanding and will of enough people.

Senator GRAVEL. But in point of fact, we cannot charge, at least from my objective perspective, that the oil industry which from my examination operates no differently than any other industry with a profit motive. If you define a fault to the oil industry, I think you should do it to the chemical industry in the pre-World War II period. Farbin, which was divided up, and so it just was not oil. You could go to chemicals. You could go to all other areas of life.

So I think what we can do is we can define that there is a frailty or there is a weakness within the free enterprise system or the capitalist system, and what we want to do is shore up that weakness.

But when we talk of openness to the people, I have not found the Government in its operation any more open to the people than the private sector. In fact, if you go ahead—and certainly the Nader organization has more experience in trying to pry things out of the bureaucracy than they have in trying to pry it out of the corporate sector——

Mr. ENGLER. May I make several comments, please, on that?

Senator GRAVEL. Please.

Mr. ENGLER. One, I never underestimate the power and stupidity of what we see as bureaucracy, academic, public, private, what have you. But with no defense of the Nader operation, which I have some admiration, some criticism of——

Senator GRAVEL. And I, too.

Mr. ENGLER. But always respect. In fact, much of the privacy in the bureaucracy relates to the fact that there is a high degree of fear within the bureaucracy that if exposed to public view, what becomes apparent is that the only public they are serving is their particular client, their particular constituents rather than public.

Senator GRAVEL. Themselves, you mean, or the perception of what they view their goal to be.

Mr. ENGLER. Both. That is the Federal Communications Commission, with the rarest of exceptions in my lifetime, has generally seen as the public primarily Dave Sarnoff and his relatives, using that as a euphemism for the industry. It has rarely acted as though the public owns the air. There are two factors involved. There is the interest of the bureaucrat in surviving, in having a pleasant life and in enjoying his own prerogative. There is also a recognition of the surveillance of government activities by the private forces with the greatest immediate stake.

Senator GRAVEL. Plus the paternalism that creeps into all human beings who exercise power, but the paternalism is the basic ingredient of dictatorships.

Mr. ENGLER. Senator Gravel, you pushed me before to make a speech in behalf of socialism, and I turn it around and ask you to do that. I am not afraid to, but what I am saying is, you are quite right. The challenge to oil could be made to other areas.

Senator GRAVEL. But that is very important in presenting objectively the problem to the American people, because when you talk of the growth of profits, I am persuaded that the approach can be somewhat demagogic, because, do we hear of any thought of forming a national steel company today when the profits of last year of steel were 101 percent, not the same rate?

Do we hear talk—and this is just a comparison, because it really shows the fallacy of dealing with growth percentages—the Washington Post in the last quarter of last year had a percentage increase in profit of 240 some odd percent. Now, that would seem unconscionable, but in fact, their profit is only around 3.3 percent for the year, which is really very, very modest, in fact, not even average return.

So, you know, you can demagog these figures. I am reminded of a statistician who taught me statistics 101, and he said that figures do not lie, but liars sure can figure. It is how you want to use the figures.

Mr. ENGLER. Can we get back to this for 1 second, sir?

Senator GRAVEL. Please.

Mr. ENGLER. Do you want to challenge the figures on the control of energy in the world by the handful of American and two European corporations?

Senator GRAVEL. No.

Mr. ENGLER. Do you want to challenge the fact that the oil industry is moving to take over coal?

Do you want to challenge——

Senator GRAVEL. Yes, Doctor, yes, I would challenge it in this respect, that I would say that I think in your paper you ascribe a de facto collusiveness that from my experience, and I could be wrong, I could be naive, but in my experience from my philosophical perspective, which I think is somewhat unique, as you stated earlier, that I have not seen that collusiveness.

Now, may be they are colluding when I am not around, but you can develop feelings as to, in social conversations, as to what they talk about, and I detect it in the last couple of years that in their negotiations with the Arabs, it is not one inference here and one inference with the public that they just went leaping to the Arab position. It was not the case; that it was the case of the Arabs' maturity, getting their Ph. D.'s from the London School of Economics and Harvard.

Mr. ENGLER. More likely the University of Texas.

Senator GRAVEL. Or the University of Texas. It makes no difference. But then saying that the oil companies or the executives are then conspiring with the Arabs to feather their nest, and from my perspective over a 2- or 3-year period, it is not that, and I think I have as good a perception on that subject as most individuals in our society. And so I think it can be somewhat demagogic when you say that an oil executive has been flying to Paris, to Zurich, to Teheran, to Beirut, to Amman, to Jidda, and then has to take early retirement at the end of the year because they have wiped him out, and then you tell me that he is part of a conspiracy with the Arabs to rip it off on the people of the world. Those are not the facts. That may be the result. I am not persuaded that that is. I think we can delve into those economics, will unfold, because there is such a system, if somebody is taking your equity and slowly eating away, there is going to come a day when you do not have any more equity, and then he will decide he is going to market himself. So the international oil companies, if they are in a conspiracy, it is a conspiracy to destroy themselves because that is essentially what is happening.

Mr. ENGLER. Senator Gravel, you have been very friendly, but you are also using words like demagogic and conspiracy, neither of which I think I have been talking about.

I think I can document, sir, and I have tried to and I still can as thoroughly as you will allow me, the ways in which the major oil companies have behaved in the Middle East, starting, as you said, at the point, quite rightly, when the native peoples in Latin America and Mexico, throughout the world, discovered they were giving away their most precious resource and getting very little in return. So gradually they fought for a better share of the royalty, for increased taxes.

For example, Aramco sent a young Saudi Arabian, Adullah Tariki, to the University of Texas to learn oil geology. On the sly this young fellow picked up oil bookkeeping, and when he came home and ended up as Minister for Resources, he insisted that Saudi Arabia should get a cut on the whole integrated process, because the skill of the oil companies was not just in making profit at the production level, but in being able to make and shift profits all along.

Now I read that Iran is about to open up its own gas stations with Ashland in New York State very shortly. That is, they want to be part of the whole process.

That is not conspiracy. You could say that is education. They have learned well from their so-called betters. They have learned how to get the most out of their resource.

Senator GRAVEL. And it is the manipulation of capital.

Mr. ENGLER. But I am saying, sir, that I cannot take seriously the belief that the immediate oil shortage was caused all of a sudden, either because of the Arab-Isreal war, or because all of a sudden some of the Arab nations tightened the screws with an oil embargo.

Oil company deliberations, diplomacy and negotiations have explored for many years what will happen when the day comes when there will be a greater worth placed on the oil in these countries, when they will talk about conservation, when they will talk about spacing out production, when they will begin to ask the question, why should we be left with the most expensive oil for our children, or why will we be left one day with no resources, depending on the country.

So, no apology for what is happening, but obviously there is, as you say, a maturation in terms of thinking. But I am saying that oil companies were aware—and there is no evidence that the oil companies raised a voice against the increase in prices Their options may have been limited, but they were already planning alternatives. That is not conspiracy.

Senator GRAVEL. Could I give you an example of where they did raise a voice, and it is easily forgotten, and it triggered the formation of OPEC—that was prior to the formation of OPEC in the early sixties. There was a rollback in prices paid to the host nations, and that happened, I believe, on two occasions, and the dates escape me, but it was rolling back these prices that caused these nations to say, hey, we just cannot let them do this to us, and we are going to form our own producing organization, and that is how OPEC came into being.

And so certainly would that not give testimony to some knowledge or some desire—I do not know, maybe they were secret considerations, but this is the public thing that happened, and it resulted in a pretty public reaction, a pretty hysterical reaction. I would think that that would cry out as a public statement in response to the point you made.

Mr. ENGLER. Senator, if I can make one other comment.

Earlier when you asked the general question, well, if we raise such questions about oil, why not look at all the industries, look at the whole economies. I do not see why anyone should be put into that position intellectually. That is, I think there are tests. I do not have an ideological test to make. I have some practical tests, starting with my notion as to public service, as to democratic ideals, and to some kind of ecological sanity. In my private life, which is unimportant, I drift out around 6:30, 7 in the morning every day to a corner shop, Shanvilla Market, talk for 15 minutes with Patrick, who has been up there since 5, buy some milk, bread. I have no argument for nationalization of Shanvilla Market. I live a part of my life in Massachusetts where my neighbors are small, conservative farmers I do not believe in nationalization of their farms. But I am talking about the areas where economic power has reached such dimension through its control over basic resources that it effectively cripples, corrodes or captures public government. The town of Washington, as well as much of the United States, has become so beholden to this particular corporate entity, this energy industry, that we seem paralyzed and unable to formulate public policy. I do not think the fear of public bureaucracy, the fear of planning, the fear of government ownership, all of which I will sign the petitions about and talk to you about as openly as possible, face up to the realities of corporate irresponsibility and public vacuums.

I welcome the call for information, I welcome the call for the energy technology assessment. But I really found no recognition of the fact that the Department of Interior today as under previous administrations, is in the pocket, and that is crude language, but it is documented by almost anyone who knows it, of the coal industry, the oil industry, the utility industry. It is not a public agency. There are other agencies which have similar records with their own constituents, but we are talking about the incapacity of a public to control a resource which they now are discovering touches every single area of life.

And so I do not see how I can jump from that to Shanvilla Market.

Senator GRAVEL. But we do not disagree in goals of human beings. I think it is in trying to implement, and in your paper you offer suggestions as to policy alternatives. Some are excellent, those on page 10, regional developments, small-scale alternatives and technologies, excellent; experimental energy systems, excellent.

We have had testimony, we have strived to structure this into this bill.

Now, when you talk of new towns; I have supported land planning. I was the one who offered the Federal Lands Planning Commission for the State of Alaska, which is a prototype for the whole Nation, which came out of the Senate. This was 3 years ago that I did this, so certainly I subscribe to these things.

But, by the same token, our work is in the Congress, it is not an area where we can just dream. We have to take concepts and goals and translate them into the perceptions that exist in the Nation, among the people and in the Congress, and see what is possible and what is not possible.

Sometimes I am not even sure, you know, when you were talking, about right and wrong. I have persuasions, but I think a lot of times to compromise is very good, because I have found a long time ago that you can pass a law, but if the people do not think it is a good law, it is not a good law. In fact, it can become a very bad law.

So in these areas, I agree, but when you talk of setting up a public corporation, I know my experience with COMSAT and the fact that today we do not have a satellite communications system in existence. They have one in Canada, we just tied onto it. And in April of 1965 I was pushing for a domestic satellite system, which still is not in being, and when it does come into being, may have to permit the amortization of another terrestrial system, when we, the Government of the people, had already paid for a technology which will not be available to us at the proper cost; for the very same thing you talk of in the oil industry, exists in the communications industry.

How do we overcome this? I think that we overcome it one day at a time with constructive informational processes and not throw out the system, not throw out the free enterprise system or the Government system, but try to develop new checks and balances.

I think that the system in the bill, which you agree with but treated so unchivalrously, the Commission on Energy Technology Assessment, this in my mind would be the first in the United States, or anyplace in the world that I know of. If it passed into law, it would be the first true adversary, automatically funded, not by a corporation, but as a percentage of what is spent in the other areas.

Now, we did not see industry coming forward and praising that technology, but in things that you search for, I can promise you it is the only hope that you have of getting them through Congress. There is not the mentality in the Congress or in the Nation today to think in terms of spending 1 percent of the total, which would be $1 billion, $1 billion in arm's length adversary approach, coupled with the energy model that exists. This could usher in a new era.

So, come in and look upon this legislation as one that is not evilly coddling existing systems. You know, I can only say that is a judgment you can make, but there are those of us who have labored hard in trying to think of handling the problem constructively, and we say that we get no support from one side of the economy, and no support from the other side, so what is going to happen is continued polarization and no solution.

I think what the people want in this country is basically a step-by-step approach toward solutionmaking that goes toward your goals. But when I hear people talk about public corporations, and I look at Comsat, and talk of treating the industry as utilities—now, I have attended a number of utility hearings in this Congress in my short tenure, and you know what we have received, the least amount of—and I say this in quotes and not disrespectful to the industry—but the least amount of contribution and imagination and thought is from the public utilities. They have got a locked-in, guaranteed-profit system where there is no discipline.

Take Con Edison, the largest in the Nation. We had a hearing a couple of years ago where they were spending, they confessed, $3 million on research, and I believe in 1969 or 1970 it was $340 million on advertising. Now, there are your public utilities. And so when somebody comes forward and says, "Well, I think we ought to go to public utilities," I get deeply chagrinned over the lack of breadth of the suggestion.

Mr. Engler. Senator, again, I think I praise, however slightly you may feel—the potential——

Senator Gravel. Maybe I have been harsh, and I apologize, but the statement comes on harsh, and I think that we are entitled to have a harsh dialog.

Mr. ENGLER. I said I think there might be something to this. I want to know more about it, but I always like to know the context. My testimony is not favoring public utility status as a resolution of the problems posed.

Senator GRAVEL. But you made a statement saying that they all should be treated as public utilities, and God forbid when that happens because the track record of public utilities in this country is abominable compared to the track record of the private oil sector and private gas sector.

Mr. ENGLER. But do not rip it out of context or put it aside as a dream. The first proposal is for something modest. This is incremental, which you favor.

There are bills in the Congress now for public corporations for handling public resources on public lands. I do not know what their fate will be. I recommend you appraise all of the suggestions. I have no illusions about public utilities, for most of their records are bad. But as an intermediate step, the one hope of the public utility concept is that a public service commission, theoretically, can hold accountable corporate operations.

What has generally happened is that they have been captive. The great exception in my lifetime was Leland Olds.

Senator GRAVEL. But even the good ones get captive.

Mr. ENGLER. Sometimes, not always. Take a case study of the life of Leland Olds——

Senator GRAVEL. But, I am dealing with individuals, not a biography. That is instructive. I do not want to minimize it, but because in fact you have brought some names that I am going to delve into for my own information, but let's take a case study in point where as a result of public policy it is in the interest of public utilities to expand their capital base. It is better for the public utility to turn around and increase the size of a capital base by building cryogenic tankers to carry liquefied gas from Algeria to this country, and that capital base must then be amortized by the people, the consumer.

Then the public body in question grants a price increase for that foreign gas, liquefied, with the attendant capital costs involved, which is treble what they will permit for domestic gas discoveries.

Now, that is not the private sector, that is the public sector forcing a skewness in the private sector, and the person who gets hurt is the consumer. So if you are truly going to go after the best price for the consumer, the best way to get it is to set up a system that has checks and balances.

Now, I am the first to agree with you that in the capitalist system, the first thing capitalists want to do is cut out competition. It is human nature. And that is the first thing that bureaucrats want to do, is cut out an informational process that operates as a discipline on them. Both are bad. Both propensities are bad, and they are built in to the human nature aspects of the system.

We have got to realize that. That is the point from which we build. We must put in disciplines and, of course, President Roosevelt did it with what he set into motion. Trust busting can have a certain value but it can also have a tremendous det'ment if you are killing bigness for bigness' sake.

And bigness can be a value. It can handle larger amounts of capital, marshall greater forces to do things, but also it can exercise power oppressively.

Mr. ENGLER. If you will recall sir, I asked that these things be looked at, and not necessarily by the partisans, but by some sort of a national commission for 2 years.

Senator GRAVEL. But that is what the bill has in here.

Mr. ENGLER. But I am talking about looking at specifically all the possible steps which might make for: (1) a sane energy policy; and (2) a responsible one.

And, to appraise, among other approaches, how antitrust has worked. It never has worked, by the way, and among the main reasons it has not worked is because it has always been captive. Its throat has been cut almost every time.

Senator GRAVEL. Well, should that not teach us then that if that does not work, that maybe we ought to think in different terms? Because if you go against human nature, if you go against some basic laws, either of economics or physical laws, or human laws, and they do not work, that is the time that one should smarten up and say well let us see if we cannot roll with the system rather than fight the system.

Mr. ENGLER. Senator Gravel, I am not arguing for antitrust, nor am I arguing as you seem to be that when the Antitrust Division constantly gets cut, that is human nature. It seems to me it is something quite different than human nature.

Senator GRAVEL. No; it is the culpability of the processes of power. It is the same thing as the point I made earlier that the first thing the capitalists want to do is cut out competition and one of the ways they do it is by exercising their will on government. It is done very easily through the contribution process of government. That is one of the reasons why I introduced legislation to have public financing.

Mr. ENGLER. I have spent about a month in Alaska and I pulled away thinking very hard about what was going on there. I did come away with one conclusion, among many, and that was that the Alaskans were probably one of the few people in the United States who had a good reason to be anti-Russian and anti big-government. They had been taken by the Russian fur trade way back. They had been taken by the American bureaucracy that ruled over the land. They had been taken by the American military. Along comes the oil industry and three cheers, it really looks like freedom and opportunity. I recognize that temptation for anyone with an Alaskan perspective. I am not saying that that shapes your thinking on this, but I do have that feeling that——

Senator GRAVEL. If it did not, something would be wrong with me.

Mr. ENGLER. Given the tremendous temptations that appear to be there, I can understand the feeling that you still want to describe this as a viable situation and as one of opportunity.

Senator GRAVEL. Not necessarily one of opportunity, but one of realizing that we are at a point in history, that we are going to move forward and are going to have change. I do not know entirely what that change will be, but I do know that the genius of our forefathers was in setting up a system of checks and balances.

And so, like you, I try to be critical, but at the same time, offer a system of checks and balances. And I think that this system, this bill, offers checks and balances, for the public sector and the private sector.

We create a Federal Energy Administration who will, incidentally, have the power to negotiate with foreign governments and foreign interests. I do not know what your solution would be to the criticism that you voice in here, but mine is in the bill.

Mr. ENGLER. That is a good point.

Senator GRAVEL. It is a beginning. We are still suffering the danger of co-opting because most of our experience is with the oil industry. It is like the atomic energy problems, and my criticism of them was because most of the expertise was in that area, we need to broaden the base.

Mr. ENGLER. Maybe the corruption comes, because I have tenure and you do not, Mr. Gravel.

[General laughter.]

Senator GRAVEL. That acts as an interesting discipline because sometimes it keeps my feet on the ground where I may have a tendency not to do that. But I made a note of another public organization in my State the last time I was up there. I asked the GAO to perform a study, and was horrified to find out that the Post Office, which is a public corporation, is, from all objective parameters, doing the worst job that it has ever been doing.

I do not know why, but it scares me when people then want to put things in the perspective of not enough discipline.

Mr. ENGLER. The three postal people in my life could not be finer and could not be more solicitous toward me. The postmistress where I live in Massachusetts looks after me as if I am her private domain. The two mailmen who deliver my mail when I live in New York, look after me most thoughtfully—if I hurt my leg, or if a letter is missing. When there is a scale where people can see one another, and people can know one another, something decent can happen.

I have no illusions about the giant postal system. I am looking at the human side of it.

Senator GRAVEL. But we are talking academically about the problems of human beings as they interact in the system, and as it structures itself.

I think I am getting pressed for time, unfortunately, and Doctor, I can say that it is loaded with things that are worthy of analysis and of deep consideration and I am most appreciative for your coming forward with your paper. I can assure you I am so appreciative that we are going to get together personally, because this is something that is going to take long hours.

But, in the meantime, so that you can get an edge up on me as I will try to get an edge up on you by pursuing your book, I would like to present you with a copy of a book that I had published. It covers some of the systems of checks and balances that do not exist in the present system and we hope we will develop. I would like to present system and we hope we will develop. I would like to present this to you and promise we will make contact in the future in the more private arena to discuss these philosophical questions. I think it has been very valuable to the educational processes of these particular hearings.

Mr. ENGLER. Thank you for your graciousness and your generosity.
Senator GRAVEL. Thank you, sir.
Our next witness is Professor Dale Jorgenson of the Department of Economics, Harvard University.

STATEMENT OF PROF. DALE JORGENSON, DEPARTMENT OF ECONOMICS, HARVARD UNIVERSITY

Senator GRAVEL. Doctor, because of the press of time, I believe you have an abbreviated statement?
Mr. JORGENSON. Yes; that is right.
Senator GRAVEL. Fine. You do not have copies of the abbreviated statement?
Mr. JORGENSON. They are right at the beginning of the longer statement. Look at the handout, you will see that there is a summary here which I will now proceed to read.
Self-sufficiency in primary energy sources is the main objective of long-term U.S. energy policy. This objective provides the rationale for project independence, a program announced by the Nixon administration for achieving self-sufficiency by 1980. Self-sufficiency by 1985 is the stated objective of the S. 2806, The Energy Revenue and Development Act of 1973, introduced by Senator Mike Gravel and the subject of these hearings.
The purpose of this report and this testimony is to analyze the feasibility of alternative approaches to achieving self-sufficiency. The first is a Btu tax on all forms of energy, as proposed by Senator Gravel is S. 2806. The second is an excise tax on all forms of energy. An excise tax would be levied as a certain percentage of the value of each transaction in energy. Using an excise tax, more valuable energy sources would be taxed more heavily.
Our main conclusion is that self-sufficiency can be attained by either a uniform Btu tax or a uniform excise tax. Under a Btu tax, total energy demand could be cut back by 9.7 percent in 1975, 17.4 percent in 1980, and 27.2 percent in 1985. Imports would be reduced to 5.7 percent of total demand in 1975, 7 percent in 1980, and 2 percent in 1985. These import reductions are well within the range required for effective independence of foreign sources of supply.
A uniform Btu tax can be used to achieve self-sufficiency in energy. However, the required tax rates would result in very substantial increases in energy prices. The impact on prices would be the most substantial for natural gas, and the least for electricity. Prices of natural gas would rise 21.4 percent by 1975, 43.4 percent by 1980, and 80.2 percent by 1985, all relative to prices that would prevail in the absence of the Btu tax. The corresponding increases in electricity prices would be 4.5 percent in 1975, 10.4 percent in 1980, and 21.8 percent in 1985.
Senator GRAVEL. Doctor, what you have done is taken the bill as we have it, and made an extension of those figures into a model?
Mr. JORGENSON. That is right.
Senator GRAVEL. I wonder if you could just describe for us what you have done?
Mr. JORGENSON. I would be glad to. Let me just finish this last paragraph and then I would be glad to answer the question.

The two tax programs we have analyzed are only two among many possible fiscal programs for dealing with the energy crisis. For example, the Nixon administration has proposed an excise tax on domestic production of crude petroleum under the guise of an "excess profits" tax.

Alternative proposals would increase taxes on gasoline sold to consumers or institute taxes on automobiles based on gasoline mileage. Our methodology is adapted easily to the analysis of these and similar proposals. Our main objective today is to illustrate the potential that exists for quantitative analysis of concrete energy policy proposals.

Let me proceed, then, to describe very briefly the methodology that we have used in order to make these calculations. And I will start by summarizing, not reading, the material beginning on page 2 of the handout.

The basic instrument that we used to make these calculations is an econometric model that has been developed by a firm for which I am a consultant, Data Resources, Inc., of Lexington, Mass. This new model is called the data resources energy model, and was constructed for the specific purpose of analyzing the impact of changes in energy policy.

The DRI energy model consists of two basic components. The first is a long-term growth model for the United States that is used to establish the development of productive potential and prices in the United States over a long-term horizon. We have used this long-term model to make judgments up to the year 2000, predicated on historical data about past growth trends and projections in the future of trends that appear to be likely to continue.

The second component of the DRI energy model is an interindustry model that has nine separate industrial sectors. The impacts of energy policies can be assessed in terms of a sectoral breakdown of the American economy that includes agriculture, manufacturing, transportation, trades and services, and five separate subsectors of the energy sector; namely, coal, crude petroleum and natural gas, refined petroleum, electricity, and gas utilities.

We have used the long-term growth model and the interindustry model to simulate the impact of changes in energy policy. First, we project the future course of the American economy, including the development of the energy sectors that I mentioned, to the year 2000 in 5-year intervals, in such a way that the projections coincide with the official projections with the Department of the Interior, prepared by Dupree and West. These projections were used in the revenue projections that were used by Senator Gravel in introducing Senate bill 2806.

The energy projections made by the Department of the Interior, are based on the energy balance approach. This approach says that energy demand and energy supply must balance. Our approach incorporates that same type of constraint as the energy balance approach, but we also attempt to assess the impact of energy policies not only in terms of quantitative magnitudes, Btu's, barrels, tons, cubic feet, and so on, but we also attempt to assess the effect of energy policies on energy prices.

Our own approach is based on supply and demand analysis. Given any proposed energy policy, supply and demand must be equal to each other and they must be consistent with the ruling energy prices.

The distinctive feature, of our approach relative to conventional energy balance projections, is that we consider both quantities, physical flows of energy, and energy prices.

To use our methodology to assess the impact of any given change in energy policy, we start with base projections that are consistent with projections of the Department of Interior. We then prepare an alternative set of projections based on the change in policy. We assess the impact of the change in policy on both the prices and quantities of all the goods and services in the economy, as well as all the different types of energy that I mentioned previously—coal, oil, gas, and electricity.

The second section of my prepared testimony, beginning on page 4, applies our methodology to the Btu tax proposed in the Senate bill.

Using the DRI energy model, of course it is possible for us to take into account the repercussions on levels of activity in the economy and any given change in the policy. This is illustrated in table 1. In table 1 we start with a base case projection of energy developments in the United States for 1975, 1980, and 1985. All energy flows are measured in quadrillions of Btu's and that the total U.S. energy demand in the absence of any kind of changing energy policy will be, roughly speaking, 80 quadrillion Btu's. That includes coal, petroleum, electricity, and gas.

If we impose a Btu tax of 4.5 cents per million Btu's for 1975, well we can see, first, that there is a sizable reduction in the total demand for energy, 3 or 4 percent. The impact of this reduction differs rather substantially from energy source to energy source. The most dramatic impact is on gas; electricity is hardly affected at all. Refined petroleum and coal are affected too.

Senator Gravel. Doctor, in your model, when you say electricity, you took, let's say, hydropower and cranked in the Btu tax?

Mr. Jorgenson. Yes.

Senator Gravel. Very good. This is fabulous.

Mr. Jorgenson. From these calculations it is clear that the Btu tax, viewed as an instrument of energy policy for the purpose of obtaining self-sufficiency, is not sufficient in itself. Now, of course that is not the objective of the bill. The objective of the bill is to finance the energy development fund which will then finance R. & D. and other kinds of investment. But now we ask ourselves the following questions:

Suppose that instead of looking to changes in R. & D. or changes in incentives to explore and develop for more energy resources, we simply rely on taxation to cut back demand, what precisely would be required in order to achieve independence of foreign sources of supply? In other words, suppose we wanted to use fiscal policy to solve the energy crisis, and to achieve independence? The results of our calculations on that subject are given in table 2, where we show the impact of various Btu taxes on U.S. energy demand.

Again, we have done these calculations for each of the years that we want to refer to here, 1975, 1980, and 1985, and we have considered various tax rates. As a point of reference, in 1975, the proposed Btu tax rate is 4.2 cents per million Btu's.

The first column of table 2 gives the base case. As you can see by reading across the first row of table 2 the tax rate is zero. The second column is headed by a tax rate of \$0.0575, or 5¾ cents per million

Btu's; that is just a little higher than the tax rate proposed in the bill for 1975. We also considered higher tax rates of 7.7 cents; 11.9 cents; and 19 cents. And what you can see is that these higher taxes have a very strong effect on demand, even as early as 1975. In fact, we find that the reduction in total demand from the base case for the smallest tax we considered, 5¾ cents, would be about 4.9 percent; that is in the third row of our table, in the second column.

On the other hand, if we are willing to tolerate a 19-cent tax rate, you would find that it would be possible even by 1975, to reduce total demand for the base case by about 15 percent which would reduce imports relative to the base case by 75 percent. So that imports would be reduced from roughly 20 percent of total demand in the absence of the tax, to about 5.7 percent. Of course, high tax rate will produce large amounts of revenue. As you can see, the largest tax for 1975, 19 cents per million Btu, would result in $13 billion revenue in that year, which is much more than the revenue requirements stipulated in the Senate bill 2806.

The 1980 and 1985 figures differ only in the quantitative magnitude. The methodology is the same. The point, that by 1985 it is easy to design a tax program that will get the ratio of imports to total demand down to 2 percent of the total. This would generate an enormous amount of tax revenue that could be used for financing R. & D.

Senator GRAVEL. Doctor, have you looked into the inflationary aspects of what this would do?

Mr. JORGENSON. Yes; we certainly have.

What we are assuming here is that any revenues generated by an excise tax of this sort, would be converted into general revenues and used as a basis for tax reduction in the personal and corporate income tax, so the inflationary impact would be minimized.

The impact on the individual taxpayer depends on precisely which taxes are reduced by the excise. In any case, all of these results are summarized, in table 3, you will see a program of Btu taxes that will result in primary energy independence by 1985, or for a higher schedule of taxes by 1980. There is no problem of using a Btu tax system to achieve independence. It is perfectly feasible and is easy to see how to implement such a system.

Senator GRAVEL. Would you care to comment on the equity involved, of a Btu tax as opposed to other taxes that are presently in public dialog?

Mr. JORGENSON. Well, I would say only that a Btu tax would have substantial impact on energy prices, and that those energy prices that directly affect the public, say gasoline prices, or the prices of home heating fuel, would be felt most severely by those taxpayers who are least able to pay. This suggests the possibility of using the proceeds of such a tax, in part at least, to reduce the income tax for those households or, possibly, to increase transfer programs that would benefit households that have relatively low incomes. One use that one might make of some of the revenue would be to compensate those people who are going to have to pay more for their gasoline or more for their home heating fuel. There is another aspect of it I would like to comment on and that is the efficiency aspect.

Senator GRAVEL. Doctor, before going into the efficiency aspect—because I want to hear that aspect too—but I just want to arrive at one conclusion here. And that is, it is true it can generate large sums of money, it can move into other fields, but the question that I asked was about equity.

It would be a more equitable system of taxation than other methods of taxation?

Mr. JORGENSON. Well, what do you have in mind? What would you conceive as an alternative way to finance this?

Senator GRAVEL. Well, a general fund that could rely upon the income tax, which is on a graduated basis, and that is a very modern and proper method of taxation, it takes care of both the little person and the big person as best it can.

But if we are looking at methods of raising money to address ourselves to an energy problem, and not to make transfer payments from other areas because if that is the case then we will have the General Treasury do that.

Mr. JORGENSON. Right.

Senator GRAVEL. That is the argument. That as soon as we move into that area, we are going to start making transfer payments, and the Treasury Department will come down and say why set up a trust fund, we already have the general fund of this country, we have got the Congress that appropriates from it.

Mr. JORGENSON. That is very true, and I think that the way to make that argument would be the following. The revenue demands for the energy trust fund would be much less substantial than the kinds of revenue that are generated by any tax that would, by itself, achieve independence. The tax revenue, as you can see by the end of the period in 1985 from table 2, would be of the order and magnitude to say the revenue generated by the Social Security program, $55 billion; that is a very large sum. The requirements for the energy development fund in that year might be something on the order of magnitude of $5 billion; the rest of it, could be transferred to general funds for the use as part of a program of transfer payments, or for use to reduce the burden of the income tax.

Senator GRAVEL. But the reason you do that is because of self-sufficiency?

Mr. JORGENSON. Right.

Senator GRAVEL. I see.

Mr. JORGENSON. In other words, if the objective is self-sufficiency, and I think that is something we should scrutinize very carefully, then you can achieve this objective by means of a tax system.

The problem of levying this tax system in an equitable way involves a consideration of the tax system in the context of all the other taxes now levied in the American economy. One would have to design a total program which would achieve both the objective of independence and whatever objectives we have for assuring the overall tax system is equitable.

Let us proceed then to see what the impact would be in somewhat more detail. As I say, the basic conclusion that you should draw from table 3, is that it is feasible to achieve independence by fiscal policy alone. That, of course, is something that is not one of the objectives of the bill S. 2806, but the tax could certainly be used, or other taxes could be used, for that purpose. Now how does that affect the energy flows for the U.S. economy? What we see in table 5, is the impact of Btu taxes on energy use.

We have converted energy flows into trillions of Btus simply to make the amounts more manageable; as you can see, some of the entries in this table for the years 1975, 1980, and 1985 are relatively small. For example, the amount of final consumption, which means personal consumption expenditures on coal is very, very small. Most people, by now, have converted to the use of home heating fuel or gas, and in some cases, even electricity for home heating purposes. The amount of coal that is used for that purpose used to be fairly substantial, but is now relatively small.

We have broken up the flows of energy into two categories. Final consumption means consumption by consumers, that is, households or the Government or exports. The only item here which is exported in any quantity is coal. We have made a separate calculation for intermediate use. What does intermediate use mean? It means the use of energy by other producing sectors, such as the energy sectors themselves, or manufacturing, agriculture, and the other sectors that I mentioned earlier.

We have given, corresponding to the tax rate of zero, a projection of what energy flows would be in the absence of any kind of Btu tax; that is a starting point for any analysis of the impact of the Btu tax. We then see what happens as you step up the tax rate in any particular year; in 1975, the first step would be to say 5¾ cents per million Btu. You are, of course, going to have substantial impact on the flow of energy, but that impact is going to differ substantially for different energy sources. Whereas the total will be reduced by 4 or 5 percent, there is a differential impact on final consumption versus immediate use. And you can see from this table there is a much larger impact on final consumption.

The first column in each of our tax calculations is the base case. In table 6, page 14, we are measuring the change in the use of Btu's for each fuel source, by final consumption and intermediate use, that corresponds to the change in the tax. Again, the story here is very clear. The largest proportional change is on the final use of natural gas. This is going to give people an incentive to use less gas, to turn their thermostats down and to substitute other kinds of energy such as electricity and coal for natural gas.

That is going to be even more dramatic if we have a higher rate of tax. If we boost the tax up to 12 cents per million Btu in 1975, there will be an 18-percent reduction in the final consumption use of natural gas; a lesser reduction in the intermediate use, which means that there will be less impact on the use of natural gas for generating electricity or for electricity or for industrial raw materials. As you can see from these percentage figures, I could spell out for you all of the implications of a change in the Btu tax as given for each of these years in terms of a percentage impact, both on final consumption and ~~their~~ intermediate use.

We have not yet come to the impact on prices; many consumers are going to be very much exercised and very much concerned about this. We have calculated these impacts in table 8. Again, the basic methodology is the same; we have zero as a base case. We first change the tax rate to 5¾ cents per million Btu. What will be the impact on prices of all the goods that enter into the American economy? For agriculture, the impact is going to be relatively small in 1975, about 0.3 on a base of 100, that is about three tenths of a percent in terms of percentage impact on price levels. The same will be true of manufacturing and transport. There will be an imperceptible impact on cost of services in the United States.

The picture is dramatically changed when we look at the impact of the Btu tax on the prices of energy. Coal will go up by 4.3 percent; crude petroleum by the same; refined petroleum by 6.3 points; electricity by 2.2; and gas by 10.1; and consumer prices as a whole which includes both energy and nonenergy, will be up by 0.4 percentage points.

Senator GRAVEL. Could we rephrase that? With the tax in 1975 as projected here of 5 cents per Btu, we are talking about a 4-point increase in the cost of living as it relates to this?

Mr. JORGENSON. Right. So that would be exactly what we think of as four-tenths of 1 percent increase in the cost of living. The way the cost of living is usually reported is tenths of percentage points per year.

Senator GRAVEL. So this would be on a yearly basis?

Mr. JORGENSEN. This is on a yearly basis, and it says that it would be the equivalent of about a 4-point increase in the cost of living between now and 1975.

Senator GRAVEL. You have heard the charges that energy price rises last year really made a big contribution to the inflationary problems we faced in the cost of living. Your table 8 sort of belies that.

Mr. JORGENSEN. Well I think that you have to keep in mind the magnitudes that are involved. If you think of the impact of recent changes in energy prices, they are really quite a bit more substantial than the 4.5- and 10-percent rises that are given here. Some energy prices have doubled. Gasoline at the pump, for example, has gone up by I suppose 20 to 30 percent depending upon the region of the country or whether you are dealing with domestic or foreign refined products. There has been a more sizable impact of these increases in prices than the increases that would result from this Btu tax.

Senator GRAVEL. Excuse me for interrupting. You have got so much meat here it is difficult to grasp it all. Can your model do that for us?

Can it tell us exactly, take this last year? Would you do that for the record?

Mr. JORGENSEN. I would be happy to do that at some time in the future. Let me just make a note of that.

Senator GRAVEL. Let me add to that request—find out what the impact, the true impact, on the cost of living was this last year in the price raises that we have experienced in all of the areas of industry.

Mr. JORGENSEN. I would be glad to do that.

Senator GRAVEL. Let me ask you, have you related price and profitability within the industry? The various energy industries?

Mr. JORGENSEN. Not in any direct way, no.

Senator GRAVEL. Could you do that?

Mr. JORGENSEN. I would say that that is a much more substantial effort than looking at the impact of energy prices on the cost of living index. It is really about as substantial a task as say preparing this testimony.

Senator GRAVEL. Well, let me just put the request to you this way, because obviously we are placed in a position of almost begging for information. But when we get this quality of information, I think it is worth begging for. The information on profitability related to prices is probably the most substantive element of dialog, intelligent dialog, to take place in the country today. There is so much misunderstanding as to what the profits are, or represent, and to not have this translated into what it means in price, and translated into what it means in inflation, I think leaves us naked to pursue unintelligent dialog.

And let me just suggest, most respectfully, that a democracy functions well when it has knowledge and information.

Mr. JORGENSEN. Well, I will certainly try to comply with that request. As I say, that is a substantial task, and it will take a while. But I think those numbers can be produced.

Senator GRAVEL. Thank you.

Mr. JORGENSEN. Let us proceed, then, to look at the total impact in a summary fashion. What I have done in table 9 is to look at a very, very large tax rate. This is a tax rate that would, in fact, make the United States into a net exporter of energy. This is larger than any of the taxes that I have considered. It is $1 per million Btu's. I have included this to highlight the impact on prices and output in order to summarize the information I have presented in these earlier tables.

What you can see in the last row in table 9 is that the overall impact on prices of even such a tax as this would be about 6 percent. In other words, prices as a whole, delivered to final buyers and so on, would go up about 6 points relative to what they otherwise would have been in 1985 in the absence of a tax. That is a very large tax as you can see. It is about 20 times the highest tax which is proposed in the Senate bill, so it is a very, very substantial tax.

Now what does this do to the prices? Well, as you can see, it has almost no impact on the prices of trade and services. It has about a 5-percent impact on price of transportation, about a 4-percent impact on manufacturing and 4.3 percent on agriculture. And, as you can see, a very dramatic impact indeed on energy prices, which again follow the basic pattern that the Btu tax exhibits throughout these calculations, namely, the largest impact is on gas and the smallest is on electricity.

Now you can see the corresponding influence on levels of output, namely, because these industries have output levels that are sensitive to prices as consumers make their decisions, you can see that the sectors for which price increases are the greatest experience the largest production in output, but the overall reduction in output of such a tax which is, if you like the efficiency cost of using a tax like this, would be about 3.2 percent, which translated into billions of dollars, would be about $30 billion. Electricity would grow about half as fast as it would otherwise. Refined petroleum would grow 60 percent slower; and so on and so on. You can read those figures for yourself in table 9. The purpose of that table is simply to calculate the percentage impact on prices and output of a large Btu tax in 1985, namely, $1 per million Btu. This information is presented in somewhat more detail in table 10, page 21.

That is the effect of one fiscal program. As I have said earlier, the model that we have constructed is unique in the sense that it enables us to calculate the impact of energy policy on the flows of all kinds of energy in the American economy, and other goods too; we are also able to make projections of the impact of different kinds of fiscal programs on the prices. There is no other mechanism that I know of for making realistic long term projections combining both demand and supply and both quantitative impacts in terms of energy flows and and price impacts of the type that I have analyzed.

To illustrate the flexibility of the approach, I have looked at the impact of a different fiscal program. Again, this may be of interest to the members of the Senate Committee on Finance, which has jurisdiction on all tax programs. The calculations that I have done here are for a uniform energy sales tax. The uniform energy sales tax is like a Btu tax. Instead of having the tax levied on the number of Btu's, it will be levied on the dollar amount of the energy source that is used. A sales tax, which is levied on the number of dollars, is going to be very different in its impact from a Btu tax, which is levied on the number of Btu's. The number of dollars per million Btu, if you want to translate that into these units we have been using, gives us an average cost of 36 cents for coal; 74 cents for gas; $1.23 for petroleum ; and $5 for electricity, all in 1971.

In table 11, I have calculated out the effect of various energy sales taxes using exactly the same methodology. We start with a base case projection that agrees with the Department of Interior projections. We then look at alternative projections of the repercussions of the tax. A 10-percent excise tax on energy in 1975 reduces energy demand in the U.S. economy by 12.8 percent. A 20-percent tax gives you a 23-percent reduction. And a 30-percent tax gives you a 31-percent reduction.

A good rule of thumb here is that the difference from the base case is roughly 1 percentage point per percentage point of the tax. In other words, if you have a 10-percent tax, you are going to get, roughly, a 10-percent reduction in energy use.

What happens to imports when we impose a sales tax of 10 percent? In 1975, the imports are reduced by the dramatic magnitude of 65.8 percent. In 1980, that figure would be 54.5 percent. In 1985, 43.6 percent. You can see that this tax is very powerful fiscal medicine indeed. It would be a simple matter, at least from the point of view of feasibility, to achieve self-sufficiency by 1980 by simply imposing a 20-percent excise tax on all forms of energy in the economy. That would reduce the base case projections of energy use by 23 percent, which would enable us to eliminate imports. As you can see, that would reduce imports by 98.8 percent, so that imports and total U.S. demand, would be 0.4 percent of the total.

The self-sufficiency by 1980 program produces revenues of $50 billion. By 1985, this figure jumps to $105 billion. The policy of Project Independence by fiscal means alone would fund a very substantial part of general revenues for the Federal Government through the proceeds of such a tax. The point is, that it is feasible to achieve independence, not that this is a desirable kind of tax.

To summarize this information, I have given in table 12 on page 25, Project Independence by 1985, an excise tax schedule increasing from 2 percent per year, beginning in 1975, to a level of 30 percent in 1985. You can summarize this information just the way I did for the Btu tax, in terms of the impact on specific fuels. I have done that in table 14, where we give the percentages impacts of the different tax rates that were given in the preceding table for each of the years 1975, 1980, and 1985.

The moral of this story is extremely plain, and that is, relative to a Btu tax, an excise tax will produce roughly proportional decreases in the use of all forms of energy. When we looked at our preceding figures, we noticed that natural gas was reduced very substantially, whereas electricity was reduced much less substantially, and petroleum and coal were in between. We can see that an excise tax is more or less uniform in its impact on demand for all of the different energy sources. That is the basic conclusion that I think one can draw from table 14.

Now, to summarize some of the information I gave before for a Btu tax, table 15——

Senator GRAVEL. Doctor, why is that?

Is it because gas is more efficient?

Mr. JORGENSEN. Yes, you see a Btu tax on electricity, for example, is relatively miniscule as a percentage of the price of electricity.

Senator GRAVEL. So in point of fact, if we pursue this approach, then we will be apportioning our resources as they should be; that is, the best fuel should be the most expensive fuel, and you come down from there?

Mr. JORGENSEN. That is one conclusion I think you can draw from these figures.

Let me just summarize the material on table 15, which just repeats the calculation that I did before for the Btu tax. It shows the impact on prices of each form of energy for 1985, for different taxes. You can see the impact on prices of the nonenergy commodities and it is again not substantial. The impact on energy prices is more or less proportionate to the tax, although it exceeds the increase of the tax simply because these taxes tend to pyramid.

If the oil industry uses oil in its own production processes, which it does to some degree, then it has to pay the tax on that oil as part of its cost of production. Pyramiding of these effects results in this somewhat larger increase in the prices of energy than in the tax rate itself. The impact on prices is less substantial for electricity and natural gas than for refined products where there is more of this pyramid effect. In any case, the overall effect on the consumer price level of a 10-percent excise for 1985 on all forms of energy is just 1.2 percent. The impact on GNP would be about 1.3 percent. And again the impacts on output are distributed more or less proportionately among the different forms of energy. That, then, summarizes my testimony, and I will be happy to pursue any other points that you would like to explore and anything else you would like to discuss.

Senator GRAVEL. Doctor, let me just make note of the fact that the chairman of the full Finance Committee has joined us, and I am very happy to see him here.

This is a most unusual paper, Doctor. I can see why you received an award as the most promising young economist.

Mr. JORGENSON. The promising young economist under the age of 40—at the time I received the award I was 39 years of age, and 6 months——

Senator GRAVEL. Well, we all have to cross the bar at one time or another. It has different impacts. It has not dulled the impact; it has not dulled your abilities at all.

I have no further questions because I think I rudely interrupted you for the points I wanted to get across, so let me just thank you for this paper, and thank you in advance for the other paper that you will provide us which will make a contribution to the private sector of the bill. You addressed yourself only to the public sector of the bill here, and the private sector can be most promising in dealing with the energy crisis.

So the table, put together with the imagination you have shown here, Doctor, on profitability and price, and broken down within industries and cognizant of the inflationary factor, could arm us in the Congress to do better policy for all the people of this country.

Mr. JORGENSON. Well, let me respond to that. Let me say that it is also possible to calculate out some of the effects of other tax provisions of the bill, or other bills, related to this problem, such as the proposed tax credits which you have suggested would be dealt with, and so on. So it is possible to use this same basic approach, and I would be happy to cooperate with your staff or with you in trying to formulate this.

Senator GRAVEL. Well, Mr. Best will be in contact with you, but let me just say that financing through the public sector is a small part of it. Financing through the private sector is where most of the chunk came.

Senator Long, would you like to pursue any questions?

The CHAIRMAN. Well, I would like to ask one. We have a proposal that we are confronted with at this moment to suggest that we should pass a renegotiation law to require companies to give back 100 percent of any profits that they make over a base period of 1967 to 1971, which, for most of them, was a depressed period.

Now, that would work out the same as 100 percent tax. I am advised that by many people that they do not think it would be constitutional. But assuming that the courts would uphold it, can you advise me how the average producer who would be affected by that type of a 100-percent tax, or 100-percent refund requirement, would be likely to react?

Mr. JORGENSON. Well, it is going to put a lot of them in serious financial trouble. What this would amount to is the following.

Suppose that each of these people had run up some debt, and now somebody came along and said, well we are just going to increase the amount of the payments that you have to make. And that will just have to enter into your financial structure along with the other things that are there, the equity and so on, you will have to pay it all.

Essentially what would happen is that these people would then have to find the means to do that. They will have to borrow from banks; they will have to issue debt, and so on.

It will simply increase the debt structure in the industry and make it harder for them to raise capital. Now of course it would wipe some of the smaller people out. This is the kind of transaction that a large company could arrange, with difficulty, but it is possible. The small producers, of course, are really going to have to have their backs to the wall since credit is not going to be so readily available to them.

The CHAIRMAN. It would seem to me that if I were a producer, and looked at the base period and saw where I made about $20,000 a year during that period and had one well and meanwhile I had opened a second well, or drilled a second well because I could get a better price and have a chance to make more money, I would just close down that second well since I could not make a penny off of it anyway. If I could not keep one penny of profit, it would seem to me I would just close down this second well so I can keep what I make.

Some people in our part of the country, big landowners, big rice farms or a lot of acreage planted in sugarcane, with maybe some large land behind it, I think they will just say well—especially if I was one of those who had 100 percent of the oil beneath his own property—I would just say well it will be worth just as much later on, maybe more, and since you will not let me keep 1 penny of what I produce, I will just produce the amount that the Government will let me keep and I will just shut it down thereafter.

And I have had people tell me that that is going to give you a lot less oil, and I wondered if you tend to agree with that?

Mr. JORGENSON. There is no question about it. It is going to result in less production of oil and especially in Louisiana, less production of natural gas.

The CHAIRMAN. Because most business people are in the business to make a profit. If you are going to take 100 percent of it away from them, I would think that they would say that they will make what the Government will let them make and beyond that they will close down.

There was a fellow over there in Texas, I am told, who had a lot of pipe which was needed to drill wells last year. And under the price control laws, he had made all the profit margin he was permitted to make. He asked for an exception so he could go ahead and sell more pipe but they would not give it to him. So he simply announced that unfortunately his circumstance was such that it would not be wise to sell any more pipe. He had enough pipe there to drill 300 wells. But he did not make any more sales for the remainder of the year.

So during that time, you could have had 300 more wells drilled.

Mr. JORGENSON. Well during this last period of price controls, I think we have seen a dramatic illustration of the supply responsiveness to price, which is what you are talking about here in terms of the fact that right now 29 percent of the production of crude petroleum in the continental United States is coming from wells not covered by price controls.

The CHAIRMAN. You say 29 percent? Would you mind repeating that? I was not aware of that figure.

Mr. JORGENSON. Twenty-nine percent of crude petroleum produced domestically in the United States right now is being produced from wells that are not subject to price controls. Which means that we are talking about strippers and wells that have been brought in or brought back in since the increase in petroleum prices. It is clear that there is enormous scope in the United States not only for exploration and development, but for further exploitation. The price impact on the supply side is just as dramatic as the price impacts that I have concentrated on in this testimony on the demand side; there is no question about it.

The CHAIRMAN. Well, I do not know as much about economics, as you do, but I did take a few courses in that area when I was in college and majored in it when I was in the arts and science part of my education. But I do know how just an ordinary person in the oil business goes about deciding to shut his business down.

I know in my family we would go out and drill a little well, it would cost $15,000 back in those days. And you would produce some oil from it. But the oil production would start diminishing after a while. There would be good production in the beginning but as you pulled the well for a while, it would begin to produce less and less. And then you would have to rework it, to clean out the paraffin and try to open up the sand a little bit so that the oil that was further away from the hole would find its way into the pipe. And maybe you would spend $3,000 reworking the well.

Well, when you got the point to where you had taken out $2,500 worth of oil since the last time you reworked, and let us say the price of reworking it was $3,000, you would conclude that if you tried to rework that well, you would never get back out of it what it would cost to clean out the well and rework it to improve its efficiency.

And, under those circumstances, you would probably be better advised to cap the thing over or pour concrete in the pipe and forget about it.

Now, when the price goes back up, as it has now, so that instead of getting $3 per barrel for oil, somebody gets maybe even $10 per barrel. A fellow takes out his pencil and paper and starts figuring. Well, let me see, if I open that well back up, 3 barrels a day, that would be $30, that is $900 in a month, maybe I could make some money out of that.

So the fellow goes out and he puts a little rig on top of it and begins to work on that well again to see if he can get some more oil out of it.

Now it is just a pure question of whether a fellow can make a profit, and whether it is justified because he can go out and open up some old wells and drill only marginal wells. But I am convinced that most people are not going to want to be accused of being price gougers.

But they cannot keep anything. They cannot keep 1 more cent out of what they have drilled new wells, or opening up old wells because they could not make a profit on them, but under the lower price, those people would just cut back on production.

Now, they can also run up expenses and escape the excess profits or renegotiation aspects of it that way. You have some familiarity with how that is going, too, do you not?

Mr. JORGENSON. Yes, indeed.

The same calculations can be made on the demand side. There is a lot of talk these days about the great patriotic effort that Americans are making to follow the President's initiatives by turning down the thermostat and that sort of thing. My feeling is that that should be regarded as admirable, but there are many people, and I would think that they are more numerous among American consumers, who have taken similar steps on grounds that it does not pay to have your thermostat at 75 when the expense is three times what it was last year. It is possible to save substantial amounts, as we have all learned, by taking fewer trips, by keeping the thermostat down and so on and so on. My feeling is that the point that you are making about the responsiveness of the producers to price can be said equally well about the responsiveness of consumers.

That leads me to conclude—is that any approach to assessing the impact of fiscal programs—and there are going to be hundreds of fiscal programs that will be discussed before your committee—it is essential to take into account the impact of prices as well as new kinds of technology. The price responsiveness on the supply side, the price responsiveness on the demand side, the fact that the two must balance in the marketplace is something that cannot be ignored in analyzing the impact of fiscal programs. The purpose of my testimony this morning is to drive home that simple point, using as a means of illustration the Btu tax in which Senator Gravel has introduced. The same basic methodology could be applied to any other kind of program.

It would be somewhat problematical, as I was suggesting to Senator Gravel earlier, to look at this question of profitability and its responsiveness to price, but that could be done, and it is obviously well worth doing.

The CHAIRMAN. Thank you very much, Doctor. You have submitted a very fine statement here today.

Senator GRAVEL. Mr. Chairman, I imposed and asked him to provide us with a product of this model on profitability and price and production so that we would have that, because I think it is the central point in the misunderstanding in the country today.

Doctor, thank you very much.

[Mr. Jorgenson and Mr. Edward Hudson's prepared statement follows:]

SUMMARY

TAX POLICY AND ENERGY USE

(By Edward A. Hudson and Dale W. Jorgenson, Data Resources, Inc., Lexington, Mass.)

Self-sufficiency in primary energy sources is the main objective of long-term U.S. energy policy. This objective provides the rationale for Project Interdependence, a program announced by the Nixon administration for achieving self-sufficiency by 1980. Self-sufficiency by 1985 is the stated objective of the S. 2806, The Energy Revenue and Development Act of 1973, introduced by Senator Mike Gravel and the subject of these hearings.

The purpose of this report is to analyze the feasibility of achieving self-sufficiency by 1980 or 1985 by means of tax policy. We consider two possible approaches to achieving self-sufficiency. The first is a Btu tax on all forms of energy, as proposed by Senator Gravel is S. 2806. The second is an excise tax on all forms of energy. An excise tax would be levied as a certain percentage of the value of each transaction in energy. Using an excise tax, more valuable energy sources would be taxed more heavily.

Our main conclusion is that self-sufficiency can be attained by either a uniform Btu tax or a uniform excise tax. Under a Btu tax total energy demand could be cut back by 9.7 percent in 1975, 17.4 percent in 1980, and 27.2 percent in 1985. Imports would be reduced to 5.7 percent of total demand in 1975, 7.0 percent in 1980, and 2.0 percent in 1985. These import reductions are well within the range required for effective independence of foreign sources of supply.

A uniform Btu tax can be used to achieve self-sufficiency in energy. However, the required tax rates would result in very substantial increases in energy prices. The impact on prices would be most substantial for natural gas and least for electricity. Prices of natural gas would rise 21.4 percent by 1975, 43.4 percent by 1980, and 80.2 percent by 1985, all relative to prices that would prevail in the absence of the Btu tax. The corresponding increases in electricity prices would be 4.5 percent in 1975, 10.4 percent in 1980, and 21.8 percent in 1985.

The two tax programs we have analyzed are only two among many possible fiscal programs for dealing with the energy crisis. For example, the Nixon administration has proposed an excise tax on domestic production of crude petroleum under the guise of an "excess profits" tax. Alternative proposals would increase taxes on gasoline sold to consumers or institute taxes on automobiles based on gasoline mileage. Our methodology is adapted easily to the analysis of these and similar proposals. Our main objective today is to illustrate the potential that exists for quantitative analysis of energy policy.

1. INTRODUCTION

Our analysis of tax policy and energy use is based on a new econometric model of the U.S. economy, the Data Resources Incorporated (DRI) Energy Model, formulated for the specific purpose of analyzing the repercussions of changes in energy policy. The most important innovation in methodology embodied in the DRI Energy Model is the integration of demand and supply determinants of energy use within the same framework. This innovation makes possible, for the first time, a logically consistent analysis of the effects of energy policy on patterns of energy utilization and the structure of energy prices.

The first component of the DRI Energy Model is the DRI Long-Term Growth Model, which relates the pattern of U.S. economic growth to demand and supply for energy. Given projected levels of consumption, investment, and government activity in the U.S. economy and projections of the prices of durable goods, nondurable goods, capital services, and labor services, the DRI Energy Model determines the demand and supply for agricultural, manufacturing, transportation, and trade and service sectors of the U.S. economy. The Model also determines demand and supply for five sub-sectors of the energy sector: coal, crude petroleum and natural gas, refined petroleum, electricity, and gas utilities.

The first step in applying the DRI Energy Model to the analysis of energy policy is to project the development of energy demand and supply in the absence of policy changes. We have used historical data for the period 1947–1972 to estimate the parameters of the Model. We have calibrated projections of energy demand and supply for the period 1975–1985 so that they coincide with official projections of the U.S. Department of the Interior, as prepared by Dupree and West. These projections are used in revenue estimates for the proposed Btu tax, as presented by Senator Gravel in the Congressional Record for December 13, 1973, Table 6, page S22729.

The second step in our analysis is to prepare an alternative set of projections corresponding to a given energy policy. For example, in assessing the impact of the Btu tax, we impose a uniform rate of tax per Btu for each type of energy used in the U.S. economy. We than calculate the impact of the tax on prices of energy, energy demand by each consuming sector, and energy supply. We take into account the repercussions of changes in energy prices on the demand and supply for the products of non-energy sectors—agriculture, manufacturing, transportation, and trade and services.

Our final step is to compare the projected course of the U.S. economy in the absence of a change in energy policy with the course of development resulting from the change. In general, the imposition of a Btu tax results in higher energy prices and lower energy utilization. However, the impact of the tax varies considerably from one energy source to another. Our methodology makes it possible to assess the effects of the tax on aggregate energy utilization and on the distribution of energy use among sectors of the U.S. economy.

2. THE BTU TAX

We turn now to the analysis of the impact of a Btu tax, as proposed in S. 2806, the Energy Revenue and Development Act of 1973, introduced by Senator Gravel. The proposed tax is a uniform tax in dollars per Btu applied to all energy produced or imported into the United States. In analyzing the impact of uniform Btu tax we follow the methodology outlined above. Our results suggest that a Btu tax can be used to achieve self-sufficiency in energy by 1985, but that the required tax rates are considerably higher than those given in S. 2806.

We can also analyze the revenue impacts of the proposed Btu tax. The calculated revenue impacts of the Btu tax presented by Senator Gravel in Table 6, page S22729 of the Congressional Record for December 13, 1973, ignore the significant inverse relationship between energy prices and energy demand that has been observed historically. Demand response to changes in energy prices can be dramatic, as evidenced by the reductions in demand that have already occurred as a result of the recent upward surge in energy prices. In the DRI Energy Model we take into account the effects of price changes on household and business demand for energy. For each of the nine producing sectors of the model and for the household sector, we have estimated the response of demand to price from historical data.

In Table 1 we present estimates of the impact of the schedule of Btu taxes given in S. 2806 on energy utilization in the United States. Our estimates take into account the direct impact of the energy tax on consumption of energy by households and businesses and also the indirect impact resulting from adjustments in levels of production of all sectors of the U.S. economy. Prices and levels of production for all sectors of the economy will be affected by the tax.

Using the results presented in Table 1 for the years 1975, 1980, and 1985, we can compare patterns of energy utilization after the introduction of the Btu tax with utilization in the absence of such a tax. Our main conclusion is that the impact of the proposed tax schedule is insufficient to produce reductions in energy demand consistent with self-sufficiency. Nevertheless, the impact of the proposed taxes on demand is clearly to reduce energy demand. The major impact is on demand for natural gas; the impact on demand for electricity is not very substantial.

TABLE 1.—IMPACT OF SENATE PROPOSED BTU TAX ON ENERGY USE

[Energy flows are in quadrillion Btu]

	1975		1980		1985	
	Base case	With tax	With case	With tax	Base case	With tax
U.S. energy demand for:						
Coal	13.7	13.3	16.7	16.2	21.2	21.0
Refined petroleum products	34.2	32.9	41.6	40.1	50.0	49.4
Electricity	7.3	7.1	10.2	10.0	14.0	13.8
Gas	25.0	23.7	28.2	26.8	31.0	30.5
Total U.S. energy	80.3	77.0	96.7	93.1	116.21	114.8

Note: The energy "base case" is the projected pattern of energy use that corresponds to the U.S. Department of the Interior energy forecast, (W. G. Dupree and J. A. West; "United States Energy Through the Year 2000." Department of the Interior, December 1972). The tax rate used in these calculations is the proposed Senate Btu tax rate for the corresponding year. Thus, the rates for 1975, 1980, and 1985 are, respectively, $0.045, $0.052, $0.022 per million Btu.

3. ENERGY INDEPENDENCE THROUGH A BTU TAX

The negative results of the previous section concerning the Btu tax do not reflect inherent weaknesses in this type of tax. This section examines various tax scenarios in which the Btu tax can be used to achieve the goal of independence from energy imports by 1985, one of the explicit objectives behind Senator Gravel's proposals. Again, the analysis is based on the DRI energy model so that account is taken of final demand, intermediate demand, and input substitution effects of the tax. Also, it must be emphasized that the Btu tax is only one of several policy instruments that are available to the U.S. government in reducing consumption of, and imports of, energy; another possible tax, the sales tax on energy, is discussed in the following section.

Table 2 shows, for the three forecast years 1975, 1980 and 1985, the impact of several Btu taxes on total U.S. energy demand and on U.S. imports of energy. The Btu tax is applied uniformly to all fuel imports and to domestic sales of coal, crude petroleum, refined petroleum products, electricity and natural gas. The simulations assume that, since import independence is the policy objective, reductions in energy usage induced by the tax are translated by import regulation into a reduction in imports. Although only oil and gas supplies are directly affected by this import reduction, the price effects of the tax, along with the lower import levels, operate through interindustry dependence and energy substitutions to produce changes in use of all types of energy. These detailed effects are examined below. Four different tax rates are shown for 1975 to illustrate the relation between tax rate and energy use; in 1980 and 1985 only two tax rates are shown.

The results shown in Table 2 show that the Btu tax can be an effective means of reducing use of energy. The taxes shown reduce demand by up to 27%; higher taxes would result in still greater reductions. But, more important, the Btu tax is an effective means of reducing dependence on imports. The 1985 simulations show that a progressive increase in the Btu tax rate to $0.640 per million Btu will serve to reduce imports to a negligible level (a level equal to about one tenth of 1973 imports). It can be seen that there are various ways of increasing the tax rate over the period up to 1985 that will secure this goal of energy independence. For example, one possible tax scheme that would secure import independence is shown in Table 3, but this is only one of many possible systems that can be inferred from Table 2. The tax cannot be removed after 1985, however. In fact, the tax rate will have to increase gradually from its 1985 level if demand is to be maintained at a level that can be satisfied from U.S. production with only minimal energy imports.

TABLE 2.—IMPACT OF VARIOUS BTU TAXES ON U.S. ENERGY DEMAND

	1975					1980			1985		
Tax rate (dollars per million Btu)	0	0.0575	0.077	0.119	0.190	0	0.184	0.290	0	0.480	0.640
Total U.S. energy demand (trillion Btu)	80,250	76,319	75,062	72,468	68,405	96,685	85,405	79,856	116,207	91,140	84,622
Change in total demand from base case (percent)	0	−4.9	−6.5	−9.7	−14.8	0	−11.7	−17.4	0	−21.6	−27.2
Imports of energy (trillion Btu)	15,557	11,670	10,375	7,783	3,896	22,454	11,232	5,620	32,998	8,256	1,659
Change in imports from base case (percent)	0	−25.0	−33.3	−50.0	−75.0	0	−50.0	−75.0	0	−75.0	−95.0
Imports in total demand (percent)	19.4	15.3	13.8	10.7	5.7	23.2	13.2	7.0	28.3	9.1	2.0
Tax revenue (billions of dollars)	0	4.388	5.779	8.623	12.996	0	15.714	23.158	0	43.747	54.158

There are two sets of considerations that would lead to a smaller Btu tax than that depicted in Table 3. First, imports from countries such as Canada, Venezuela and Indonesia might be regarded as sufficiently reliable that the objective of import independence might be interpreted as independence from Middle East producers. If this were the case, then a lower tax rate profile could be inferred from Table 2 as sufficient for the purpose. Second, the simulations in Table 2 are predicated on the U.S. energy production levels underlying the forecasts of the U.S. Department of the Interior (Dupree and West, 1972). These allow for Alaskan North slope oil production and some new discoveries in the lower 48 states.

New discoveries of oil and/or gas reserves in the U.S. would provide an alternative potential means of reducing dependence on imports. Whether such a discovery, even if it were to occur in the near future, would result in a substantial contribution to domestic oil or gas output much before 1985 can be regarded as questionable. However, on the latest available information on United States domestic production and reserves of oil and gas, the figures in Table 2 for the tax rates required for energy independence are appropriate.

TABLE 3.—A POSSIBLE BTU TAX SYSTEM FOR ENERGY INDEPENDENCE

Year	Tax rate (dollars per million Btu)	Imports in U.S. energy use (percent)
1975	0.0575	15.3
1976	.0795	
1977	.110	
1978	.152	
1979	.210	
1980	.290	7.0
1981	.340	
1982	.400	
1983	.466	
1984	.546	
1985	.640	2.0

The relation between the rate of Btu tax and the resulting reduction in energy use is shown in Table 4. It is clear from this information that a higher tax rate leads to a greater reduction in energy use but that the relation is not one of proportionality. Increases in the tax rate have a diminishing impact on the reduction in energy use. Therefore, each additional Btu reduction in energy usage requires a large increase in the rate of the Btu tax. Fortunately, the reduction in the effectiveness of the Btu tax is gradual; substantial reductions in energy use and in import dependence can be obtained from tax rates that are not unreasonably high in terms of revenue yield.

TABLE 4.—RELATION BETWEEN BTU TAX RATES AND REDUCTION IN 1975 ENERGY USE

Tax rate (Dollars per million Btu)	0.041	0.0575	0.077	0.119	0.190
Reduction in U S energy use (tr Btu)	3,007	3,931	5,188	7,782	11,845
Energy reduction/tax rate	73,341	68,365	67,376	65,395	62,342

The impact of the various Btu taxes on energy use is given in detail in Table 5. This information shows that the Btu tax has markedly different effects on the use of the different types of fuel—coal, petroleum, electricity, and gas. In each of the three years analyzed, the ranking in terms of change in energy use is substantially the same: The greatest change in use occurs in natural gas, then petroleum, then coal, and the least change in use occurs in electricity. The effect as measured by the percentage reduction in total U.S. demand for the fuel caused by the Btu tax is clearly greatest for gas usage, which in turn is substantially greater than petroleum, with coal and electricity then following without so much difference between their usage reductions.

Apart from coal, which is used almost entirely as an intermediate input, both final consumption and intermediate uses share substantial drops under the Btu tax. The impact on final demand relative to intermediate use does vary among the different fuels. In terms of the percentage reduction in use that results from the tax, consumption of petroleum products falls more in final consumption than in intermediate use, while for electricity intermediate use falls more and for gas final use shows the greater reduction.

TABLE 5.—IMPACT OF BTU TAXES ON U.S. ENERGY USE

[Energy flows in trillion Btu]

	Final consumption			Intermediate use			Total U.S. demand		
1975:									
Tax rate (dollars per million Btu)	0	0.0575	0.119	0	0.0575	0.119	0	0.0575	0.119
Coal	71	69	68	13,671	13,130	12,585	13,742	13,199	12,663
Refined petroleum	15,542	14,553	13,597	18,698	18,097	17,484	34,241	32,650	31,080
Electricity	3,106	3,039	2,968	4,169	4,016	3,861	7,275	7,055	6,830
Gas	7,874	7,131	6,447	17,118	16,284	15,448	24,992	23,415	21,895
Total	26,593	24,792	23,080	53,657	51,527	49,388	80,250	76,319	72,468
1980:									
Tax rate (dollars per million Btu)	0	0.184	0.290	0	0.184	0.290	0	0.184	0.290
Coal	86	81	79	16,603	15,012	14,222	16,688	15,094	14,301
Refined petroleum	18,522	15,587	14,201	23,040	21,262	20,313	41,561	36,848	34,514
Electricity	4,663	4,370	4,213	5,563	5,025	4,747	10,226	9,395	8,960
Gas	8,984	7,000	6,138	19,224	17,067	15,944	28,208	24,068	22,081
Total	32,254	27,039	24,631	64,430	58,366	55,225	96,684	85,405	79,856
1985:									
Tax rate (dollars per million Btu)	0	0.480	0.640	0	0.480	0.640	0	0.480	0.640
Coal	109	97	93	21,112	17,408	16,448	21,221	17,505	16,541
Refined petroleum	22,371	15,402	13,785	27,667	23,660	22,439	50,038	39,062	36,224
Electricity	6,723	5,763	5,484	7,227	5,733	5,332	13,950	11,496	10,815
Gas	9,712	5,874	5,074	21,285	17,204	15,967	30,998	23,078	21,042
Total	38,916	27,135	24,436	77,291	64,006	60,186	116,207	91,140	84,622

TABLE 6.—IMPACT OF BTU TAXES ON U.S. ENERGY USE

[Percentage by which energy flow after introduction of the Btu tax differs from the energy flow with no tax]

	Final consumption			Intermediate use			Total U.S. demand		
1975:									
Tax rate (dollars per million Btu)	0	0.0575	0.119	0	0.0575	0.119	0	0.0575	0.119
Coal	0	−2.8	−4.2	0	−4.0	−7.9	0	−4.0	−7.9
Refined petroleum	0	−6.4	−12.5	0	−3.2	−6.5	0	−4.6	−9.2
Electricity	0	−2.2	−4.4	0	−3.7	−7.4	0	−3.0	−6.1
Gas	0	−9.4	−18.1	0	−4.9	−9.8	0	−6.3	−12.4
Total	0	−6.8	−13.2	0	−4.0	−8.0	0	−4.9	−9.7
1980:									
Tax rate (dollars per million Btu)	0	0.184	0.290	0	0.184	0.290	0	0.184	0.290
Coal	0	−5.8	−8.1	....	−9.6	−14.3	0	−9.6	−14.3
Refined petroleum	0	−15.8	−23.3	....	−7.7	−11.8	0	−11.3	−17.0
Electricity	0	−6.3	−9.7	0	−9.7	−14.7	0	−8.1	−12.4
Gas	0	−22.1	−31.7	0	−11.2	−17.1	0	−14.7	−21.7
Total	0	−13.1	−23.6	0	−9.4	−14.3	0	−11.7	−17.4
1985:									
Tax rate (dollars per million Btu)	0	0.480	0.640	0	0.480	0.640	0	0.480	0.640
Coal	0	−11.0	−14.6	0	−17.5	−22.1	0	−17.5	−22.1
Refined petroleum	0	−31.2	−38.4	0	−14.5	−18.9	0	−21.9	−27.6
Electricity	0	−14.3	−18.4	0	−20.7	−26.2	0	−17.6	−22.5
Gas	0	−39.5	−47.8	0	−19.2	−25.0	0	−25.6	−32.1
Total	0	−30.3	−37.2	0	−17.2	−22.1	0	−21.6	−27.2

The different relative impacts of the uniform Btu tax on the various fuels can be attributed to various factors. Electricity is already the most expensive source of energy. The 1971 cost per Btu for the different fuels are shown in Table 7. Electricity is four times as expensive per Btu as the next most expensive fuel, petroleum. Each dollar of tax per Btu results in a smaller relative increase in the price of electricity than in the price of other fuels; this is detailed in the price information in Table 8. Thus, electricity becomes relatively less expensive than other energy sources, leading to some substitution of electricity for these other fuels. Also, electricity is such a convenient and flexible energy source that, for many uses, it has no close substitute and its use is relatively insensitive to changes in price.

Coal usage falls only slightly more than usage of electricity, but for different reasons. From Table 7 coal can be seen to be much the cheapest energy source and even after its price has risen to accomodate the Btu tax, it is still relatively cheap for those uses to which it is suited, particularly industrial and electricity generating fuel. Lack of availability of substitute fuels in similar quantities, with similar reliability of supply or as cheaply as coal, results in a smaller reduction in coal use than in the use of any other primary energy source.

TABLE 7—*Energy costs of different fuels, 1971 ($1,971mn/tr Btu)*

	Average cost
Coal	0.36
Petroleum products	1.23
Electricity	5.00
Gas	.74

Consumption of petroleum products is reduced initially by the reduction in imports and the consequent rise in price. The rise in the prices of petroleum products caused by the tax leads to significant reductions in usage, particularly in the final consumption level. Natural gas is similar but is subject to more competition from substitute fuels. Given the substantial rise in price of natural gas, added to a price already artificially low due to price regulation, there is a substantial reduction in usage of gas, particularly in final consumption.

The impact of the Btu taxes on prices is shown in Table 8. Taxes on energy lead to higher energy prices and these, in turn, filter through the entire economic system, raising prices in all sectors. The effect on overall prices, as measured by the average price of goods and services, for example, is not sustantial. In 1985, under a Btu tax system sufficient to achieve energy independence, the overall price level is 3.1% higher than it would have been without an energy tax. Inflation would average 3.3% a year with the tax as opposed to 3.0% without it over the period to 1985.

TABLE 8.—EFFECT OF BTU TAXES ON PRICES

[Percentage difference of the average output price of each sector with the tax imposed from the pr ce with no tax]

	1975			1980			1985		
Tax rate (dollars per million Btu)	0	0.0575	0.119	0	0.184	0.290	0	0.480	0.640
Agriculture	0	.3	.6	0	.8	1.2	0	1.7	2.3
Manufacturing	0	.3	.6	0	.7	1.2	0	1.7	2.2
Transport	0	.3	.7	0	.9	1.4	0	1.9	2.6
Services	0	.1	.2	0	.3	.6	0	.6	.8
Coal	0	4.3	8.9	0	11.0	17.4	0	23.2	31.0
Crude petroleum	0	4.3	8.9	0	11.6	18.4	0	27.3	36.5
Refined petroleum	0	6.3	13.2	0	17.0	27.4	0	39.1	53.8
Electricity	0	2.2	4.5	0	6.5	10.4	0	16.1	21.8
Gas	0	10.1	21.4	0	26.5	43.4	0	57.2	80.2
Consumer prices	0	.4	.8	0	1.0	1.7	0	2.3	3.1

The impact of the Btu tax on the energy sector prices varies markedly between the different fuels—electricity prices increase the least, in percentage terms, since electricity is already expensive in terms of Btu. The price of coal does not increase much more in price than electricity since supply conditions in the coal industry are such that only part of the tax is passed on to purchasers. Petroleum products increase in price by more than electricity as demand conditions permit the tax to be passed on in the form of higher prices. Natural gas prices behave similarly, but increase even more than petroleum prices. The average percentage increase in prices for a Btu tax of $1 million per trillion Btu is given in Table 9, although it should be noted that the relation between tax rate and price increase is not proportional—increases in prices increase with taxes but not as rapidly.

TABLE 9.—AVERAGE EFFECT ON PRICES AND OUTPUT IN 1985 OF THE BTU TAX

[Average percentage increase of prices or output with the Btu tax imposed over prices or output with no tax, for a tax of $1/m Btu]

	Prices	Output
Agriculture	4.3	−4.4
Manufacturing	4.0	−4.2
Transport	4.9	−4.9
Services	1.6	−2.5
Coal	60.0	−45.0
Crude petroleum	63.0	−43.0
Refined petroleum	93.0	−60.0
Electricity	35.0	−44.0
Gas	145.0	−75.0
Total	5.7	−3.2

The effect of the Btu taxes on output is shown in Table 10. The reduction in energy use caused by the Btu tax does have a cost in production and consumption. This cost is not, however, very large—energy independence by 1985 leads to output in that year only 1.6% below the output that would have been possible if there had been no restriction on imports and no Btu tax. The sectoral impact of the tax is primarily on output of the energy sectors. As has already been discussed, the impact is, among the energy sectors, least for electricity, slightly more for coal, more for petroleum and most for gas. Economising on fuel use and substitutions between fuels in the producing sectors, along with the fact that the main burden of energy reduction falls directly onto final consumers, permit the other producting sectors to continue with only minimal impact from the tax and energy cutbacks.

TABLE 10.—EFFECT OF BTU TAXES ON OUTPUT

[Percentage difference of the output with the Btu tax imposed from the output with no tax]

	Tax rate (dollars per million Btu)								
	1975			1980			1985		
	0	0.0575	0.119	0	0.184	0.290	0	0.480	0.640
Agriculture	0	−0.3	−0.7	0	−0.8	−1.3	0	−1.9	−2.4
Manufacturing	0	−.3	−.6	0	−.8	−1.2	0	−1.7	−2.3
Transport	0	−.3	−.7	0	−.9	−1.4	0	−1.8	−2.4
Services	0	−.2	−.4	0	−.5	−.7	0	−1.0	−1.4
Coal	0	−3.5	−6.9	0	−8.5	−12.7	0	−15.7	−19.8
Crude petroleum	0	−3.3	−6.5	0	−8.2	−12.2	0	−16.1	−20.0
Refined petroleum	0	−4.7	−9.3	0	−11.4	−17.0	0	−22.0	−27.7
Electricity	0	−3.0	−6.1	0	−8.1	−12.3	0	−17.6	−22.5
Gas	0	−6.3	−12.4	0	−14.7	−21.7		−25.6	−32.2
Total output (GNP)	0	−.3	−.5	0	−.6	−.8	0	−1.3	−1.6

Transportation is most affected by the tax, with agriculture and manufacturing affected almost as much; but output of services is reduced very little. The average effect on sectoral output of a one dollar tax per million Btu is shown in Table 9. All these output figures show that a Btu tax high enough to achieve energy independence by 1985 would not significantly reduce real economic growth; in fact, the rate of growth of real GNP would be reduced by only about 0.15 percent points per year, compared to growth with no limits on imports and no energy tax.

This discussion of energy tax in the form of a uniform tax per Btu on all energy sources can be summarized in the following points: (a) a Btu tax does give effective control over total U.S. energy usage; (b) a Btu tax program would be adequate to achieve energy independence by 1985, the tax rates required for this would not be unreasonably high in terms of revenue yield; (c) a Btu tax to secure energy independence would result in higher prices, particularly of energy products, but

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the average increase in the rate of inflation would only be in the order of 0.3 percentage points a year; (d) a Btu tax to secure energy independence would have a cost in terms of reduction in output, but real growth would continue with the reduction in the rate of growth only in the order of 0.15 percentage points a year; (e) a Btu tax to secure energy independence would have differing effects on different fuels—electricity and coal output would be reduced the least; output of petroleum products and natural gas, the most.

4. ENERGY INDEPENDENCE THROUGH AN ENERGY SALES TAX

This section investigates the impact of an energy sales tax on the total use of energy in the United States. The tax considered is a proportional tax applying at a uniform rate, to all transactions of fuel in the U.S. Thus, all sales of coal, petroleum and petroleum products, electricity and natural gas are subject to a tax of a specified proportion of the value of the sale.

This tax system can achieve energy independence by 1985. Table 11 shows the results, as predicted by the DRI energy model, of the introduction of an energy sales tax on the forecast years 1975, 1980 and 1985. Tax rates of 10%, 20% and 30% are used to illustrate the general effects of an energy sales tax. The predictions in Table 11 also assume that import regulation is used in conjunction with the sales tax to translate reductions in domestic use of energy into reductions in energy imports. The basic result is that an energy sales tax does have sufficient impact on energy use to permit energy independence to be achieved earlier than 1985, for example, by 1980.

The general pattern suggested by the results in Table 11 is that each percentage point of energy sales tax leads to U.S. energy use one percentage point below its level in the absence of such a tax. In terms of the goal of no energy imports by 1985, the required rate of energy sales tax would have to increase to 30% by 1985. Since the impact of this tax is primarily on energy demand, continuing import independence after 1985 would require the retention of the energy sales tax as a permanent feature after 1985. The rate would increase gradually over time so as to keep energy demand down to a level that can be sustained by domestic production.

TABLE 11.—IMPACT OF VARIOUS ENERGY SALES TAXES ON U.S. ENERGY DEMAND

	Tax rate (dollar per dollar sales)											
	1975				1980				1985			
	0	0.10	0.20	0.30	0	0.10	0.20	0.30	0	0.10	0.20	0.30
Total U.S. energy demand (trillion Btu)	80,250	70,012	61,694	54,837	96,684	84,442	74,502	66,301	116,207	101,835	90,147	80,488
Difference from base case (percent)	0	−12.8	−23.1	−31.7	0	−12.7	−22.9	−31.4	0	−12.4	−22.4	−30.7
Imports of energy (trillion Btu)	15,557	5,319	0	0	22,454	10,212	272	0	32,998	18,626	6,938	0
Difference from base case for imports (percent)	0	−65.8	−100.0	−100.0	0	−54.5	−98.8	−100.0	0	−43.6	−79.0	−100.0
mports in total U.S. energy demand (percent)	19.4	7.6	0	0	23.2	12.1	.4	0	28.4	18.3	7.7	0
Revenue from energy sales tax (dollars in billions)	0	17.0	34.2	51.6	0	24.5	49.3	7.45	0	34.7	70.0	105.9

One possible system of energy sales tax rates that would secure energy independence by 1985 is shown in Table 12. This is only one of the many tax rate profiles that can be inferred from Table 11, but they have the common feature that a tax rate of approximately 30% is required in 1985. The sales taxes required to achieve energy independence would generate substantial amounts of revenue. Under the scheme depicted in Table 12, the tax revenue would be $17 bn in 1975, rising to $105 bn in 1985. The collection of such amounts in taxes would have a severe deflationary impact unless there were some program for the return of this income to the economy by expenditure through an Energy Trust Fund or a general increase in Federal spending.

TABLE 12.—A POSSIBLE ENERGY SALES TAX FOR ENERGY INDEPENDENCE BY 1985

[In percent]

	Rate of energy sales tax	Imports in total U.S. energy use
1975	10	8
1976	12	
1977	14	
1978	16	
1979	18	
1980	20	.5
1981	22	
1982	24	
1983	26	
1984	28	
1985	30	0

The impact of an energy sales tax on energy consumption is stable across the forecast years. The general form of the relation between the tax rate and energy reduction is shown in Table 13. This table shows that each additional percentage point added to the tax rate has a smaller impact on energy use although overall each percentage point increase in the tax rate induces about a one percentage point reduction in energy use.

TABLE 13.—RELATION BETWEEN RATE OF ENERGY SALES TAX AND REDUCTION IN ENERGY USE, 1985

	Tax rate (percent)		
	10	20	30
Reduction in energy use from base case (percent)	12	23	31

The different fuels are affected to different degrees by the energy sales tax. Table 14 shows the extent of the reduction in output of each fuel caused by the various rates of tax. Coal use is least affected by the tax, with electricity use reduced by slightly more, followed by petroleum products with gas consumption reduced by the greatest proportion. There is not, however, a very wide spread between the percentage reductions in consumption of the various fuels. In 1985 with a 30% energy sales tax the use of each fuel is reduced by between 26% and 34%.

TABLE 14.—IMPACT ON SALES TAXES ON U.S. ENERGY USE

[Percentage difference from energy use with no tax]

	Tax rate dollar per dollar											
	1975				1980				1985			
	0	0.10	0.20	0.30	0	0.10	0.20	0.30	0	0.10	0.20	0.30
Coal	0	−11.8	−21.5	−29.5	0	−11.6	−21.1	−29.0	0	−10.8	−19.5	−26.8
Refinod petroleum products	0	−12.7	−23.0	−31.5	0	−12.5	−22.6	−30.9	0	−12.2	−22.1	−30.4
Electricity	0	−11.8	−21.5	−29.6	0	−11.9	−21.7	−29.8	0	−12.1	−22.0	−30.2
Gas	0	−13.6	−24.7	−33.7	0	−13.8	−25.0	−34.2	0	−13.8	−25.0	−34.2
Total	0	−12.8	−23.1	−31.7	0	−12.7	−22.9	−31.4	0	−12.4	−22.4	−30.7

Fuel prices rise substantially under the impact of the energy sales tax. The price of each fuel rises by a greater proportion than the tax rate, reflecting the process of cost and prices increases being superimposed as the tax affects prices throughout the economy. Table 15 gives the details of sectoral price changes. Crude petroleum price rise only by the amount of the tax since there is very little feedback from fuel prices into the costs of the crude petroleum sector. But the other fuel sectors show greater price rises as the tax affects their costs not only directly by the amount of the tax but also indirectly by increasing the cost of their own fuel inputs. However, demand conditions for each fuel do provide a limit to the extent to which these cost increases can be passed on in the form of higher prices.

TABLE 15.—IMPACT OF ENERGY SALES TAXES ON PRICES AND OUTPUT IN 1985

[Percentage change of price or output from the price or output with no tax]

	Tax rate (dollar per dollar)							
	Prices				Output			
	0	0.10	0.20	0.30	0	0.10	0.20	0.30
Agriculture	0	0.8	1.6	2.4	0	−1.0	−2.0	−2.9
Manufacturing	0	.9	1.7	2.5	0	−1.0	−2.0	−2.9
Transport	0	.9	1.9	2.8	0	−1.4	−2.7	−3.8
Services	0	.4	.7	1.0	0	−.8	−1.4	−2.1
Coal	0	15.1	30.8	46.9	0	−10.4	−18.8	−25.9
Crude petroleum	0	11.4	23.0	34.6	0	−14.9	−26.7	−36.1
Refined petroleum products	0	17.0	35.4	55.2	0	−12.7	−23.1	−31.6
Electricity	0	13.7	27.9	42.9	0	−11.8	−21.5	−29.6
Gas	0	17.0	35.7	56.1	0	−13.6	−24.7	−33.7
Total	0	1.2	1.8	2.4	0	−1.3	−2.4	−3.3

The net result of these cost and demand influences is that for each percent of sales tax rate, coal and electricity prices increase by about 1.5% while petroleum products and gas prices rise by almost 2%. The 30% sales tax required for energy independence causes fuel prices to increase by about 50% above their no-tax levels. These price increases then filter through the rest of the economy resulting in a rise of average prices of 2.4% for the 30% sales tax. This means that prices in 1985 under a 30% energy sales tax would be 2.4% above their predicted level in the absence of such a tax. Or, in terms of the rate of increase of the price level, about 0.25 percentage points is added to the rate of inflation over the next decade. Thus, if the inflation rate were 3.0% a year without the energy sales tax, introduction of the tax to secure energy independence would increase this rate to about 3.25% a year.

The effects of the energy sales tax on production are shown in Table 15. The tax causes fuel output to fall significantly from the no tax levels. Output of the rest of the economy is reduced somewhat, the greatest reduction being in the transport sector, the least in output of services. The magnitude of the reduction is very much less than in the fuel sectors. In this part is due to the fact that final consumption bears the greater part of the reduction in fuel use, partly due to greater economy in fuel use in the production sectors. Production in the economy as a whole is not greatly reduced as a result of the tax induced changes to secure energy independence—a 30% energy sales tax leads to a reduction in total output of 3.3% relative ot its no-tax level. This corresponds to a reduction of about one third of a point in the average real growth rate over the next decade, for example, from 3.9% a year to 3.6%.

The results of this discussion of the energy sales tax can be summarized in the following points: (a) An energy sales tax could secure energy independence by 1985; (b) the rate of tax required for this would rise to 30% by 1985; (c) total energy consumption would be reduced by about 30% under this tax with use of each fuel reduced by roughly this same proportion; (d) fuel prices would rise sharply but the overall impact on the rate of inflation would be only about one quarter of a percentage point per year; (e) the tax would reduce total output slightly but the reduction would correspond to a reduction of about one third of a percentage point per year in the rate of growth of total output.

Senator GRAVEL. Our next witness is Hon. Carl Bagge, president of the National Coal Association.

Mr. Bagge, nice seeing you again. We are glad to have you before us. We apologize for the inconvenience of schedule, of transferring from yesterday to today.

Please proceed at your pleasure.

STATEMENT OF HON. CARL BAGGE, PRESIDENT, NATIONAL COAL ASSOCIATION, ACCOMPANIED BY ROBERT STAUFFER, GENERAL COUNSEL, NATIONAL COAL ASSOCIATION; AND ROBERT PRICE, EXECUTIVE VICE PRESIDENT, NATIONAL COAL ASSOCIATION

Mr. BAGGE. Yes, thank you, Senator.

I am accompanied by Robert Stauffer, the general counsel of the National Coal Association, who is our tax expert, and Mr. Robert Price, executive vice president of the National Coal Association.

Senator GRAVEL. Mr. Bagge, before you begin, might I make an announcement for our next witness and for the audience?

I plan on staying here to hear the witnesses until we complete the testimony this morning. I think we will have time, and I am hopeful that we will be out of here well before 1 o'clock.

Please continue.

Mr. BAGGE. Senator, the American coal industry is most appreciative of this opportunity to deal with this bill and also for the opportunity to discuss with you and the committee our broad range problems. I will summarize the statement which we have submitted in the interests of time.

May I deal generally with the first topic of my paper that has been submitted for the record. That deals with coal's financial requirements, and I should say that when we deal with the coal industry's financial requirements we are talking about the financial problems and the new challenges that this industry faces today. The American coal industry's projected financial requirements are staggering. The National Petroleum Council estimated over a year ago, on the assumption that Mideast oil would continue to be available, that the American coal industry's capital needs would be in the range of $10 to $15 billion by 1985. This was projected in 1970 dollars. For an industry with a current total capitalization of only $4 billion, the magnitude of that task, as it was identified even before the Middle Eastern crisis, seemed to us to be almost unattainable.

Senator GRAVEL. What was that figure?

Mr. BAGGE. $10 to $15 billion.

Senator GRAVEL. By when?

Mr. BAGGE. By 1985. The National Petroleum Council study is about 1½ years old. That was before the present crisis and before the coal industry emerged in the public mind as the important and very vital industry that it is today.

However, we believed then and we believe today that such financing levels can be met if the investment climate surrounding coal production and coal utilization is strongly expansionary. And I must point out that we have been at a plateau in production for the last two decades. There has been no incremental expansion in capacity for 20 years in the American coal industry. Coal must compete for investment funds, and to do so successfully, it must be an attractive investment opportunity with a competitive short- and long-range rate of return.

Currently the coal industry simply does not have such a rate of return, and thus the potential for development is very limited. And as we look at our industry today, it is only a potential and not a reality as yet. Current price restrictions inhibit coal development and simply must be removed. New mining capacity is badly needed and yet it cannot be added without a far more favorable return on investment. The Cost of Living Council gave credence to this factor only recently in exempting long-term utility coal contracts. The action, however, was not nearly enough. A more proper course would be to remove coal from price restrictions entirely, and of course, this is one of the key elements of S. 2806, which you have introduced.

Senator GRAVEL. Could I interrupt you because a situation comes to mind where we have military bases in Alaska that switched to oil, and the reason why that became more economically competitive was that they were dealing in short-term contracts, 1 year or 2 years, and the miners could not amass the capital or do the job on that basis. To your knowledge, is this a practice that is prevalent with the Government in other parts of the country?

Mr. BAGGE. Yes, unfortunately, Senator, the U.S. Government has been dealing with our industry with these 1-year, short-term contracts for the entire Military Establishment, both domestically, and overseas.

I note that just recently, to illustrate the scope of this problem, that the official who is in charge of the entire military procurement of energy supplies came to visit me just a week ago, to explain the problem that they are having now. Well, what has happened is that the Military Establishment, in order to comply with the various State environmental constraints, and national environmental constraints, has been shifting as a matter of policy from coal under these short-term contracts, to oil. Now when they have made this major shift of major military establishments, now they come back to us, and they demand coal. I have forgotten what the tonnage figure is, but it is substantial. Of course, meanwhile, we have committed that coal production, such as it was, to long-term utility contracts, and we are simply unable to meet this demand today because of these policies.

I might add another sector of our economy, Senator, that deals in the same way with my industry, is the many municipal utilities throughout the country. The city of Los Angeles, for example which is the largest, of course, but most of the smaller municipal utilities are by law required to deal only in 1-year fuel increments. Of course, our industry's problem is to secure the capital investments, to open a mine, in this highly capital intensive industry, at a cost of $20 million to $25 million a mine. This is totally inconsistent with this kind of a short-range purchasing policy of both the Federal and municipal governments.

Senator GRAVEL. Right. So the policy itself, the past policy itself, actually destroyed markets for the coal industry.

Mr. BAGGE. That is correct. The utilities of Iowa present another example of this. I understand that there is no utility in the State of

Iowa that has dealt with our industry on more than a 1-year basis. Well, how can we plan, how can we attract and recruit creative people, how can we engage in research and development when we are an industry dealing on a 1-year incremental basis with our market? And this, unfortunately is symptomatic of a large portion of our industry.

What we are saying now and pleading for before the Congress is some recognition of the elemental fact that we write environmental controls, which recognize that this is a long term commitment that has to be made to the American coal industry if we are going to turn it around. The short term markets, spot markets, are simply going to be nonexistent.

Senator GRAVEL. Are you persuaded by your experience in recent months that the Government is making an effort to change its policies so that it can encourage the necessary financial undertakings that you believe are necessary?

Mr. BAGGE. I regretfully have to respond in the negative to that, Senator. We have not seen evidence of a single green light from the Government to oversimplify the thing. This testimony may be in sharp contrast to the two previous witnesses who were far more articulate and far more knowledgeable about economic matters than I am. But I might put it this way, that everywhere we turn in terms of Government policy, even today, Senator, whether it is in terms of leasing of western lands for coal expansion, whether we look at the kind of regulations that are written by the Senate and the House in terms of surface mining legislation, whether we turn to the coal utilization side, we do not see any evidence that any one of these constraining influences is being moderate on a long term realistic basis in order to turn our industry around.

We want and need a green light from Government. The Senate has before it a bill in the Interior Committee entitled the Coal Conversion Act, Senator, the National Coal Conversion Act which, in effect, declares that never again, no matter what happens in the Middle East, never again shall we commit the large utility boilers which are generating electric power for the Nation, or the large industrial boilers, to oil or to natural gas. The bill says, in effect, that coal shall be the mother fuel for the Nation for the generation of steam and electric power—not gas and not oil.

Senator GRAVEL. Is it legislating that or is it permitting that through a free market?

Mr. BAGGE. It is legislating as a matter of national policy, as a conservation measure, as a means to assuring our industry of a long term market. It is legislating that face that we shall not be flaring, If I can use that phrase, natural gas or oil in the utility boilers of the Nation.

Senator GRAVEL. But if we went to a free market situation and let the markets clear, and did not artificially keep gas down so low where it does not belong, might not that be a better approach to the problem rather than through command legislation saying that coal will be the mother fuel?

We could make the mistake both ways. In other words, we could make the mistake by keeping gas cheap, or we could say that coal is going to be the mother fuel, but would it not be better to take recourse here in the free enterprise system and let the economics of the situation be the disciplinarian, and let the free choice of the consumer be the ultimate factor.

Mr. BAGGE. Well, there is not any question that if that policy had been pursued in the last two decades, coal would not have lost its utility markets to natural gas. But I fear, Senator for the consequences if they ever bring down the price of imported oil again. It was that cheap oil from the Middle East applying a 4.6 rate or productivity based on the economic experience of the industry in the decade of the 1960's. We could not recover these active costs. They have been applying conceptually a rate of productivity which is totally inconsistent with the facts and does not permit my industry to recover its actual costs. And I find that to be scandalous.

Senator GRAVEL. What has been the result of this?

Have there been closure of some mines?

Mr. BAGGE. Well, there have been many closures. Even in 1973, Senator, there have been major mines closed in West Virginia, Ohio, and Pennsylvania, and of course, this problem is one of the contributing factors.

Senator GRAVEL. Has anybody made any study of this, that we might have for the record to show the rigor mortis of Government reactions to the plight of you people?

Mr. BAGGE. Senator, we fully documented this entire thing. The National Coal Association on behalf of the entire industry submitted a formal petition to the Cost of Living Council over a year ago documenting the entire inconsistency of what they are doing to us in terms of trying to realize our otherwise realizable costs.

Senator GRAVEL. It is a very voluminous thing?

Mr. BAGGE. No; it is not.

Senator GRAVEL. Would you give it to us for the record?

I think it is very germane to the dialogue of whether we should have more government or less government in the operation and market place.

Mr. BAGGE. We would welcome the opportunity Senator.

[The information referred to follows. Hearing continued on p. 1723.]

Form S-16 (Rev. Feb. 1972)

Department of the Treasury - Internal Revenue Service
Economic Stabilization Program

Application for Exemption or Exception
(Please type or print)

Official Use Only
Control number

Part I — Identifying Data *(Check applicable boxes)*

1. Kind of application	2. Notification category of applicant	3a. Is this a resubmission?	3b. If "Yes," show previous reference number:
(1) [ ] Pay (2) [X] Price (3) [ ] Rent	(1) [ ] Prenotification (2) [ ] Reporting (3) [ ] Nonreporting not applicable	(1) [ ] Yes (2) [X] No	

4. Applicant information			5. Parent firm information *(Complete only if different from item 4)*		
a. Name: National Coal Association			a. Name: N/A		
b. Address *(Number and street)*: 1130 - 17th Street, N. W.			b. Address *(Number and street)*		
(City or town, State and ZIP code): Washington, D. C. 20036			*(City or town, State and ZIP code)*		
c. Last fiscal year ending: Mo. N/A, Day, Year	d. Employer identification number *(if none, show social security number)*: N/A	e. Total revenues in last fiscal year: $ N/A	c. Last fiscal year ending: Mo., Day, Year	d. Employer identification number	e. Total revenues in last fiscal year: $

Part II — Request for (1) [ ] Exemption (2) [X] Exception

6. Reason for requesting exemption or exception *(Summarize. If this application involves a pay exception, also complete Part V on the back of this form.)*

The application of a 5.6 percent productivity increase factor will result in a serious hardship to the coal industry. The attachment, using published data, documents that the imposition of any theoretical productivity increase cannot be justified. If the 5.6 percent productivity increase factor is applied to increased costs, the industry would suffer a gross inequity. This would be compounded by the high labor-cost factor (45 to 55%) in the industry.

This request for an industry-wide exception is not part of a plan having as its purpose the avoidance of the purposes of the Economic Stabilization Act of 1970.

7. Regulations from which exemption or exception is requested *(Price applications only)*	a. Ch. III Price Stabilization, Part 300 - Sec. 300.11a	b.

Part III — Supplemental Attachments *(Check applicable boxes and attach supporting documents specified)*
NOTE: Not required for posting exception

8a. Pay	8b. Price	8c. Rent
(1) [ ] Form IB-1 (2) [ ] Form IB-2 (3) [ ] Other *(specify)*:	(1) [ ] Form PC-1 (2) [ ] Form PC-1R *(Or Form PC-10. See instructions.)* (3) [ ] Form PC-1, Part II only (4) [ ] Form PC-60 (5) [ ] Form PC-61 (6) [ ] Other *(specify)*:	[ ] Notification of rent increase

Part IV — Previous Exemption or Exception

9. Has the applicant or any affiliate currently or previously filed a request for an exemption or exception, or applied for a ruling on this or any other stabilization matter?

[ ] Yes [X] No — *If "Yes," attach supplemental statement identifying the request, entity, and issue.*

NOTE: A false answer will be grounds for denial of your application and may also be punishable by fine, or imprisonment, or both, under 18 U.S.C. 1001.	Signature of applicant or authorized representative CARL E. BAGGE, PRESIDENT	Date July 25, 1972

Form S-16 (Rev. 2-72)

Part V — Pay Exception Request

An application is not necessary to qualify for exemptions that are self-executing, i.e., the "catch-up" exception, the cost-of-living allowance calculation, or the exemption for wages below the $1.90 hourly wage-rate level. *(Please see instructions.)*

10. Specific exception requested ▷ a. ☐ Tandem Relationship *(see item 11, below)* b. ☐ Essential Employees *(see item 12, below)* c. ☐ Other *(see item 13, below, and instructions)*

11. Tandem Relationship Maximum permissible yearly aggregate increase may be 7%, instead of the standard 5.5%, *if each of the following tests are met and fully described.* Attach statements, if necessary.

a. Was the wage and salary increase in the employment contract to which a tandem relationship is claimed in excess of the standard?
(1) ☐ Yes (2) ☐ No *If "Yes," show percent:* ________ %

b. Date contract or pay practice referred to in item 11a, became effective *(month, day, year)*	c. Proposed effective date of the wage and salary increase in tandem-claiming unit *(month, day, year)*

d. Is the employee unit to which a tandem relationship is claimed another unit of the same employer, or within the same industry or the same local labor market? (1) ☐ Yes (2) ☐ No *If "Yes," describe:*

e. For each of the past five years or in the immediately preceding two consecutive collective bargaining agreements, provide the following information:	Tandem-claiming unit seeking exception *(a)*	Employee unit to which tandem relationship is claimed *(b)*
(1) Dates wage and salary increases were received by appropriate employee units ▶		
(2) Average hourly wages paid after increases ▶		
(3) Nature of increases (general wage, salary, and benefit changes) ▶		

12. Essential Employees Maximum permissible yearly aggregate increase may be 7%, instead of the standard 5.5%, *if each of the following tests are met and fully described.* Attach statements, if necessary.

a. Are wage and salary increases exceeding the 5.5% standard necessary to attract or keep employees essential to the efficient operation of the employer? (1) ☐ Yes (2) ☐ No *If "Yes," describe:*

b. Has there been a significant number of vacancies in the unit for which a wage and salary increase is requested? (1) ☐ Yes (2) ☐ No
If "Yes," show number of vacancies, and describe period and kind of recruiting activity.

c. Have there been significant changes in the conditions of employment? (1) ☐ Yes (2) ☐ No *If "Yes," describe:*

d. Is there a reasonable expectation that a wage and salary increase will be effective in recruiting or maintaining qualified employees?
(1) ☐ Yes (2) ☐ No *If "Yes," describe:*

13. Other *(Specify kind of exception requested and justify. Attach separate statement if necessary. See instructions.)*

Instructions for the Preparation of Form S-16

PURPOSE OF THIS FORM

This form must be used to request an exemption or exception from the Economic Stabilization Program. If you are requesting an exception from both Pay and Price Regulations, a separate Form S-16 must be prepared for each request.

WHO MAY FILE

Any person may file an application for an exemption or exception.

WHERE TO FILE

File this form with your local District Director of Internal Revenue, unless the Cost of Living Council, Pay Board, or Price Commission has agreed to accept a direct filing. Tier I and Tier II firms that request an exception from Pay Regulations should file direct with the Pay Board. Tier I firms that request an exception from Price Regulations should file direct with the Price Commission.

DEFINITIONS

Exemption means a general waiver of the requirements of all rules, regulations, and orders issued pursuant to the Economic Stabilization Act.

Exception means a waiver directed to an individual firm in a particular case which relieves it from the requirements of a rule, regulation, or order issued pursuant to the Economic Stabilization Act.

GENERAL

Please review and consider current guidelines and regulations to determine if the proposed action can be taken without filing an application for exemption or exception. Local Internal Revenue Service and Compliance Centers are available if you need help.

Part I—Identifying data

Item 3b—Previous reference number—If you are submitting an application that has been returned to you, please show in this item the number that was recorded in the top right-hand corner of the returned application.

Item 4—Applicant information—Enter the identity information for the individual or business covered by this application.

Item 5—Parent firm information—This item is required when an applicant is a subsidiary.

Part II—Reason for exemption or exception

Item 6—Show why a serious hardship has occurred, or is likely to occur.

Item 7—Regulations from which an exemption or exception is requested—Specify the regulation numbers. (*Complete this item for price applications only.*)

Part III—Supplemental attachments. (For exception applications only)

Item 8a—Pay—(*Also see Part V of these instructions*).

Attach Form PB-1, General Wage, Salary, and Benefit Changes Under a Collective Bargaining Agreement, when the pay request is governed by a collective bargaining agreement.

Attach Form PB-2, General Wage, Salary, and Benefit Changes for Employees Not Under a Collective Bargaining Agreement, when the pay request is not governed by a collective bargaining agreement.

All persons, including prenotification and reporting firms, must attach the appropriate Form PB-1 or PB-2, and other supporting documents and information to Form S-16. Supporting documents should include a statement of their effect on the application.

Item 8b—Price—Attach Forms PC-1 or PC-1R (wholesalers and retailers only—PC-1R will be superseded by Form PC-10 in the future), or PC-1 (Part II only), and PC-50, PC-51, and other information depending upon whether the application is considered justified under one of the following:

Allowable Costs—Costs, whether direct or indirect, that have been specifically disallowed by the Price Commission. Attach Forms PC-1 or PC-1R, PC-50, and PC-51.

Loss or Low Profit—Businesses in a loss or very low profit situation during the base period requesting an exception to have a higher profit margin limitation. Attach Forms PC–1R or PC–1 (Part II only), PC–50, and PC–51, a prior three-year balance sheet, and a 10-year summary of income.

Base Period Profit Margin—Base period profit margin is not representative of its historical profit margin. Attach Forms PC–1 or PC–1R, PC–50, and PC–51, a prior three-year balance sheet, and a 10-year summary of income.

New Product—A recently introduced product is going to increase the profit margin above the base period margin. Attach Forms PC–1R or PC–1 (Part II only), PC–50, and PC–51, and a projected income statement.

New Company—All new companies should attach Forms PC–1R or PC–1 (Part II only), and PC–51.

Base Price—The highest price charged by a business for a product or service during the freeze. If that price did not reflect the normal competitive price, attach Forms PC–1R or PC–1 (Part II only), PC–50, and PC–51.

Health Care Service—Providers of health services. Attach Forms PC–1R or PC–1 (Part II only), PC–50, and PC–51, and the health providers' supplemental worksheet.

Other—Specify request, and attach Forms PC–1R or PC–1 (Part II only), PC–50, and PC–51. (These supplemental attachments are not required for posting requirements.)

Information Required—Prenotification and reporting firms that have already filed Forms PC–1 or PC–1R, PC–50, and PC–51 because their sales are $50,000,000 or more a year may submit copies of these forms with the Form S–16.

Firms with sales under $50,000,000 a year should complete the required forms to the extent possible. Firms not having all the financial information available to them should indicate "information not available" in the entry space on the Forms PC–1 or PC–1R, PC–50, and PC–51.

The "10-Year Summary of Income" and the "Projected Income Statement" should include at least the following:

Net sales.
Cost of sales.
Gross profit.
Other operating expenses.
Operating income (loss).

The "Prior Three-Year Balance Sheet" should include at least the following:

Current assets.
Fixed assets.
Current liabilities.
Long term liabilities.
Stockholders equity.

Item 8c.—Rent—Requests for exception from rent regulations shall be considered by the Price Commission only in cases of extreme hardship. A lessor seeking an exception shall, at the time the exception is requested notify his tenants, on a unit-by-unit basis, of the dollar and percentage amount of adjustment or increase being sought. A copy of the notification to the tenant must be attached to the Form S–16.

Part IV—Previous Exemption or Exception

An exemption or exception request on the same issue may not be considered in two different districts at the same time, nor may the applicant file an exemption request and a request for an interpretation or a ruling at the same time.

Part V—Pay Exception Request.

Complete item 10 if this application is for a wage and salary exception that is not self-executing. (The permissible yearly aggregate wage and salary increase for an appropriate employee unit is generally limited to 5.5 percent.)

EXEMPTIONS THAT ARE NOT SELF-EXECUTING

If you meet the criteria for exception in the following circumstances, the maximum permissible yearly aggregate wage and salary increase may be 7 percent instead of the standard 5.5 percent. However, all exceptions under the following rules require the prior approval of the Pay Board or its delegate:

(a) Items 11. and 12. Tandem Relationship and Essential Employees.—The information required must be fully demonstrated before an exception can be granted.

(b) Item 13. Other.—In the development of additional criteria for exceptions, the Pay Board shall consider such factors as ongoing collective bargaining and pay practices, the equitable position of the employees involved, and other factors necessary to foster economic growth and to prevent gross inequities, hardships, serious market disruptions, domestic shortages of raw material, localized labor shortages, and windfall profits.

EXEMPTIONS THAT ARE SELF-EXECUTING

Under the circumstances below, an exception to the 5.5 percent standard is self-executing. Submit Form PB-1 or PB-2, as appropriate, with the following information:

1. Computation of allowable catch-up increases (limit—7 percent).

(a) Employment contract situation.—Total the percentage of wage and salary increases for each year of the prior contract, that is, the contract expiring prior to the new contract for which an exception is requested. Subtract the total, if less, from the sum of a percentage increase of 7 percent a year for each year of the prior contract. Then, add that difference to 5.5 percent to determine the maximum permissible increase for the appropriate 12-month period (see limitation—1(c)).

(b) No employment contract.—Total the percentage of wage and salary increases in the preceding three years. Subtract the total, if less, from the sum of a percentage increase of 7 percent a year for each of the three years. Then, add that difference to 5.5 percent to determine the maximum permissible increase for the appropriate 12-month period (see limitation below).

(c) Limitation.—The maximum permissible yearly aggregate increase under the catch-up rules may not exceed 7 percent. The exceptions provided by these rules expire March 31, 1972, and may be claimed only for employment contracts entered into or pay practices established before April 1, 1972. Exceptions under these rules are self-executing for pay adjustments applying to less than 5,000 employees; however, reports of all catch-up increases are to be made to the Pay Board or its delegate. Also, catch-up increases applying to 5,000 or more employees require prior approval by the Pay Board.

2. Cost of living calculation

The guidelines limit the yearly aggregate increase in wages and salary to 5.5 percent, calculated as the sum of any percentage increase granted during the yearly period. If, in addition to a normal wage and salary increase, a new contract or pay practice also provides an increase pursuant to, and justified by, a generally accepted cost of living escalator formula, you may use a different method to calculate a cost of living portion of your yearly aggregate increase: include only the part of the cost of living increase that is actually due during the yearly period. For example, if you are due a cost of living increase only during the last quarter of your yearly period, include only one quarter of that increase in computing the yearly aggregate increase.

The sum of the cost of living increase computed by the special method, and any other increase computed by the normal method, may not exceed 5.5 percent. Exceptions under the cost of living calculation rules are self-executing for pay adjustments applying to less than 5,000 employees, but reports of such increases are to be made to the Pay Board or its delegate. Cost of living calculation increases applying to 5,000 or more employees require prior approval by the Pay Board.

3. Hourly wage-rate level of $1.90

Wages below $1.90 an hour may be increased by all firms up to the $1.90 an hour wage level, without regard to the 5.5 percent standard and without the necessity of filing an exception application.

SIGNATURE

This application must be signed by the applicant or his authorized representative except as noted below. If the request is signed by a representative of the applicant, or if the representative is to appear before the Internal Revenue Service in connection with the request, he must either be:

1. An attorney who is a member in good standing of the bar of the highest court of any State, possession, territory, Commonwealth, or the District of

Columbia, and who files with the Service a written declaration that he is currently qualified as an attorney and that he is authorized to represent the principal, or

2. A certified public accountant who is duly qualified to practice in any State, possession, territory, Commonwealth, or the District of Columbia, and who files with the Service a written declaration that he is currently qualified as a certified public accountant and that he is authorized to represent the principal.

NOTE.—The above requirements do not apply to an individual representing his full-time employer, or to a bona fide officer, administrator, trustee, etc., representing a corporation, trust, estate, association, or organized group.

ATTACHMENT TO FORM S-16 SUBMITTED BY THE NATIONAL COAL ASSOCIATION

I. THE PRICE COMMISSION'S USE OF NATIONAL PRODUCTIVITY DATA AS PUBLISHED WITHOUT CORRECTING FOR THE CHANGE IN PERCENTAGE PARTICIPATION BY METHOD OF MINING AND GEOGRAPHICAL AREAS RESULTS IN A DISTORTED MEASURE OF PRODUCTIVITY CHANGE. AVERAGING THE PRODUCTIVITY CHANGES OVER THE HISTORICAL PERIOD IMPROPERLY REFLECTS PRODUCTIVITY CHANGES DURING THAT PERIOD. PRODUCTIVITY HAS FURTHER DECLINED SINCE THE 1958-69 BASE PERIOD.

A. Changing mining methods and geography

In no other industry do the methods of production and geographic location affect productivity as in the coal industry. Productivity varies from high to low depending on whether the method is surface or underground mining. Similarly, productivity varies from high to low as the production location moves from the thick seams of the western states to the thin seams of Appalachia. See Schedule A.

Progressive changes in production methods and in geographical location of mines occurred in the coal mining industry during the historical period, 1958 through 1969, selected by the Price Commission. Schedule B shows the changes which occurred in mining methods and Schedule C shows the changes in geographic location. There was a steady increase in the proportion of coal produced by surface mining and from thicker western seams. These changes distort the published productivity data so that they do not truly reflect productivity increases which resulted from increased efficiency.

To correct for these changes in the production mix and obtain a truer picture of real productivity gains, those which resulted from increased efficiency, we have recalculated the productivity for each year, taking 1969 as the base year and keeping the geographical and method of mining proportions constant. This is shown in Schedule D.

Column I shows the tons per man day productivity as published by the Bureau of Mines; Column II shows the percentage increase in productivity over the preceding year, using the published figures; Column III shows the recalculated tons per man day, using 1969 as a base year; and Column IV shows the percentage increase in productivity over the preceding year, using the revised figures for man day production.

Graph I illustrates productivity in tons per man day as published by the Bureau of Mines, compared with our recalculation keeping the method of mining and geographical mix constant.

Maintaining a constant as opposed to variable mix of mining methods and geographical locations shows that the annual productivity gain during the years 1958 through 1969 was 4.7% rather than 5.6%.

B. Average productivity, 1958 through 1969

An analysis of changes in productivity in the coal industry during the years 1958 through 1969 reveals that using an average gain in productivity based on the total period is misleading. Actually the years 1958 through 1969 included two distinct and significant periods of productivity change in the coal industry; one, 1958 through 1964, and the other 1964 through 1969. Further, within the period 1964 through 1969, a significant decrease in productivity occurred in 1967–1969 which should also be considered.

Graph II illustrates the percentage increase in productivity by year, using the data from Schedule D for both the published and recalculated bases. During the 1958 through 1964 period, the coal industry had a 6.3% annual rate of productivity increase. In the five-year period from 1964 through 1969, the rate of productivity increase dropped to 2.8%. For the two-year period from 1967 through 1969 the increase averaged only 1.5%.

The higher annual gains in productivity for the earlier years resulted from the increased use of continuous mining machines in underground coal production. From its introduction about 1950 through 1964 the proportion of coal mined by continuous mining machines increased dramatically. The proportion started to level out in 1965 and has remained almost constant since 1966. This is shown in Schedule E. The leveling out was the result of nearing the saturation point; almost all mines where continuous miners were usable for increasing productivity had applied such equipment.

The extent to which mechanization of coal mining took place in the years 1958–1969 is further shown in Schedules F and G. Hand loading and hand cutting have been practically eliminated.

Other factors which contributed to growth in productivity in the early years of the selected historical period were increasing coal mine size and increasing number of days worked each year. These are shown in Schedules H and I. As in the case of the use of continuous mining machines, there was a leveling off during the latter years of the period.

As can be seen by the schedules and graphs, as each year has gone by in the 1958–69 period, the opportunities for productivity gain by adding mining equipment and change in the methods of mining within the coal industry diminished. For this reason it is most appropriate to consider the changes in productivity that the coal industry has experienced in the 1967 through 1969 period. The productivity increase for this period averaged 1.5%.

C. Productivity experience since 1969

After the 1958–69 base period (the period selected by the Price Commission) productivity in the coal industry was adversely affected by the requirements of the Coal Mine Health and Safety Act of 1969. What was for the most part, the effect of this legislation is dramatically illustrated by the substantial declines in tons per man day and in percentage increase in productivity shown in Graphs I and II. According to the official figures of the Bureau of Mines, productivity per man day in all coal mine operations was down 5.3% in 1970; underground productivity alone declined 11.9%. Adjusting the Bureau of Mines data to the 1969 base, as shown in Schedule D, indicates a decline of 10.3% in productivity for all coal mines. Although not yet officially reported by Bureau of Mines data, these declines have continued in 1971 and until the present.

Other factors in addition to the effect of the Coal Mine Health & Safety Act must also be considered in any appraisal of coal industry productivity. It is impossible to quantify the impact upon productivity of newly enacted and increaseingly stringent water quality control laws and surface mining reclamation standards. In each instance, however, these environmental constraints have added an increment of additional manpower which have had an adverse effect upon productivity in terms of tons per man-day.

In addition, increasingly stringent air quality standards have changed the production of coal in many areas from raw coal to washed coal. The impact of this on the coal industry is a reduction in volume of marketable product and an addition of personnel which reduces the productivity experienced by as much as 25%.

Finally, consideration must also be realistically accorded the current labor situation within the coal industry which, along with the need to recruit and train a larger inexperienced work force, has exerted a negative influence on productivity.

All of these additional factors have, like the Coal Mine Health & Safety Act, exerted their influences upon productivity in the coal industry since 1969.

D. Conclusion

An analysis of the published data on coal production for the period 1958–1969 shows that the 5.6% annual productivity gain projected by the Price Commission is erroneous. Correcting for changes in mining methods and geographical location alone reduces the indicated annual gain to 4.7%. In addition, the decreased impact of mechanical equipment, of larger mines and of more working days reduces the historical annual gain to a maximum of 2.8% if based on the 1964–69 data. and 1.5% if based on the more recent and more relevant 1967–69 period.

A further dramatic decline in productivity occurred after the base period selected by the Price Commission. As a consequence of the industry's experience since 1969, we contend that a zero productivity factor should be applied to the coal industry.

II. THE PRICE COMMISSION'S APPLICATION OF AN INCORRECT PRODUCTIVITY INCREASE FACTOR TO THE COAL INDUSTRY WILL SERIOUSLY IMPAIR THE VIABILITY OF THE INDUSTRY IN A TIME OF FUEL SHORTAGES AND ENERGY CRISIS

A. The impact on the Nation.

The nation is fast approaching an alarming energy shortage that has the very real potential of becoming a major crisis. For the past three decades the United States has enjoyed an unparalleled prosperity. During that time we have come to assume that a limitless supply of cheap energy will be available to power our ever-expanding economy. At the beginning of this decade, however, it became clear that in recent years we had been living not on new discoveries but on basic reserves, thereby depleting our real fuel balance. Recognition of this fact came in 1970 when the threat of a major crisis demonstrated that our energy economy had shifted from apparent plenty to real scarcity.

Adding to the existing energy dilemma are forecasts of future energy demand. The interim report of the National Petroleum Council projects that total U.S. energy consumption will probably grow at an average rate of 4.2% for the next 15 years and thus will more than double the fuel requirements of the nation by 1985. The magnitude of these figures raises a serious question as to whether our present sources of energy, especially oil and gas, can be expanded to keep up with the increasing total energy requirements. The outlook for some energy forms through the latter part of this century is bleak; coal is the only fuel we have in abundance.

Coal presently has many problems, but certainly not the problem of adequate supply. We have one and a half trillion tons of coal already mapped, and the U.S. Geological Survey states that there is probably that much more waiting to be found. That is a supply sufficient for centuries, even at the greatly accelerated consumption rates being forecast for the future. Coal makes up 88% of the nation's proved reserves of energy fuels, and that is the great, overpowering fact which must be considered in any long-term governmental policy decisions. Only the coal industry has the domestic reserves which can supply the nation for centuries from resources within the United States; therefore, every recent government study indicates that the coal industry will be required to double its production by 1985. However, this goal cannot be achieved unless the continuing viability of the industry is maintained. The industry must be kept alive and healthy—its labor force intact, its mines operating and its future sufficiently attractive to draw the vast investments required for future capacity.

B. The impact on the industry

It should be recognized that the average coal mine has a life expectancy of about 20 years. This means that about 5% of the total production from all mines must be replaced each year, simply to maintain stable production. Annual programmed new mine openings are essential; it takes two or three years from the time of conception to the date the first tone of coal is mined. It is vital that this cycle not be broken otherwise a detrimental impact on our energy base will be certain in the future.

It is generally accepted in the industry that it requires between $10 and $15 of initial capital investment to produce a ton of coal per year. To open a million ton a year mine requires between ten million and fifteen million dollars. To obtain financing of this magnitude there must be an assurance of return on the investment. Today there exists no such assurance. If the coal industry is not permitted to recover increases in costs because of the application of an improper productivity increase factor, it will further jeopardize the industry's ability to secure public financing for the capital investment required.

As a result of the Price Commission's use of an improper productivity factor, the entire economics of the industry have been so altered as to cause uncertainty in the continued operation of some existing mines and the opening of new mines. The Commission's action in this regard markedly affects long-term contracts with price adjustment clauses which are typical in the coal industry.

C. Conclusion

Coal is the one indigenous fuel in the United States which is adequate to meet the growing energy demand. But to play its role in supplying the energy demand as a fuel for power plants and as feedstock for a synthetic gas and oil industry, a viable coal industry must exist.

Coal resources are sufficient to meet all the nation's energy needs for several hundred years. But to make that coal available for use requires operating mines, working miners and the incentive to expand production. None of these basic requirements will be satisfied if the Price Commission limits price increases on the basis of an unrealistic productivity factor.

SCHEDULE A

DIFFERENCES IN PRODUCTIVITY IN THE COAL INDUSTRY [1]

[In tons per man-day]

Location	Surface	Underground
North Dakota (West)	76.62	(2)
Illinois (Midwest)	37.62	22.94
Pennsylvania (East)	22.66	13.92

[1] The bituminous and lignite coal mining industry has available 2 sources for published productivity information: the Bureau of Labor Statistics and Bureau of Mines. The Bureau of Labor Statistics reports only on a national basis, while the Bureau of Mines reports on a national basis, geographic basis and method of mining basis. To analyze productivity Bureau of Mines' data is more appropriate because of its broader scope. The data presented herein, unless otherwise noted, are taken from Bureau of Mines publications.

[2] Not available.

SCHEDULE B

PERCENT OF COAL PRODUCTION BY MINING METHOD

[In percent]

	Underground	Surface and auger
1958	69.9	30.1
1959	68.8	31.2
1960	68.6	31.4
1961	67.7	32.3
1962	66.6	33.4
1963	65.9	34.1
1964	66.1	33.9
1965	64.9	35.1
1966	63.4	36.6
1967	63.1	36.9
1968	63.1	36.9
1969	61.8	38.2
1970	56.4	43.6

SCHEDULE C

PERCENT OF COAL PRODUCTION BY STATES

[In percent]

	1958	1969
Alabama	2.72	3.12
Arkansas	.09	.04
Colorado	.72	.99
Illinois	10.69	11.55
Indiana	3.66	3.58
Iowa	.29	.16
Kansas	.20	.23
Kentucky	16.14	19.46
Maryland	.20	.24
Missouri	.63	.59
Montana	.07	.18
New Mexico	.03	.80
North Dakota	.56	.84
Ohio	7.79	9.14
Oklahoma	.40	.33
Pennsylvania	16.49	14.03
Tennessee	1.65	1.44
Utah	1.30	.83
Virginia	6.53	6.34
Washington	.06	.01
West Virginia	29.13	25.16
Wyoming	.48	.82
Other States	.17	.12
Total	100.00	100.00

SCHEDULE D

COAL MINE PRODUCTIVITY

	As published		1969 base[1]	
	Col. I, tons per man-day	Col. II, percent increase	Col. III, tons per man-day	Col. IV, percent increase
1958	11.33		12.00	
1959	12.22	7.86	12.82	6.83
1960	12.83	4.99	13.51	5.38
1961	13.87	8.11	14.44	6.88
1962	14.72	6.13	15.34	6.23
1963	15.83	7.54	16.31	6.32
1964	16.84	6.38	17.34	6.32
1965	17.52	3.88	17.93	3.40
1966	18.52	5.71	18.77	4.68
1967	19.17	3.51	19.31	2.80
1968	19.37	1.03	19.59	1.45
1969	19.90	2.74	19.90	1.58
1970	18.84	(5.33)	17.85	(10.30)

[1] Calculated from cols. I and II.

SCHEDULE E—*Percent of underground production by continuous mining methods*

	Percent		Percent
1945		1962	37.4
1950	1.8	1963	40.2
1955	9.5	1964	44.4
1956	13.0	1965	47.6
1957	17.6	1966	50.0
1958	23.2	1967	50.2
1959	27.0	1968	49.7
1960	31.7	1969	51.5
1961	35.8	1970	51.6

SCHEDULE F—*Percent of underground production hand loaded into mine cars*

	Percent		Percent
1958	15.1	1964	12.6
1959	14.0	1965	10.8
1960	13.7	1966	8.3
1961	13.7	1967	5.5
1962	14.3	1968	4.3
1963	14.2	1969	3.4

SCHEDULE G—*Percent of underground mining cut by hand*

	Percent		Percent
1958	5.1	1964	3.8
1959	4.7	1965	3.4
1960	4.8	1966	3.2
1961	4.4	1967	2.5
1962	4.7	1968	2.6
1963	4.5	1969	2.3

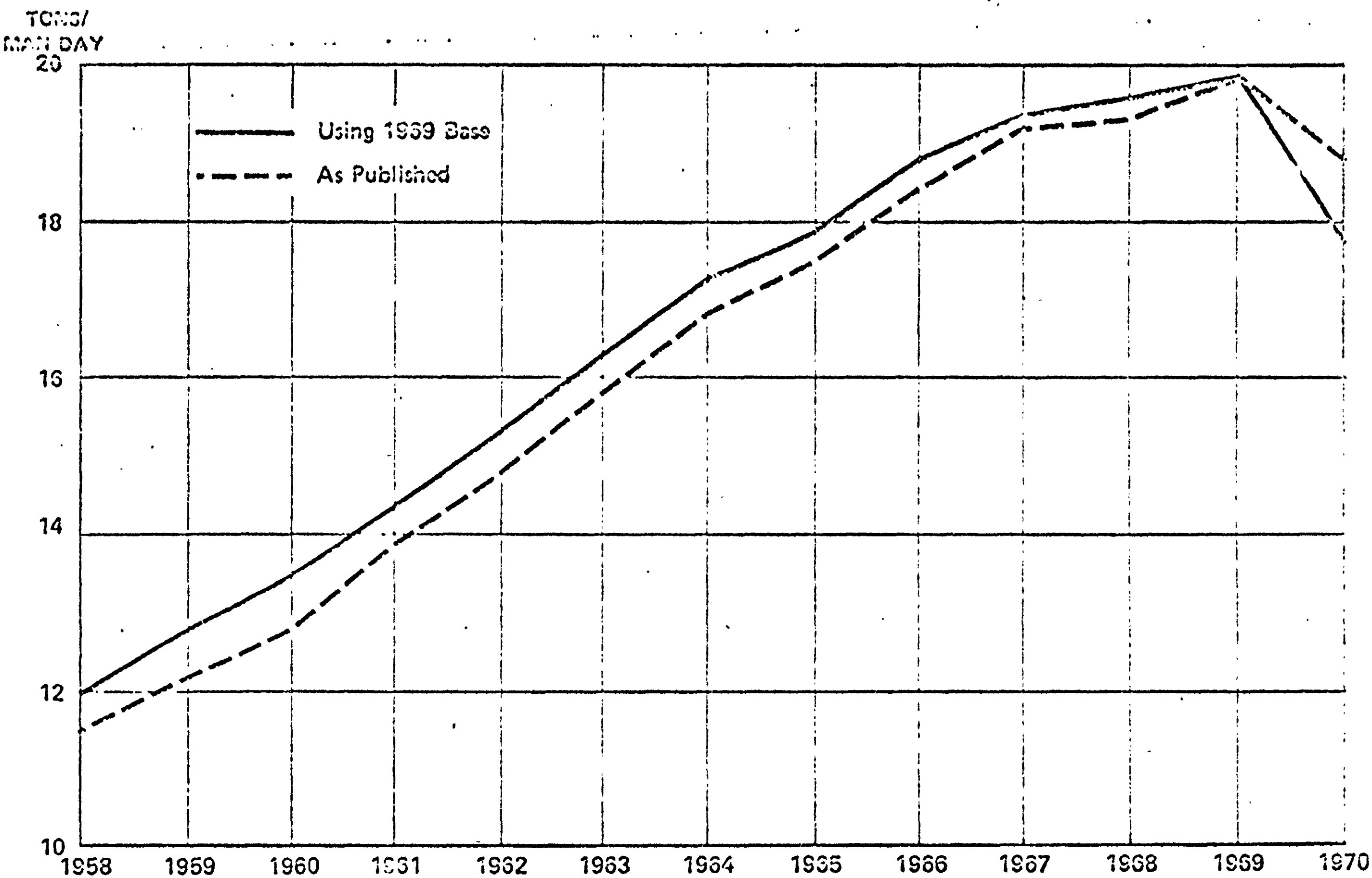
SCHEDULE H—*Percent of production from mines over 500,000 annual tons*

	Percent		Percent
1958	45.8	1964	54.9
1959	49.9	1965	57.2
1960	49.3	1966	57.9
1961	50.4	1967	59.1
1962	50.6	1968	58.5
1963	52.9	1969	60.3

SCHEDULE I—*Average number of days worked*

	Number of days		Number of days
1958	184	1964	225
1959	188	1965	219
1960	191	1966	219
1961	193	1967	219
1962	199	1968	220
1963	205		

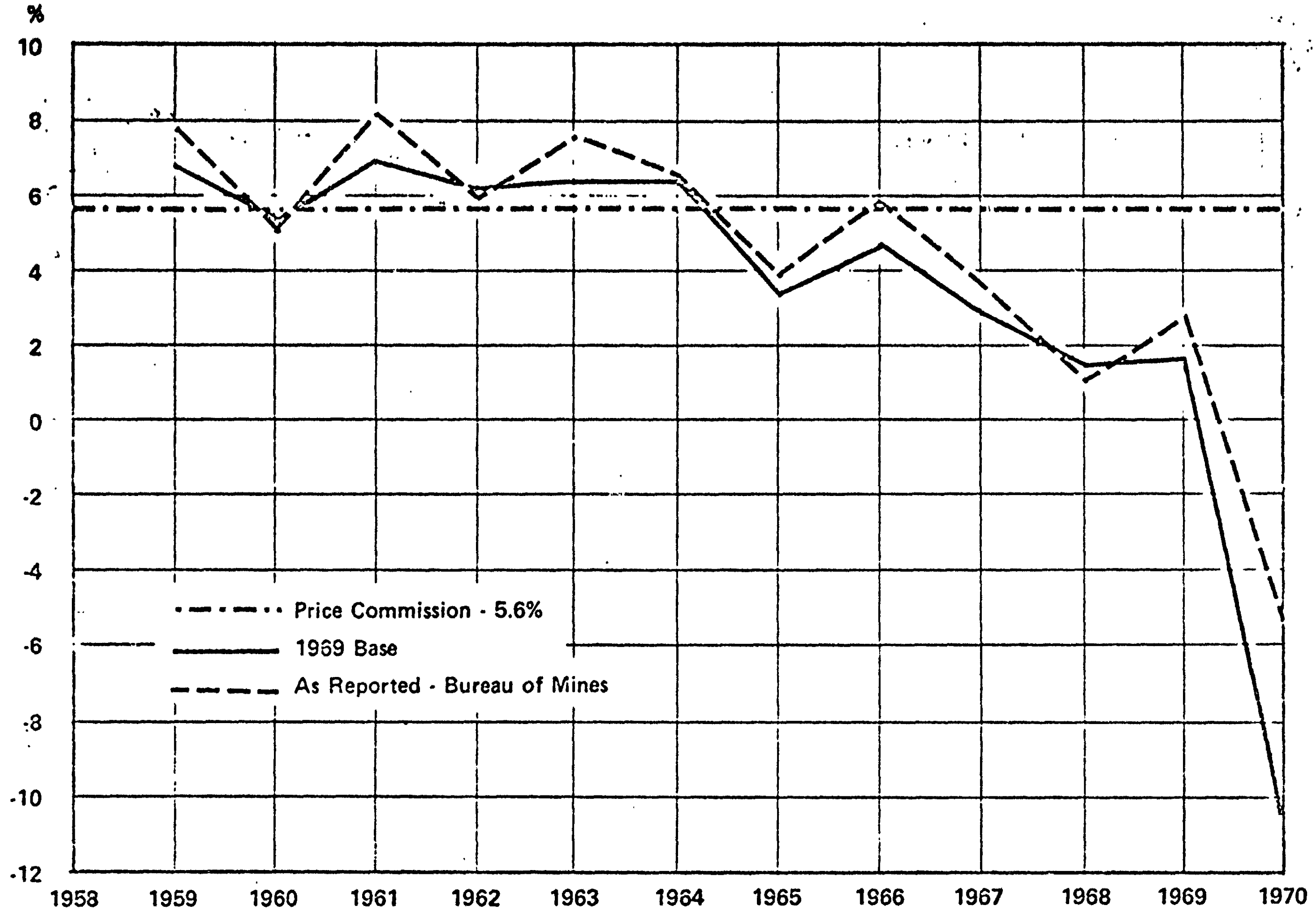
GRAPH I - TONS / MAN DAY



1710

1710

GRAPH II % INCREASE FROM PRECEDING YEAR



Executive Office of the President, Price Commission, Washington, D.C.

Case No. 73-EP-1051

NATIONAL COAL ASSOCIATION, PETITIONER

REQUEST FOR RECONSIDERATION

For the reasons stated herein, National Coal Association ("Petitioner") hereby petitions the Price Commission for reconsideration of its Order, dated November 17, 1972, and received by Petitioner on November 20, 1972.

I. PRELIMINARY STATEMENT

Petitioner's Request for Reconsideration is filed pursuant to Sections 305.32 *et seq.* of the Rules and Regulations of the Price Commission (the "Commission").

Petitioner requests that, on reconsideration, the Commission grant in full the relief requested in Petitioner's Application for Exception, dated July 25, 1972, a copy of which is appended hereto and incorporated herein by reference.

In its Application for Exception, Petitioner requested that the Commission reduce the productivity factor applicable to the coal industry to 0.0 percent to reflect the industry's current actual negative productivity as the result of counter-productive developments drastically affecting operating conditions. The Petitioner in its Application for Exception documented beyond any doubt that the coal industry has experienced no current productivity increase and that productivity has in fact declined, that the 1958-1969 period of measurement cannot be considered representative of the situation today since it does not reflect the marked changes in circumstance affecting productivity, and that while, in fact, a negative productivity factor is justified, a zero productivity gain would be considered reasonable, inasmuch as no industry classification was rated with a negative productivity percentage.

In its November 17, 1972, Order, the Commission found that:

(a) The current structure of operations in the coal industry may distort achievable productivity rates and thereby result in an unrealistic average annual rate of productivity gain as established by the Price Commission;

(b) there are differences in productivity factors affecting surface and underground mining operations;

(c) the information submitted by the National Coal Association provides a basis for the present Commission industry study which may result in a refinement or redetermination of the productivity rate for this standard industrial classification;

(d) the results of this study will enable an equitable determination of a representative average annual rate of productivity gain for the coal industry.

The Commission ordered, that the Request for Exception to adopt a zero percent productivity factor in lieu of the annual 5.6 percent average gain promulgated by Commission Regulation 300.11(a) be denied.

It should be noted that the Price Commission, in what appears to be a completely separate action on November 13, 1972, reduced the productivity factor for the coal industry from 5.6 to 4.9 percent. This reduction was effectuated without any explanation or rationale as to its derivation. However, Petitioner must assume that the 4.9 percent factor was obviously arrived at without consideration of the data and arguments presented by Petitioner. The 4.9 percent figure is just as unrealistic as the former percentage and in no way has it been substantiated as a justified and equitable productivity factor for the coal industry.

II. THE GRANTING OF THE PETITION WILL NOT ESTABLISH ANY BINDING PRECEDENT DETRIMENTAL TO THE ECONOMIC STABILIZATION PROGRAM

As set forth below, the current productivity increase factor is actually working contrary to the stabilization program. There are coal mines which have been shut down due to the limitation on capital return. Similarly, there are mines that are not being engineered or opened. This coal which is not and will not be available is being replaced by foreign oil at a substantially higher cost. Rather than being detrimental to the national interest, a zero productivity factor for the coal industry would prove beneficial to the goals of the Economic Stabilization Program.

III. GROUNDS FOR RECONSIDERATION

It is the Petitioner's contention that the decision of the Commission to reject the July 25 Request for Exception was in error and contrary to the facts presented.

The Commission erred in not giving consideration to external forces which have resulted in an absolute negative productivity factor. To arbitrarily assign a 4.9 percent positive factor is patently in error and ignores the facts that were earlier detailed by the Petitioner, and as elaborated upon and set forth below.

IV. ARGUMENT

When the Price Commission chose the 1958–1969 period as a base for its productivity increase factor, it was obviously considering the whole sweep of American business and not any individual industry. It may be possible to infer the logic involved in picking that particular span of years—a period far enough in the past that data for the terminal year would be available for most industries, and a time span long enough to demonstrate trends.

We do not know how well the productivity record of the base period relates to current productivity of other industries. But for the coal industry it was utterly inappropriate. Ironically, one day before the end of the base period—on December 30, 1969—President Nixon signed the Federal Coal Mine Health and Safety Act. As much as any one factor, this legislation brought a complete and drastic change in the productivity rate of the bituminous coal industry—beginning immediately after the end of the base period, still occurring, and expected to continue indefinitely.

The price constraints which flow from the selection of this base period by the Price Commission are now making it impossible for coal mines to realize a sufficient return on investment which is necessary to finance new coal producing capacity to replace present mines as they are worked out and to provide the added capacity which current government studies indicate is required for future energy demands.

The existing damage to the financial integrity of the coal industry has been compounded further with the second round of pay increases and royalties under the National Bituminous Wage Agreement of 1971. The Pay Board allowed the 7 percent wage increase which is called for in the second year of the contract. This will be a further increase in costs which the industry cannot fully recover under the present Price Commission 5.5 percent formula. While the Pay Board permits the full cost increase of the second year of the contract, its sister agency, the Price Commission, has—in applying an outdated productivity factor and its 5.5 percent wage limitation—compelled the industry to absorb a great part of the wage increase.

The effects of the productivity formula and the 5.5 percent limit produce the opposite result from the intent of the Price Commission's policies to combat inflation. If coal consumers are unable to obtain coal they must turn to imported oil. Oil is not only higher in price than coal in most of the United States, but its price is rising faster. Moreover, these imports are a serious drain on the nation's balance of payments, causing more inflation.

These points are discussed in detail below.

A 4.9 PRODUCTIVITY FACTOR IS NOW TOTALLY INAPPLICABLE

The Commission's formula states that the productivity of bituminous coal miners increased an average of 4.9 percent annually in the dozen years which ended the day after the safety bill was signed. There are some grounds for disputing the accuracy of that figure and questioning its method of computation; these were set forth in the National Coal Association's Application for Exception, filed July 25, 1972, and attached hereto and are not argued further here. More important and really indisputable is that a 4.9 percent annual productivity increase, or any similar figure derived from the 1958–1969 period, is completely inapplicable to present conditions in the coal industry.

Data from the Bureau of Labor Statistics, U.S. Department of Labor, which were not included in Petitioner's July 25 filing, further reinforce this point. A BLS computer printout, a copy of which is attached, as Appendix A, shows the average annual change in output per production worker man-hour in bituminous coal and lignite mining for various periods from 1947 through 1971. For the 1958–1969. period, the average annual increase was 5.5 percent, very close to the original 5.6

percent figure chosen by the Price Commission. However, the printout also shows that figure or the more recent 4.9 percent is no longer representative of subsequent performance.

From 1969 to 1970, BLS shows an annual loss in productivity of 1.5 percent in the coal industry. From 1969 to 1971, the average annual loss of productivity was 1.4 percent. From 1970 to 1971, the loss was 1.3 percent.

Further illustrating the loss in productivity, BLS data (Appendix C) also shows that in the base period nonproduction workers in the industry decreased at an average annual rate of 4.1 percent, whereas, they increased 13.8 percent from 1970 to 1971.

Clearly, therefore, there is a serious inequity when one arm of government, the Price Commission, assumes a productivity increase in the coal industry while the government agency which furnished such data, BLS, documents that it is no longer true. We submit that the Price Commission should regulate coal prices in light of current conditions, and not according to past conditions which no longer prevail. History is instructive only if it is possible for it to repeat itself.

As demonstrated, the coal industry has experienced a negative productivity factor. Since the Commission does not grant a negative productivity factor, it should at least change the factor for the bituminous coal industry to zero.

Some explanation of the changed conditions is in order, to show why the 1958-1969 historical experience no longer applies:

EFFECTS OF SAFETY ACT

Congress has decreed that coal mines must be made safer and healthier places to work, and in furtherance of the Coal Mine Health and Safety Act the Bureau of Mines has issued literally hundreds of stringent new regulations in a process which is still continuing and will go on for several more years.

The coal industry accepts the responsibilities imposed by the health and safety law, and is making a major and continuing effort to comply in full with the spirit of the law as well as the still-growing volume of new regulations. However, it should be recognized that one effect of the regulations has been to seriously reduce productivity, not only by slowing work but by adding non-productive employees. In some underground mines, the average output per man-day has fallen as much as 30 percent. On an industry average, the productivity in underground mines decreased 11.9 percent in 1970. Stated another way, employment is up but production is down.

Federal inspections of mines are required much more frequently than during the 1958-1969 base period. Some mines are now inspected every day. This takes supervisory personnel away from their normal duties, and the inspector is also likely to interrupt production himself.

For example, the new law imposes increased requirements for ventilation of the working face of the mine, the area where coal is actually produced. This entails additional labor—non-productive labor—to install the temporary curtains which direct air currents within the mine, and to advance them as the mining machinery advances. In addition, the constant and necessary movement of men and machinery within the mine is slowed by the requirement to pass through these curtains. The result is a substantial slowing of the mining cycle. Under the law, such steps must be taken at all underground mines, even though there is no methane present at some operations.

For another example, the law specifies that the electrical cables which carry power to the mining equipment can have no more than one temporary splice, and such a splice may be tolerated for no more than 24 hours. The result is more frequent interruptions to change cables, as well as the additional non-productive work force necessary to make the changes.

We do not here argue the merits of these requirements. We do argue, however, that they are a real and major new factor externally applied to coal mining since the end of the 1958-1969 base period, and have not only stopped the annual gain in productivity achieved during the base period, but have reversed it.

CONTINUING IMPACT ON PRODUCTIVITY

And the end is not in sight. New regulations are still being issued, some of them requiring actions far in the future. On September 30, 1972, for example, the Bureau of Mines published a new regulation requiring protective canopies or cabs on self-propelled underground equipment used at the mine face, to protect the operator from falls of coal or rock. The cabs or canopies must be installed by

January 1, 1974, in mines where the mining height—the distance from floor to roof at the face of the coal seam—is six feet or more. In mines with lower roofs, the timetable is extended, affecting the lowest group of mines on July 1, 1976. This means that sometime during the next four years, every piece of self-propelled equipment is going to be out of service long enough for these protective devices to be installed. This will inevitably have an adverse effect on the productivity of the mine and of the industry. Last year the underground mines producing bituminous coal operated 2,065 mobile loading machines, 1,781 continuous-mining machines, 2,058 cutting machines, 731 mobile drills, 1,883 rotary roof-bolting drills, 1,853 rubber-tired tractors, 6,175 shuttle cars, and sundry other equipment. The aggregate loss of production time, compounded by the non-productive work time required to install the cabs and canopies, will be substantial.

Yet this is only one example of the continuing impact of the new law on the coal industry's productivity. Another example of the continuing impact: the dust content of air at the mine face is now limited to 3 milligrams of respirable coal dust per cubic meter of air; at the end of this year, the limit is reduced to 2 milligrams. At great effort, the industry has generally met the 3 milligram limit, but complying with the new and more stringent standard will be more difficult and further reduce production.

The point here is that the Federal Coal Mine Health and Safety Act did not simply impose a one-time requirement to install new machinery or procedures, causing a temporary loss of productivity from which the industry could soon recover. Its effects are pervasive and continuing, and new requirements are still being added. In fact, the Secretary of the Interior is required to upgrade standards continually. In the long run—the very long run—their effects on productivity may be overcome, but not this year or next or the year after.

This is substantiated by National Economic Research Associates, Inc., in a just-released report to the Edison Electric Institute. The report, entitled, "Fuels for the Electric Utility Industry 1971–1985," considers the future availability and price of electric utility fuels and the prospects of developing technology which will allow their use under various environmental restrictions. In its introduction and summary, the NERA report states:

"The mine workers' bargaining position will continue to be strong, with the coal-mining industry needing to expand in the face of an inadequate labor supply. *Productivity gains that might offset the higher wage costs will, moreover, tend to be limited by the second source of upward cost pressure—the Coal Mine Health and Safety Act of 1969. Productivity has declined since it became effective in 1970, as mine operators attempted to cope with the new requirements. Once the adjustment to the stiffer standards has been accomplished, productivity may again resume its long upward trend, but this may take the better part of the decade.*" (Emphasis added)

There are, of course, other costs occasioned by the Coal Mine Health and Safety Act. Substantial expenditures are required for new equipment and procedures. The Commission does not recognize the need to receive a return on the necessary added investment. One provision which bears particularly hard on small operators in Appalachia is the requirement that mines previously considered non-gassy must be re-equipped with "permissible" (i.e., sparkproof) mining machines and other face equipment. These are not only more costly than the non-permissible equipment they previously used, but the machines are expensive to maintain in permissible condition, which means in essence that all their electrical equipment and motors must be air tight, even around shafts and bearings.

While this discussion has dealt principally with deep mines, the Health and Safety Act applies also to surface mining on a slightly delayed timetable now taking effect. This also involves additional non-productive labor for such purposes as installing roll bars on equipment scaling highwalls, improving haul roads, etc., in addition to substantial added capital costs.

For the Commission to make decisions based on the erroneous assumption that productivity is increasing and offsetting these costs, when in fact it has declined and is compounding them is, of course, inequitable and contrary to the intent of Phase II controls.

The combined effects of the health and safety legislation—direct costs plus loss of productivity—amount to substantial expense for a mine operator. Recouping these expenses contributes to and enhances health and safety as set forth in the Federal Coal Mine Health and Safety Act.

OTHER NONPRODUCTIVE FACTORS

The new health and safety law is only one cause of added non-productive labor externally imposed on the coal industry. The costs of surface mining, for example, have increased significantly because of sharply increased reclamation costs. The industry is doing more reclamation work than in the past because of many factors—an increased sense of civic responsibility, response to public pressure, and increasingly stringent state laws and regulations. Although Congress did not enact federal strip mining legislation this year, it is expected to do so in 1973, probably increasing costs further.

Other environmental costs, externally applied, also are increasing non-productive labor and other costs. These include increasing controls on mine drainage, refuse disposal, water impoundments, and air pollutants from coal preparation plants. The requirements of the Water Quality Act likewise increased costs.

Also, the increasingly stringent air quality standards affecting coal are causing more and more customers to demand washed and prepared coal instead of the run-of-the-mine product. Construction of the requisite facilities requires more non-production labor and investment.

EFFECTS ON THE ENERGY CRISIS

The misapplication of the productivity increase factor and the 5.5 percent limit on the coal industry has already had serious long-term effects on the industry's future. It is resulting in a rate of return so low that the coal industry is unable to generate, attract, nor justify the large amounts of new capital required to finance new mines. While capital costs may vary according to the terrain and the depth of the seam, it is generally accepted in the coal industry that the capital cost of installing a new mine is $10 to $20 per ton of annual production. Thus a medium-large mine, with a capacity of 1 million tons a year, represents $10 million to $20 million investment by the time it begins commercial production.

Since the industry needs to replace about 5 percent of its capacity every year simply to replace mines that are worked out, it must open new mines with about 30 million tons of capacity annually just to stay even.

Attracting the requisite capital is proving extremely difficult. There are more than enough risks already in coal industry investments. Increasingly stringent air pollution controls may severely limit the market for all but the very lowest-sulfur coal until some technically and economically feasible form of stack-gas sulfur removal equipment is on the market—and as the National Economic Research Associates report cited earlier says, this may not occur before 1980.

Add to these and other drawbacks the fact that a misapplied productivity factor in pricing regulations is seriously diminishing the rate of return on most coal mines, and it becomes obvious why investors are leery. This is storing up trouble for the future. To install a new deep mine takes three or four years; the new mines we will need in 1975 and 1976 should be begun now. This is not happening.

The Tennessee Valley Authority, in its power report for the fiscal year ended June 30, 1972, said this:

"Even with higher prices being paid, there is a growing concern over the future availability of fuels for power generation. Coal reserves are plentiful, but producers appear hesitant to increase production and open new mines because of the uncertainty over proposed sulfur dioxide emission standards which might leave them with a product that has no market."

While government price and environmental policies on one hand are retarding and discouraging coal production now and in the future, other agencies of government are deeply concerned about present and future fuel supplies. With the nation running low in recoverable reserves of oil and gas, the enormous reserves of coal are our only clearly abundant domestic fuel source. The principal near-term alternative is to import large additional amounts of oil from the Middle East, supplemented by liquefied natural gas from Algeria and possibly from Russia. None of these territories is a secure source of supply in the vagaries of international politics.

James Akins, director of the State Department's Office of Fuels and Energy, earlier this year said that State sees a "profoundly disturbing" picture as it looks at oil import forecasts for 1980. He said, "If we're consuming 24 million barrels a day of oil—and most of that is coming from the Middle East—we'll find it very difficult to conduct a foreign policy with the degree of independence we would like." He went on to say that the cost of oil imports is estimated by State to be $18 billion in 1980.

The National Petroleum Council earlier this year projected that the demand for oil imports in 1985—five years after the time for which Mr. Akins forecast—would be 14.8 million barrels a day at a cost of $19 billion annually. In addition, the NPC projected an unfulfilled potential demand for 24 trillion feet of natural gas annually by 1985; if this were filled by imports, it would be a probable cost in excess of $25 billion annually.

Thus the NPC projection indicates we may be spending close to $45 billion a year in 1985 for imported fuels. Last year the United States had a $3 billion deficit in its balance of payments, leading to devaluation of the dollar. The $45 billion a year bill for imported fuels would be more than the value of all our exports last year. There would seem to be no way that the United States could withstand a drain of this magnitude, year after year, without severe impairment of our economy, and its implications of loss of employment.

The NPC projection of future demand for imported fuels is typical of forecasts made by many government agencies, private economists and staffs of Congressionl committees which have studied the problem. We would suggest the Price Commission ask independently the opinion of such agencies as the Department of the Interior, the Office of Emergency Preparedness, the Department of Commerce, the Department of State, and the White House staff as to the seriousness of the various aspects of the energy supply problem.

COAL UTILIZATION RESEARCH

The principal hope of mitigating the dependence on imported fuel is the great U.S. reserve of bituminous coal—1.5 trillion tons mapped and explored, the U.S. Geological Survey says, and a probable total of 3.2 trillion tons. Testing programs are well advanced, as the previously cited NERA-EEI report points out on stack gas desulfurization processes which will allow coal to continue as the principal fuel of the electric utility industry, reducing the need for imported residual oil. Several gas companies are already contemplating use of the German designed Lurgi coal gasification method, and four government sponsored processes to make pipeline gas from coal are in the pilot plant stage. Groundbreaking took place October 27 for a pilot plant to produce a solid or liquid fuel from coal that is virtually free of sulfur and ash. Other research is working on synthetic petroleum from coal.

All these processes promise to lessen the nation's need for a ruinous amount of fuel imports—but they all require a viable coal industry, working and financially capable of expanding to supply the vast amounts of coal they will consume. But the economic vability of the coal industry has already been damaged by the restrictive actions of the Price Commission in December 1971, which would be compounded by their continuation and by further restrictions from the productivity formula.

DOLLAR IMPACT OF PRODUCTIVITY FACTOR ON THE COAL INDISTRY

The second round of wage increases under the current labor contract in the coal industry, approved by the Pay Board, calls for a 7 percent increase in labor costs and an 8.3 percent increase in royalty for the union's welfare and retirement fund. Assuming labor to constitute 40 percent of the cost of coal, and the welfare fund 10 percent, the price increase without restrictions would work out in this way:

Labor cost increase	Percent of labor cost to total cost	Price increase (percent) (1)×(2)
Labor, 7 percent	40	2.80
Welfare, 8.3 percent	10	.83
Total		3.63

But the labor cost increase allowable is now limited to 5.5 percent. So—

[In percent]

Labor, 5.5 percent	40	2.20
Welfare, 8.3 percent	10	.83
Total		3.03

Applying the 4.9 percent productivity factor—	*Percent*
4.9 times 40 percent labor portion of total cost	1. 96
Allowable price increase	1. 07

Thus the 5.5 percent labor cost limit and the 4.9 percent productivity factor result in a price increase of 1.07 percent instead of 3.63 percent—a reduction of 71 percent

Applying this to the average 1971 value of coal at the mine, which the U.S. Bureau of Mines says was $7.07—

	Percent
$7.07 times 3.63 percent equals	$0. 256
$7.07 times 1.07 percent equals	. 076
Price increase denied	. 180

Actual experience may show larger losses than this hypothetical example for the Bureau of Mines computation of the average value of coal f.o.b. mine at $7.07 in 1971 necessarily covered only about six weeks of operations under the wage agreement which went into effect November 12, 1971. Even at a loss in earnings of 18 cents a ton, however, the effect would be profound. Assuming that the industry may produce 600 million tons of coal in 1973, application of these figures would indicate $108,000,000 of otherwise justified price increases would be denied.

Almost all coal covered by contracts is being sold at ceiling prices, and there is no room to cover steadily increasing labor and material costs incurred as a result of the externally imposed factors already mentioned.

DOLLAR IMPACT ON THE CONSUMER

The $108 million cut-out of coal industry income is important to the industry, but consider the alternative, oil. The impact of such a sum as $108 million on the national economy is relatively insignificant, when compared with the impact of petroleum imports. In 1970, estimated value of residual oil imports alone was more than $1 billion, and the total for all petroleum imports was $2.9 billion.

If mistaken application of an outdated productivity factor forces additional mine closings or makes it impossible for a company to finance a mine for the future, that coal will be replaced, in the aggregate of the nation's energy consumption, with imported oil. The price of the oil will be higher than coal, and its effect on the national economy will be damaging.

Electric utilities, the principal users of coal, increased their coal consumption 2.4 percent in 1971, while their consumption of oil rise by 16.8 percent and their use of gas was up 4.2 percent. However, as shown in Appendix D, coal was substantially cheaper than oil on a national average, and its cost increase "as burned"—which includes increases in rail rates as well as any increases in the selling price—rose less than half as much as the rise in oil costs.

Specifically, the average cost of coal consumed by electric utilities last year was 36 cents per million Btu, an increase of 15.8 percent from 1970. The cost of oil was 51.5 cents per million Btu on a national average, representing a 40.7 percent rise from 1970.

Thus in 1971 the average cost of oil to utilities was 43 percent more than the average cost of coal. To the extent that price regulation may cause coal to be replaced with oil, this would mean that denial of a 2.56 percent coal price increase (as shown above, 3.63 percent actual cost increase due to labor, minus 1.07 percent allowable under present rules) would cause a switch to an alternative fuel at a 43 percent price increase.

CONCLUSION

In summary, an exception should be made for the coal industry from the general application of productivity increase factors based on the 1958–1969 period. The Coal Mine Health and Safety Act and other externally applied factors have drastically reversed the productivity trend in the coal industry.

Recognition of this productivity reversal justifiably warrants relief for the coal industry—including a zero productivity rating. But the nation has a stake in this as well. Critically needed coal supplies for the future are being jeopardized by the current policy. The substitution of higher priced foreign fuels means higher prices to the consumer and an unwarranted increase in our balance of trade deficiency.

An artificially depressed coal industry simply cannot meet existing national needs for coal in its conventional forms today nor the role assigned to it by energy planners as the feedstock for the newly emerged synthetic fuels industry tomorrow.

The rationale of the Price Commission's order of November 17 rejecting outright Petitioner's Request for Exception does not justify the action taken. The four reasons set forth in the order are as follows:

(a) The current structure of operations in the coal industry may distort achievable productivity rates and thereby result in an unrealistic average annual rate of productivity gain as established by the Price Commission;

(b) there are differences in productivity factors affecting surface and underground mining operations;

(c) the information submitted by the National Coal Association provides a basis for the present Commission industry study which may result in a refinement or redetermination of the productivity rate for this standard industrial classification; and

(d) the results of this study will enable an equitable determination of a representative average annual rate of productivity gain for the coal industry.

Essentially these points support Petitioner's Request for Reconsideration. The Commission summarily rejects a change in the productivity gain percentage to zero, and yet (a) recognizes the structure of the coal industry as being one that would be difficult to measure in terms of precise productivity, (b) notes the difference in productivity between deep and strip mined coal, (c) states that refinement may be justified, and (d) affirms that a study by the Commission will enable an equitable determination of productivity gain.

Stated simply, there is tacit admission that the current percentage is inequitable and unjustified, but the Commission refuses to take the next step and give recognition to the documented evidence which warrants a finding that the productivity percentage should be zero.

The adverse impact the application of a productivity factor may have on the nation's welfare for collateral reasons, and the coal industry directly, are herein documented. This is not, however, the basic purpose of this petition. The truth remains that any productivity increase factor is unrealistic, and cannot be defended in light of the existing facts.

For all of the reasons stated above, therefore, it is respectfully requested that this Petition for Reconsideration be granted and that the relief requested in the Petitioner's Application for Exception be allowed in full, or to the maximum extent the Commission deems proper.

In addition, because of the importance of this matter to the nation as well as the coal industry, the Petitioner requests a hearing before the Commission at which time oral argument would be presented.

Respectfully submitted.

CARL E BAGGE,
President, National Coal Association.

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APPENDIX A

BITUMINOUS COAL AND LIGNITE MINING SIC 12

OUTPUT PER PRODUCTION WORKER MAN-HOUR

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1947	-0.2	2.4	4.6	5.2	4.2	4.7	[illegible]	6.4	6.6	6.5	6.6	[illegible]	6.4	6.5	[illegible]	5.4	5.4	6.4	[illegible]	6.3	6.3	[illegible]	[illegible]
1948		5.2	7.3	5.1	4.8	5.2	6.5	7.1	7.2	6.9	[illegible]	[illegible]	[illegible]	6.7	6.7	[illegible]	[illegible]	5.5	[illegible]	[illegible]	6.4	6.2	[illegible]
1949			9.5	[illegible]	4.3	5.1	6.5	7.5	7.5	7.1	7.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.2	[illegible]
1950				-0.5	[illegible]	4.5	7.2	[illegible]	7.8	7.3	7.2	[illegible]	6.7	[illegible]	6.7	[illegible]	6.5	[illegible]	[illegible]	6.4	5.3	6.2	[illegible]
1951					5.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.9	6.7	5.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1952						6.2	12.1	11.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.7	[illegible]	6.5	[illegible]	6.5	[illegible]	[illegible]	[illegible]	[illegible]
1953							10.1	11.7	[illegible]	[illegible]	[illegible]	[illegible]	6.1	6.3	[illegible]	[illegible]	6.2	[illegible]	[illegible]	[illegible]	[illegible]	5.9	[illegible]
1954								7.7	5.5	4.3	5.4	[illegible]	[illegible]	5.6	5.9	[illegible]	[illegible]	[illegible]	[illegible]	5.9	5.3	5.7	[illegible]
1955									3.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.9	5.7	[illegible]
1956										2.3	[illegible]	[illegible]	[illegible]	6.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1957											11.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1958												[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1959													[illegible]	[illegible]	7.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1960														13.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1961															[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1962																3.7	[illegible]	6.1	6.1	[illegible]	[illegible]	[illegible]	[illegible]
1963																	7.2	7.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1964																		[illegible]	6.3	[illegible]	[illegible]	[illegible]	[illegible]
1965																			[illegible]	[illegible]	[illegible]	3.3	[illegible]
1966																				[illegible]	3.6	[illegible]	1.7
1967																					[illegible]	[illegible]	1.2
1968																						[illegible]	[illegible]
1969																							[illegible]

	1971	19
1947	[illegible]	
1948	[illegible]	
1949	[illegible]	
1950	[illegible]	
1951	[illegible]	
1952	[illegible]	
1953	[illegible]	
1954	5.1	
1955	[illegible]	
1956	[illegible]	
1957	[illegible]	
1958	[illegible]	
1959	[illegible]	
1960	[illegible]	
1961	[illegible]	
1962	[illegible]	
1963	[illegible]	
1964	[illegible]	
1965	1.7	
1966	[illegible]	
1967	[illegible]	
1968	[illegible]	
1969	-1.4	
1970	[illegible]	

Source: U.S. Department of Labor, Bureau of Labor Statistics, Div. of Productivity and Technological Developments,

Appendix B

19[illegible]-1971 COMPARATIVE SUMMARY OF FUEL CONSUMPTION AND UNIT COSTS

THOUSANDS OF TONS	YEAR	NEW ENGLAND	MIDDLE ATLANTIC	EAST NORTH CENTRAL	WEST NORTH CENTRAL	SOUTH ATLANTIC	EAST SOUTH CENTRAL	WEST SOUTH CENTRAL	MOUNTAIN	PACIFIC	TOTAL UNITED STATES	COAL CONSUMING [illegible] 1
COAL	1966	8,872	46,639	[illegible]	16,923	50,999	35,253	2	8,546	-	265,357	264,367
	1967	[illegible]	45,035	101,947	17,216	56,595	39,051	2	9,105	-	273,369	273,129
	1968	6,379	45,355	107,170	18,561	61,337	41,365	2	9,605	-	292,353	292,751
	1969	4,557	43,630	115,[illegible]	22,045	63,429	45,774	2	10,743	-	305,435	305,[illegible]
	1970	3,[illegible]	45,766	117,652	26,300	63,585	50,053	2	14,345	-	319,621	319,620
	1971	2,701	43,669	119,455	27,489	65,993	51,556	10	15,685	-	327,357	327,347
PERCENT INCREASE 1971/1970		-21.8	-0.9	+1.5	+6.4	+3.8	+3.0	-	+10.5	-	+2.4	+2.6
OIL (COAL EQUIVALENT)	1966	7,215	13,273	181	87	8,057	14	11	476	5,448	34,773	29,364
	1967	10,256	15,472	176	98	8,246	13	12	419	5,153	37,811	32,656
	1968	12,0[illegible]	18,035	232	240	9,579	27	52	462	5,093	45,672	40,[illegible]
	1969	15,[illegible]	25,203	555	228	14,019	60	92	528	5,533	62,251	55,[illegible]
	1970	20,175	31,[illegible]	2,792	500	21,264	163	256	633	5,859	83,153	77,076
	1971	20,456	3[illegible],553	4,401	430	25,911	309	917	912	9,227	97,135	86,592
PERCENT INCREASE 1971/1970		+1.6	+9.1	+57.7	-14.0	+22.3	+116.1	+247.3	+44.1	+57.5	+16.6	+12.9
GAS (COAL EQUIVALENT)	1966	417	4,057	3,250	12,969	5,278	3,682	47,531	6,259	26,776	110,218	35,901
	1967	392	4,712	3,652	13,713	5,850	4,910	52,046	6,233	26,129	117,686	39,491
	1968	356	5,407	4,612	14,295	8,566	4,997	57,664	6,812	31,526	134,573	45,[illegible]
	1969	275	6,537	6,[illegible]	16,122	10,[illegible]	5,612	62,373	7,969	26,6[illegible]	149,579	55,241
	1970	329	6,503	10,[illegible]	17,167	13,562	6,123	77,761	8,760	29,673	170,336	62,752
	1971	507	5,313	10,657	17,593	16,851	5,967	84,645	9,797	26,753	177,515	66,117
PERCENT INCREASE 1971/1970		+54.1	-18.3	-2.1	+2.5	+24.3	-2.5	+8.9	+11.8	-10.3	+4.2	+5.4
TOTAL (COAL & EQUIVALENTS)	1966	16,504	61,969	102,[illegible]	29,079	64,316	41,969	47,542	15,270	32,235	[illegible]	[illegible]
	1967	17,[illegible]	66,21[illegible]	105,7[illegible]	31,[illegible]	[illegible]	43,5[illegible]	52,[illegible]	15,797	[illegible]	[illegible]	[illegible]
	1968	18,777	68,676	114,719	33,596	79,410	46,398	57,513	16,879	36,616	473,353	370,036
	1969	21,102	75,[illegible]	123,[illegible]	36,595	88,767	51,456	65,465	19,[illegible]	32,459	517,265	417,312
	1970	23,915	82,658	130,363	43,967	98,251	55,319	78,025	23,775	35,[illegible]	573,136	479,438
	1971	23,6[illegible]	83,735	133,932	46,012	106,685	57,832	85,572	26,556	35,983	602,009	480,456
PERCENT INCREASE 1971/1970		-1.0	+1.5	+2.6	+4.7	+10.6	+2.7	+9.7	+11.9	+0.8	+5.0	+4.6
[illegible] (CENTS)												
COAL	1966	33.6	26.5	24.4	26.4	25.6	19.3	2	20.4	-	24.7	24.7
	1967	34.3	27.8	24.7	25.6	26.6	20.1	2	20.1	-	25.2	25.2
	1968	36.3	28.3	25.2	25.1	27.0	20.1	21.5	20.4	-	25.5	25.5
	1969	36.9	30.0	26.4	26.2	28.6	21.1	2	20.6	-	26.6	26.6
	1970	41.9	35.1	30.4	28.2	36.1	23.6	2	19.8	-	31.1	31.1
	1971	48.8	40.9	35.5	31.6	41.8	29.2	17.8	20.9	-	36.0	36.0
PERCENT INCREASE 1971/1970		+16.5	+15.3	+16.8	+12.1	+15.8	+23.7	2	+5.6	-	+15.8	+15.8
OIL	1966	32.9	31.8	59.8	49.9	33.6	52.1	40.7	25.4	31.5	32.4	32.6
	1967	30.5	33.2	62.9	51.6	32.5	53.7	42.4	26.1	31.4	32.2	32.3
	1968	29.4	35.0	64.6	52.6	32.3	55.2	39.2	26.8	32.0	31.8	32.9
	1969	28.3	33.6	62.0	51.8	30.4	51.1	36.9	27.3	36.5	31.9	31.7
	1970	32.8	40.7	56.7	59.0	31.9	54.1	44.6	28.2	36.8	36.6	36.6
	1971	47.6	57.1	63.2	70.3	43.3	49.6	59.8	40.4	55.4	51.5	51.0
PERCENT INCREASE 1971/1970		+45.1	+42.0	+11.5	+19.2	+35.7	-8.3	+35.1	+43.3	+50.5	+40.7	+39.3
GAS	1966	33.8	35.4	25.9	24.2	31.8	22.7	19.8	26.7	31.7	25.1	27.1
	1967	32.7	35.4	26.7	24.0	31.7	23.4	19.9	26.2	30.8	24.7	27.1
	1968	32.0	35.8	28.0	24.5	31.6	23.9	20.1	25.9	30.7	25.1	27.8
	1969	33.7	35.6	31.6	24.9	31.6	24.3	20.5	27.3	31.2	25.4	28.8
	1970	35.3	39.3	37.1	25.6	35.7	25.3	21.1	29.3	32.4	27.0	31.8
	1971	45.5	44.9	42.9	28.3	39.7	27.9	22.2	32.6	34.6	28.8	35.4
PERCENT INCREASE 1971/1970		+28.9	+12.2	+15.6	+10.5	+11.4	+10.3	+5.2	+10.6	+6.8	+6.7	+12.7

1. Excludes West South Central and Pacific regions. (Prior to the 1966 FACTS report Arizona, [illegible] and [illegible] were also excluded from this area. The 1971 [illegible] excluding Arizona, [illegible], [illegible], West South Central and Pacific are: Coal, 321,313 tons; oil 77,351 tons; gas, 66,75[illegible] tons; [illegible] total [illegible] tons. Cost [illegible] (cents) were: Coal, [illegible]; oil 53.3; gas, 35.7)
2. [illegible]
[illegible] converted on the basis of the Btu data shown in Table 2. Conversion factors: [illegible] 1966 data, 22,[illegible] Btu; 1967 data, 23,[illegible]; 1968 and 1969 data, 23,[illegible] Btu; 1970 data, 23,750,000 Btu. [illegible] figures may not add due to rounding.

Source: Steam-Electric Plant Factors, 19[illegible] 1972 Edition, Table 2.

Appendix C

BITUMINOUS COAL AND LIGNITE MINING SIC 12

NON-PRODUCTION WORKERS

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1947	5.5	2.1	-0.6	-1.4	-1.9	-2.9	-4.0	-4.3	-3.6	-2.5	-1.6	-1.3	-1.2	-1.5	-1.9	-2.3	-2.5	-2.7	-2.7	-2.7	-2.7	-2.6	-2.5
1948		-1.1	-3.5	-3.1	-3.1	-4.1	-5.1	-5.2	-4.1	-2.6	-1.6	-1.3	-1.2	-1.5	-1.9	-2.4	-2.7	-2.8	-2.9	-2.8	-2.[illegible]	-2.7	-2.5
1949			-5.7	-3.7	-3.4	-4.7	-5.8	-5.7	-4.3	-2.6	-1.5	-0.9	-0.9	-1.2	-1.6	-2.3	-2.7	-2.3	-2.9	-2.5	-2.5	-2.7	-2.5
1950				-1.6	-2.5	-4.9	-6.3	-5.1	-4.1	-2.0	-0.3	-0.3	-0.3	-0.9	-1.5	-2.2	-2.5	-2.8	-2.3	-2.6	-2.7	-2.5	-2.5
1951					-3.3	-6.8	-7.9	-6.9	-4.0	-1.4	0.0	0.5	0.3	-0.5	-1.3	-2.1	-2.6	-2.8	-2.9	-2.6	-2.5	-2.5	-2.4
1952						-10.1	-9.8	-7.4	-3.1	0.1	1.5	1.7	1.2	0.1	-1.0	-2.0	-2.5	-2.8	-2.7	-2.8	-2.7	-2.5	-2.4
1953							-9.5	-5.6	-0.8	3.4	4.2	3.7	2.5	0.9	-0.6	-1.3	-2.5	-2.6	-2.9	-2.8	-2.8	-2.6	-2.4
1954								-1.5	5.4	8.0	7.3	5.5	3.5	1.2	-0.7	-2.2	-2.9	-3.2	-3.2	-3.1	-3.0	-2.8	-2.5
1955									12.8	12.3	9.1	5.5	3.1	0.2	-1.9	-3.4	-4.0	-4.2	-4.0	-3.8	-3.5	-3.2	-2.9
1956										11.8	6.8	3.2	0.5	-2.4	-4.3	-5.5	-5.8	-5.6	-5.2	-4.7	-4.3	-3.9	-3.4
1957											2.1	-3.7	-2.7	-5.4	-6.4	-7.7	-7.5	-6.9	-6.1	-5.4	-4.8	-4.2	-3.6
1958												-3.3	-4.9	-7.8	-8.9	-9.3	-8.6	-7.5	-6.5	-5.6	-4.8	-4.1	-3.4
1959													-6.4	-10.1	-10.6	-10.5	-9.2	-7.7	-6.3	-5.2	-4.4	-3.7	-2.9
1960														-13.7	-12.1	-11.2	-9.1	-7.2	-5.5	-4.4	-3.5	-2.[illegible]	-2.[illegible]
1961															-10.6	-10.0	-7.5	-5.3	-3.7	-2.7	-2.1	-1.5	-0.9
1962																-9.4	-5.5	-3.3	-1.3	-1.1	-0.7	-0.3	0.2
1963																	-1.4	-0.4	0.4	0.5	0.5	0.6	1.1
1964																		0.7	1.3	1.0	0.[illegible]	0.9	1.4
1965																			1.9	1.0	0.5	0.8	1.5
1966																				-0.0	0.3	0.6	1.7
1967																					0.6	0.9	2.4
1968																						1.3	3.5
1969																							5.7

	1971	19
1947	-2.2	
1948	-2.5	
1949	-2.2	
1950	-2.1	
1951	-2.1	
1952	-2.0	
1953	-2.0	
1954	-2.0	
1955	-2.3	
1956	-2.7	
1957	-2.[illegible]	
1958	-2.5	
1959	-1.9	
1960	-1.0	
1961	0.1	
1962	1.2	
1963	2.1	
1964	2.6	
1965	3.[illegible]	
1966	3.[illegible]	
1967	4.9	
1968	6.7	
1969	9.7	
1970	13.8	

Senator GRAVEL. And I can appreciate that some mines probably would not meet the safety standards, but in addition to improving the safety standards, it would fly in the face of economic laws purely as a matter of policy.

Mr. BAGGE. Well, we would be delighted to do that, Senator. The foreign oil which has flooded the east coast, and usurped coal's utility markets, not only on the east coast, but Chicago, where Venezuelan oil has been coming up the Mississippi to replace coal, of course, for environmental purposes. And yet the future of the country we believe, at least for the midterm, will depend literally, quite literally, on coal in one form or another.

So, briefly, Senator, we say that Government policies today are operating as a total constraint on both coal production and on coal utilization. We are closing mines, tragically, at the very time that we are being told by Mr. Simon, the new Energy Administrator, that we should be generating an additional production this year of 60 to 70 million tons of incremental expansion in order to accommodate the conversion of east coast utilities back to coal from Middle Eastern oil.

But coal production simply cannot be turned on and off like a spigot, like a valve, and people do not understand this, Senator. They think it is something off the shelf. I think they think of the oil industry and the gas industry in the same way. We must, however, have assurances for the future to guarantee the Nation a stable and continuing supply of coal. As a direct result of existing erroneous governmental policies, the American coal industry cannot attract the necessary capital to open new mines or even to expand existing ones. And yet, because of various governmental requirements, including health and safety and environmental standards, our costs are increasing substantially.

I am not downgrading any of these programs. We must have safe mines. We are not quibbling about the Mine Health and Safety Act. We are not even quibbling about the goals of the Clear Air Act. We do quibble, however, with the means by which it is being implemented. We think it is totally irrational. The mines must be safe, we have to make them as safe as humanly possible. The environment should be protected. But the costs of these programs have resulted in a rate of return so low that the American coal industry is unable to attract or justify the large amounts of capital required to open new mines.

Senator GRAVEL. Could I ask you a question here?

Excuse my interruption again, but if the Cost of Living Council gave you the ability to be good environmentalists, could we assume that you would be good environmentalists, that you would crank in the costs of producing a cleaner product, and of course, make it safer for the employees who work there, and could this be done through the cost mechanism itself?

Mr. BAGGE. Well, the Cost of Living Council, in all fairness, is permitting the recoupment as an allowable cost of the costs of coal cleaning and direct costs such as that.

But the fact remains that because of the totally illogical productivity factor that they are applying and because of the profit margins which shackle us to the best of the last 3 years, we are not permitted to be profitable. Senator Long was referring to that experience in questioning the previous witness about the test years.

Now if these were the lean years of oil, Senator, they certainly were for coal with the exception of 1970 when we had another crisis in the Middle East, when a pipeline broke and the American coal industry was called upon to serve its usual ambulance role in 1970, when there was a little profit blimp—we have not been profitable in these years.

But to shackle us, as the Cost of Living Council does in fact today for the larger producers based on the best of those 3 years, and as some Members of the Congress would do in this legislation which is pending before you, I think is totally inconsistent with the public interest.

Senator GRAVEL. But the point I was trying to make, and I want to press it because it should be underscored, is that to be environmentally acceptable to many people, it takes money. It takes cost. It adds cost to the product and the people in the private sector might well want to go to this cost to do the job, assuming that it could be cranked into the market place. Otherwise, they cannot do it.

Mr. BAGGE. Right.

Senator GRAVEL. And what you are telling me is that the main thing you object to is the inability to receive a reasonable profit. And this inability causes you to not produce because it cannot be done.

Mr. BAGGE. Or, to not expand.

Senator GRAVEL. And the other economic factors.

It is a product of the mine safety problem, and the environmental problem, but your primary objection is to the pricing and the lack of ability to create a profit to stay in business?

Mr. BAGGE. With one little footnote to the environmental problem, we quibble not with the goals but with the methodology which is being employed to implement the Clean Air Act of 1970. There is a fixation, a simplistic fixation, on the amount of sulfur in the fuel, and I say there is more concern in the legislation about the kind of sulfur in the stack than with the quality of the air that people breathe. We can burn a great deal of high sulfur coal, Senator, in this country—not in all urban areas—but in areas outside of the immediate urban environment, by using tall stacks, by using intermittent control techniques, and other technologies. The point is that even without the SO-2 scrubbers, which are not today available, this coal can and should be burned.

Senator GRAVEL. You have seen pictures of the 4 Corners plant?

Mr. BAGGE. Yes, I have been out there, Senator. I have visited 4 Corners and I can say that the whole problem there has been resolved. All the units are clean now. All you can see today, Senator, and it should have been put on in the first instance, but all you see now is vapor coming out of those stacks at 4 Corners.

Senator GRAVEL. They have been cleaned up?

Mr. BAGGE. Yes, all the units are operating now and have—we are talking now about the electrostatic precipitators which remove not the sulfur, but which remove the particulates from the emissions. That is now clean. I have been out there only recently and observed them. Only two of those units were covered initially. They are all covered now.

Senator GRAVEL. Very good.

Mr. BAGGE. While capital costs may vary according to terrain and depth of the seam, it is generally accepted in the coal industry that the capital cost of installing a new deep mine is $20 to $25 per ton of annual production. Thus, a medium-sized mine with a capacity of a million tons per year represents a $20 to $25 million investment by the time it begins commercial production.

And since the industry needs to replace about 5 percent of its capacity every year to compensate for mines that are worked out, the depleted resource, the new mines with about 30 million tons of capacity must be opened annually just to maintain the existing level of production.

But here is the important point, Senator. Unfortunately for the past two decades, the capacity of the American coal industry has remained stagnant. It has remained totally stagnant. And there were slight expansions in response to what were short-term crises in supply and demand relationships, particularly in 1970 when we had another ambulance role to play for the Nation.

But for the most part, national policies resulted in a tight rein on coal expansability. The magnitude of the short-sightedness is clearly evident today when our national well-being, indeed our national welfare, is clearly tied to the availability of coal to expand on an accelerated basis, not only in its conventional form, but as the mother fuel for the whole range of emerging synthetics.

Unfortunately, expansion of this sort is better attained from a base of growth rather than stagnation. And stagnation has characterized our industry, and does, unfortunately, even today.

Now, next Senator, I deal—and I will summarize this.

I begin on page 8 with your bill S. 2806 and let me if I can comment very briefly on that. The ultimate goals, we believe, of S. 2806, are highly commendable—and I underscore Senator, highly commendable. We certainly could not agree more with the objectives of your bill.

I had the unique pleasure of discussing this with you privately before you wrote the bill, and I thank you for that opportunity.

We do not quibble with the goals at all. The coal industry supports greatly expanded research in the energy area. We think we need a new agency. We need to ventilate new ideas, to get new people, and we agree with taking this research away from the Atomic Energy Commission as it is presently constituted.

So we agree in large part with the thrust, certainly the thrust of many of the features of the bill. Equally important, we support the aim of the legislation, to make the United States at least 95-percent energy self-sufficient by 1985.

And beyond this there are certain provisions that merit special comment.

May I briefly comment on those?

Now, I think the key thing and the thing that you and I have discussed, Senator, that in fact motivated you—I do not want to presume when I say this, but I have given it a good deal of thought following our conversations about the problem that you put to me when this bill was in its conceptual stages—that is, how can we finance at these greatly expanded levels the national needs in energy R. & D. These are unprecedented, really, in our history, in terms of energy R. & D. because we never thought about the problem of energy before.

Senator GRAVEL. R. & D. and prototyping.

Mr. BAGGE. That is right.

Without a substantial tax increase, and I think it was your opinion, that it would be very difficult. On the one hand, to have a major tax increase to fund this, and on the other hand, you indicated the other option is to have a substantial decline in our Federal programs in other areas, each of which are difficult. Maybe in our ordering of priorities we could cut other programs. And I want you to know. Senator, I genuinely gave this a great deal of thought, and we have here an alternative for your consideration.

I do not want to be presumptuous when I say this, but I would like to request your consideration and the committee's consideration of what we in the Coal Association, came up with as an alternative to your proposal.

Senator GRAVEL. What page is that on?

Mr. BAGGE. So I am focusing first on the trust fund and tax. One of the basic provisions, if indeed not the thrust of the bill, because of your concern, you personal concern, with this issue was the establishment of an energy trust fund to be supported by a tax on energy sources based on the Btu content.

I think this is the key element that distinguishes this bill from other pieces of legislation which are pending before the Congress in other areas. And for a number of reasons we believe that such a proposal, speaking now for our industry, is not in the public interest.

To our knowledge, such a Federal tax has never been levied before. In the past, when the Congress determined the need for research money, it was appropriated out of the general funds. The electric utility industry was not taxed for the development of nuclear power, and hospitals were not taxed for medical research. The aerospace industry was not taxed for putting an American on the Moon.

Further, while the tax would apply proportionately to the existing fuel industries, there is no assurance that these industries taxed would receive their proportionate share of reasearch, although I know from discussing this with you and the members of your staff. That was one of your basic objectives, Senator.

For example, in a typical year coal might generate as much as $650 million through the Btu tax as we have calculated. Such an amount would far exceed the annual net income of all coal producers in the Nation. Under this proposal, oil and gas would be assessed much more than coal. Nuclear and geothermal would for the foreseeable future contribute very little. Yet, nuclear research would undoubtedly receive a lion's share of the funds, just to maintain its current rate of Government funding.

Now, it is interesting to note that even in fiscal year 1975 budget, the proposals that the President submitted, nuclear still has the lion's share of the funding.

Moreover, there is serous question as to how much additional research is needed in the natural gas and petroleum industries, in light of what is presently carried out by private industry. And there, I think private industry has to be commended and certainly the oil and gas industry—the coal industry has been hard-pressed for funding of R. & D. programs. Take the kind of marketing pattern that you yourself opened this discussion with, how can the small producers, who operate on a marginal, 1-year-to-year basis, be putting money away for R. & D.?

They have no certainty they are going to be in business a year from now. Without profits and the hope for the future of the industry, a long-term hope, substantial research was both impossible and unnecessary for the coal industry.

The picture is now changing. The future of coal is brighter, and while profits may still be low, industry money is now going into research.

The next paragraph on the page I would like to read very carefully, because we have been thinking about this hearing, and, in trying to be responsive to it, made a survey of our own membership on R. & D. which we are disclosing here for the first time. The National Coal Association has now completed a survey of industry research activities. We are making this now publicly available through this hearing and this forum today. Although the results are not yet complete and require more intensive review, we do believe that they indicate that coal research funding is significant.

Our preliminary figures indicate that in the period 1969 to 1973, a portion of the industry spend about $135 million on energy R. & D. of all types. More importantly perhaps, for the next 5 years, for the next 5 years, Senator, these same companies, members of my association, plan to spend nearly $400 million, or an increase for the American coal industry of 196 percent. This level of spending in a period of low coal profitability is a sure indication that the coal industry believes in its future and is willing to commit its resources to that future, even though we still want some green light from the Government.

The Government policymakers do help us share the conviction in our own future. Clearly, there is much to be done. Of particular concern to us is the need to both perfect underground mining systems, and more importantly for the longer range, to develop new mining systems, which are obviously needed if coal is to treble its production by the year 1985.

Senator, I want to say parenthetically, we are still, using the mining technology that has done nothing more than mechanize the pick and shovel. This is an obsolete technology, the so-called "continuous miner," which was developed 30 years ago, this is still our most advanced tool. That is continuous only 35 percent of the time. We need great breakthroughs in underground mining technology.

The CHAIRMAN. Would you mind giving us just some idea as to the kind of potential that exists or the kind of new technique which you think might make it possible to improve your mining efficiency, and that is the extraction and delivery of the energy to the public?

Mr. BAGGE. In the deep mines?

The CHAIRMAN. Well, however, in other words, you said a continuous miner is a good machine, but that is just an improvement on the pick and shovel.

Mr. BAGGE. That is all it is.

The CHAIRMAN. What do you have in mind as something that might be a better approach?

Mr. BAGGE. Senator, let me start out and say, we can improve the so-called "continuous miner" to make it truly continuous; it is now operating only 35 percent of the time when it is at the face. This is a tremendously sophisticated machine at a tremendous cost, which is only operating 35 percent of the time, because we have not solved the logistical problem—inside the mine. We have a logistical problem on the surface because of the railroad industry, which is not able to handle our new production. That is another story—but we also have a logistical problem, Senator, within the mine of keeping the flow of coal from the face, from the continuous miner. If we could lick that problem and have a belting system that would be continuously operated, we could operate the continuous miner 100 percent of the time, increase its productivity or treble its productivity, and that itself would be a breakthrough. We are working on that.

Now, other concepts which I think your question suggests, Senator, include hydraulic mining, mining with water, laser beam technology, taking the men away from the mine face, putting them on machines. Senator, the challenge of 20 or 30 years ago when John L. Lewis led the mineworkers, was the mechanization of coal mining in this country. Today, our challenge is the automation of coal mining. We are talking about gasification, Senator, where we can actually transform the coal resource into gas in the bowels of the earth, without even having the men's hands put down there. We are talking about huge sophisticated consoles, which would take the men away from the mine, remove them from the hazards, from the hazards of mining.

We are talking about a whole range of different technology.

The CHAIRMAN. Let me see if I understand just one thing you are talking about.

Mr. BAGGE. Yes, sir.

The CHAIRMAN. As I understand it, you are thinking about trying to develop a way in which a man above the ground can direct the machines—let us say something like a closed-circuit TV device—so that he is completely safe in an air-conditioned room above the ground where he can sit there in complete comfort pushing buttons and doing things with machines, doing just what he would do with his hands if he was down there with the pick and shovels in the olden days?

Mr. BAGGE. This is our hope, Senator. This is our dream. This is the hope and the dream of our industry, to do precisely that.

The CHAIRMAN. Well, some nights when I have had difficulty sleeping I have thought about things like that. And it seems to me that that type of thing would have to be the way of the future in the coal mining business. That way you do not risk the life of a man below ground, or very few, anyway. Just once in a while somebody goes down to repair the machine, and the machinery does the work.

Mr. BAGGE. This is our dream, Senator, and one that we hope will be realized.

But I want to say, when we talk about that, that there has not been a nickel, there has not been a nickel put in by the Federal Government, by the Bureau of Mines or the Office of Coal Research or any agency of the Federal Government to assist our industry in enhancing mining productivity.

This year in fiscal year 1974 we have as a line item in the Bureau of Mines budget, about $3.2 million, as I recall the number. This is the first time that the Government has chosen to assist us in trying to perfect that dream, the first time in fiscal year 1974.

The CHAIRMAN. Well, I believe that in the next few days—Senator Byrd of West Virginia is better qualified to speak to it than I am—but I believe that you are going to have an affirmative commitment sometime within the next few days of a large amount of money to help. We think it is very important.

Mr. BAGGE. Senator, we are very gratified.

Senator GRAVEL. If I could pose one question.

You are taking the position here against an ability to raise the money to do it. So far, you have not done too well competitively with the Federal budget up to this point in time. Now, I am looking to the proposal where you are going to show me where we are going to get the money to do this. Since you have not done it competitively, let us see where you can find it now.

Mr. BAGGE. I am going to get to that. This is where you personally challenged me. Senator—when you had this concept in your mind and asked me to think about it. I have thought about it.

Senator GRAVEL. With money we can do a lot of things.

Mr. BAGGE. That is right. We have got you the answer. I want to say this respectfully—when I say, Senator, that we have a suggestion for you and your colleagues to think about.

If indeed a separate energy trust fund is determined to be necessary, there are other possible ways of generating these funds. And here is the thought that we give to you respectfully but we hope you will regard it as a creative response to your challenge to me.

For instance, over the past years billions of dollars have poured into the Federal treasury through the development of fuel resources on Federal lands and the Outer Continental Shelf. In the fiscal year ending June 30, 1973, the Federal Government received over $3.3 billion from royalties, bonuses, and rentals with respect to the development of fuel resources on these properties.

In raising this alternative, I am not endorsing the present methods by which the Federal Government disposes of its interest in these lands. You know there is criticism of the bonus and the bidding: whether we are opening it up to enough of the smaller people and other energy industries. So we are not condoning that method. We think improvements can be made so other interests can come in and bid for these leases.

But I am referring only to disposition of the funds raised in the existing system. In the future, I think we can anticipate a substantial increase from this source, Senator. Witness the prices being paid for offshore drilling rights right now—the last offshore sale, two small tracts of oil shale at Rifle, Colo., the geothermal steam reserves, as well as past coal leases.

And I might say parenthetically we have not had a coal lease in the last 3 years from the Department of Interior. Not one coal lease.

Now, if we are going to fund energy R. & D. from this there is going to have to be an incentive to start some leasing programs.

Senator GRAVEL. Well, let us stop there for a moment. You have not had any coal leases. Do you bonus bid coal leases like you do oil leases?

Mr. BAGGE. I think so.

Senator GRAVEL. So if we bonus bid coal leases we are going to take money away from you and put it in another pot to do the research that you want to do?

Why recycle the money?

Why not let you have the money and you do the research, and not hire the bureaucrats to walk around with the money?

Mr. BAGGE. Well, we are doing this anyway today.

Senator GRAVEL. But your suggestion here of $3.3 billion, that is right. That came in. So we could get the oil industry to finance the coal industry. But as I know a little bit about who owns the coal industry, and we are robbing Peter to pay Paul.

Mr. BAGGE. Negative, Senator. With all due regard, that statement you just made about who owns whom, I have to respectfully dissent from that, Senator.

Senator GRAVEL. Well, maybe I could ask you to submit for the record, and it will help to clear up this thing, because I was just mouthing a cliche, and I would like to have it corrected for the record. Could you furnish and submit for the record the names and the percent of production of coal companies owned by major oil companies?

Mr. BAGGE. I can do that right now. But I would be happy to submit it for the record.

Senator GRAVEL. We want a good, detailed analysis of the entire ownership pattern, and I think that we could put that issue to rest once and for all.

Mr. BAGGE. I wish we could put it to rest for once and for all.

Senator GRAVEL. Well, we will try.

[The following was subsequently supplied for the record:]

Oil producers and companies with oil producing interests which produce coal

	Annual tonnage
Continental Oil (Consolidation Coal)	64, 942, 000
Occidental Petroleum (Island Creek Coal)	22, 605, 114
Standard Oil of Ohio (Old Ben)	11, 235, 910
Gulf Oil (Pittsburg & Midway)	7, 678, 672
Belco Petroleum (Hawley Fuel)	1, 650, 000
Falcon Seaboard:	
(Breathitt County Coal Corp.)	2, 100, 000
(Black Eagle Coal Co.)	742, 678
(Falcon Coal Co.)	386, 566
(Mount Top Stripping)	N.A.
Mapco, Inc. (Webster County Coal Corp.)	1, 431, 000
Humble Oil & Refining (Monterey Coal Co.)	1, 974, 355
W. R. Grace & Co. (Blue Diamond Coal Co.)	1, 107, 009
McCulloch Oil Corp.:	
(Kingdom Come Coal Co.)	507, 785
(Carbon Fuel Co.)	322, 225
(McCulloch Coal Co.)	295, 815
(Maxietta Coal, No. 7 Corp., and Big Four; Kentucky mines)	N.A.
Zapata Corp. (Boone County Coal Corp.)	658, 757
U.S. Natural Resources (Twilight Industries)	725, 518
Westrans Industries, Inc.:	
(Canterbury Coal Co.)	590, 647
(Kristianson & Johnson Coal Co.)	448, 909
Crestmont Oil & Gas Co. (Black Lode Coal Co.)	N.A.
Total (approximately 20 percent of 1972 coal production of 595,000,000 tons)	119, 402, 960

1972 tonnages are given or latest figure available.
N.A.—not available.

The CHAIRMAN. Well, while we are on the subject, though, do you agree with those of us that feel that asking for these big bonuses on these leases does no more than take away from the industry money that we would like to see used in producing more energy?

I do not care whether you put the money into coal, or put it into oil, or gas or shale. If you have got $3 billion, you should not be trying to pour that into the Federal Treasury, the balance of the Federal budget. You ought to be putting that into trying to find more energy, and then you could make more money for the Government in all probability by simply reducing the bonuses to just a sufficient amount to indicate good faith, and then proceed to place a requirement that they produce immediately, and especially out of the best reserves, and then having done that, you could then, instead of a bonus, require them to pay more at the other end, so that as they produce the energy and as they pay back their investment, they then give us a lot more than we would have had. In the long run, the Government would make more money that way then it would the other way.

Mr. BAGGE. And it also broadens the number of economic entities who have the ability to compete in the production.

The CHAIRMAN. That way, the little fellow who has got a $5 million company, but very efficient, might find it possible to go out and compete with the big fellow who has got a billion-dollar company. But he cannot do it now. He cannot bid any $60 million for a lease. I am told that one of these leases brought a bid of $200 million.

Now, how many companies can bid $200 million not knowing for sure whether there is oil down there or not?

Mr. BAGGE. Exactly.

We are not condoning the system. We are just saying, let us take the funds as they flow into the Treasury. Use that as your source for the energy R. & D.

I would like to make two points in this, Senator, if I may. Two arguments seem persuasive to this approach. First, in taking funds generated from public energy resources and investing them in energy R. & D., America will in effect be capitalizing these resources. And your two previous witnesses, who are both economists, I think should be attracted to the concept of our capitalizing our natural resources for energy R. & D. The potential return on that capital investment in terms of our national welfare is enormous, dwarfing the magnitude of the resources themselves and offering America the promise of energy abundance long after the age of present energy resources has passed its apex.

Senator GRAVEL. This is where I have a problem.

Mr. BAGGE. The concept is one of capitalizing our resources through the mechanism of the royalty mechanism, to capitalize our natural resources as we place them in the private sector for development by taking those funds flowing to energy——

Senator GRAVEL. Where do these funds come from, though?

Mr. BAGGE. They come from the parties that are going to be developing the resource.

Senator GRAVEL. But then that is a tax on you. You are developing the resource, and you are saying we are going to get the money from you to tax on you.

What we have devised with the Btu tax is saying that we do not think we ought to discriminate against you as opposed to atomic energy. In your proposal, coal is going to pay a tax, and the atomic energy plant that is selling electricity is not. Now, you may say that, you know, they are going to take the lion's share of the budget. But at least be willing to take the gift that I am trying to give you of having them taxed like you are and like oil is.

Mr. BAGGE. Well, uranium reserves are in the Federal domain, too, and you are going to have uranium producers participating in this.

Senator GRAVEL. Sure, they are going to have to pay. Sure, they are going to have to pay. And there is nothing wrong with that.

But you are coming out against the tax which I think is more equitable to the coal industry, and you are talking to us about a theory of capitalization.

Where are you going to get the money to fund it?

And then the $3.3 billion that Senator Long has pointed out is just robbing Peter to pay Paul. We are building into the bill a 7-percent investment tax credit for the whole energy field.

Mr. BAGGE. We welcome that.

Senator GRAVEL. Which you benefit from. But then you are going to take $3 billion, more if we accelerate the offshore leasing. We will take maybe $5 billion away.

What is the point of taking the money away if we are trying to get it back into the oil industry?

Mr. BAGGE. Because the coal industry is paying this fee now.

Senator GRAVEL. Which fee are you paying now?

Mr. BAGGE. Well, in terms of as we go on the Federal lands if they will ever give us a lease, which we hope they will, in the very near future that this is an existing cost that we are bearing, we are paying now.

Senator GRAVEL. Well, you will be paying if you have some leases. You will have bonus bidding, and you will be doing the same thing as the oil companies.

Mr. BAGGE. That is right.

Senator GRAVEL. But if we recognize that it is robbing Peter to pay Paul with the oil companies, why will it not be robbing Peter to pay Paul with the coal industry?

Mr. BAGGE. This is more advantageous to the coal industry.

Senator GRAVEL. To take money from you?

Mr. BAGGE. No, to use the funds that we would——

Senator GRAVEL. Understand me, Mr. Bagge. We are going to take the money, if we follow present policy you are going to bid on a piece of ground. We are going to take that money and put it in a general fund, and then you go fight with the Interior Department to get your million dollars for research.

Mr. BAGGE. No, because you are going to set up a trust fund, which is going to provide that all of this money shall flow to the trust fund for energy R. & D., not to the general fund. So we do not have to fight for the money any longer.

The CHAIRMAN. Well, I heard the chairman of the subcommittee—not to dismiss this idea out of hand. Frankly, from my point of view, just as a politician, I would rather vote to capitalize something than tax somebody. But the more you think about it, it may be that this may just be a way to avoid a big tax.

Mr. BAGGE. Exactly. You are capitalizing a resource. You are not taxing people. You are capitalizing a resource. I am delighted to have the Chairman's comment.

The CHAIRMAN. Well frankly, I have been trying to find some way that this cup might pass us, so that we might avoid voting for a great big tax and find some other way to do the same thing. I just did not know any better way to do it. Now, I believe you are going to have to spell it out a little bit better so I can get the picture as to just how you have in mind that you are going to capitalize something rather than tax it.

Mr. BAGGE. Exactly.

The CHAIRMAN. Well, you might explain that a little bit, though. Be more graphic, if you can.

Mr. BAGGE. I am not an economist. I have not taken the courses that you say you took, Senator. I just took a basic freshman economics course. But I know the concept. We say we have a natural resource in the ground, the Outer Continental Shelf. Let us take the east coast; we are looking at that now. And if the environmentalists would ever let us put a rig down there to drill for oil and gas (if we view this as a resource that ought to be capitalized), the concept is that we should take the money that the private sector pays as they go in to exploit that resource and that shall be dedicated through a trust fund for the purpose of our Nation investing it in the proceeds of energy R. & D. It is only some economists or econometrician, I guess, who can articulate this succinctly enough and clearly enough.

But it seems to me that by capitalizing the resource, by taking the money flowing into a trust fund in energy R. & D., we can leverage, Senator, our natural resources in a way that we never dreamt of before. Expanding the thermal efficiency, let us say, of our electric generation is a great need.

The CHAIRMAN. Well, let us just take one aspect of it now, just one little aspect of this.

You have got all that oil up there at Prudhoe Bay in Alaska. And right now it is not worth much because you cannot get it out of there. But we put a pipeline to get that oil out. That oil is worth a lot more than it is without the pipeline. Now, if you simply put the oil reserves on the books as an asset, there is just a great deal of money that is worth. My God, if you try to think about the amount of money, it staggers you to think about the kind of money that will be needed for the job.

But there is an enormous resource up there. That thing must be worth——

How much would you guess in terms of dollars at the going market price with all those oil reserves at Prudhoe Bay would be worth. Senator?

Can you give me a guess?

Senator GRAVEL. Ten billion, minimum. At a minimum, it would be 10 billion barrels.

The CHAIRMAN. Well, let us say you got 10 billion barrels at a price of $5 per barrel. There is $50 billion. That is just about what we think we are going to need to get into high gear in producing the amount of oil that is needed.

But your thought is that if you capitalize that and you simply—and you borrow some money to drill the wills, and you simply capitalize that along with what you have got here, and you have got to pledge the whole thing and pay the money off.

Mr. BAGGE. Right.

There is another aspect to this, Senator, too, that I think is important. This alternative appears to be far less inflationary than a Btu tax, with all due respect to your bill, Senator. This is because the Btu tax would be passed directly through to consumers, adding significantly to the Nation's total energy bill and impacting most heavily on those consumers least able to pay the higher energy costs.

Now, we see it as less inflationary to capitalize these great resources we have. Use that as a basis for your energy R. & D. trust fund, and we think it has a great deal of merit. And I must say that I was delighted with Senator Long's reaction——

Senator GRAVEL. We just had testimony—you were sitting here, you heard—that the highest rate of tax that Dr. Jorgensen put forward was 4 percent, which is average inflationary.

Mr. BAGGE. Well, Bill Simon testified before you, and I have to rely on what the Administration at least in part says, that it would impact 18 percent on coal.

Senator GRAVEL. Well, you do not rely on them for your research moneys. You do not find wisdom there. We just had an economist there that we are all impressed with who said that it did not have an inflationary factor.

But, back to the capitalization, I know one simple law of economics, and I majored in economics, and I would say this, that somebody pays. There is nothing for nothing. And if you say that it is going to be passed through to the consumer, then it will not hurt the coal industry to have this tax. Now, we have had testimony that coal is discrimiuated against by the Btu tax because it is not as efficient as other fuels. So, when you testify that you would like to have legislation that says coal is the mother fuel, I came back to you with a free enterprise system to let the people choose and the market dictate that. That is exactly what would happen with the Btu tax; you would let the market then make a choice as to what is the most desirable fuel for people to have.

Mr. BAGGE. Except that the Btu tax is going to impact on coal more.

Senator GRAVEL. Why does it impact on coal more?

Mr. BAGGE. Well, our paper deals with it. We say that one estimate, of the amount of money generated here, is $650 million. This is more than the total net income of all coal producers in the Nation.

Senator GRAVEL. That does not respond to my question, Mr. Bagge. Why does it impact more on coal than on oil?

Mr. BAGGE. Well, this is our estimate of how we think it is going to impact.

Senator GRAVEL. Well, the reason why it impacts more on coal than oil is because oil is more efficient than coal, and gas is more efficient than oil, and we have got it backwards in our society. We have artificially kept oil and gas low, which has skewed the whole marketplace. And what I am trying to do in this bill is to come back to some sanity in a free enterprise system where we can then make proper priority decisions.

Mr. BAGGE. Right. And I do not question your motivation, Senator. I just say that I am throwing out another idea for your consideration.

Senator GRAVEL. I think that in the interest of time, maybe you could submit it and I will be happy to accept it for the record. And I can assure you that I will try to give it as much of my attention as possible. If you could submit a paper expanding upon your capitalization theory?

Mr. BAGGE. I would be delighted to.

(Mr. Bagge subsequently submitted the following additional material:)

NATIONAL COAL ASSOCIATION,
Washington, D.C., February 8, 1974.

Hon. MIKE GRAVEL,
U.S. Senate,
Washington, D.C.

DEAR SENATOR GRAVEL: This will elaborate on our testimony before your committee as it relates to S. 2167 as proposed by Senator Cook on the concept of "capitalization of the resources" with respect to energy research and development.

Several assumptions underlie our decision to support the idea of an investment of funds generated by federal leasing in the R&D area.

First, the widely recognized need for energy self-sufficiency demands a quantum jump in the technological base supporting our energy industry, most notably in the coal area.

Second, a large portion of the funds necessary to support this R&D will, of necessity, have to come from the federal government either through the use of general tax revenues or from funds specifically earmarked for that purpose.

Third, energy research and development funding will have to complete for a share of the federal dollar with other national priorities in an atmosphere hardly conductive to the additional generation of funds through the tax mechanism.

Fourth, whatever measures are used to generate research and development funds for energy care must be complemented so as to minimize any adverse impact on industry and to reduce to a minimum the cost impact on the final consumer.

From these assumptions our analysis led us to reject the idea of a Btu tax as suggested in S. 2806 on energy sales.

We did this because:

It impacted most heavily upon the coal industry and in our opinion made coal's competitive position less, rather than more, desirable.

It is very definitely inflationary with the ultimate consumer quickly feeling the impact of the tax.

It represented what we considered to be a system which could easily be used as one more tax measure to generate funds for general governmental purposes.

By the same token, however, we recognize that federal research and development programs must be financed, and that such financing would place a heavy burden on the treasury and the taxpayer. We believe such a burden to be worthwhile, but nonetheless a heavy one.

Further analysis led us to consider two alternatives for governmental funding of research and development:

General Treasury Funds

"Capitalizing the Wealth Represented by Federal Energy Resources"

The first option has much to recommend it. Energy self-sufficiency is a goal closely tied to our national well-being. Since this accomplishment will mean so much to our national life style, logic would indicate that the public should pay the cost involved.

There is much precedent for this in the energy field. The nuclear power program has received, and continues to receive, substantial federal financial assistance.

Indeed, the federal government has invested billions in the civilian nuclear power program with ongoing programs costing billions more; all of these funds come from general tax revenues.

Another program where similar efforts have been made is in the space area. Here again the diversion of national economic resources was through the general tax mechanism and was borne by the general taxpayer.

We believe that energy independence for the United States fully justifies the proposed research and development expenditures whether we are considering the Administration's proposal or several now pending before the Congress.

However, we also recognize the need for fiscal savings where such savings can, in fact, be made. One mechanism for reducing the need for general tax revenues to fund R&D would be to shift the burden where possible from the cash assets of the U.S. citizen obtained through the tax mechanism to the resource assets held for him in trust by the federal government. In this way the funds generated through the development of these assets would be invested in energy R&D so that their worth may be enlarged and enhanced by development, much as prudent investment guarantees, over time, continuing value growth.

In essence, we view the federal energy resources as a part of the asset portfolio of the American people. We are suggesting that one option which should be carefully analyzed is for the diversion of a portion of this asset into energy R&D, i.e., the assets should, in part, be capitalized and invested specifically in energy research programs rather than flowing through the general treasury to be utilized immediately for a multitude of purposes.

The intent here is "capital accumulation" for investment purposes—a plowing back into the economy for future benefit a portion of our current income derived from the use of our energy resource assets.

The magnitude of the potential investment is relatively large. Senator Cook of Kentucky, for example, in introducing S. 2167, estimated that funds obtained from outer-continental shelf lease sales totaled more than $6.3 billion for the years 1968 through 1973. When receipts from leasing programs on coal and oil shale are added to that of the OCS, and when the increasing value of these resources is taken into account it is obvious that the national patrimony represented by federal energy holdings is indeed significant.

In raising this alternative method of funding, I am not endorsing the present methods by which the federal government disposes of its interests in these lands. I am referring only to the disposition of the funds raised through the leasing system.

The same logic which dictates our expanded energy research and development program out of general funds is applicable here. Research, while only one part of the system necessary for energy independence, nonetheless has exciting potential. For, research can give us new mining technology, more efficient power generating systems, technologically superior ways to use our vast coal resources as a base for both liquefaction and gasification, and finally a bridge between energy growth and the environment. But most importantly, money invested in energy R&D now will build the technological basis for the maintenance of our industrial economy and the national well-being which is so dependent upon that economy.

We recognize that the Congress must carefully consider various approaches to funding R&D research with maximum effectiveness for the national interest. Perhaps a trust fund financed by both monies from federal leasing programs and general revenues will be the ultimate answer to this dilemma. Whatever the outcome, however, the research and development program of the federal government must be viewed in terms of an investment and monies put into that fund must be considered as capital.

Along this line we would recommend a careful consideration of S. 2167 along with other current funding proposals. From this effort must come a responsive and long-term national research program capable of helping America to achieve energy independence.

Sincerely,

CARL E. BAGGE.

Senator GRAVEL. The Chairman may find it attractive and I may find it attractive, too, because I do not like the idea of raising taxes in a political year when I am running for reelection.

Mr. BAGGE. You would rather, as he said, be capitalizing our resources?

Senator GRAVEL. I would rather hide from the problem.

And if you can show me a way to do it, I would be happy to take that on.

Mr. BAGGE. Believe me, we worked on this, and this is the way.

Senator GRAVEL. I would be happy to see an expanded paper from you.

Mr. BAGGE. We would be happy to do so.

Senator GRAVEL. Could you summarize as briefly as possible?

Mr. BAGGE. Could I just submit the rest of this for the record in the interest of time? I just wanted to say one thing. The invitation also addressed itself to problems in addition to S. 2806, and rather than take your time here, I submit that we try to identify, Senator, those pending bills before this very committee which we think are vital to increased coal expansion. To mention one of those, I think it is scandalous that our depletion rate is less than shale oil.

We have been discriminated against since our depletion is at the rate of 10 percent. Shale oil has been increased to 15 percent. Here we are thinking of oil shale and coal in the same context today. We think this should be enacted as promptly as possible.

Thank you very much.

Senator GRAVEL. Well thank you. And I can assure you that I will read it and we may get back to you with some questions to expand upon.

Mr. BAGGE. Thank you very much.

[Mr. Bagge's prepared statement and a subsequent letter of Mr. Bagge follows:]

PREPARED STATEMENT OF CARL E. BAGGE, PRESIDENT, NATIONAL COAL ASSOCIATION

My name is Carl E. Bagge. I am president of the National Coal Association, whose members include the major coal producing and coal sales companies of the nation. I am accompanied today by Robert Stauffer, NCA general counsel and Joseph Brennan our vice president of economics and planning.

We appreciate the opportunity to express our views on S. 2806, as well as other financial and tax-related subjects which impact on the energy crisis.

I realize that the details of the energy crisis have been discussed at length in earlier hearings before your committee. I do believe, however, that some discussion about coal and its role in helping resolve the crisis would contribute to your deliberations. Although there are several significant requirements which must be met if the coal industry is to expand its productive capacity, I will limit the scope of my remarks before this committee to the impact fiscal policy and financial incentives have on the coal industry's ability to meet its commitments.

COAL'S FINANCIAL REQUIREMENTS

The coal industry's projected financial requirements are indeed staggering. The National Petroleum Council estimated a year ago, on the assumption that Mid-East oil would continue to be available, that coal's capital needs would be $10–$15 billion by 1985. This was projected in 1970 dollars For an industry with a current total capitalization of $4 billion, the magnitude of the task seems almost unattainable. However, such financing levels can be met if the investment climate surrounding coal is strongly expansionary.

Coal must compete for its investment funds. To do so successfully it must be an attractive investment opportunity with a competitive short- and long-range rate of return. Currently the industry simply does not have such a rate of return and thus the potential for development remains only that—a potential.

Current price restrictions which inhibit coal development must be removed. New mining capacity is badly needed, and yet it cannot be added without a more

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favorable return of investment. The Cost of Living Council gave credence to this factor in exempting long-term utility coal contracts, but the action was not nearly enough. A more proper course would be to remove coal from price restrictions entirely, at least until significant new coal capacity had been added and coal profit margins move upward to competitive levels. We are gratified that S. 2806 would remove price restrictions on coal. Hopefully this would be accomplished immediately rather than in less than the one year time frame proposed in the bill.

The heavy burden of "retroactivity"—benefits to miners who incurred the disease before law required the industry to pay for benefits—imposed by the black lung law must be removed. If the industry must pay the potential billions of dollars for "retroactive" black lung disease, its ability to expand will be greatly impaired. This is especially true in the "traditional" mining segment of the industry, particularly those companies with a long history of underground mining in the Appalachian region.

The tax structure of coal must be shifted to encourage expansion. NCA has supported changes in the tax code to do this. Each of these individually and all of them collectively will enhance coal's financial attractiveness and should be considered by the Congress.

America is an energy intensive nation. Raw energy value in 1972 was about $23.7 billion. This includes crude oil value at the wellhead of about $11.2 billion; coal at the mine of $3.6 billion; domestic natural gas at the well of $4.1 billion and energy imports of all types in excess of $4.8 billion. The 1973 figures will, of course, be much higher.

The substantial figures highlighted above, however, do not begin to indicate the vital importance of energy, both in our national life and in our relative position in the world at large. For, it is evident that energy now occupies the central role in the rapidly unfolding dilemma of industrial America which, accustomed to unlimited natural resources, now finds itself dealing with growing fuel shortages. At stake is our ability to continue the social and economic progress which we have made over the past several decades and, more importantly perhaps, our ability to function in the world community as s stable and progressive force.

Energy, its supply and consumption, is no longer of parochial interest only to the energy industry. Rather, its importance has escalated and it must now occupy the immediate attention of those charged with the determination of national policy at the highest level. This fact is being underscored today in these hearings you have convened on this subject, Mr. Chairman.

In the area of oil imports, for example, James Akins, former director of the State Department's Office of Fuels and Energy, said in 1972 that State sees a "profoundly disturbing" picture as it looks at oil import forecasts for 1980. He said, "If we're consuming 24 million barrels a day of oil—and most of that is coming from the Middle East—we'll find it very difficult to conduct a foreign policy with the degree of independence we would like." It happened sooner than Mr. Akins anticipated. He went on to say that the cost of oil imports is estimated by State to be $18 billion in 1980.

A National Petroleum Council study made in 1972 indicated we may be spending close to $45 billion a year in 1985 for imported fuels. That was before the astounding escalation of prices recently announced by the OPEC countries and other oil exporting nations. Even that now obviously low estimate of $45 billion a year for imported fuels would be more than the value of all our exports last year. There would seem to be no way that the United States could withstand a drain of this magnitude, year after year, without severe impairment of our economy, and its implications of loss of employment.

The NPC projection of future demand for imported fuel is typical of forecasts made by many government agencies, private economists and staffs of congressional committees which have studied the problem.

Based on the potential disaster embodied in these import projections, the imperative for creating incentives for domestic resource development is now clear. Either we will develop our indigenous energy resources and thus regain national self-sufficiency, or we will become increasingly dependent on foreign resources with the gravest possible consequences for our national security and our ability to promote the well-being of our own citizens, as well as to act as a responsible member of the world community.

The United States must now look to domestic sources for its energy. In this country, coal represents 88 percent of known total U.S. fuel reserves, including uranium. From this vast supply base will logically come a significant increase in demand for coal in its conventional form. Additionally, in a few years we will also be able to utilize some of these coal reserves in the form of contaminant-free synthetic fuels. Even if the Arabs turn on the oil faucet, we must never again be lulled into complacency and forced into the position in which we find ourselves today.

There are several requirements that must be met to develop what, up until recently, has been a neglected coal industry. Today the financial community is very reluctant to finance the expansion of existing mines, or open new mines. Lending institutions recognize that the risk is not justified by the return; the dollar incentive is not there.

The coal industry is currently beset by a host of significant problems. Air quality restrictions prohibit the burning of much of our available reserves; the Coal Mine Health and Safety Act has substantially reduced our deep mine productivity; foreign residual oil has flooded the East Coast and usurped coal's markets. And yet, the future of the country, for the mid-term at least, will depend on coal, in one form or another.

But coal production cannot be turned on and off like a spigot. We must have assurances for the future to guarantee the nation a stable and continuing supply of coal.

As a direct result of existing law and governmental policies, the coal industry cannot attract the necessary capital to open new mines or expand existing ones. Because of various government requirements, including health and safety and environmental standards, our costs are increasing substantially. I am not downgrading any of these programs. The mines must be made as safe as humanly possible. The environment—air, water and land—should be protected. But the costs of these programs have resulted in a rate of return so low that the coal industry is unable to generate, attract, or justify the large amounts of capital required to open new mines.

While capital costs may vary according to the terrain and depth of the seam, it is generally accepted in the coal industry that the capital cost of installing a new deep mine is \$20 to \$25 per ton of annual production. Thus a medium-large mine, with a capacity of 1 million tons a year, represents \$20 million to \$25 million investment by the time it begins commercial production.

Since the industry needs to replace about 5 percent of its capacity every year simply to compensate for mines that are worked out, new mines with about 30 million tons of capacity must be opened annually just to maintain the level of production.

Unfortunately, for the past two decades the capacity of the coal industry has remained stagnant. There were slight expansions in response to what were short-term crises in supply/demand relationships but, for the most part, national policies resulted in a tight rein on coal expansibility. The magnitude of this short-sightedness is clearly evident now when our well-being, indeed our national welfare, is clearly tied to the ability of coal to expand on an accelerated basis. Unfortunately, expansion of this sort is better attained from a base of growth rather than stagnation.

S. 2806

The ultimate goals of S. 2806 are highly commendable. The coal industry supports greatly expanded research in the energy area. Equally important, we support the stated aim of the legislation to make the United States at least 95 percent energy self-sufficient by 1985. Beyond this there are certain provisions that merit special comment.

Trust fund and tax

One of the basic provisions of S. 2806 is the establishment of an energy trust fund to be supported by a tax on energy sources, based on Btu content. For a number of reasons, we believe such a proposal is not in the public interest.

To our knowledge, such a federal tax has never been levied before. In the past when the Congress determined the need for research, money was appropriated out of the general funds. The electric utility industry was not taxed for the development of nuclear power. Hospitals are not taxed for medical research. The aerospace industry was not taxed for putting an American on the moon.

Further, while the tax would apply proportionately to the existing fuel industries, there is no assurance that those industries taxed would receive their proportionate share of research. For example, in a typical year, coal might generate as much as \$650 million through the Btu tax. Such an amount would far exceed the annual net income of all coal producers in the nation.

Under the proposal, oil and natural gas would be assessed much more than coal. Nuclear and geothermal would, for the foreseeable future, contribute very little. Yet, nuclear research would undoubtedly receive the lion's share of the funds just to maintain its current rate of government funding. Moreover, there is a serious question as to how much additional research is needed in the natural gas or petroleum industries in light of what is presently carried out by private industry.

The coal industry has been hard-pressed for funding of R. & D. programs. Without profits and hope for the future ot the industry, substantial research was both impossible and unnecessary. The picture is changing now. The future of coal is brighter, and while profits may be low, industry money is now going into research.

The National Coal Association is now completing a survey of industry research activities. Although the results are not yet complete and require a more intensive review, we do believe they indicate that coal research funding is significant. Our preliminary figures indicate that in the period 1969 to 1973 a portion of the industry spent about $135 million on energy research and development of all types. More importantly perhaps, for the next five years these companies plan to spend nearly $400 million, or an increase of 196 percent. This level of spending in a period of low coal profitability is a sure indication that coal industry believes in its future and is willing to commit its resources to that future.

Clearly there is much to be done. Of particular concern to us is the need to both perfect underground mining systems and, more importantly for the longer range, to develop new mining systems which are so obviously needed if coal is to treble its production by the year 1985.

Based upon the good-faith commitment by the coal industry of its limited funds to R. & D. and upon the need for additional funding and programs in such areas as production technology and coal utilization, I believe a proposal that would tax our industry billions of dollars over several years, yet invest only a small portion of that sum directly on the industry, is inequitable and indeed contrary to the public interest.

If indeed a separate energy trust fund is determined to be necessary, there are other possible ways of generating these funds. For instance, over the past years, billions of dollars have poured into the federal treasury through the development of fuel resources on federal lands and the outer continental shelf. In the fiscal year ending June 30, 1973, the federal government received $3.3 billion from royalties, bonuses and rentals with respect to the development of fuel resources on these properties. In raising this alternative, I am not endorsing the present methods by which the federal government disposes of its interest in these lands. Rather, I am only referring to the disposition of the funds raised through the existing system.

In the future we can only anticipate a substantial increase from this source. Witness the prices being paid for off-shore drilling rights, two small tracts of oil shale, the geothermal steam reserves, as well as past coal leases. The value of these reserves will escalate in the future and the royalties received by the federal government will multiply.

Two arguments seem pursuasive for this approach. First, in taking funds generated from the public energy resources and investing them in energy R&D, America will, in effect, be capitalizing those resources. The potential return on that capital investment in terms of our national welfare is enormous, dwarfing the magnitude of the resources themselves, and offering America the promise of energy abundance long after the age of present energy resources has passed its apex.

Second, this alternative appears to be far less inflationary than a Btu tax as suggested in S. 2806. This is because the Btu tax would be passed directly through to consumers, adding significantly to the nation's total energy bill and impacting most heavily upon those consumers least able to pay high energy costs.

Commission on Energy Technology Assessment

The system to control disposition of the R&D funds in the bill also raises some significant problems. Among other things, industry, which is supporting the fund, would have no input as to how the money should be spent. We think such a proposal is just as repugnant today as it was in Colonial days—namely, the concept of "taxation without representation."

Section 401 of S. 2806 establishes an Energy Technology Assessment Board of 21 members to advise the Administrator on the disposition of trust fund monies. Provision is made for the staggering of terms, with seven of the first appointees to serve for four years, seven for seven years, and seven for ten years. Even with this staggering of terms, we believe there is a serious possibility of stagnation of ideas within the Board. During the first four years there would be no new official input on this governing body.

We believe that in the interest of flexibility and the ventilation of new ideas, a new person should be appointed every year. Further, we would urge that extensive use be made of advisory committees made up of industry scientists, engineers, and others working on a day-to-day basis with the problems of energy.

Energy source excise tax

In the case of coal, we do not believe that the 20 percent limitation on profits is in the public interest. We do not quarrel with the objective of preventing windfall profits or with the intention of the legislation to incorporate incentives for investment of energy producing facilities.

However, the current low profitability of the coal industry, coupled with the staggering financial demands incident to the expansion of coal capacity, are such that any limitation on coal profits at this time would inhibit the flow of funds into coal and reduce the amount of internal capital available for reinvestment. As a practical matter, the coal industry's profit level is far below the 20 percent level and, thus, the chief impact of the legislation as applied to coal would be the psychological barrier of profit limitations in an industry which desperately requires both capital inflow and internal capital generation of a magnitude without historic parallel.

Export controls

Recently, the Coal Exporters Association, an affiliate of the National Coal Association, adopted a position paper on export controls. This paper sets forth the policy of the Exporters Association as well as National Coal's on this vital issue, and we would like to submit it for the record.

In summary, we are opposed to any unnecessary constraints on the exportation of coal, much less any proposal to ban all exports. We do not believe that any export restraints are necessary at this time. However, if restrictive measures such as export licenses become necessary, they should be designed and administered to minimize their effect on existing or traditional customers abroad. In no event should export licenses be determined under an auction system.

Price controls

We fully support the proposal to terminate price controls on coal. Pricing restraints are among the most critical problems affecting the coal industry's ability to generate an immediate surge capacity from existing mines to supply the demand for coal over the next year. Price regulations have contributed to a serious lack of profitability in the coal industry that has also made it exceedingly difficult for coal producers to generate or attract new capital to open new mines.

Instead of ending price controls over a one year period, however, we believe that the controls should be eliminated at once. This could be accomplished either by executive authority or legislation. Another year of low profit margins in the coal industry will further contribute to the industry's burden of meeting the immediate and future demand for coal. In light of the national needs, such a situation should not be prolonged, but rather resolved as soon as possible.

Increased production

Section 1104 of the bill provides for increasing production of oil and gas on federal lands. We strongly urge that this section be expanded to include coal.

The Department of the Interior has effectively declared a moratorium on coal leasing on federal lands and, as a result, few coal leases have been granted over the past three years on these lands. At a time when the nation is faced with increasing fuel shortfalls and when the low-sulfur coal deposits on these lands in the West are badly needed to meet our environmental standards, we believe the government's policy is unconscionable. In order to rectify this counterproductive situation, increased coal production on federal lands must be an espoused commitment of national policy.

OTHER ENERGY-RELATED TAX PROPOSALS

Beyond S. 2806 there are other issues of fiscal policy and financial incentives that warrant our brief discussion.

We believe there should be no diminution of the incentives afforded by existing Code provisions relative to percentage depletion. In fact, we strongly support S. 198, introduced by Senator Hansen and co-sponsored by Senators Stevens, Fannin, Bennett, Moss and Randolph, and referred to the Finance Committee. This bill would raise the depletion rate for coal to 15 percent, the allowance permitted most other non-energy minerals. This would still be substantially less than the 22 percent allowed oil, gas and uranium, but on par with oil shale.

As the members of the committee know, the percentage depletion allowance is limited to 50 percent of the taxable income from the property. Because of the relatively low rate of profit in coal (in terms of percentage of the selling price), the limitation operates with particular effect on the coal industry. According to our estimates, the limitation results in an average effective rate of depletion equivalent to about 6 or 7 percent of the gross income from the property.

For a coal mine limited by the net (as most mines are), an increase in the gross rate will not be of immediate benefit—by the same token, it will cost the Treasury practically nothing.

There are a few mines—very few—which could derive some slight benefit from an increase in the gross rate. The amount of this benefit, and the concomitant reduction of federal revenue, would be extremely small.

The question naturally arises, "if the benefit is so small, why does the industry bother to ask for it?" The answer lies in the future. If the coal insustry is to be able to serve the nation's future energy needs (not only for electricity but also for synthetic fuels), extremely heavy financial commitments will have to be made to open the necessary coal mines. Those commitments will not be made without proper incentives. One such incentive is the possibility of receiving an adequate depletion allowance if sufficient success is achieved and mining techniques are improved.

Senator Hansen has also introduced S. 1853, a bill to extend the cutoff point for depletion purposes for coal used for conversion to low-pollutant liquid, gas, or solid fuels.

Existing law provides that if coal is processed to produce liquid, gas or solid low-sulfur fuel, such processing is considered beyond the valuation point for percentage depletion purposes. That is, for percentage depletion purposes the coal must be valued before it is converted to low-sulfur fuel. Existing law, however, does permit the processing of oil shale to the point where it is equivalent in value to crude petroleum.

Again, looking to the future, we believe that legislation should be enacted which would permit, for percentage depletion purposes, processing of coal into low-sulfur fuel—synthetic gas, synthetic oil, or low-sulfur solid fuel. Thus, the same depletion valuation would apply to natural gas, natural petroleum, synthetic fuels from oil shale and synthetic fuels from coal. If coal is processed to remove pollutants, the valuation for depletion purposes would occur after such processing.

Coal and oil shale constitute such a huge part of our total energy reserves that inevitably they must be used to satisfy future deficiencies in supplies of natural gas and oil. As noted earlier, coal represents 88 percent of known total U.S. fuel reserves, including uranium, and 74 percent of all of our ultimately recoverable fuel reserves. The only question is, how soon before coal must meet its potential? The conversion of these fuels to low-sulfur fuels should be encouraged to the extent possible because the commercial utilizatiou of such conversion will contribute immeasurably to assuring the United States an adequate domestic energy supply which can be used without damage to the quality of the ambient air.

Congress has already provided, in Section 613(c)(4)(A) of the Code, that processes to convert oil shale to the equivalent of crude petroleum (retorting) shall be considered as taking place prior to the depletion "cutoff point." Such treatment increases the incentive for investment in oil shale conversion plants, since it increases the possible future percentage depletion deduction. Similar treatment should be provided for coal which is converted to low-sulfur fuel, not merely as a matter of equity but, far more important, because the nation needs additional sources of clean fuel, and synthetic fuel from coal appears closer to reality than is true with respect to oil shale.

In the absence of some unexpected scientific breakthrough, synthetic liquid and gas fuels from coal and oil shale will not supplant natural gas and petroleum—they will merely supplement them in the very difficult task of meeting future energy needs. This is true because the cost of producing oil and gas from coal and oil shale is probably still higher than the current price of natural gas and oil. However, with current escalating oil prices, the lines may be very close to crossing. When that time arrives, the shortage of natural gas and oil and the increasing cost of finding new supplies will drive the price upward to a level where synthetic fuels from coal and oil shale will be competitive. At that point, which may already have been reached, the additional supplies represented by synthetic fuels will be badly needed.

Legislation here proposed would also cover processing of coal to produce a low-sulfur solid fuel—a process currently in the research stage. This should be encouraged because many of the smaller industrial plants have need for solid fuel but are not large enough to warrant building a chemical plant to remove pollutants from the boiler stack. With the increasing demand for a clean environment, such plants may wind up with no source of energy unless industry is encouraged to invest in these processes.

There are other tax features that should be considered in the effort to make this nation self-sufficient in energy by 1985. Some are provisions now in the Code that are often under attack, but which should be preserved. Others might be considered for enactment into law.

In the interest of time, I will mention them without detailed comment.

There must not be a reduction in the incentives for the development of mineral properties by amending the Code to force full capitalization of these costs. Development of mineral properties is risky at best; those undertaking this risk should be encouraged to do so.

As a further incentive to the financial community to invest in mining properties, the investment credit should be preserved. Moreover, we support the additional tax credit to 14 percent for depreciable property used in the exploration and development of energy resources as proposed in S. 2806.

The coal industry is opposed to the minimum tax in its present form. In essence, the minimum tax is not a "minimum tax" at all. For most coal companies it is nothing more than an additional tax. As conceived, this levy was intended to force some income tax requirements on those *individuals* with very large incomes who, because of Code provisions, source of income, etc., paid no taxes. As it now operates, however, this intention is overshadowed by the fact that while these certain individuals may now be taxed, the revenue raised from corporations probably exceeds that realized from the individual taxpayers. It is counterproductive to incentive measures that exist in the Code and proposed in S. 2806. At the very least, the minimum tax should not be assessed against corporations.

The current capital gains treatment of coal, timber and iron ore royalties should be continued. The basis for this treatment is sound tax policy due to the fact that the disposal contracts under which they are paid are in reality sales.

Legislation should be enacted to extend the 5-year amortization privilege to all owners of rolling stock, not just common carrier railroads. This would encourage large coal consumers to purchase unit trains of the type necessary to move the huge quantities of coal from the mines to the marketplace. Unfortunately, many railroads do not have the necessary investment funds for purchase of such equipment.

This leads to one final item of discussion. In 1969 certain Code provisions were enacted allowing for accelerated amortization on selected depreciable property. By the terms of the provisions, they will expire at the end of this year.

Of particular interest to our industry is Section 187 relating to the amortization of certain coal mine safety equipment, Section 169 relating to the amortization of pollution control facilities and Section 184 relating to the amortization of certain railroad rolling stock.

The extension of these provisions can be justified, and the committee should give such action favorable consideration while expanding Section 184 to cover all owners of rolling stock, not just common carrier railroads.

CONCLUSION

The United States is locked in the grip of a severe energy crisis. That fact can no longer be talked away. Our domestic oil supply is limited and our known natural gas reserves are running out. Compounding the problem is the cut off of imports from the Arabic nations. Meanwhile, the promise of the atom is still years away.

Balancing this dilemma is the fact that we have approximately three trillion tons of coal reserves in the United States—sufficient to last for hundreds of years, at any conceivable level of use. And now we must turn to this reserve to preserve our national integrity, both from a balance of payments standpoint and as a necessity for national security.

However, faced with the problems of the coal industry, the financial community is reluctant to invest in new mines. The dollar incentive does not justify the inherent risk.

Much of this risk could be ameliorated through tax incentives. The incentives we have discussed here today would go far toward restoring this nation to self-sufficiency in energy.

U.S. EXPORTS OF BITUMINOUS COAL

(By Coal Exporters Association of the United States, Inc., Washington, D.C.)

The United States is the largest coal exporting nation in the world. To attain this record has not been an easy task for the American suppliers who furnish coal to many nations throughout the world. U.S. coal suppliers face severe competition abroad from other coal-producing countries including Canada, Australia, Poland and the U.S.S.R.

The United States expects to be in the business of exporting coal as long as there are markets abroad for high-quality coal at realistic prices. This is simply a matter of good business for America, which needs all the export leverage it can get. Our government has actively encouraged coal exports, which contribute more than $1 billion to the nation's balance of payments. Overseas exports have historically accounted for between 6 and 7 percent of U.S. coal production, and the U.S. government has consistently urged that these exports be increased to aid the chronic balance of trade deficit, which only recently has shown a surplus.

The foreign nations who need U.S. metallurgical coal have shown foresight. They have entered into purchasing contracts ahead of time—far enough ahead of time to give the necessary incentive for capital investment in productive facilities. In consequence, the growth of the coal export market has benefited the nation by the $1 billion contribution (1972) toward the nation's balance of trade.

Some foreign customers have invested millions of dollars in U.S. coal production facilities which are dedicated to supplying their requirements. Many of these mines, providing thousands of jobs in Appalachia, were installed specifically to meet foreign customer contracts and would not exist without them. An embargo on the coal which these investments have helped to provide would amount to confiscation.

About 98 percent of all U.S. coal shipped to overseas markets (excluding shipments to Canada) is of metallurgical grade, and most of it is used in the steel industries of Japan, Europe and South America. The overwhelming part of this coal is sold under long-term contracts, some for as long as 15 years, negotiated and signed by overseas customers in good faith. Should the United States dishonor these contracts by government fiat for short-term expediency, the steel industries of our allies would be seriously hurt. Moreover, they would look to other countries for their coal requirements, and once this business is lost to American suppliers, it is doubtful that it could ever be regained. The coal export business is not an "off-again, on-again" business. Our foreign customers must be able to rely on us to keep faith with them when long-term contracts have been negotiated, and they should not be affected by the energy crisis to any greater extent than American users of coal.

In 1970, great pressure was put upon the Administration, particularly by the utilities, to embargo coal exports. But the Administration withstood this pressure and U.S. coal continued to be shipped abroad. At that time, Dr. Paul W. McCracken, Chairman of the Council of Economic Advisors, speaking to the press about this matter, said, "It isn't possible to maintain that type of market by turning supplies off and on." And in 1970, according to the Department of Commerce, U.S. exports of all commodities exceeded imports by $2.7 billion. The Department said the increase was due to several commodities, including *coal.* Without coal's contribution of over $1 billion, this favorable balance of trade would have been substantially reduced.

As stated previously, approximately 98 percent of total U.S. bituminous coal exported overseas consists of metallurgical grades. This high-grade, high-cost metallurgical coal is not practical for use in some utility boilers, so it would not be feasible to place an embargo on it to meet utility needs for steam coal. Many of the utilities simply cannot use this type of coal because it doesn't meet the design criteria of the furnaces. On the other hand, if it should become necessary to limit U.S. coal exports to overseas destinations, shipments thus curtailed should be that type of coal which can be readily consumed by the domestic utilities.

It should be noted that during the coal shortage in 1970, several steps were voluntarily taken to help alleviate the situation. The N&W and the C&O railroads which handle the bulk of the export coal traffic instigated a "permit" system for movement of export coal to ports of exit. Prior to that time, some coal which traditionally went to steam markets was moving to the ports on speculation, and being purchased for export. This not only deprived domestic markets of traditional suppliers, but it also tied up some vitally needed railroad coal cars in inefficient use, because this speculative coal would remain in cars at the ports for long periods of time. But under the "permit" system instituted by the railroads, coal was shipped from the mines to tidewater ports for export only when the estimated time of arrival of the vessel was indicated. This greatly reduced the number of cars held at ports, increasing the supply of cars available to transport coal to domestic consumers. The "permit" system is still in effect on the Norfolk & Western Railway which handles the major part of the overseas coal export business.

Another factor in easing the 1970 coal shortage was the agreement of the Japanese buyers of coal to reduce "spot" purchases of coal in the United States to the extent practical. The Japanese have been major consumers of American coal for many years, and they were willing to do their part in seeing that this long-term relationship was not destroyed by an "on-again, off-again" government policy with respect to exports.

As in 1970, U. S. coal exporters are willing to cooperate in every way possible with the government in the energy crisis. During the 1970 coal shortage, at the Department of Commerce's request, they filed weekly reports showing the type of coal exported, country of destination, sulfur content, volatile matter, tonnages, and custom districts. They are again willing to file such reports, perhaps in greater detail, to assist the government in determining how much coal, by types, is being exported, if deemed necessary. These weekly reports can confirm that about 98 percent of total U. S. coal exports are of metallurgical grades used in coke plants and steel mills abroad.

The current level of U. S. coal exports is substantially lower than in the previous year. In fact, some American suppliers now find it impossible to ship all of the coal tonnages committed under long-term contracts. This shortage results primarily from wildcat work stoppages, absenteeism and other problems at the mines affecting production.

According to the latest figures released by the Bureau of Mines, exports of U. S. bituminous coal in January-September totaled 36.9 million net tons, a decrease of 5.1 million tons or 12.1 percent from the corresponding period of 1972. Of the 36.9 million tons of coal exported in the first nine months of the year, 11.7 million tons went to Canada and 25.2 million were shipped overseas. Of the 25.2 million tons of coal exported overseas in January-September, 20.6 million tons or 81.7 percent went out of Hampton Roads, Virginia. Lesser tonnages moved through Baltimore, Mobile, New Orleans, Philadelphia, and Los Angeles.

Most of the coal exported from the United States originates in the central Appalachian area where efforts continue to help improve the economy. Not only do coal exporters and coal producers benefit from shipments abroad, but so do the railroads, equipment manufacturers, and allied industries. And indeed, the economy and welfare of the nation are benefited by U. S. coal exports.

U.S. BITUMINOUS COAL EXPORTS OVERSEAS [1] AND PERCENTAGE OF TOTAL U.S. PRODUCTION

Year	Thousand net tons—		Percentage exports to total production
	Production	Exports [1]	
	(1)	(2)	(3)
1963	458,928	33,316	7.3
1964	486,998	33,782	6.9
1965	512,088	34,521	6.7
1966	533,881	33,474	6.3
1967	552,626	34,220	6.2
1968	545,245	33,889	6.2
1969	560,505	39,446	7.0
1970	602,932	[2] 52,270	8.7
1971	552,192	39,068	7.1
1972 [3]	595,386	37,835	6.4

[1] Excludes shipments to Canada.
[2] Increased exports due to shortage of coking coal and expanded steel output abroad.
[3] Preliminary.

Source: Cols. (1) and (2)—U.S. Bureau of Mines; col. (3)—Computed by NCA.

NATIONAL COAL ASSOCIATION,
Washington, D.C., February 8, 1974.

Hon. MIKE GRAVEL,
U.S. Senate,
Washington, D.C.

DEAR SENATOR GRAVEL: This will elaborate on our testimony before your committee as it relates to S. 2167 as proposed by Senator Cook on the concept of "capitalization of the resources" with respect to energy research and development.

Several assumptions underlie our decision to support the idea of an investment of funds generated by federal leasing in the R&D area.

First, the widely recognized need for energy self-sufficiency demands a quantum jump in the technological base supporting our energy industry, most notably in the coal area.

Second, a large portion of the funds necessary to support this R&D will, of necessity, have to come from the federal government either through the use of general tax revenues or from funds specifically earmarked for that purpose.

Third, energy research and development funding will have to compete for a share of the federal dollar with other national priorities in an atmosphere hardly conducive to the additional generation of funds through the tax mechanism.

Fourth, whatever measures are used to generate research and development funds for energy care must be complemented so as to minimize any adverse impact on industry and to reduce to a minimum the cost impact on the final consumer.

From these assumptions our analysis led us to reject the idea of a Btu tax as suggested in S. 2806 on energy sales.

We did this because:

It impacted most heavily upon the coal industry and in our opinion made coal's competitive position less, rather than more, desirable.

It was very definitely inflationary with the ultimate consumer quickly feeling the impact of the tax.

It represented what we considered to be a system which could easily be used as one more tax measure to generate funds for general governmental purposes.

By the same token, however, we recognize that federal research and development programs must be financed, and that such financing would place a heavy burden on the treasury and the taxpayer. We believe such a burden to be worthwhile, but nonetheless a heavy one.

Further analysis led us to consider two alternatives for governmental funding of research and development:

General Treasury Funds.

"Capitalizing the Wealth Represented by Federal Energy Resources."

The first option has much to recommend it. Energy self-sufficiency is a goal closely tied to our national well-being. Since this accomplishment will mean so much to our national life style, logic would indicate that the public should pay the cost involved.

There is much precedent for this in the energy field. The nuclear power program has received, and continues to receive, substantial federal financial assistance. Indeed, the federal government has invested billions in the civilian nuclear power program with ongoing programs costing billions more; all of these funds come from general tax revenues.

Another program where similar efforts have been made is in the space area. Here again the diversion of national economic resources was through the general tax mechanism and was borne by the general taxpayer.

We believe that energy independence for the United States fully justifies the proposed research and development expenditures whether we are considering the Administration's proposal or several now pending before the Congress.

However, we also recognize the need for fiscal savings where such savings can, in fact, be made. One mechanism for reducing the need for general tax revenues to fund R&D would be to shift the burden where possible from the cash assets of the U.S. citizen obtained through the tax mechanism to the resource assets held for him in trust by the federal government. In this way the funds generated through the development of these assets would be invested in energy R&D so that their worth may be enlarged and enhanced by development, much as prudent investment guarantees, over time, continuing value growth.

In essence, we view the federal energy resources as a part of the asset portfoloi of the American people. We are suggesting that one option which should be carefully analyzed is for the diversion of a portion of this asset into energy R&D, i.e., the assets should, in part, be capitalized and invested specifically in energy research programs rather than flowing through the general treasury to be utilized immediately for a multitude of purposes.

The intent here is "capital accumulation" for investment purposes—a plowing back into the economy for future benefit a portion of our current income derived from the use of our energy resource assets.

The magnitude of the potential investment is relatively large. Senator Cook of Kentucky, for example, in introducing S. 2167, estimated that funds obtained from outer-continental shelf lease sales totaled more than $6.3 billion for the years 1968 through 1973. When receipts from leasing programs on coal and oil shale are added to that of the OCS, and when the increasing value of these resources is taken into account it is obvious that the national patrimony represented by federal energy holdings is indeed significant.

In raising this alternative method of funding, I am not endorsing the present methods by which the federal government disposes of its interests in these lands. I am referring only to the disposition of the funds raised through the leasing system.

The same logic which dictates our expanded energy research and development program out of general funds is applicable here. Research, while only one part of the system necessary for energy independence, nonetheless has exciting potential. For research can give us new mining technology, more efficient power-generating systems, technologically superior ways to use our vast coal resources as a base for both liquefaction and gasification, and finally a bridge between energy growth and the environment. But most importantly, money invested in energy R&D now will build the technological basis for the maintenance of our industrial economy and the national well-being which is so dependent upon that economy.

We recognize that the Congress must carefully consider various approaches to funding R&D research with maximum effectiveness for the national interest. Perhaps a trust fund financed by both monies from federal leasing programs and general revenues will be the ultimate answer to this dilemma. Whatever the outcome, however, the research and development program of the federal government must be viewed in terms of an investment and monies put into that fund must be considered as capital.

Along this line we would recommend a careful consideration of S. 2167 along with other current funding proposals. From this effort must come a responsive and long-term national research program capable of helping America to achieve energy independence.

Sincerely,

CARL E. BAGGE,
President.

Senator GRAVEL. Our next witness is Mr. William Traeger, and he is accompanied by a colleague. Mr. Traeger, we appreciate your patience. You can see the nature of a hearing that leads into many varied areas of interest.

STATEMENT OF WILLIAM V. TRAEGER, VICE PRESIDENT AND GENERAL COUNSEL, OTIS ENGINEERING CORP., ON BEHALF OF PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION, ACCOMPANIED BY ANDREW ROSE

Mr. TRAEGER. I will try to keep this as brief as possible, Senator. I realize the time is getting late. My name is William V. Traeger. My colleague is Mr. Andrew Rose.

I am here today representing the Petroleum Equipment Suppliers Association which is a trade group better known as PESA, and it is the manufacturers of specialized equipment, the companies servicing this equipment in providing specialized services, and the companies distributing this equipment to the petroleum industry.

Mr. Rose is a retired executive of Borg-Warner and has been helping our association with its problems in Washington. We are not a lobbying group. We have only an executive secretary and two paid employees in Houston and most of the work that we do is through volunteer representation by our industry companies.

We basically provide the type of equipment and services that is essential to the petroleum industry in their work in exploring for, drilling, and producing oil. We have 136 member companies which range from large billion dollar companies to small, locally owned companies. And we represent approximately 85 percent of our industry.

We operate out of 20,000 different locations here in the United States, that have approximately 50,000 employees. We have reviewed the provisions of your bill, Senator Gravel, and we feel that there is much in the bill that will help to alleviate the problems that are presently facing our industry.

We do have some concern about title VIII of that bill. In fact, the provisions of title VIII may prove to be counterproductive to the purposes of the bill and might actually prove to be detrimental to increasing our energy supply.

It is that that I would like to comment about today. In past years we have always been able to meet the demands of our industry. We have done this through capital expansion, putting money in to build the plants, and to expand our operations to meet the requirements of the petroleum industry. We have been able to expand to cover both the foreign market with the encouragement of the Government agencies in order to help meet our balance-of-payments problems.

We have been quite successful in our efforts to penetrate the foreign market for the type of equipment we produce, and to some extent, we have been so successful that we have many operations in foreign lands that are almost completely dependent on the type of products that we produce. In other words, if the members of our association, the U.S. companies producing equipment and offering services, were to be limited or embargoed from furnishing equipment to certain foreign oil operations, we would literally shut those operations down.

Senator GRAVEL. You mean you would deny the ability to acquire oil for other nations for their own purposes?

Mr. TRAEGER. That is right.

This is particularly true in the marine, or subsea type of development operations.

Senator GRAVEL. What would be the impact on, say the North Sea?

Mr. TRAEGER. I think to some extent we might shutdown the operations temporarily, and it might be for some period of time because they would have no ability to go to an alternate source of supply.

Senator GRAVEL. So they would have to develop the technology that we now have and are profiting from, is that what you are saying?

Mr. TRAEGER. That is right. And right now I would say that the countries that would primarily be involved would be Canada, Japan, Mexico, Brazil, Ecuador, Argentina, Australia, and all of the marine countries of Europe, the Middle East, and Africa. All of these countries are highly dependent on our products, particularly a country like Japan. They are almost totally dependent upon us for technology.

Now if we in any way limit our ability to make this technology available to them and this equipment, we are going to cause severe repercussions, and we are going to have some people that are very resentful. And, of course, there are countries where we may have reason to feel that we should take this type of action against, but some of these countries are good friends. They are not people who have cutoff our supply.

Senator GRAVEL. In fact if we want to see them solve their energy crisis, it is almost as important to the world economy as our own We would be compounding their problem and our problem.

Mr. TRAEGER. Let us look at our shipments to foreign countries and to serve foreign markets, and it is not all detrimental to our U.S. industry. It is this foreign market that has helped produce the capital to expand our plants.

Our foreign market makes possible our carrying increased inventories and increased types and sizes. As you know, many of the technological developments in industry arise out of meeting customer problems. And our work with foreign customers to meet the problems they are encountering in their foreign operations, have produced such developments that have been very beneficial to our U.S. industry. The Down Hole Safety systems that are being used today in the Gulf of Mexico were pioneered many, many years ago in Venezuela.

When they were needed here to control pollution and blow-outs, they were already perfected, developed, and on the shelf. The equipment to meet the highly corrosive conditions that we are encountering in some of our wells now in the Jay Field in Florida and in Mississippi, this equipment was developed to meet the highly corrosive conditions in Canada and the Middle East.

When the problem arises now, we have the metal technology, we have the equipment design, it is there waiting for the U.S. industry to use. We have new equipment that we have developed for subsea oil well completions that enables us to go into extremely deep water. Deep water problems were encountered in foreign areas prior to their being encountered here. Tests were run at a very early date by the French oil companies in Algeria and Gabon. And when the equipment was needed here, it was already tested and those test results are available.

So you cannot look at the foreign market as being strictly a detriment to us. Now one thing we have to remember is that our best estimates indicate that until 1985 we are going to be a net importer of oil. This means that we are going to have to look at the world market for petroleum products to meet our deficit in energy requirements. Or at least in petroleum products.

Now if we are going to be realistic about it, we have to look at the fact that demand for petroleum products is probably going to increase. That means if we are looking at the normal laws of supply and demand, the only way we can keep it at a reasonable cost is to look at increasing the world supply of oil. And I think that the best way for us to work at doing this is to help the people that are drilling in foreign areas whether they be U.S. companies drilling for oil abroad, or whether they be foreign oil companies attempting to develop their own industry. Because even if we are supplying equipment to a foreign oil industry, if they discover productive reserves at the very least, we are eliminating a competitor from that world oil market that would otherwise be bidding against us for the world oil supply.

And we, therefore, will be helping ourselves. I think we have to look at ourselves as being in a world oil market. And we have to consider what we are doing. Now let us to specifically go the provisions of title VIII. We feel that this will act in effect as an embargo or at least a severe limitation on our ability to handle our foreign customers.

We are already encountering very severe problems due to the distance that we have to transport——

Senator GRAVEL. Could I ask you a question, Mr. Traeger?

Mr. TRAEGER. Yes.

Senator GRAVEL. Do you feel that given the situation that we have today, that you can meet—that your industries, the companies that form your group—do you feel that they can meet the needs, the domestic needs, that our Nation will face as we move forward? And, as you know, we are going to try to provide some incentives to vector onto developing independence—maybe not self-sufficiency, but certainly independence.

Do you feel that your companies, with the nonexistence of section VIII, could meet their responsibilities in arriving at that?

Mr. TRAEGER. Yes, I believe we can meet the needs of our domestic customers, as well as the needs of our foreign customers.

Senator GRAVEL. This would be an explosive demand.

Mr. TRAEGER. We realize this and we are gearing up for it. Our own company has been running for the last several years—we have one plant expansion being completed that we will be moving into; another one being let for bid to the contractors; and a third one being designed. This is just a normal state for us.

Senator GRAVEL. What would that represent in percentage production? Productive capability for your company in that regard?

Mr. TRAEGER. Well, I think that——

Senator GRAVEL. Well, say, just what you have recited? Would that be 10 percent? 20 percent? 30 percent?

Mr. TRAEGER. No; I think we are looking at over the last few years of having expanded close to 100 percent.

Senator GRAVEL. And then you are projected for these plants?

Mr. TRAEGER. We are projected to provide the plants to service our customers both domestic and foreign. That is what we are providing for.

Senator GRAVEL. But you have had, what, 100 percent increase?

Mr. TRAEGER. I would say in the last 7 years, we have expanded approximately 100 percent.

Senator GRAVEL. And you feel you have the capability to expand another 100 percent?

Mr. TRAEGER. We will expand whatever it takes to meet our commitments to our customers. Now the only thing that is going to, I think, in any way hamper our abilities to supply our customers would be the shortages of raw material. The shortages of support services such as castings, or the shortages of fuels or petrochemicals.

But I think to a very large extent, this is a problem of dislocation rather than actual shortage. And it will tend to correct itself. But the thing that worries me is that we will, at this time of shortage, that we will take some ill-advised action that will lose our foreign market. We will lose our foreign markets and that is what we are worried about is the possibility of completely losing our foreign markets.

Senator GRAVEL. Well let me assure you, Mr. Traeger, that with your testimony—and I would be happy if you would be willing to take your testimony verbatim from the record and have this process where it goes in the record just as if you read the entire testimony—it will be placed in the record.

But let me assure you, from the committee's side and certainly from my personal side, that I think the point you make was not so well made by the administration in the testimony of Mr. Simon. I think you have added to the position that he has taken by asking relief for your facet of the oil industry.

I think our proposal was a reaction. The purpose of these hearings is to acquire additional information so we can hone down and improve and correct the legislation. I can assure that the facet of the legislation that you object to, will be honed out of existence. In the last 30 days I have realized that our international and domestic position are highly interrelated, and not only in oilfield services, but also other facets.

Mr. TRAEGER. Well, I very much appreciate your understanding, Senator. And, taking the time to listen to the problems that are facing our industry and I hope in the work that you do on the legislation that is bound to come before you, that we do not take some action with regard to the oil operation in foreign areas that will be detrimental to those operations in the future, because we are going to be somewhat dependent on that source of petroleum supply.

Senator GRAVEL. I can assure you that philosophically was not our intent. In fact, I personally feel that if we can make our Nation independent or self-sufficient, that this will help the rest of the world with their voracious appetities for energy.

I just want to underscore that. I think it is more complex and sophisticated than what it appears on the surface. You have made a contribution to the body of knowledge that we have, as have others, in the course of these hearings. I can assure you that that part that causes you fear will not be there, for one; and two, that the contribution to knowledge we have now acquired will carry over into other policy decisions that may relate to this, either in other committees or on the floor.

Thus, the fact that you did this service for your industry is of more lasting duration than just plugging an error in one particular bill.

Mr. TRAEGER. Thank you, sir.

Senator GRAVEL. Thank you both for coming forward to wrap up what I hope is a very significant piece of information in the whole hearing process.

[Mr. Traeger's prepared statement follows:]

PREPARED STATEMENT BY WILLIAM V. TRAEGER, PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION

My name is William V. Traeger. I am Vice President, Secretary and General Counsel of Otis Engineering Corporation of Dallas, Texas. I am appearing here today as a representative of the Petroleum Equipment Suppliers Association with offices in the First City National Bank Building, Houston, Texas. Our Association is generally called "PESA". In PESA I am presently a member of the Association's Board of Directors and Executive Committee, Chairman of the Legislative Committee, and Chairman of the Southern Mid-Continent District.

PESA is a trade association comprised of manufacturers of specialized oil field equipment, the supply companies distributing and servicing such equipment, and the service companies that perform the highly specialized services essential to exploration, drilling, and production activities of the petroleum industry.

The 136 member companies of PESA have more than 50,000 employees located throughout the United States based at more than 20,000 plants, stores, service shops, and offices standing ready to put highly specialized equipment and highly skilled technicians at any location being explored for oil or where a well is being drilled, completed, or otherwise serviced. PESA members represent 85% of the annual dollar volume of this industry. They range from large billon dollar plus companies with international operations to small locally-owned and operated companies in this distinctive industry which assists in the search for and production of petroleum products so necessary for fueling our nation's homes, industries, and transportation systems.

Our Association has reviewed the provisions of Senate Bill 2806 as they relate to the operations of our Association's member companies and our oil industry customers and, while we feel the Bill contains many provisions that will act to improve this nation's supply of petroleum products, we are concerned about the adverse effects of Title VIII of the Bill relating to export controls on petroleum products, natural gas, and coal and certain drilling and mining equipment, which might prove to be counter-productive in actual operation.

During past years, our member companies have been able to meet the ever-increasing demands of the petroleum industry through extensive capital expansion and the hiring and training of additional employees. The expansion of operations by our member companies has involved both the foreign and domestic markets, with the foreign portion of this expansion encouraged and supported by the U.S. government to alleviate the balance of payment problems being encountered by our nation.

Through the sales efforts of our member companies, supported by the U.S. government through its Department of Commerce, many U.S. oil companies operating in foreign areas as well as oil companies owned by private interests abroad or by foreign governments have become dependent upon technology and equipment supplied by U.S. manufacturers. This is particularly true with respect to subsea equipment furnished by our industry members to the offshore oil industry worldwide. If the export of such subsea equipment were to be embargoed or limited to our surplus by an unwieldy system, the world offshore oil industry could literally be strangled for an extended period of time. This could create unnecessary resentment toward the United States by such friendly foreign governments as Canada, Japan, Mexico, Brazil, Ecuador, Argentina, Australia, and all of the maritime countries of Europe, The Middle East, and Africa. With regard to a substantial portion of the equipment and services furnished by our Association members from their U.S. facilities, we are the only source from which such services and equipment can be obtained. Our foreign customers are entirely dependent on us. If we cannot be relied on to supply the required equipment and services, our foreign customers will have to develop sources in foreign areas, a time-consuming project that will throw their operations into chaos. Under these circumstances, would the allocation and embargo provisions of Title VIII be fair? Would the setbacks that would surely be suffered by the petroleum operations in foreign areas be justified or consistent with the purpose of this legislation?

The expanded foreign markets of our member companies have aided in producing the capital necessary for the facilities expansion required to fully serve the needs of our domestic customers. We anticipate that any shortages of our products or services that develop in the United States will result from shortages of raw materials, support services, and fuel, and, if our industry is able to obtain adequate supplies, it has the capacity to continue serving both its domestic and foreign markets.

It is essential that we fully develop our nation's petroleum resources and maintain a strong, viable oil industry in the United States. Our Association members have always supported this position in the past and have geared their operations to achieve this objective. We intend to fully serve the needs of our U.S. customers.

There are some factors, however, which should be carefully considered prior to enacting any legislation which would restrict our ability to serve the foreign markets which we have developed.

The United States is at present a net importer of oil and the most optimistic estimates indicate we cannot achieve self-sufficiency in meeting our petroleum requirements prior to 1985. This obviously means that for some period of time we will be one of the countries competing for petroleum products in the world market.

As with any product we purchase for import on this basis, the price we will have to pay will be greatly affected by factors of supply and demand. It is becoming increasingly obvious that the demand for petroleum products will not diminish, but will in fact increase in coming years. Price relief must then necessarily be accomplished through increasing the world oil supply.

Fortunately, our U.S. oil companies are actively engaged in exploring for and developing foreign oil reserves, and the United States will have a preferred position as to these reserves through the United States' distribution systems of these companies. Even the discovery and development of oil reserves by foreign oil companies will benefit our purchases in the world market by increasing the petroleum products available for import to the United States or, in the alternative, by reducing the requirements of potential competitors for the world supply of petroleum products.

Consider also that sales of equipment and services by our industry in the foreign markets have contributed substantially to our nation's economy in terms of balance of payments.

Most of the equipment sold in these foreign markets or used to perform services is produced in the United States. A substantial portion of the personnel staffing these operations are U.S. expatriates and these operations produce substantial tax revenues. Our industry's foreign markets have enabled our member companies to utilize increased sales to hire additional employees in their U.S. manufacturing facilities and maintain inventories in a greater range of sizes and types of products.

Since improved technology in our industry usually develops from attempts to meet the petroleum industry's changing operational requirements, new and improved equipment has developed out of our work with customers in the foreign market. For example, remotely controlled downhole safety systems now being installed in the Gulf of Mexico to prevent blowouts and control pollution were pioneered in the oilfields of Venezuela. Equipment required to resist the highly corrosive effects of the high sulphur content wells currently being drilled in the United States was developed, tested, and put into inventory to serve the needs of the Canadian petroleum industry and the petroleum industry of the Arabian Gulf. Equipment necessary to complete wells on the ocean floor was tested and used at an early date by the French oil companies in their operations in Algeria and Gabon, and the benefits of these tests and the resulting improvements in equipment are now fully available to the U.S. oil industry.

If we are to maintain technological superiority, it is essential that we continue to have access to the operational requirements which produce technological advances and improved products and services essential to the efficient development of our nation's petroleum resources.

Let me explain why our industry would have difficulty in maintaining its foreign markets if subjected to the requirements of Title VIII.

Equipment and services required to explore for, drill, complete and produce petroleum products is highly customized to a particular field location and these equipment requirements are constantly revised over the life of a field or a well with the changes that occur in well conditions. For this reason, and because of continuous product improvement and development, there is a high rate of obsolescence.

Our customers try, to the extent possible, to develop programs for drilling, completing and producing their wells and once such a program is developed, operations are designed around the equipment and services selected. Individual items of equipment often interact as a system, when installed, to perform a function and many such systems cannot operate unless all items of equipment are available and functioning. This is particularly true of customers in foreign areas.

Our industry already experiences great difficulty in serving foreign markets due to the long lead times required due to transportation, import procedures, etc., and the provisions of Title VIII that could make individual products we produce available or unavailable for export from quarter to quarter would be completely unworkable. Under such a system, we could be placed in a position of having an entire installation for a foreign customer made unworkable by our inability to ship one essential item.

Additionally, our foreign customers would be under the constant threat that our Secretary of Commerce would not allocate any of the equipment available for export to their country so that their ability to obtain equipment would depend upon the political relations of two governments over which they, in most instances, would have no influence or control.

If Title VIII should be enacted in its current form, our industry will be placed in the position of the wife once unfaithful and never to be trusted again. The impetus to foreign competition that would be created by Title VIII would be extremely detrimental to our industry, the U.S. petroleum industry, and the interests of our nation. The embargo and allocation provisions of Title VIII would make our admonitions to the Arabian states not to use their petroleum supplies as a political weapon ring hollow. How can any foreign government dependent on us for products or services view the potential of these provisions as anything but a vehicle for the exertion of political force.

The practical problems that will confront the Secretary of the Interior in determining "the quantity of each energy producing commodity, if any, and the quantity of each essential drilling or mining article, if any, available for export during the succeeding quarter," in allocating the commodities or articles available among foreign countries, and, in setting up and administering a licensing program on a bid submission basis are so complex for our industry alone that the resulting administrative program could easily rival or exceed the price controls structure in complexity and—cost. In addition to the requirements placed on the Secretary of Commerce, the Secretary of the Interior would be required to monitor a myriad of items of equipment to determine which should be certified as "essential drilling or mining articles" and make quarterly determinations of which articles should be considered in short supply.

Considering that products in different sizes, of different metals and with different thread connections are not interchangeable in use, I would estimate our Association members produce in excess of 1,000,000 individual items of equipment for the petroleum industry. What will it take in terms of men and money to apply Title VIII to those 1,000,000 plus items? Could repair parts for previously sold equipment be treated the same as original sales? How would export of service equipment to supply an existing service operation in a foreign area be handled? What procedure would be followed if a foreign purchaser wanted to buy equipment produced by a U.S. manufacturer other than the high bidder for the required export license.

These are only a few of the endless list of practical problems that would arise under the system proposed by Title VIII. I feel certain that our foreign markets would be lost long before these problems could be worked out.

Title VIII would surely require a complex procedure complete with volumes of regulations, rulings and guidelines the end product of which would be the conversion of friendly foreign customers to angry former customers resentful of the misuse of our position of dominance.

In conclusion, it is our opinion that the provisions of Title VIII would be unworkable, counter-productive to the intended purpose of this legislation, and could cause extreme hardships for companies or governments exploring for the producing petroleum products in foreign areas. These hardships could be so extreme in some areas, such as Japan and the North Sea, that they could—test the economic stability of our friends abroad by interfering with their ability to meet their energy requirements. Will we be so short-sighted as to ignore our responsibilities to the world community and retreat to a posture of isolationism failing to recognize that our economic well-being will ultimately depend upon the economic health of the free world?

Thank you.

Senator GRAVEL. We are now adjourned.

[Whereupon, at 1:10 p.m., the subcommittee adjourned, subject to the call of the Chair.]

APPENDIX A

Communications Received by the Committee Expressing an Interest in These Hearings

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CONGRESS OF THE UNITED STATES,
HOUSE OF REPRESENTATIVES,
Washington, D.C., January 21, 1974.

Mr. ROBERT BEST,
Chief Economist, Senate Finance Committee,
Dirksen Building, Washington, D.C.

DEAR MR. BEST: The Energy Revenue and Development Act of 1973, S. 2806, represents a bold and imaginative step in the establishment of a comprehensive national energy policy. The creation of a trust-fund is in my view essential to an effective energy policy. While I heartily commend the initiative of this legislation, there are provisions—such as the decontrol of prices on existing reserves of natural gas—to which I object. Nonetheless, I would like to raise several points which I hope the Committee will consider.

THE ENERGY TRUST FUND

The legislation proposes that a trust fund be created from a primary fuels tax on fossil fuels and electricity not generated by fossil fuel. The tax would be imposed at the mine mouth and the wellhead and would be based on a BTU equivalent. While a convenient procedure, the suggested tax has several weaknesses. First, the tax is in the nature of an excise tax on the producer. It will be passed on to the consumer as an additional cost of production. The import of the tax, in short, is regressive and is added onto rate structures which are already themselves frequently regressive. For the sake of progressivity, compensatory provisions must be included.

In my own legislation, I have proposed that in the case of natural gas and electricity small users be exempt from any tax. This is a simple procedure with the utilities collecting the tax. While this proposal does not escape the problem of regressivity entirely, it does offer a possible solution. I would hope the Committee will explore this problem more fully in the upcoming hearings.

Second, S. 2806, in proposing to tax all fossil fuels, does not take into account the interchangeability between fossil fuels. Presently, we are attempting to encourage utilities to convert from petroleum to coal. At least initially, this conversion—and the goal of long-run self sufficiency—would be encouraged by exempting coal from any tax.

Further S. 2086 only directly taxes electricity which is not generated from fossil fuels. But electricity is a special case which demands special attention. Fossil fuel growth has been around 4% a year; electricity growth is over 7%. In short, we are rapidly charging toward electricity as a primary energy source. Conventional power generation, even with fission nuclear fuel, poses serious environmental problems because of its inefficiency. There are studies available which assert that in the long run, electricity demand is responsive to price. A special excise tax on electricity could have the impact of slowing the demand growth for electricity.

FEDERAL ENERGY ADMINISTRATION/COMMISSIONON ENERGY TECHNOLOGY ASSESSMENT

The legislation recognizes the importance of mobilizing a coherent organizational base in order to launch an effective energy policy. But I see several weaknesses which should be pointed out. First, the bill leaves the relationship between FEA and CETA foggy and undefined. The Administrator is under no obligation to follow the recommendations of CETA. I recommend that the two organizations be merged, with the Commission establishing policy goals and an Administrator to conduct the activities of the organization.

In addition, membership on the Commission should be broadened to include representatives of consumer and environmental groups. Decisions on energy policy often have significant environmental trade-offs. In the end, it is the consumer who must shoulder most of the burden of these decisions. It is imperative, therefore, that these two segments of the public interest be fully represented. I would also recommend that members of the energy industry, past or present, be disallowed from membership on the Commission to avoid any possible conflict of interest. For too long, our energy policy has been dictated by industry "experts". If industry expertise is needed, as I am sure it will be, we should provide for it on the staff level.

RETURN TO THE UNFETTERED MARKET

S. 2806 recognizes the importance of the market in allocating scarce resources. However, I question some of the attempts in this act to readjust fiscal policy to this end.

In addition to the variable tariff structure proposed in this legislation, I would recommend for consideration the establishment of a National Defense Petroleum Reserve. The essential problem of import control is to protect domestic industry—and, hence, our national security—at the least cost to the American consumer. The old oil import quota was geared to protect our security, but only at a tremendous cost to consumers. The establishment of a Petroleum Reserve system on the public lands of the U.S. appears to be a relatively efficient way of protecting our security against interruptible imports. This system could be supplemented with inventory requirements for both producers and refiners.

Second, the Act fails to deal forthrightly with the problem of tax incentives to foreign investment. We must recognize that for the multinational oil companies there already exist significant economic incentives to foreign investment—lower costs, fewer construction regulations, rapidly expanding markets, and often the additional enticement of tax-free holidays. Our tax system encourages this trend by offering the opportunity of minimizing or eliminating altogether a U.S. tax liability through wise investment abroad. For this reason, I recommend the Committee support immediate elimination of percentage depletion and the option to expense intangible costs on foreign properties. In addition, the foreigh tax credit should be altered to a business deduction.

Finally, the Act appears to be working at cross-purposes with regard to tax subsidies for domestic production. On the one hand, the legislation eliminates price controls (Title V) on the assumption that a long run equilibrium price for petroleum will stabilize the present supply/demand imbalance. In making this decision, the Committee should recognize that a price policy is an adequate substitute for a tax policy to insure adequate supplies of petroleum. To decontrol prices while at the same time adding tax subsidies for production is not only illogical from a long run economic standpoint, but also unfair. The consumer/taxpayer is victimized by paying higher prices and additional taxes. I strongly urge the Committee not to adopt further tax incentives in the face of escalating petroleum prices.

In addition to the foregoing remarks I have included some additional comments, which I hope the Committee will find of use. I appreciate this opportunity to present my views and look forward to working with the Committee to develop further this important legislation.

Sincerely yours,

CHARLES A. VANIK,
Member of Congress.

ADDITIONAL COMMENTS ON S. 2806, "ENERGY REVENUE AND DEVELOPMENT ACT"

SEC. 102(1). It is unwise in our state of ignorance to establish unrealistic goals. Sec. 102 establishes an arbitrary goal and singles out policies which should be pursued. Rather than being needlessly committed, we should establish the FEA to formulate policies within the broad national goals of national security, economic growth, and environmental quality.

(3) Any independent commission should be broadly representative of the public interest.

(9) The matter of national security—long the bane of energy policy—should be defined and separated from other concerns. This can be accomplished through the establishment of a national defense petroleum reserve on the public lands of the U.S.

(10) Stimulation of production through further subsidies is inconsistent with the general reliance in the market mechanism expressed in (8). Either subsidies or prices should be a sufficient encouragement to production. To provide the industry with both is poor economics and hits the consumer coming and going.

SEC. 202(a). This section should not include a tax on coal use. Self-sufficiency demands an increase in our reliance on coal, a practice we can encourage by excluding coal from an excise tax. There should be, however, a tax on electricity—a particularly inefficient form of energy use on which we are increasingly dependent. For the sake of clarity BTU should be referred to as British Thermal Unit in "Sec. 4497(a)."

SEC. 302(b)(1). The goal here is needlessly restrictive and artificial. Economic growth and environmental quality, both geared to an expanding social well-being, are more sensible alternatives.

(b)(5)(ii). The tremendous potential of hydrogen gas should be mentioned here.

SEC. 303(a)(6). More care should be taken to outline the goals of and controls over potential commercial projects. An example of alternative legislative language is H.R. 11864, which establishes a commerical project for solar heating and cooling.

(7) In view of the tax incentives and planned increase in petroleum prices proposed in Title 9, and notwithstanding my own objections that such incentives are counterproductive to the long-range goal of self-sufficiency by encouraging the uneconomic exhaustion of petroleum, it appears illogical to offer financial assistance of this nature. I would prefer to see actual government operation of several TVA-type energy projects rather than further subsidy of highly profitable private ventures. Such projects could provide an important price yardstick by which to judge the performance of the essentially monopolistic oil industry.

SEC. 304. The mechanism of loan guarantees is a good one, but it should be directed toward the development of specific technologies where there is a good opportunity for commercial development but little attraction for capital from private sources. The Administrator should target these areas for special treatment.

SEC. 306. Monetary awards may be a useful way to insure the participation of individuals and small firms. For example, much of the present solar energy development has been made by small developers. These awards should be restricted to encouraging the participation of individual inventors and small industry.

SEC. 309(a). Reporting requirements should include a complete inventory of our energy reserves. To compile this inventory, the Administrator should be given authority to verify the energy industry's reserve claims.

SEC. 310. More attention should be paid to the thorough transfer of the functions of existing federal energy-related agencies to FEA. Unless this is done, inefficiencies will arise which will subvert the mission of FEA.

SEC. 401(c). The membership of the board should include environmental and consumer representatives, as well as others not involved in energy production.

(g)(1) The FEA should be subjugated to the Commission. The position of Commissioner should be merged with the Administrator.

(g)(2) More attention should be paid to reconciling the demands of economic growth and environmental quality. In addition the Commission should be charged with formulating various strategies of energy policy for the future. Each projection should include a outline of the assumptions used in the formulation of the projection. There is not going to be any one answer to the energy crisis. Congress must be in the position of evaluating the tradeoffs of various energy strategies. We are unable to do this at present.

SEC. 501. It appears unwise to establish an arbitrary deadline for the elimination of price controls. This will undoubtedly create a perversion in the marketplace whereby supplies will be held off the market until the price goes up. The goal of a higher price is to increase supply. Since it takes 3–5 years to bring in a well, I would favor the easing of price control over a much longer period of time, while at the same time avoiding an absolute deadline.

SEC. 702. It is unwise to establish artificial barriers for the importation of oil. We have just seen the havoc the import quota system has played. A much more sensible alternative to insuring our security is the establishment of a reserve system. This reserve system could be supplemented by reserve requirements for producers and refiners.

SEC. 901. I oppose any further tax concessions to subsidize production. In the long run, these subsidies encourage over-production and wasteful consumption. Increasing prices should serve as an adequate incentive. There is no justification for asking the taxpayers of America to shoulder a heavier tax burden as well.

SEC. 1101. The percentage depletion allowance and the intangible drilling expense should be eliminated for domestic production as well. They encourage the uneconomic exhaustion of petroleum from known reserves and fail to provide an efficient incentive for new exploration in new locations.

SEC. 1002. I commend the committee for including this provision to encourage the sound insulation of residential buildings. I am particularly encouraged that the potential of solar energy is recognized.

SEC. 1101. In the development of oilshale reserves on the public lands, the committee should consider the establishment of a federal corporation. Such a corporation would not only guarantee the public interest in these vast resources but also would serve as a competitive counter-balance to private development by a small number of large oil companies. I am presently drafting legislation along these lines.

NATIONAL SCIENCE FOUNDATION,
Washington, D.C., February 25, 1974.

Hon. MIKE GRAVEL,
U.S. Senate,
Washington, D.C.

DEAR SENATOR GRAVEL: In response to your inquiry as to several statements on energy technology recently presented to your Subcommittee on Energy, members of our staff have provided the following information:

SEA THERMAL POWER—STATEMENT OF MR. J. HILBERT ANDERSON

The National Science Foundation has selected ocean thermal energy conversion as one of its six solar energy programs because of the large potential for energy production from that source. During the past eighteen months we have been funding a systems study of ocean thermal energy conversion at the University of Massachusetts at Amherst under Professor William E. Heronemus, and for the past eight months a similar study at Carnegie-Mellon University under Professor Clarence Zener. Both projects will continue through calendar 1974. The study at the University of Massachusetts includes a small subcontract with Mr. Anderson's firm, Sea Solar Power, Inc., and another with United Aircraft Research Laboratories.

Although it is premature to come to any quantitative conclusion concerning Mr. Anderson's cost and time estimates for the development of sea thermal power, our studies to date are encouraging in those regards. Ocean thermal energy conversion technology mainly requires adaptations of existing technologies, and its ultimate cost and the time frame for its development will depend on how well, how soon, and how economically we can make such adaptations. Professor Heronemus and his group are currently estimating costs of about $500 per kilowatt of plant capacity, and that it might require about six years to produce the first large-size demonstration plant. Mr. Anderson estimates that this could be done more rapidly at lower cost per kilowatt.

We are currently preparing a Program Solicitation (as mentioned in the enclosed announcement copied from Commerce Business Daily of January 4) that will enable us to award one or more contracts seeking to obtain an independent engineering evaluation of the technical and economic feasibility. Meanwhile, our plans for the Ocean Thermal Energy Conversion Program will place emphasis on research on component hardware and testing. The objectives of this program in the next five years is to accomplish the research that will permit us to design proof-of-concept experiment. This would probably be a near-shore or ocean-based pilot plant of about 10 Mw capacity.

TESTIMONY OF PROFESSOR WILLIAM E. HERONEMUS

Professor Heronemus touched upon several technological matters in his testimony, one of which is treated above. We basically concur in what he said about the potential of windpower, bioconversion, and solar heating using flat plate solar collectors. As noted in the enclosed summary, there are many current NSF grants funding work in those areas, and the results of our studies to date are encouraging.

TESTIMONY OF DR. JOSEPH LINDMAYER

Dr. Joseph Lindmayer of Solarex Corporation is an acknowledged authority in the solar cell manufacturing field. His work at COMSAT on the development of a superior solar cell for space use is well known and is now being applied in the U.S. and abroad.

The general approach outlined in his testimony concerning cost reduction of solar cells for terrestrial applications is consistent with the objectives of the NSF/RANN program on Photovoltaic Conversion of solar energy. This program is outlined in greater detail in the attached copy of a talk recently presented by Dr. Richard Blieden, our Program Manager in this area.

We also concur with Dr. Lindmayer's concern for the "great need for serious support of solar energy research." We believe that the long-range plan for solar energy research proposed by the National Science Fundation will properly address this need.

With regard to the Solar Breeder, while a detailed analysis of this idea has not yet been made, we believe that it is a concept worthy of further investigation. If the research on photovoltaic conversion currently supported by the NSF/RANN program achieves its goals, it would appear that the Solar Breeder concept could become a reality, and much of the solar energy resource could be utilized rather than wasted.

Testimony of Dr. Stephen Krajcovic-Ilok

In order to evaluate the presentation by Dr. V. Stephen Krajcovic-Ilok, we need more data on the systems operations or experimental data. However, obtaining these data seems difficult, as referenced below in the abstracted letters. There are indications that Dr. Krajcovic-Ilok is unwilling and/or unable to furnish data which may violate the conservation of energy law.

The following are some relevant quotations from two letters regarding Dr. Krajcovic's continued search for support:

(a) April 2, 1973 letter to Senator John L. McClellan from the Office of Coal Research (OCR) signed by George Fumich, Jr.:

Dear Senator McClellan: ". . . We find that you have been advocating this system with various Government agencies since at least March 1969. Among the agencies which have reviewed your submissions are the Department of Defense; the Office of Coal Research and Bureau of Mines of the Department of Interior; the Tennessee Valley Authority; the Air Pollution Control Office; and the Office of Science and Technology, Executive Office of the President. It our understanding that independent evaluations were made in considerable detail by all of these and were not favorable to proceeding with the work you proposed.

". . . Basically, it seems to us that your position would be greatly enhanced if you would do several things:

(a) Submit samples of the Ilok powder to us for independent evaluation. You state that equipment has been developed which is producing this powder so that it should be a simple matter to obtain samples.

(*b*) Have the process equipment examined and evaluated by a well qualified, independent, impartial consultant who would then make a suitable report to us. We realize that you may wish to protect the secrecy of the process, but this is common in many industries and secrecy agreements can be readily executed. Likewise, patents should provide you with ample protection.

(*c*) Submit a process flowsheet containing a complete material and energy balance. This means that the mass flow of all material in must equal the mass flow of all material out. All energy in, thermal, mechanical, electrical, and due to change of state, must equal energy out. Previous submissions were inconsistent in this regard."

You will note that this office and many other Government agencies have been attempting to evaluate the Ilok Powder Company's process for many years. The essential problem is that we have never been given any hard information to evaluate, despite repeated requests.

(*b*) January 16, 1974 letter to Mr. John J. Rhodes, MC, from the Atomic Energy Commission (signed Edward H. Fleming):

"We have searched the scientific literature and found no detailed publications by Dr. Krajcovic on his process or his project. We have also checked with the office of Coal Research, Department of the Interior, and learn that they have had many dealings with Dr. Krajcovic on this subject.

The Office of Coal Research advised us that in all their dealings with Dr. Krajcovic they have been unable to obtain from him a description of his process in sufficient detail to permit a reasonable technical evaluation.".

Mr. George Fumich (OCR) stated to Senator McClellan "if we could find some merit in the process this office would be interested in supporting a research and development program." Without experimental data and detailed review, the expenditure of resources to support the Ilok concept appears to be unwise.

Sincerely yours,

H. Guyford Stever, *Director.*

Enclosures.

Statement of the Edison Electric Institute, Submitted by Mr. W. Donham Crawford, President

The Edison Electric Institute submits for the record this statement on S. 2806. The Institute is the principal national association of the investor-owned electric utility companies whose 193 member companies directly serve about 78 percent of the ultimate customers for electric service in the United States.

The electric utility industry is basically a converter of energy. In 1972 electric utility power plants used almost 25 percent of all primary energy consumed in the United States. Of this 25 percent, about four-fifths, or 80 percent, was converted from fossil fuels (coal, oil and gas) to more convenient and desirable electrical energy. The remaining 20 percent came from hydroelectric, nuclear, and a small amount of geothermal generation. The following table shows energy usage for 1972 in terms of Btu:

1972 ENERGY USE FOR UTILITY GENERATION OF ELECTRICITY AND TOTAL UNITED STATES ENERGY USE*

	Electric utility use (10^{12} Btu)	U.S. total use (10^{12} Btu)	Electric utility use as percent of total U.S. use
Hydro	2,901	2,937	98.8
Nuclear	606	606	100.0
Coal	7,581	12,428	61.0
Oil	3,206	32,812	9.8
Gas	4,157	23,308	17.8
Total	18,451	72,091	25.6

*Source: Bureau of Mines.

As can be seen from the table above any legislation affecting primary fuels and their usage is of utmost importance to electric utility companies and to their customers. Because the use of energy affects the basic structure of our society, the enactment of legislation dealing with energy should be approached carefully and with consultation among all those affected.

OBJECTIVES

The objectives of a national energy policy should be to assure that reasonably priced energy is made available in sufficient quantity to the American people in a manner that will have a minimal effect on the environment and without major dependence on foreign sources.

While certain forms of energy are, and should be, regulated, competition should still play the major role in making reasonably priced energy available. Competition among energy sources should be retained and strengthened.

The imposition of taxes and the granting of tax incentives for certain purposes should be even handed and should not favor one industry—or a certain segment of an industry—over another.

There should be coordination between industry and government with regard to energy research and development, and the government should be prepared to participate in the funding of such programs to an appropriate degree.

TAX ON ENERGY

Section 202 of S. 2806 would impose a tax, based on Btu content, upon: (1) the extraction of oil, gas or coal within the U.S.; (2) the production of electricity by sources other than oil, gas or coal, or derivative; and (3) the importation into the United States of oil, gas, or coal, or any derivatives. The proposed tax would cover an 11 year period, begin at 4.1 cents per one million Btu, increase to 6.5 cents in 1978, and fall to 2.8 cents in 1984.

We estimate that in the 11 years (1974 through 1984) covered by the tax, as proposed in S. 2806, approximately $45.9 billion would be raised. There are numerous disadvantages to such a tax approach which militate against enactment of the bill.

1. At the same time that inflation is forcing increases in fuel prices, there would be an added jump in fuel and electricity prices due to the imposition of the energy

tax. For consumers of electricity, it is estimated that the impact of the tax would be about equivalent to a sales tax in the 2.5 to 3.0 percent range.

2. As may be noted from the preceding table a considerable portion of this energy tax would fall on consumers of electricity. Practically all hydro and nuclear energy production is for electric use. In addition, 61 percent of coal, 18 percent of gas and almost 10 percent of oil is used for electric generation (expressed in terms of Btu content). Thus, taxes on these fuels are passed along to the utility in the base price of the fuel purchased and ultimately are paid by the electric consumer. A tax of this nature on consumers would be a regressive form of taxation in that it would be felt the most by those least able to pay.

3. Tax proposals and research and developments proposal involve such divergent fields that they should not be considered in a single legislative package. Each needs the attention of the appropriate committees in the Congress that have the background, the knowledge and the skilled staff to fully evaluate all the ramifications of each proposal.

4. It is a paradox that the nation is trying to encourage and promote the use of energy sources other than oil and gas, yet we would discourage their development by placing a tax on those sources. Nuclear, geothermal and solar energy do not deplete our nation's fossil fuel supply and development should be encouraged rather than discouraged. One of the primary objectives of the Administration is to promote the use of more coal to conserve our oil and gas supplies. An energy tax applied to coal could have just the opposite effect.

5. An Energy Trust Fund and the proposed tax are not necessary. There is no apparent reason why appropriations for research and development obtained through the normal budgetary process of government cannot be utilized to the extent they are necessary. With a research and development program beginning as contemplated under S. 2806, it is doubtful if all the funds generated by the special energy tax, approximately $4 billion a year on the average, could be effectively utilized. Furthermore, the establishment of a trust fund locks in and perpetuates a single operation. In a few years priorities may change and research funds may be needed for more urgent programs.

RESEARCH AND DEVELOPMENT

S. 2806 again brings to the fore a problem of long standing importance. What is the role of the Federal Government in research? S. 2806 attempts to answer this question by placing the Federal Government in the primary role, giving the new Federal Energy Administration the authority to contract to ". . . design, construct, operate, and maintain a demonstration-type, or full scale, commercial-size facility to produce energy from oil shale, coal gasification, solar power, tidal power, or other unconventional sources of energy . . ." [Section 303(a)(6)]

This broad mandate could place the Federal government further in the commercial energy business and we do not believe this to be in the public interest. There is a role for government to perform, just as there is a role for private industry to perform in the development of our domestic resources and research into unconventional means of producing energy. The unlimited authorities S. 2806 would grant to the Administrator would lead to a centralized agency that could dictate at will to energy producers, be in competition with private industry and, if past Federal power developments serve as an example, could espouse a policy that could well be in conflict with the will of the Congress and the people.

We believe there is an appropriate role for the Federal government. The government should provide incentives to development, establish policy, regulate where necessary, and maintain surveillance of industry's progress. In this connection, we call to your attention the contributions and potential contributions in the research and development field presently being undertaken by the electric utility industry. The Electric Power Research Institute (EPRI) was established by all ownership segments of the electric utility industry in 1972 as the successor to the Electric Research Council. EPRI is engaged in research of both near and long term problems. It is unique in that it is 100 percent industry supported and its interests range from the laboratory to the end user—its research activities cover the whole spectrum of the energy industry. The programs of EPRI are financed by all the ownership segments of the electric utility industry and all those segments and their customers will benefit from the research performed. Any Federal research program in this area should complement, not duplicate, present and future industry programs.

TAXES

Section 901 of the proposed legislation provides a 14 percent tax credit for domestic exploratory drilling expenses for oil and gas wells and for costs paid or incurred for the secondary and tertiary recovery of oil or gas from wells located in the United States. We note that this same tax incentive has been omitted for the drilling of wells for the production of energy by geothermal means and for investment in development of advanced nuclear power plants. Although we cannot believe it was intended, it appears that the result would be to inhibit, or at least not encourage, the development of energy which is not dependent on those fuels not in short supply.

Section 601 imposes a 40 percent excise tax on the non-invested profits of energy suppliers. This tax is in addition to the regular 48 percent corporation income tax. Although electric suppliers are exempt from the application of this excise tax we oppose its enactment as being discriminatory, a violation of the basic taxing principle that all citizens should be treated in an equal manner. Its application would tend to discourage potential investors from purchasing the securities of the energy suppliers covered by the tax.

We are encouraged that the introduction of S. 2806 and other energy bills in the Congress recognizes that with conservation, research, and careful development of our energy supplies, our Nation can reduce its dependence on foreign oil and gas sources. We can accomplish these objectives if given consistent government energy policies, sound workable legislation, and government-industry cooperation.

The Edison Electric Institute appreciates the opportunity to present these views to the Subcommittee on Energy, Committee on Finance, U.S. Senate.

KOPPERS INTERNATIONAL,
Pittsburgh, Pa., January 22, 1974.

Mr. ROBERT A. BEST,
Chief Economist, Senate Committee on Finance,
New Senate Office Building, Washington, D.C.

DEAR MR. BEST: As an officer of Koppers Company, a company that you know is deeply engaged in the development of technologies to provide new means for recovering energy from coal, I would like to comment on S. 2806 the "Energy Revenue and Development Act of 1973."

While we believe that the bill as a whole comprehensively provides in excellent manner a means for establishing a national energy program, we are seriously disturbed by some of the aspects of Sec. 305 of the bill. We are disturbed about subsection (3)(A) which would make all of an energy-program participant's previously developed background patents, trade secrets, know-how and proprietary information available to any qualified applicant on reasonable license terms. We believe that this compulsory licensing of privately owned technology is directly opposed to the constitutional purpose of the patent laws to promote useful technologies and would instead hinder commercial development of inventions and suppress the self-interests of private persons in developing new inventions and technology. We believe that the provision in sub-paragraph (3)(B)(b) would even further tend to suppress development since it would provide statutory bases for the compulsory licensing of patents owned by any "other party conducting research or development work."

But we are perhaps most concerned by the requirement in Sec. 305(a)(1) which would require all information resulting in whole or *in part* from Federally assisted research to be made available to the general public. The requirement is vague but if literally applied would necessarily include all inseparable technology and would lay open to the public, and thus to one's competitors, all of one's proprietary technical information and know-how even though it had been acquired privately.

We are very much inclined to support the position expressed by Karl E. Bakke, Esq. the General Counsel of the Department of Commerce in his letter to Senator Jackson of December 7, 1973 (cf. Congressional Record of that date) in which he suggests that the disposition of patent rights arising out of such research be governed by the President's Statement of Government Patent Policy, issued on August 23, 1971 as amended September 1973. We believe that this Government Patent Policy will allow the Government to deal in an equitable way with many varying situations and would provide the flexibility required to obtain the cooperation of all those capable of supporting this excellent program without the need for confiscating the property of anyone.

Very truly yours,

T. C. KEELING, Jr.,
Vice President and Director.

ATWOOD OCEANICS, INC.,
Houston, Tex., January 30, 1974.

SENATE FINANCE COMMITTEE,
Subcommittee on Energy, Dirksen Senate Office Building,
Washington, D.C.

GENTLEMEN: The Energy Revenue and Development Act of 1973 is intended to state the policy that the U.S. intends to become energy dependent by 1985. This stated policy is, of course, very worthwhile and is long overdue. However, with the cooperation of the Federal Government, this goal of self sufficiency can be attained under the free enterprise system. Price controls, restrictive legislation, and unavailability of federally leased lands for further exploration and development have contributed to our present state of dependency on foreign sources of energy to meet our domestic needs. With the removal of price controls, programs which have been uneconomical in the past will now become feasible and, in conjunction with new available lease land sites increased exploration and development should begin immediately. However, it does not follow and it would be very unwise to impose restrictive controls on the export of petroleum, petroleum products and especially drilling equipment solely because one sector of a foreign energy source chose to use their power for political purposes. It would be a harsh penalty indeed and would severely penalize drilling contractors who have been forced in the past to plan their entire operations around foreign drilling operations due to the policies of the United States regarding exploration and development within a state.

In Title VIII of the proposed Act, the overall effect of a restrictive export policy would be to increase still further the cost of various drilling equipment since there would be essentially a captive market and inventories of the various manufacturers would be regulated by the Secretary of Commerce. The present shortage of drill string, casing and other drilling equipment is due to the fact that price controls exist on such equipment and also from the stockpiling by users of the small available supplies that resulted from such price controls. The imminent passing of this Bill with Title VIII intact would result in still more stockpiling since the availability of the drilling equipment to be exported would be contingent on a submission of bids for the purchases of licenses to export which would result in possibly paying two or three times more than the market value of such equipment simply because it is going to be exported for international use.

In Title X, Miscellaneous Tax Provisions, it is proposed to deny tax incentives to U.S. companies for development of foreign energy sources which would seriously curtail the development of foreign energy sources, which, contrary to popular belief, are not inherently bad. This provision would also seriously penalize the U.S. companies that have spent millions of dollars in research and development of foreign energy sources and the literally thousands of companies that are dependent on the development of resources outside of the United States.

The current energy crisis in the United States has been brought about largely by the actions of the United States and not by any of our foreign neighbors. Title VIII and Title X of this Senate Bill No. 2806 are overactions to the present situation in the United States and would result in injustice, a worsening of our balance of payment situation, lessening of competition, and prices higher than need be to have a self-sufficient energy program by 1985.

Sincerely,

JOHN T. ATWOOD, *President.*

WARWICK, R.I., *January 30, 1974.*

FINANCE COMMITTEE,
U.S. Senate,
Washington, D.C.

GENTLEMEN: A small item in our Providence Evening Bulletin on January 29th states that Prof. William E. Heronemus of M. I. T. appeared before your committee to recommend the country's turning to solar energy. I certainly do not have the knowledge of one such as the professor, but from everything I've been reading these days the most "common sense" type of energy is that from the sun, and I cannot understand why something hasn't been done before this. I have heard every once in a while all my life about this energy but always felt that someone who knows how must be converting it for the general public's use, but it seems it is as remote now as it was forty years ago. I realize now that the petroleum industry has had a tremendous hold on the country, and after this year's problems with Egypt it just doesn't seem possible that our leaders aren't ready to promote something like solar energy so that the U.S.A. doesn't have to depend on another country's product that is so important to so many.

I have been interested in any articles written in the local newspaper on this subject and was pleased to hear that a Dr. Loferski of Brown University said experimental energy production facilities will be installed in a foundry by the Research and Design Institute in Providence. When finished, it will be an energy research and conservation center intended to live, as far as possible, off its environment. Dr. Loferski did say that solar energy for electrical power is at least ten years away, so I was especially interested when the article about Prof. Heronemus mentioned a solar breeder that could be built within five years.

As I said before, I have no real knowledge of the process involved, but when oil companies have been so powerful in influencing everything in this country and we have a free source of clean energy that needs only effective conversion, it seems the only sensible thing to do, so I heartily echo Prof. Heronemus' sentiments and pray that you who are in high office will heed men like him who are knowledgeable in the field.

Very truly yours,

MRS. CALVIN E. PEARSON.

[Telegram]

LOS ANGELES, CALIF.

Senator MIKE GRAVEL,
Chairman, Subcommittee on Energy,
Senate Committee on Finance, Capitol Hill, D.C.

The Western Oil and Gas Association respectfully requests that this message be made part of the hearing record on your bill, S2806, "the Energy Revenue and Development Act of 1973," in order to reflect the fact that the members of this association strongly endorse the testimony recently given before your subcommittee on behalf of the American Petroleum Institute by Mr. Annon M. Card and Mr. William L. Henry.

Our members are united in believing that the governmental actions recommended to you by Mr. Card and Mr. Henry are imperative if the petroleum industry on the West Coast, including Alaska, is to achieve the large increase in domestic production necessary to meet the rapidly growing demands by consumers for petroleum and petroleum products. These steps include, as Mr. Card and Mr. Henry pointed out, continued prompt and favorable action on offshore leasing, orderly decontrol of prices, deregulation of natural gas wellhead prices, adequate incentives for oil and gas exploration, expediting construction of the Alaska Pipeline and offshore ports, the acceleration of alternate energy development, and a rebalancing of environmental restrictions with energy goals and requirements.

Consideration of our views in your further deliberations on S2806 will be very much appreciated.

HARRY MORRISON,
Western Oil & Gas Association.

SEDCO, INC.,
Dallas, Tex., January 24, 1974.

SENATE SUBCOMMITTEE ON ENERGY,
Dirksen Senate Office Building,
Washington, D.C.

GENTLEMEN: Our company would like to go on record as opposing certain portions of Title VIII of Senate Bill 2806 known as the Energy Revenue and Development Act of 1973 sponsored by Senator Mike Gravel. We understand that hearings are being held on this bill and would, therefore, like to go on record at this time.

The sections we object to are Sections 801 through 807, which impose export controls on certain drilling and mining equipment. Our company is presently engaged in drilling for oil overseas, both on land and in the water.

We feel it is in the interest of the United States to increase the production of oil and gas in the free world. We are presently importing, we understand, about seven million barrels a day and predictions are we will be importnig almost eleven million barrels a day by 1980. In order to increase our imports it will clearly be necessary for the foreign countries to increase their production. American contractors have been in the forefront in supplying drilling equipment, people and techniques to increase the production in the free world. Many of the rigs presently operating in the North Sea are owned and operated by American drilling contractors. Insofar as we are able by our equipment and technology to increase production in the free world, we simplify our problem with respect to imports from the free world and in controlling the price of these imports. To unduly restrict the use of American equipment abroad will certainly have an adverse effect on the worldwide production on the amount of oil we can import.

The second point we would like to make is that much of the work we do overseas is for U.S. international oil companies such as Esso, Texaco, Standard of Indiana and similar companies. To the extent these companies can develop reserves overseas, it again simplifies the problem of obtaining sufficient oil from overseas sources and controlling the price of this oil. Certainly it is not in the interest of our country to limit the production by these domestic oil companies.

Finally, we feel the best solution with respest to the proper use of drilling equipment is to leave it to the normal law of supply and demand to settle these problems. Clearly as the demand increases in the United States, both on land and in the offshore areas, drilling contractors will respond to this demand in the normal fashion and supply the rigs to adequately meet this demand. Over the past ten years the number of rigs in the United States has gradually decreased because of reduced demand. Once the demand increases, this number will also increase.

Yours very truly,

By TOM B. RHODES,
Senior Vice President.

SANTA FE INTERNATIONAL CORP.,
Orange, Calif., February 4, 1974.

SENATE FINANCE COMMITTEE,
Subcommittee on Energy,
Dirksen Senate Office Building,
Washington, D.C.

GENTLEMEN: Santa Fe International Corporation is a California corporation which provides world-wide contract drilling services to the petroleum industry both offshore and on land; engages in offshore construction, including docks and deep-water loading facilities; and undertakes marine and land pipeline construction. Santa Fe and its corporate affiliates share the national concern over present and future energy shortages and wholeheartedly support the underlying policy and goal of the proposed "Energy Revenue and Development Act of 1973" to make the United States energy independent by 1985. We do, however, wish to convey our concern over certain methods proposed by Senate Bill #2806 as means of achieving energy self-sufficiency.

We take particular exception to Title VIII of the Act, Sections 801–807, which would impose export controls on petroleum, petroleum products, natural gas and coal, and certain drilling and mining equipment. We believe the imposition of such controls particularly with reference to drilling machinery would be unnecessary, would virtually defy equitable administration, would be prejudicial to firms long established in servicing the petroleum industry abroad, and would not contribute to achieving the intended self-sufficiency objectives. The following sets forth some of our reasoning in this regard.

The petroleum industry and its equipment suppliers have historically demonstrated an ability to make the necessary adjustments to meet supply and demand requirements without the need for direct governmental regulation. We at Santa Fe believe that the primary thrust of any regulation, the purpose of which is to foster domestic energy self-sufficiency, must be economic incentive geared toward providing our free enterprise system with an attractive climate for operation in the domestic market. Given such encouragement, the industry will, as in the past, respond with appropriate investment of capital and sufficient drilling equipment through relocation from overseas and new fabrication to meet the demand.

The concept of "going where the work is" has always been true for Santa Fe International Corporation. Since the post World War II period the number of drilling rigs operating domestically has decreased from approximately 2500 to the present estimate of 1400. Since our incorporation in 1946 we have engaged in international operations almost from the outset. This was due primarily to the oversupply of domestic rigs and resulting adverse pricing factor and in large measure to the geographical predominance of exploration and production prospects outside the United States. In short, we couldn't afford to invest substantially in the domestic market and we went where the work was. With conditions changing in the United States we would expect that precisely the same phenomenon would occur with a resulting return of drilling contractors and their equipment to the United States. Restrictive export controls imposed by the United States might well have the effect of indirectly encouraging expropriation and nationalization of U.S. owned equipment presently operating overseas. Should this occur, such equipment would never be available to work domestically.

Finally, U.S. companies have long been the dominant force in the exploration, drilling and production of oil and gas throughout the world. Such pre-eminence has an obvious beneficial effect on our balance of payments position. We believe the enactment of Title VIII could drastically reduce the U.S. drilling contractors' established position in the world market and thus deal a crushing blow to our position of technological leadership and to the assurance of necessary energy supplies for the free world.

In summary, we feel confident that the petroleum industry and petroleum services industry are quite capable of responding to meet our national goal of achieving energy self-sufficiency without the need for direct governmental export control regulation as proposed by Title VIII of Senate Bill #2806. We further believe that it would be most prejudicial to achieve this goal by penalizing a viable petroleum service corporation employing over 6,300 employees and making a direct contribution toward furnishing a portion of our domestic energy requirements. We urge you to consider the above and trust that you will agree that passage of the Senate Bill #2806 as presently drafted would severely retard oil and gas operations outside the United States by U.S. drilling contractors.

Respectfully submitted.

GORDON ANDERSON, *Director.*

THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA,
Washington, D.C., February 6, 1974.

Hon. MIKE GRAVEL,
U.S. Senate, Washington, D.C.

DEAR SENATOR GRAVEL: The Associated General Contractors of America is a national trade association representing more than 9,500 general construction firms with 120 chapters in all 50 States, Puerto Rico, and the District of Columbia. In addition, about 17,500 subcontractors, suppliers and service organizations belong to the Association as associate members. Our membership performs the greater part of all heavy, building, highway, industrial and utilities construction done by contract in the United States, amounting to approximately $80 billion annually.

Our Association applauds the congressional effort, in Section 502 of S. 2806 "Energy Revenue and Development Act of 1973", to deregulate natural gas. As early as March 1973, our Association foresaw the impending danger of an energy crisis and immediately established an Energy Crisis Committee to seek solutions to the developing shortages.

One of the first recommendations made by the select committee was that "The ceiling on the well-head price of natural gas be removed so that the price of gas can be established at its real competitive supply and demand market value." The recommendation was based on the Committee's finding that control of the well-head price of natural gas has been, and will continue to be, damaging to our nation's welfare. Despite the trillions of cubic feet of unutilized gas on and off the coasts of our nation, both drilling and production of new gas has steadily declined since the 1960's. The primary reason for this incongruous situation is that the Federal Power Commission, as a result of the 1954 *Phillips* decision, has held the well-head price of gas so low that investors have not found it profitable to drill for or produce new domestic reserves.

Until increased production becomes more attractive, through normal market competitive forces, one can only forsee a diminishing supply of domestic natural gas; an increased reliance on imported gas; and increasing consumer 'trade-offs' from natural gas to middle distillates, thus increasing the short-fall that already exists for middle distillate fuels.

The Associated General Contractors of America, anxious to resolve the shortages that now face our nation, strongly urges affirmative action on Section 502 of the "Energy Revenue and Development Act of 1973."

We respectfully request that this letter be made a part of the record of hearings on the "Energy Revenue and Development Act of 1973" currently underway in your subcommittee.

Sincerely,

JAMES M. SPROUSE,
Executive Director.

OUR R. & D. CHALLENGE FOR NATIONAL ENERGY POLICY

THE SCOPE OF THE R. & D. TASK IS BROADER THAN ANY OF US REALIZED UNTIL RECENTLY; WE CANNOT GO WITH PIECEMEAL RESULTS—WE MUST SHAPE THROUGH R. & D. A COMPLETE "SYSTEM" PICTURE, FROM SOURCE TO USER

(By Raymond L. Bisplinghoff, Deputy Director, National Science Foundation)

Shaping a national energy policy: Most people have recognized this as among the half-dozen overriding priorities for our country, if not the world, in the year just ahead. Formulating that policy requires a factual foundation. Formulating that policy means R&D.

The scope of the R&D task is broader than any of us had realized until recently. As so often happens in situations showing exponential growth, the developing mismatch between supply and demand manifested itself at first in relatively small ways, and correction seemed a matter of applying relatively small fixes.

That proved not to be the case. We now know that there is hardly any part of the government, nor any nongovernmental institution, nor any sector of American society, nor any aspect of the life of any family or individual not affected by our growing use of energy.

Consequently, one is inclined to say that research has never had a larger or more exacting obligation. Moreover, it must be carried out within a new and powerful constraint—make our energy system environmentally clean. "Clean" no longer means just non-polluting to the air, the Earth, and the waters. It has also come to mean that energy must be conservative of non-replenishable resources; that the means of providing it must support rather than run counter to our requirements respecting international security, international politics, and international trade; that the energy system must be equitable as among competing sources, competing elements of the energy industry, and competing users; that the system must strengthen rather than burden the economy generally; that its social benefits must clearly outweigh its social costs; and that it must do minimal damage to the environment.

It is these restrictions which impose demands for R&D in a vast area beyond hard technology and set a task of unprecedented scope and complexity. Clearly, we must take a systems approach to the energy task, not only now but also into the foreseeable future as changes inevitably occur. I shall return to this point.

This discussion will examine some of the responsibilities the Federal government must discharge in giving effect to a national energy policy, note some of the R&D tasks which must be performed—to a very large extent through Federal initiative or guidance—and give some attention to R&D programs in the energy industry, using the electric-power industry as example.

The Federal responsibilities in meeting national energy needs might be outlined as follows:

1. Resolve issues—

Among competing sources, existing and potential.

Among competing technologies, existing and potential.

Among Federal mission agencies having either active or passive roles in relation to national energy policy.

Among competing large categories of users.

As to use or non-use of energy—i.e., conservation; trade-offs, as between telecommunications and transportation.

2. Monitor consequences of energy production and use.

3. Make anticipatory technology assessments of the consequences of energy production and use—physical, environmental, economic, social, political; search out technological opportunities—e.g., agro-power—and research them.

4. Estimate available energy resources and predict demand.

5. Resolve energy-related issues bearing on—

Tax policy for constructive allocation of economic incentives and constraints to development of energy sources and to energy production.

International economic and political policy.

Allocation of national energy resources among competing requirements, having in mind highest and best use of resources.

National security.

Equitable patterns of national user cost levels overriding geographic-transportation factors affecting cost at point of use; i.e., "end-of-the-line" high costs. (It seems clear that an area remote from points of production and origins of distribution pays more for it senergy and incurs a penalty on its economy.)

6. Formulate and apply measures for large-scale conservation in—

Uses of energy.

Technology of energy-using devices, large and small.

Efficiency of conversion.

Introducing or encouraging alternative technologies for high-energy-demand or excessively polluting activities; e.g., improved home insulation; lifetime costing of buildings.

7. Develop and carry out an optimal program of transition to—

Emerging sources, such as fusion and solar power.

Emerging conversion methods, such as MHD.

Improved distribution methods, such as super-conducting transmission lines.

8. Specifically, develop and carry out a program of transition from energy sources threatened by exhaustion, or from sources or production methods prospectively of unacceptable cost, or environmentally unacceptable; manage tradeoffs for such transition.

9. Develop and carry out an optimal program for coordinating and conducting R&D. This task involves—

Meshing government, university, and industry research on energy, both as to individual projects and aggregate programs.

Identifying and obtaining basic research relevant to energy problems; e.g., materials and plasma-physics research; environmental studies.

Analyzing impediments to R&D in the energy industry.

Developing incentives and means of support for R&D by energy producers and vendors as well as suppliers.

Devising of means whereby producers and distributors can recover R&D costs by straight-forward commercial practices.

Designing more productive programs of education in the capability for energy R&D and in convertibility of scientific and technological capability into the energy field.

Identification, performance, and application of collateral R&D; e.g., advanced excavating technology.

10. Resolve a miscellany of issues such as—

Reconciliation of private economic interest with the national interest.

Development and encouragement of technologies which, for one reason or another, cannot be developed by the private sector.

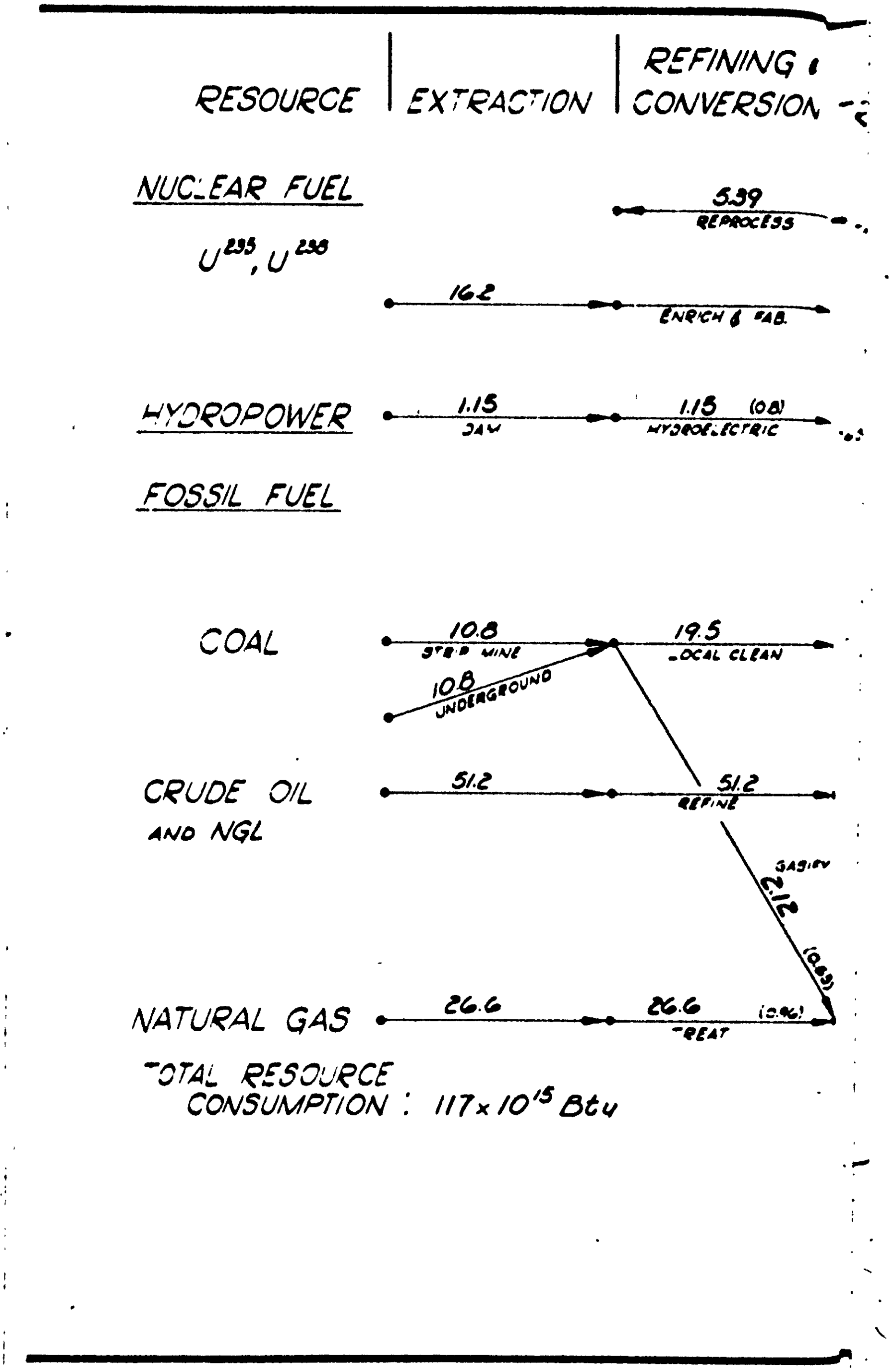
The phasing of technological advances, perhaps randomly occurring, into the existing system, as to both small and large components.

The effect of regulation upon energy supply.

It needs to be repeated that every one of these topics calls for intensive R&D efforts, in a program going well beyond traditional confines of energy R&D. Research must be extended to include, for example, the total biography, including environmental impact, of a ton of coal from the mine to the electrically driven machine. Thus the supplying of energy to the machine has come to involve a myriad of questions involving economics, environmental science, political science, social science, and a wide range of physical sciences and engineering fields.

Our aim must be a cohesive national policy. We cannot stop short with simply this or that part of the R&D enterprise—with piecemeal results. Each of the articles in this issue of *A/A* deals with a promising energy source or energy-conversion method, but neither do these by themselves nor taken together give anything like the whole matter we must shape to a new energy economy. They typify, however, the great options opening to us and make it clear we should think big and wide. And they also make it clear how large the prospective investment, whatever choice is made, and how great the impact of implementation, economically and socially. They put us unequivocally on notice that, to the extent humanly possible, we must know exactly what we are doing in forging the energy machines of the future.

Just a scan of this horizon brings into view such a complexity of needs in energy R&D that the reader will recognize the impracticality of an exhaustive inventory of individual research topics in this article.



There are, of course, various inventories available which attempt to be complete. From them there may be drawn—for illustrative purposes only—items of needed research related to policy formulation. These have been arbitrarily limited here to four under each heading, from a field which, in the case of any one heading, may run from 20 to 40 items or more:

Energy projections and system modeling.—Consistent energy statistical studies; projection techniques for population and GNP; demographic and social-trend analysis; energy models for U.S. and the world.

Energy conservation.—How to increase efficiency; social impacts of conservation; consumer behavior; changes in life styles.

International affairs, trade in energy, and security of supply.—International capital flows; limits of national seabed jurisdiction; international pollution control; long-term projection of supply and demand by country by type of energy source.

Policy formulation and institutional mechanisms for action.—Federal and state regulatory practices; role of administrative bodies at Federal, state, regional and local levels; policy flexibility in uncertainty.

Rate-structure design.—Validity of rate of return on investment as measurement tool; regulatory economics; innovative future rate-structure design; rate equity to end-users.

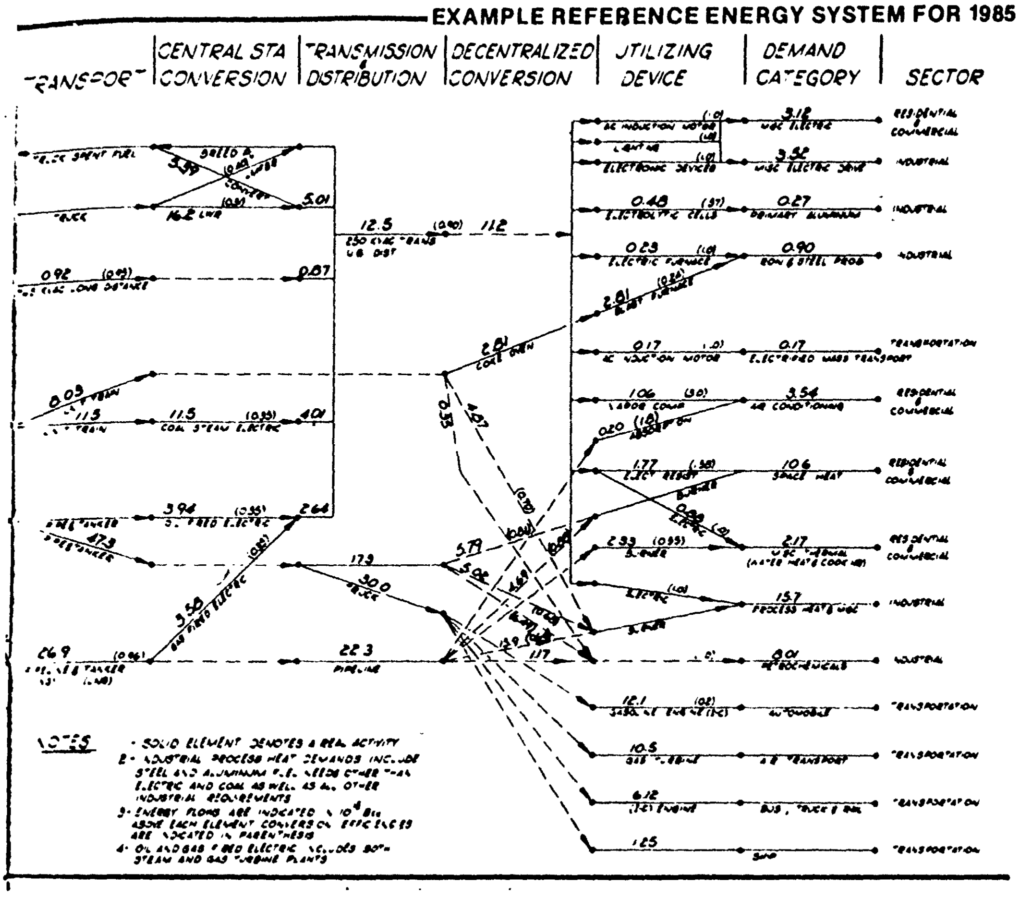
Energy-industries' structure, functional characteristics, and comparative behavior.—Cost analysis of industry (inter-industry cost comparison and cost-efficiency); distribution cost analysis (includes transportation cost; structure, behavior and performance of the energy industries; productivity of labor).

Capital requirements and finance of energy supply and environmental control.—Sources of capital (private vs. public); estimation of capital requirements under uncertainty; social risk-bearing; profit motives of private industry.

Strategy for R&D investments in energy hardware, public and private.—Criteria identification for evaluation of future R&D programs; future R&D decision-making techniques; incentives for private R&D on energy; career development and personnel requirements.

Incentives (price and non-price) in energy production and consumption.—Pricing incentives or disincentives; state conservation regulation; interaction of tax incentives with state conservation regulation; and public policy.

EXAMPLE REFERENCE ENERGY SYSTEM FOR 1985



To expand more extensively upon just one of the many areas referred to, consider the effect of rate structure on energy demand. Until recently it had been generally believed that the cost of energy was so low that increasing rates would negligibly influence the rate of growth of demand; in the language of the economist, the elasticity of demand for energy with respect to price was considered negligible. Now a number of studies of electricity prices and demand sponsored by NSF make a convincing case that demand for electricity proves quite sensitive to price—but with a delay of several years between the time a price change occurs and the time the demand changes. The effect is large, but subtle. (For example, owners of electrically operated appliances don't stop using them if the cost of electricity increases, but they may think hard about *buying a replacement* if the operating cost goes up.) Such econometric analyses are already affecting rate hearings before utility commissions in several regions of the country. They also show that price increases can encourage energy conservation. In applying such considerations one must, of course, be careful of discriminatory effects against low-income groups.

To iterate, the great complexity of our national energy system demands unified analysis and action: Energy R&D must be examined and evaluated from a total systems point of view. An example of this approach is contained in a document prepared by Associated Universities, Inc., for the Office of Science and Technology in April 1972. It includes simplified diagrams of energy flow in our national energy supply, distribution, and utilization system. Such a diagram for the year 1985 accompanies this article. "Reference energy systems" of this type diagram energy flows associated with technologies employed in the conversion of resources into, useful forms of energy. This is done for the entire spectrum of end-uses, such as space conditioning, ferrous metal production, air transport, etc. For the most part they reflect existing technologies. Others might assume expected magnitude of the growth in energy consumption, policy decisions affecting the individual energy resources, such as Middle East oil, breeder reactors, environmental constraints, and the like.

For the evaluation of R&D, each reference system of interest should provide a self-consistent framework for assessing the total system effects of proposed R&D; for R&D on a particular system component may affect other parts of the system in unanticipated ways. One easily sees how this can happen, since responsibility for R&D on different parts of the energy system is highly fragmented, being distributed among many Federal agencies and offices, as well as a broad spectrum of private industries.

A diagram like the one cited here shows energy demands sorted by specific end-use and associated resource consumption. It indicates each component activity, from extraction of the resource through transport, conversion, distribution and utilization, along with the flow of energy and the efficiency (relative effectiveness) associated with an activity. Starting with this kind of a reference system many other properties of the system besides flow and utilization of energy can be analyzed. Any energy-associated problem that can be quantified can be "overlaid" on it, and the effect of proposed R&D can be evaluated in that context. Progress has been made in performing such analyses for emissions into the environment and energy-related health effects (industrial and public). Examples of other energy-related R&D that might be examined in this way include risk analysis, resource conservation, land-use planning, capital requirements, and perhaps even public acceptance. It is well to remember that responsibility for energy-related R&D is often fragmented in two dimensions—one being the part of the energy system concerned and the other being the type of problem considered.

I feel that it is of great importance that analyses of this type be vigorously pursued. Funds so expended are more than repaid by R&D effectiveness. And the diagrams lend themselves readily to policy making as well.

Work along these lines is being supported largely by the NSF, the Environmental Protection Agency, the Council on Environmental Quality, and the AEC in the Federal government, and with private funds, most notably by the Ford Foundation. A recently formed NSF Energy Task Force is exploring the use of such a framework in preparing future Federal energy-R&D budget requests.

Being careful to avoid overstatement of its role, I may note that NSF has been and is busy in the field of energy research, both directly and in energy-related research areas. This activity is organized in two principal ways. NSF's own function of obtaining the performance of research in universities, industry, and government facilities has developed rapidly in the past two or three years. It is centered in the Division of Advanced Technology Applications (ATA) in the NSF program of Research Applied to National Needs (RANN), and has connections to relevant programs in other parts of RANN and elsewhere in the Foundation. Second, this past spring NSF talent was drawn into an R&D Energy Task Force which had as a principal objective providing a detailed proposal for the development of a comprehensive national program for conducting energy-related R&D. This work put special emphasis on the long-term Federal role in coordinating and furthering energy R&D and on over-all environmental, conservation, and policy issues. I am indebted to that group for a great deal of what has been said here about the R&D task.

The ATA program in energy just mentioned has developed strong coupling with industry—an early involvement of users in problem-oriented research. For example, ATA increasingly interacts with the Electric Power Research Institute (EPRI), which is launched upon an ambitious program of research in which utilities, as distinguished from their supplies, have a newly dominate role.

I have chosen the R&D activities of the electric-power industry for purposes of illustration here because they are so broad in scope and so varied. The industry, of course, is primarily interested in means for producing electricity and making possible its efficient, economical, and nonpolluting generation and distribution. But the research upstream from those results explores much of the field of energy sources and their exploitation, and it might well in some cases find applications other than central-station generation of electricity.

An idea of the industry program can be gathered by examining correlations between EPRI and NSF research areas. EPRI's interest in nuclear conversion—breeder and fusion reactors, nuclear fuels, and safety being primary concerns—aligns with NSF's fundamental science and engineering programs in energetics and plasmas. EPRI's interest in fossil conversion by present methods, including SO_x and NO_x problems, lines up with RANN programs in coal gasification, desulfurization, and materials. EPRI's interest in embryonic conversion methods—including MHD, fuel cells, and solar energy—fits in with RANN programs in solar and geothermal energy, new cycles, and MHD. In overhead transfer, EPRI is interested in a high-power test facility and UHV tests; RANN has programs on insulators and flashover. In underground transfer, RANN is working on superconducting cable research and on tunneling and excavation technology. On planning and control, including security assessment, EPRI's concern is recognized in RANN-sponsored control projects in several universities, and a control and planning project at another institution. And EPRI's concern with the environmental effects of utility-industry operations parallels the underlying reasons for a variety of RANN programs on the environment. This skeletonized listing represents work already in progress. Extensive discussion between EPRI and NSF have already taken place on joint funding of advanced projects as well.

In somewhat broader terms, there are recognizable correlations between the main subject headings of RANN's Energy Research and Technology Program and those of EPRI. NSF's program covers energy systems, energy resources, solar energy, energy conversion, and energy and fuel transportation. EPRI's includes industry growth and system development, energy conversion, and transmission and distribution.

On a specific project basis EPRI and NSF also share research interests. Without attempting a detailed correlation, let me recite a sampling of specific project titles under NSF sponsorship:

Evaluation of the two-field synchronous machine to improve power-system security.

Studies of principles for the all-digitally-controlled and -operated power system.

Study of multi-computer control of system voltage and reactive power on a real-time basis.

R&D on lithium-sulfur secondary batteries.

Low-cost silicon photovoltaic cells for large solar power systems.

Projects in the study of thermal conversion of solar energy for electrical power production.

Comprehensive research program on management of heat rejected from large powerplants.

Hydrogen production by photosynthesis and hydrogenase activity.

Studies toward improving techniques for gasifying coal.

National energy needs and environmental quality.

Investigations of procedures for desulfurization of fossil fuels.

Potassium-steam binary vapor cycle.

Surveying R&D needs builds an awareness of large problems inherent in the national energy task—especially on financing the R&D, finding the scientific and technological brainpower to carry it out on the required scale, and financing new technology and enhancing the effectiveness of existing technology.

Meeting these objectives may well mean we must invent new institutions, particularly to resolve conflicts over use of the nation's land, air, and water resources.

As the energy problems facing us increase in complexity, so too is the nation turning its best efforts toward finding solutions. Historically, America has experienced unlimited growth in its use of energy and natural resources. The photographs of Earth taken by the astronauts drove home to all the fact that we must live on a finite world—a world in which the products of energy use pollute the air we breathe and the water we drink. But space exploration also made it clear to all that research can open new options for the nation and the world—options which can permit a high standard of living for mankind with minimal environmental impact. It should be with some humility that we develop through our R&D the alternatives for a new world energy economy, for the decisions based on them may shape the lives of the people of Earth till Kingdom Come.

Harnessing Solar Energy: The Potential

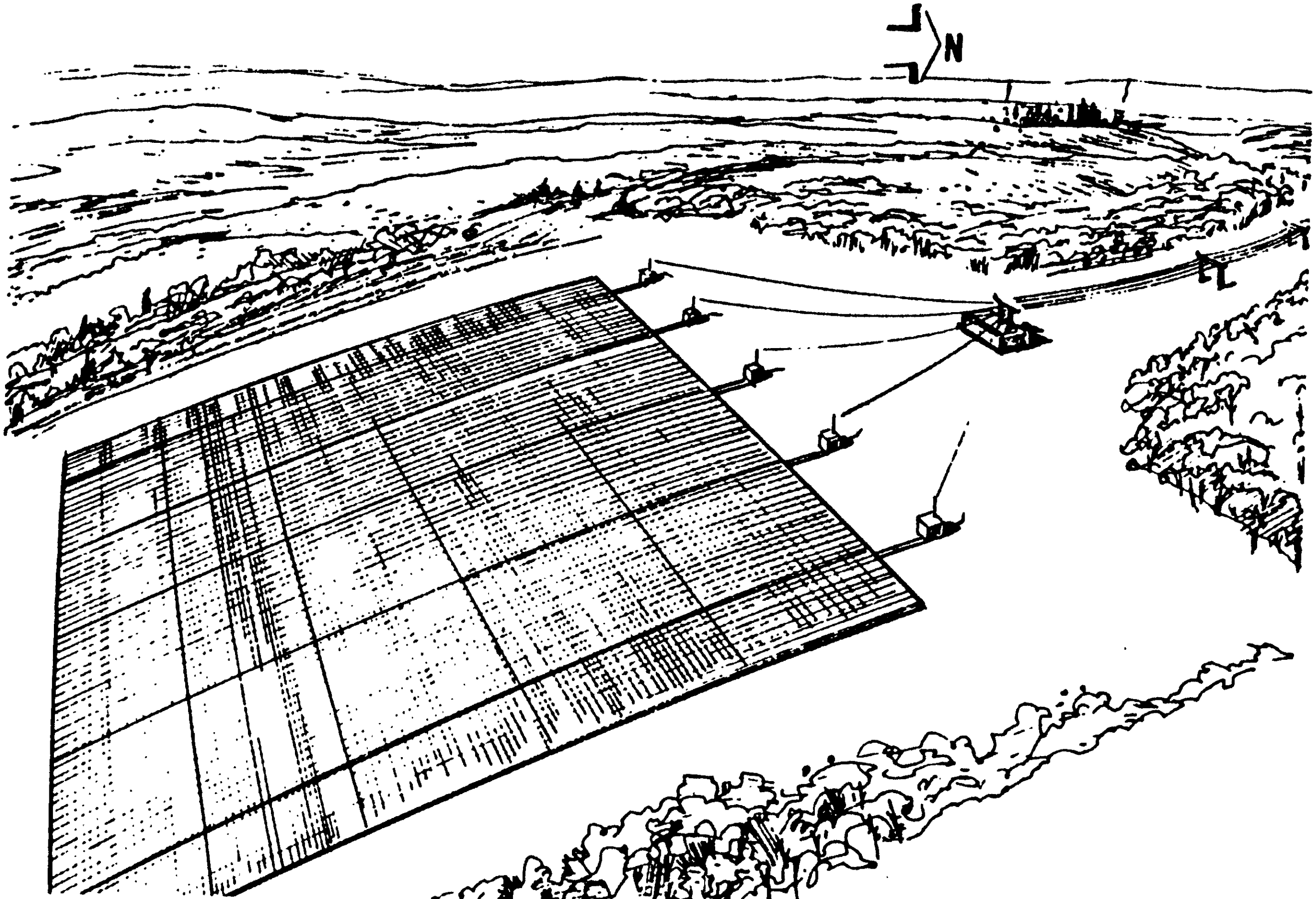
(By William R. Cherry)

The time has come to harness solar energy as a major national energy resource. Besides being inexhaustible, it can be utilized with minimal impact on the environment three major ways: heating and cooling of buildings, production of clean renewable fuels, and generation of electrical power. We need no major scientific breakthroughs to bring about the economic competitiveness of solar energy—just improvement of known materials, processes, and engineering.

Properly directed, an investment of about two-and-a-quarter billion dollars over a 15-year period in solar conversion and collection technology will make available vast amounts of clean thermal energy and clean gaseous, liquid, and solid fuels to help relieve our dependence upon the unrenewable fossil fuels, particularly foreign sources of them, and so help rectify our balance of payments. By the year 2020 at least 20% (almost the total energy consumption of the U.S. in 1970) of the U.S. total energy needs could be met with solar-energy processes.

Why Use Solar Energy? Enormous domestic reserves of fossil and nuclear deposits feed most of our country's energy needs. Only recently has there been a major concern about their depletion, the consequences of using them at ever-increasing rates, and the effect of their use upon our environment. U.S. gas and oil reserves probably will meet our needs for another 50 years or so; but since U.S. production can not keep up with demand, we will become more and more dependent upon foreign sources of supply. Not only is this an undesirable position in terms of national security, it also strongly tilts our balance of payments. Furthermore, other countries consume ever-larger amounts of fossil fuels, thus driving up their cost.

Over the next 50 years the U.S. will increase its use (T-1) of liquid fuel by a factor of 3, coal by a factor of 5.5, and nuclear-energy sources for reactors to produce electricity by more than 800. All of the (T-1) fuels are nonrenewable, with the exception of nuclear material for breeder reactors, and all have undesirable pollution problems, ranging from land degradation to the disposal of thermal and genetically hazardous wastes.



Terrestrial solar powerplant concept in a configuration covering a square mile. By the end of the century such photovoltaic powerplants could be supplying 1% of U.S. electrical needs; by the year 2020, about 10%.

In strong contrast, solar energy can serve us as long as we inhabit Earth, collected and converted to useful energy with minimal impact on the environment and in many cases with no wastes to speak of. Solar energy can and should provide our country with a significant portion of its future energy needs.

Availability of Solar Energy: Solar energy arrives on the surface of the U.S. at an average rate of 1500 Btu/ft^2/day (about 42 x 10^9 Btu/mi.^{2}/day). Over the period of a year a square mile receives about 15 x 10^{12} Btu. In 1970 the total energy consumed by the U.S. for all purposes was about 65 x 10^{15} Btu. Thus 4300 sq mi. of continental U.S. land receives on the average in one year the equivalent of all the U.S. energy needs! At 10% conversion efficiency 43,000 sq mi.—about 1½% of the land area of the 48 contiguous states—could produce the amount of power the U.S. consumed in 1970. (Our major metropolitan areas cover about this much land. The Great Lakes occupy about 3% of the U.S. area and farm crops cover more than 15% of the country.)

The solid vertical lines in F-1 project U.S. energy requirements for 1970, 1977, 1985, 2000, and 2020. The dotted vertical lines show the energy expected to be consumed in those years to produce the electrical power. The sloping lines describe solar-energy-conversion efficiencies. By following the 10% conversion-efficiency line to its intercept with the year 2000's total energy requirement, you can see that the solar energy falling on about 4% of the 48-state surface area and converted at 10% efficiency could produce the equivalent of the U.S. total energy needs for the year 2000. F-1 also shows that about 22% of our total energy consumption supported electrical-power production in 1970. About 27% in 1977, 32% in 1985, 43% in 2000, and 54% in 2020 will likely go to produce electricity—we will become increasingly electrified in the years ahead.

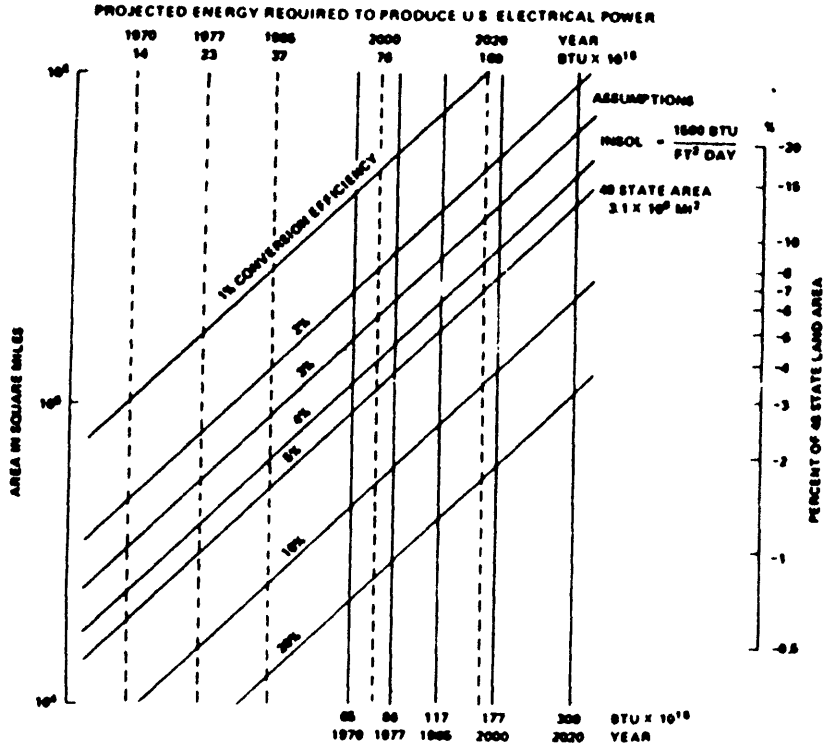
T-1.—PROJECTED U.S. ENERGY DEMAND BY SOURCE

[All figures in 10^{15} Btu]

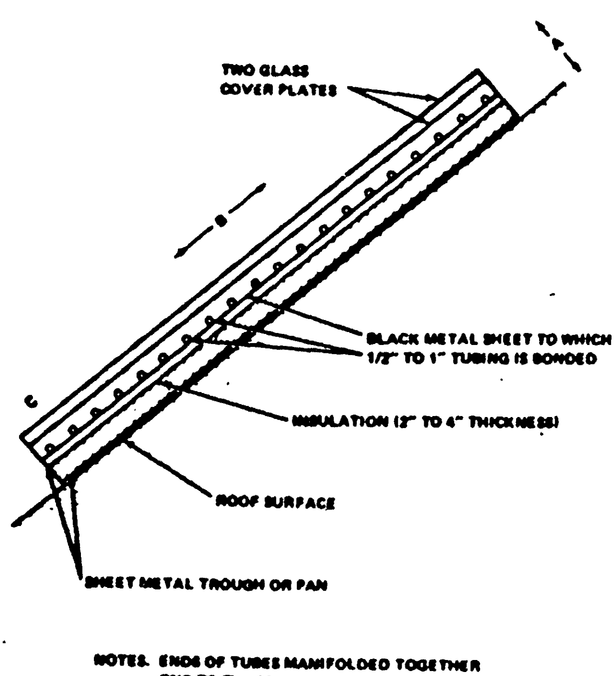
Fuel	1970	1977	1985	2000	2020	Increase
Gas	21.5	24.6	26.6	27.9	29.2	1.4
Oil	28.7	38.7	51.2	65.5	81.7	2.9
Coal	13.3	16.0	21.6	36.5	74.6	5.6
LWR	0.14	5.7	16.2	25.5	27.7	800.0
LMFBR				20.5	84.5	
Hydro	1.1	1.1	1.2	1.4	1.6	1.5
Total	65	86	117	117	300	4.7

From AET-8 Assoc. Univ. Inc., April 1972.

F-1 AVAILABILITY OF SOLAR ENERGY VS. LAND AREA



F-2 A SOLAR COLLECTOR FOR RESIDENTIAL HEATING AND COOLING



NOTES: ENDS OF TUBES MANIFOLDED TOGETHER
ONE TO THREE GLASS COVERS DEPENDING ON CONDITIONS

DIMENSIONS: THICKNESS (A DIRECTION) 3 INCHES TO 6 INCHES
LENGTH (B DIRECTION) 4 FEET TO 20 FEET
WIDTH (C DIRECTION) 10 FEET TO 50 FEET
SLOPE DEPENDENT ON LOCATION AND ON WINTER-SUMMER LOAD COMPARISON

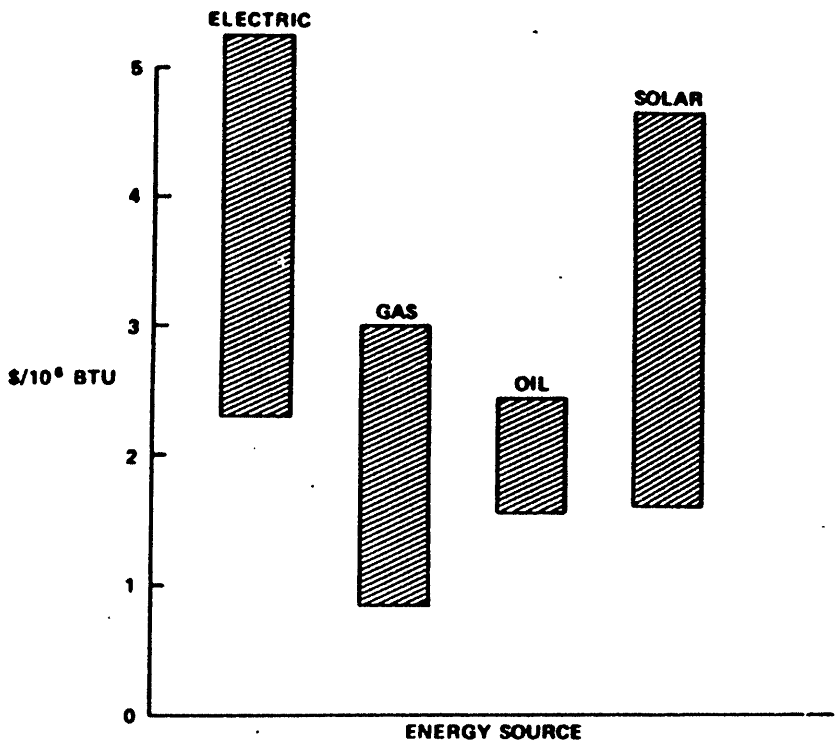
Although abundant, the diffusion and interruption of solar energy as yet keeps it from being economically competitive with conventional fuels in most applications. As fossil-fuel costs increase and more constraints are placed on their use, solar energy will become more attractive economically in many regions of the U.S. and abroad. A relatively modest R&D effort—ranging between 2- and 3-billion dollars over 15 years can bring a number of solar-energy utilization options to commercial readiness and form the basis of a multibillion-dollar industry.

Last year NSF and NASA formed a Solar Energy Panel to examine the potential of solar energy as a national energy resource. What follows reflects the findings of this panel and its conclusions.

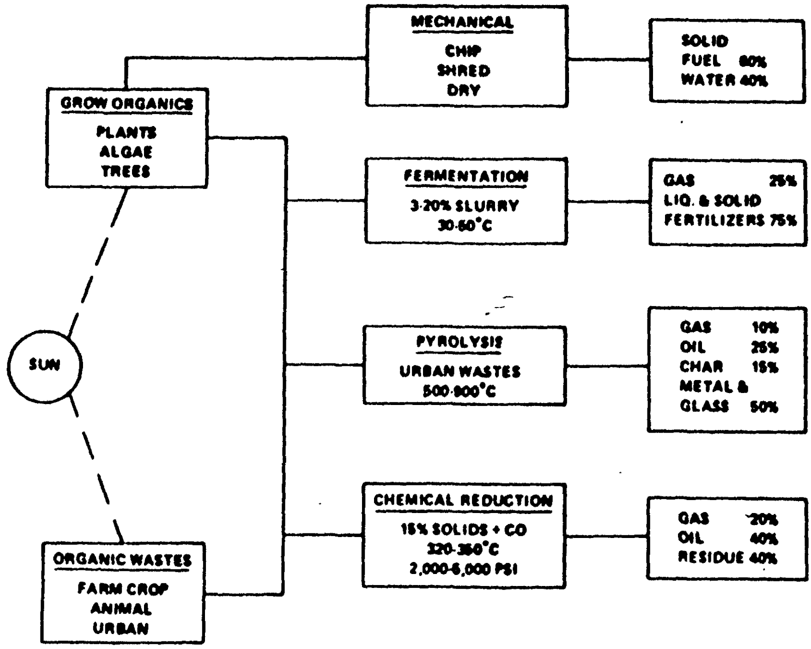
Heating and Cooling of Buildings: It would take only 5 to 7 years to develop solar-heating and -cooling systems for buildings to commercial readiness. The flat-plate collector, a prominent contender for this role, traps thermal energy beneath glass plates using the greenhouse principle (F–2). Either water or air circulated over the hot collector collects energy and then runs into insulated storage tanks or rock bins. While heating systems alone are competitive with conventional heating systems in only a few places in the U.S., a combination heating and cooling system using the same solar collectors would be much more widely cost competitive.

The major technical problems to be solved primarily concern the cooling portion of the solar-conditioning system. An efficient cooling cycle must operate effectively between ambient and 200 F for integration into the total system. Since the heaviest cooling loads occur when the solar energy is at its maximum, the loads are in phase with the energy source. Long-life roof collectors are now available for solar hot-water heaters as well as space heating. Some units have been operating more than 14 years without major servicing.

F-3 COSTS OF SPACE HEATING



F-4 PRODUCTION OF FUELS FROM SOLAR ENERGY



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Solar-collector costs must be reduced by a factor of 2 to 4 to make them economically attractive. Flat-plate collectors can now be built for around $4 per sq ft. Mass production can probably bring the cost below $2 per sq ft, and a new method of producing extruded collectors might lower it even further. F–3 shows comparative costs that a residential consumer pays for various sources of thermal energy. Gas costs range from about $0.75 to $3.00 per million Btu, but these will be rising rapidly as gas becomes more difficult to get. In some regions of the U.S. today no new installations of gâs service are being made. Oil costs range from about $1.50 to $2.50 per million Btu. As more and more of the U.S. supply is brought in from foreign sources, the cost of oil will likewise increase.

Heat from electricity is the most expensive and least efficient way of heating buildings. Electricity costs will of course rise as fuel and powerplant construction costs increase. Solar-energy heating costs range widely depending upon climatic and solar insulation conditions (see F–3). Combining cooling with heating systems and developing an industry for mass producing solar space-conditioning systems will dramatically decrease these costs, and make solar space conditioning indeed competitive with gas, oil, and electric heating and cooling in many regions of the U.S.

With the investment of approximately $100 million over the next 10 years in the development of inexpensive yet long-life collectors, thermal-storage devices, coolers, systems engineering, product engineering, and architectural design, the solar heating and cooling of buildings could be incorporated into about 1% of the U.S. buildings by 1985, 10% by 2000, and over 35% by 2020. By the turn of the century this could represent more than a $2-billion per year savings in fossil fuels and more than $12-billion per year by 2020.

Production of Clean Renewable Fuels from Solar Energy: Production of renewable clean fuels using photosynthetic processes represents another malor use of solar-energy. F–4 portrays several methods which can produce solid fuels, such as wood or char, gaseous fuels like methane, and oils suitable for burning in electric powerplants.

In several regions of the U.S. where trees or plants grow rapidly, the trunks or stalks could be processed into dried chips and these burned to produce thermal energy. Such an energy plantation covering between 400 and 500 sq mi. could produce enough fuel to supply a 1000-megawatt electric powerplant continuously with fuel.

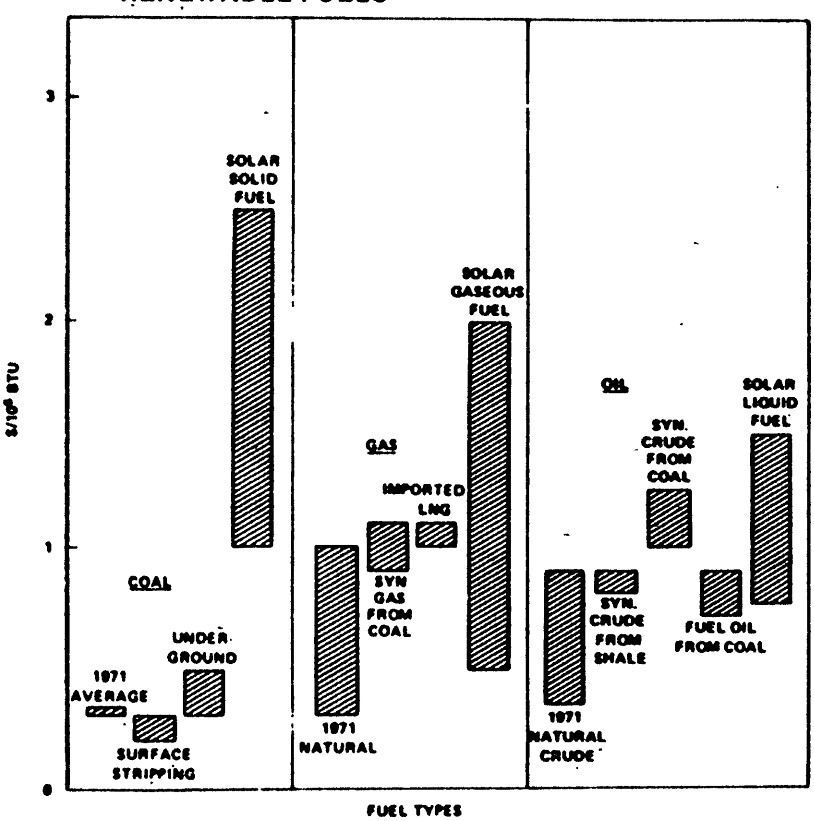
Algae grown on ponds, harvested, and then fermented will produce a gas of between 50 and 70% methane, the rest being mostly carbon dioxide. About 5 cu ft of methane can be derived from one pound of dry organic matter. So substantial amounts of methane can be produced from algae grown on ponds. According to one estimate, about 3% of the continental land surface could produce all the U.S. gaseous fuel.

Subjected to pyrolysis at 500–900 C, organic materials can produce large amounts of gas, oil, and char. The gas can be used to maintain the pyrolysis heating requirements and the oil and char produced as commercial fuel products.

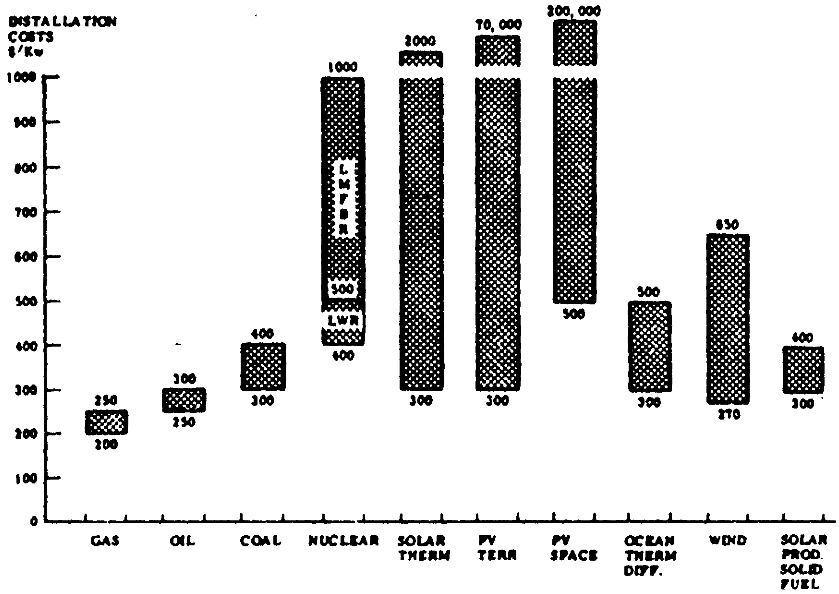
Today most processes like these are being run on a small, laboratory scale. The most difficult technological problems to be overcome involve economic collection or harvesting of the crop and its transport to the point of processing. If the materials are wastes and must be disposed of anyway, some transport costs can be credited against the expense of disposal. Some optimization of the various processes to yield more of the desired product, such as gas or oil, will be necessary to maximize the process efficiency and economy.

F–5 compares the cost of solid (coal), gaseous (natural gas), and liquid (petroleum) thermal energy for powerplants. As constraints are applied to the mining of coal and the ejection of effluents, the cost of using coal will dramatically increase. Natural gas is already in short supply in many places in the U.S. and the long-range forecast predicts ever-decreasing supplies. Synthetic imported gas costs much more than well-head supplies and will probably go ever higher. U.S. natural crude oil will be running in short supply over the next few years and the U.S. will become more dependent upon foreign sources. This will drive prices up. Oil from shale or coal will cost considerably more than natural crudes. So solar-produced oil should become competitive in price where the proper crops can be grown.

F-5 COSTS OF FOSSIL AND SOLAR-RENEWABLE FUELS



F-6 ESTIMATED INSTALLATION COSTS FOR ELECTRIC GENERATING PLANTS



For an R&D investment of about $250 million over a 15-year period, this country would be able to produce a substantial amount of the gas, oil, and solid fuel. By the turn of the century, when we will find ourselves in a pressing fossil-fuel shortage, solar cropping could meet at least 1% of the solid-fuel, 10% of the gaseous-fuel, and 1% of our oil requirements. By 2020 these figures could be 10%, 30%, and 10%, respectively. Even more could be produced if necessary.

These renewable fuels would represent an annual savings in non-renewable fossil fuels of $5 billion per year by the year 2000 and over $35 billion in 2020.

Generation of Electric Power from Solar Energy: Since 1958, the U.S. space program has powered satellites with electricity produced from solar cells. The first solar-powered system, flown on Vanguard I in March 1958, produced about 0.1 watt. The largest U.S. solar array, the combination Skylab/Apollo Telescope Mount, generates about 21 Kw. Can such technology be used on the ground?

For years studies have been made on the conversion of terrestrial sunlight into electrical power by two major methods: (1) solar concentrators employing linear heat absorbers to collect the thermal energy for producing steam for a conventional turbogenerator and (2) the use of photovoltaics (solar cells) to convert the sunlight directly into D.C. electricity.

The Solar Energy Panel identified four types of systems which might be developed:

1. Systems mounted on the roofs and sides of residences and commercial buildings.
2. Large generating plants adjacent to industrial complexes, such as aluminum or caustic-soda plants.
3. Large terrestrial powerplants.
4. Solar-powered space stations that would convert the solar-array D.C. power to microwaves, beam these to Earth, and then convert the power back to A.C. or D.C. for conventional transmission to cities.

T-2.—IMPACT OF SOLAR-ENERGY APPLICATIONS ON U.S. ENERGY NEEDS

Year	Annual consumption, 10^{15} btu*	Percent total energy consumption in United States	Estimated percent of market captured	$\$10^6$ annual savings in fossil fuel ($1 per 10^6 btu)	Significance† of impact by year 2020
A. Thermal energy for buildings:					
1985	17	15	1		Major on building industry; minor on total energy consumption.
2000	21	12	10	2,100	
2020	30	10	35	10,500	
B. Conversion of organic materials to fuels or energy:					
Combustion of organic matter:					
1985	37	32			Major on electric utility; modest on total energy consumption.
2000	76	43	1	760	
2020	160	53	10	16,000	
Bioconversion to methane‡					
1985	27	23	1	270	Major on gas consumption; minor on total energy consumption.
2000	31	18	10	3,100	
2020	41	41	30	12,300	
Pyrolysis to liquid fuels:**					
1985	50	44			Major on oil consumption; minor on total energy consumption.
2000	63	36	1	630	
2020	80	27	10	8,000	
Chemical reduction to liquid fuels:**					
1985	50	44			Do.
2000	63	36	1	630	
2020	80	27	10	8,000	
C. Electric power generation by thermal conversion: *					
1985	37	32			Modest on electric utility industry; modest on total energy consumption.
2000	76	43	1	760	
2020	160	52	5	8,000	
D. Photovoltaic electric power generation:					
Systems on buildings: ††					
1985	9	9			Major on building industry; minor on total energy consumption.
2000	15	9	5	750	
2020	21	6	50	10,500	
Ground stations: *					
1985	37	32			Major on electric utility industry; modest on total energy consumption.
2000	76	43	1		
2020	160	52	10	16,000	
Space stations:*					
1985	27	32			Do.
2000	76	43	1	760	
2020	160	52	10	16,000	

†Minor, 0 to 5 percent; modest, 5 to 10 percent; major, greater than 10 percent.
*Nonrenewable fuel consumed to generate the electrical power, as projected in AET-8, Associated Universities, Inc., April 1972.
‡Methane consumed to meet projected energy needs, AET-8.
**Oil consumed to meet projected energy needs, AET-8.
††Nonrenewable fuel consumed to generate the projected electrical power requirements for buildings, AET-8.

Note: Each of these impact estimates assumes successful development of practical, economically competitive systems. However, each estimate here reflects less than the maximum possible. The estimates are not necessarily additive since not all systems will be carried to commercial readiness.

Solar thermal systems need clear skies and an abundance of cooling water. With concentration ratios as little as 10, sufficiently high temperatures can be attained to operate conventional steam turbines at efficiencies between 20 and 25%. No technological reason prevents the building of a solar powerplant today; but considerable development on low-cost, long-life solar concentrators, absorbers, heat-transfer systems, and thermal storage systems are needed to make a solar powerplant economically competitive with conventional electric powerplants.

Solar-cell arrays, while highly developed for the space program, cost 200–300 times too much for large-scale ground applications. This country now produces about 5000 sq ft of solar-cell arrays per year using extensive hand operations. However, high-volume automated processes could easily reduce cell costs by a factor of 20 to 30; and new approaches of producing solar arrays, similar to ones used for manufacturing photographic film, could reduce costs by at least another order of magnitude. Because photovoltaics do not need intense sunlight to generate power and they do not use cooling water, they would have wider application than solar thermal systems. But electrical storage systems capable of rapid charge and discharge daily for 10 to 20 years need to be developed to make the photovoltaic systems independent of auxiliary support during night periods and extremely cloudy weather.

F-6 depicts the dollar-per-kilowatt installation costs of various conventional and developmental electric powerplants. Natural-gas plants are the least expensive and cleanest conventional electric utilities today, but the scarcity of gaseous fuel precludes its use in new plants. Oil plants are next cheapest, followed by coal plants at slightly more per installed kilowatt. The most expensive conventional powerplant to build today is the lightwater reactor powerplant. The first major U.S. liquid-metal fast breeder reactor, being designed now, may cost anywhere from $500 to $1000 per installed kilowatt fully developed.

Solar thermal plants will be capital-equipment intensive, requiring about 10 sq mi. of desert land per 1000-Mw installation capable of operating at the average of 70% capacity. Installed costs should range from $300 to $2000 per kilowatt; we lack the experience to make a better appraisal.

Photovoltaic powerplants will also be capital-equipment intensive, requiring about 20 sq mi. or more of land per 1000-Mw installation, but would not require cooling water or towers. Photovoltaic terrestrial systems, using today's space technology but not incorporating the high reliability parts needed for flight hardware, could be built for about $70,000 per installed kilowatt. Highly automated techniques for producing huge volumes of solar arrays should reduce these costs by at least two orders of magnitude. This would make photovoltaic systems competitive with future conventional powerplants. The photovoltaic space station today would cost about $200,000 per installed kilowatt; but under massive production techniques, using space shuttles and remote assembling methods, costs could be substantially reduced.

As with all major new energy systems, many years of development will be required to bring solar-power stations to economic readiness. About 15 years should be adequate to demonstrate the capability of a solar thermal powerplant—at an estimated cost of $1,125 million, including $1000 million for a 750-Mw demonstration plant built and operated on a government/industry cost-shared basis. Over a 15-year period, with the expenditure of about 800-million dollars, photovoltaic systems for buildings and space applications could be developed and small pilot plants demonstrated. Construction of large generating stations would start out as a joint venture between the government and industry, and then the government investment gradually phased out.

By the year 2000, solar thermal systems could be producing about 1% of U.S. electrical needs, and photovoltaic systems could be producing another 1% from terrestrial and perhaps 1% from space stations. By the year 2020, 5% of the U.S. electrical power would be developed from solar thermal systems, 10% from terrestrial photovoltaics, and 10% from space stations.

The table here (T-2) describes the over-all impact of solar energy on the three major areas of application, as envisioned by the NSF/NASA Solar Energy Panel.

Conclusions: For an investment of about $2,275 million over a 15-year period (considerably less than government expenditures on nuclear energy so far), a vast new source of clean energy could be made available to us and the peoples of Earth in perpetuity. The products from this massive development would be thermal energy, clean solid, liquid, and gaseous fuels, and electricity—all produced with a minimal impact on the environment.

By the year 2020, the NSF/NASA Solar Energy Panel concluded, solar energy could provide—

—At least 20% of the U.S. total energy needs—about 60×10^{15} Btu/year, or nearly equivalent to the total energy consumed in the U.S. in 1970.

—At least 35% of the U.S. heating and cooling needs for buildings, from coast to coast and border to border.

—From renewable organic materials, at least 30% of the U.S. gaseous fuel and 10% of the liquid-fuel needs.

—At least 20% of the U.S. electrical power needs.

—Less U.S. dependence, by at least 20%, on foreign sources of energy.

REFERENCES

1. Associated Universities, Inc., "Reference Energy Systems & Resource Data," AET-8, April 1972.

2. Lof, G. O. G., and Tybout, R. A., "Solar House Heating," *Natural Resources Journal*, Vol. 10, No. 2, pp. 268-326, April 1970.

3. NSF/NASA Solar Energy Panel Report, "An Assessment of Solar Energy as a National Energy Resource," Dec. 1972, Mechanical Engr. Department, Univ. of Maryland.

4. Szego, G. C., Fox, J. A., Eaton, D. R., "The Energy Plantation," Paper No. 729168, IECEC, Sept. 1972.

5. Christopher, G. L. M., "Biological Production of Methane from Organic Materials," United Aircraft Research Laboratories Report K910906-13, May 1971.

6. Sanner, W. S., *et al.*, "Conversion of Municipal and Industrial Refuse into Useful Materials by Pyrolysis," U.S. Dept. of Interior, Bureau of Mines Report No. RI-7428, Aug. 1970.

7. Meinel, A. B., and M. P., "A Harvest of Solar Energy," a presentation made at the REERIO Conference on the Energy Crisis at Las Cruces, N. Mex., May 4, 1972.

8. Ralph, E. L., "A Commercial Solar Cell Array Design," International Solar Energy Society Conference, NASA/GSFC Greenbelt, Md., May 1971.

9. Wolf, M., "Cost Goals for Silicon Solar Arrays for Large Scale Terrestrial Applications," Proceedings of the 9th IEEE Photovoltaic Specialists Conference, May 1972.

10. Glaser, P. E., "The Future of Power from the Sun," IECEC, IEEE Transactions on Aerospace and Electronic Systems 1968, 68C-21-Energy, pp.98-103.

HYDROGEN—TRANSPORTABLE STORABLE ENERGY MEDIUM

(By Derek P. Gregory)

In the last 30 years, man has used as much energy as during the whole of his previously recorded history. He will use the same amount again in the next 15 years, and the same again in the following seven years. Until now, almost all of this energy has come from the Sun, stored as wood, oil, coal, gas, or water power. The storehouse of energy shows signs of running dry. Based on previous trends, the rate of production of all fossil fuels on a worldwide basis will peak out around the middle of the Twenty-First Century—about 75 years from now. Constraints such as import restrictions and environmental considerations could well cause the availability of U.S. fossil fuels to peak out rather earlier. We have to develop new sources, such as nuclear energy or different forms of solar energy. Unless we do, we cannot maintain even our present standard of civilization, let alone improve it.

Despite the urgent need, the introduction of novel energy sources is not taking place fast enough to satisfy U.S. domestic needs. The nuclear-energy program has lagged behind the original plan, and solar energy has not found extensive economic direct use so far.

Several constraints have held back the growth of the nuclear-energy supply. A powerplant converts nuclear energy to heat; and because heat energy does not travel very far economically, the heat is used to generate electricity as the "useful" energy form. Nuclear powerplants prove economical only in large units, producing 1000 Mw or more, and operate best at a continuous constant output rate. Sites for them, moreover, must satisfy their large cooling requirements with no degradation of the local ecology.

The conversion of solar energy (including wind power) as envisioned today also faces serious constraints. Present technology most readily converts solar energy to heat or to electricity. The Sun shines (or the wind blows) only periodically, with seasonal and daily weather variations. Sun and wind occur most plentifully in limited geographic areas. Unfortunately, our energy needs do not fall into line with these constraints.

Our power demand goes up and down cyclically, in contrast to the constant output of nuclear plants. The cycles do not correspond either with those for solar-energy production. Also, demand concentrates in "high-energy-density" areas, such as large cities, where little or no natural cooling capacity remains for nuclear power stations. Neither do the energy load-centers correspond in general to areas with the highest sunshine levels or wind speeds.

One of the largest consumers of energy, and certainly the fastest growing, transportation (air and land) requires a storable, transportable fuel. Electricity cannot yet be stored well enough. In 1970, only 10% of the end-use of energy in the U.S. took the form of electricity. The nation consumed 90% by direct combustion. By 1985 projections (F-1) put the split at 20% electricity and 80% "heat." Trends indicate nuclear or solar technology will not meet most of this need for heat.

To bridge the gaps between demand and the limitations of supply, a synthetic fuel made by our new non-fossil energy sources seems desirable. A storable, portable, cheaply transportable fuel made from abundant materials—that burns with little or no harmful effect on the environment—would ideally meet our needs.

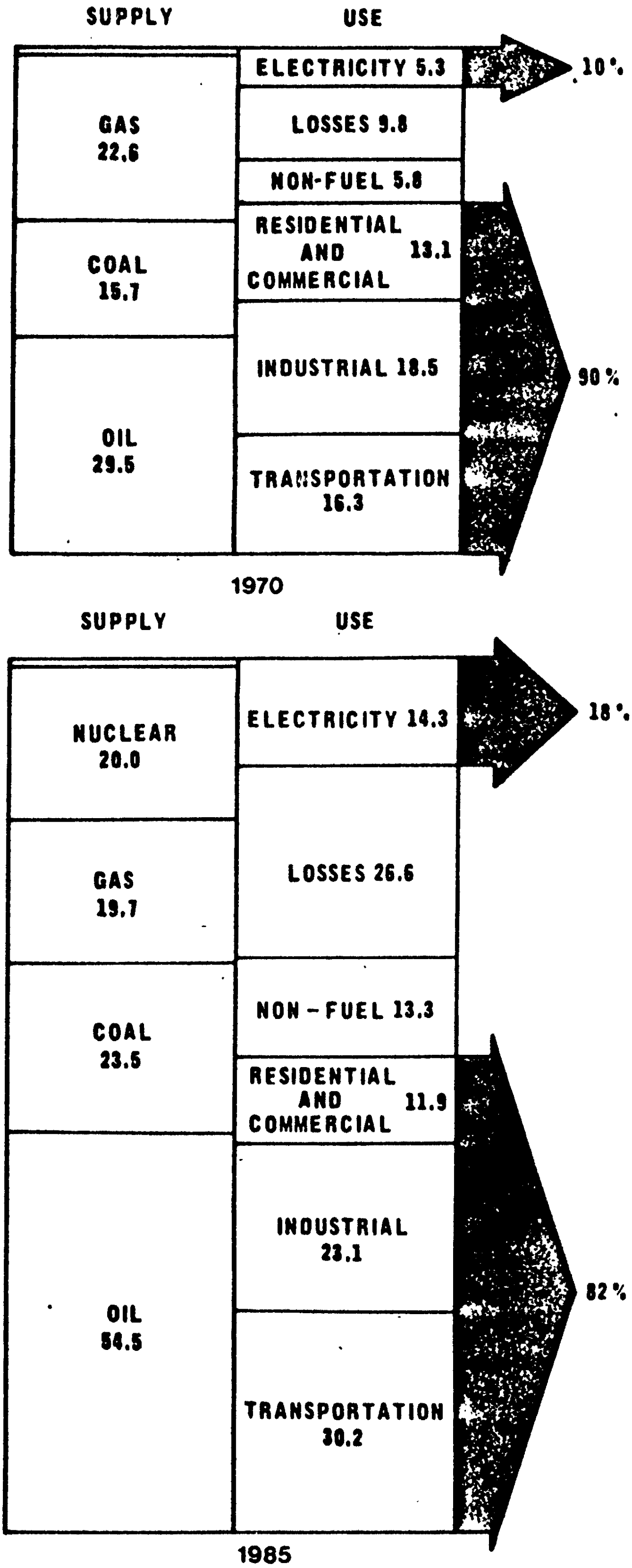
What are possible candidates? Electricity from non-fossil sources can decompose water into hydrogen (and oxygen), operate an air-separation plant to make nitrogen, and from these gases manufacture ammonia for use as a fuel. Also given a source of carbon dioxide (for example, carbonate rocks) electric power can synthesize methanol or even hydrocarbons, also using hydrogen from water. However, the precursor of all of these "fuels," hydrogen, is itself a fuel gas that offers all of the advantages of natural gas, and more. Pipelines can transport hydrogen underground relatively cheaply. Hydrogen stores readily as a compressed gas or cryogenic liquid. It produces little or no pollution, and its manufacture requires only water and heat.

A general awareness of the potential of hydrogen as a future fuel has developed in the past year. A few people have been proposing this concept for several years; but only now, in the shadow of an impending energy crisis, has the idea attracted significant attention. In the light of many recent articles in the scientific and business press, it is important to stress that hydrogen does not constitute a new energy *source*. It cannot replace fossil fuels or nuclear energy, but rather simply provides a means for making these energy supplies available in a more convenient form. Most important, it will allow us to retain in the nuclear age and thereafter many of the present procedures and much of the present hardware for fossil fuels.

Several authors have described a hydrogen energy system. In summary, hydrogen derived from nuclear or other energy forms would supply all the demands commonly met today by fossil fuels, including industrial, commercial, residential, and vehicular power, as well as the local generation of electricity. Others have termed the concept the "hydrogen economy" or "ecoenergy" system. Studies carried out by the Institute of Gas Technology and elsewhere find no insuperable problems in transmitting and distributing hydrogen or in using it for domestic and commercial heating and cooking. For many industrial uses it represents an ideal fuel and reducing gas. Applying hydrogen as a vehicular and aircraft fuel seems to depend on solving tankage and transfer problems, rather than anything to do with the engine.

The costs of producing hydrogen with nuclear or solar power can be assessed fairly accurately. For the simple case of electrolysis, the hydrogen must always cost more than the electricity which makes it unless unexpected returns come from the sale of byproduct oxygen or heavy water. The relatively less expensive transmission and distribution of hydrogen compared with electricity make its use attractive. Its extreme cleanliness in use (combustion gives off only water vapor) gives it an extra environmental advantage.

F-1 SOURCES AND USES OF ENERGY
From AEC, in units of 10^{15} Btu.



Electricity transmission is expensive and requires considerable land area for right-of-way. Placing long-distance bulk-power transmission lines underground costs prohibitively more. Transmission problems already faced by the electricity industry will likely multiply as demand grows and the distances between generating stations and load centers widen with a spreading population.

The natural-gas industry has well-established the technology for moving energy in underground gas pipelines. Pipelining gas costs considerably less for an equal amount of energy than transmitting electric power. For example, a typical 36-in. natural-gas pipeline can move about 1-billion Btu/hr, or 12,000 Mw, at a cost of about 1-2¢/million Btu per 100 mi. ($0.03 to $0.07 per Mwh per 100 mi.). Compare this to a high-voltage overhead transmission line which can carry up to 2000 Mw at a cost of 9-20¢/million Btu per 100 mi. ($0.3 to $0.8 per Mwh per 100 mi.). Underground power cables will likely cost between 10 and 40 times as much as overhead lines.

Pipelines made of the same materials as natural-gas lines already carry industrial hydrogen short distances. For transmission over longer distances, pipelines would need larger compressor stations than those now used for natural gas. Because of hydrogen's low density, a given pipe can carry a greater volume of hydrogen than natural gas, which almost compensates for the lower volumetric heating value of hydrogen. Estimates of the cost of hydrogen transmission in bulk pipelines range from 3-4¢/million Btu per 100 mi., or $0.10 to $0.14/Mwh per 100 mi.[7, 8] This cost amounts to only about one-hundredth of the cost of underground electric-power transmission. Stopping the analysis at this point might tempt you to conclude that producing hydrogen by electrolysis and later reconverting the hydrogen to electricity at the load center makes the best way to move nuclear energy. However, continuing on to an estimate of over-all efficiency soon dampens the temptation.

Even optimistically assuming an electrolyzer efficiency of 90%, no energy losses in transmission, and an efficiency of a local fuel cell (or other hydrogen-to-electricity device) of 60%, you find an over-all transmission efficiency of 54%, compared with over 95% for conventional electricity transmission. In other words, to deliver the same amount of energy to the user requires 75% more primary-generating-plant capacity—the cost of which, together with the cost of the fuel cell itself, probably eliminates the savings in transmission costs except at very long distances. More realistic numbers for electrolyzer, transmission system, and regenerator in the '70s—75% efficiency for electrolysis, 95% for transmission, and 45% for fuel cells—makes the concept look even more unattractive—a 32% efficiency over-all.

However, storage comprises part of the complex picture. A means of storing "electric" energy would greatly benefit today's utility industry and will be almost mandatory for the extensive use of nuclear, solar, or wind power. Where geography permits, utilities now install pumped hydro-storage systems. Research continues into the very difficult development of inexpensive, high-efficiency, bulk-storage batteries. *But hydrogen presents a possibility for storage on a scale never before contemplated within the electricity industry.*

The gas industry stores large quantities of gas for peak-shaving in underground porous-rock formations, such as depleted gas fields and aquifers, and by cryogenic storage elsewhere. In 1970 it had in use a total underground natural-gas storage capacity of 5.2-trillion SCF, representing 22% of the total annual production of gas—almost equivalent (1523-billion kw-hr) to the total annual production of electricity in 1970 (1638-billion kw-hr). In addition, the fast-growing use of liquefied-natural-gas storage had reached a capacity of nearly 15-million SCF. In some instances, more than 75% of winter peak-day sendouts came directly from storage.

With such a huge capacity, the industry can store energy on a seasonal rather than a daily basis. This brings considerable savings to the gas industry in transmission and production capacity. In contrast, the world's largest pumped hydro-system, now under construction at Ludington, Michigan, will work on a daily storage cycle. It has a relatively small energy capacity (15-million kw-hr) compared to a typical liquefied-natural-gas tank (300-million kw-hr).

There seems no geological reason why we can not store hydrogen underground in the same way we do natural gas. The aerospace industry, moreover, has spurred liquid-hydrogen technology. Tanks up to a million gallons in capacity exist.

The efficiency of an electricity storage system using hydrogen poses the principal argument against its use. The same criteria apply to the needed electrolysis and reconversion stages, and our optimistic estimate of 54% (lower for liquid-hydrogen storage) more closely approaches the typical 60–70% for pumped water than it did electrical transmission efficiency. Hydrogen energy storage, however, has the outstanding advantage of availability on an enormous scale at almost any geographical location.

A combination of hydrogen transmission and storage has to bear the cost and inefficiencies of hydrogen generation and reconversion just once. The capital requirements of the combination do not appear quite as prohibitive as when considering each separately. However, probably only very large storage capacities or very long (or very expensive) transmission distances can justify such a system for today's electrical energy system. In any case, a proper evaluation calls for far more complex system studies than outlined here. For extensive use of nuclear, solar, or wind energy, hydrogen deserves serious consideration as an energy carrier, because of remote power stations with production profiles that do not match demand curves.

Eliminating the cost and inefficiency of the electricity reconverter (fuel cell) changes the picture entirely. The direct use of hydrogen as a fuel for such things as space heating, cooking, transportation, industrial processing, and heating appears technologically quite possible. The economics look attractive, especially compared with the long-range alternatives: all-electric supply, use of marginal (expensive) remaining fossil fuels, or production of synthetic fossil fuels from limestone or atmospheric carbon dioxide. *It should be possible to produce hydrogen from nuclear or solar heat, and deliver it to its point of use more cheaply than to produce electric energy and deliver that.*

Hydrogen offers advantages no other fuel can for aircraft and automobiles, but needs some kind of technological breakthrough to make its use safe and economical. As an auto fuel it has no equal for pollution-free burning. Several conventional gasoline engines modified to burn hydrogen have performed well. The real bonus is that no carbon monoxide or unburned hydrocarbons can be produced, and the limited number of experiments run so far have found nitrogen oxide levels lower than those of gasoline engines. How to get enough hydrogen stored on the vehicle to give it a reasonable range remains the basic problem. Compressing the hydrogen adds too much weight from the storage cylinders. Liquid hydrogen takes too much room and would further require a large and rather expensive vacuum-insulated tank. Work in progress aims at developing a metal-hydride storage system of reasonable size and weight.

Although far more bulky than hydrocarbon fuels, on an equal-energy basis hydrogen weighs only one-third as much as kerosene. This tremendous advantage holds special interest for designers of high-speed or long-range aircraft, where fuel weight dominates the aircraft design. Aircraft gas turbines run on hydrogen have given promising results, and engines designed to take special advantage of the combustion properties of hydrogen have reached the stage of testing. (In 1956 a B–57 bomber flew on hydrogen fuel in a NACA program.)

Again, tankage of liquid hydrogen on aircraft and supplying it to the world's major airports present problems. The high boiloff rate required in flight is not compatible with the low boiloff required on the ground. However, the enormous potential weight savings should justify an attempt to solve these tankage problems. (Lockheed Aircraft Corp. has estimated that substituting hydrogen for kerosene would reduce the takeoff weight of an advanced supersonic transport from about 600,000 lb to 400,000 lb.)

Since the potential use of hydrogen as a fuel and as a storage means hinges so critically on the economics of hydrogen production, we should look toward other sources of suitable hydrogen.

Research supported by the American Gas Association at the Institute of Gas Technology and elsewhere seeks to make hydrogen directly from water using the heat of a nuclear or solar reactor to carry out a sequence of chemical reactions. Such a process would circumvent the need to generate electricity at all, but research has not progressed far enough to forecast the cost or efficiency possible.

Hydrogen can be made quite easily and inexpensively from the fossil fuels, including coal. Practical processes for converting gas and oil to hydrogen find everyday use, and coal conversion presents no huge obstacle. *If we could commit ourselves right now to the use of hydrogen as a universal fuel, we could start immediately by using our large remaining coal deposits to make the hydrogen.* The energy industry could make a smooth transition from oil, gas, and coal to shale and nuclear, solar, wind, and tide power without any noticeable effect upon the customer.

We already have much of the technology needed to put hydrogen into use. It needs only developing, a task that looks far simpler than making the breakthroughs necessary to providing renewable energy sources themselves. Undoubtedly, a hydrogen system will cost more than the present one; but whichever solutions we adopt we will probably have to pay more for energy in the future. Hydrogen can make the additional charges, particularly for environmental cleanup, less.

References

1. Elliott, M. A., and Turner, N. C., "Estimating the Future Rate of Production of the World's Fossil Fuels," paper presented at the American Chemical Society Division of Fuel Chemistry Meeting, symposium on non-fossil fuels, Boston, April 13, 1972.
2. Austin, A. L., et al., "Energy: Uses, Sources, Issues," UCRL-51221, Lawrence Livermore Laboratory, May 30, 1972, pp. 1-19 and 4-9.
3. "When Hydrogen Becomes the World's Chief Fuel," *Business Week*, Sept. 23, 1972, pp. 98-102.
4. Lessing, L., "The Coming Hydrogen Economy," *Fortune*, Nov. 1972, pp. 138-146.
5. Gregory, D. P., Ng, D. Y. C., and Long, G. M., "The Hydrogen Economy" in *Electrochemistry of Cleaner Environments*, Bockris, J. O'M., Ed., New York, Plenum Press, 1972.
6. Hausz, W., Leeth, G., and Meyer, C., "EcoEnergy," paper No. 729206, Inter-society Energy Conversion Engineering Conference, San Diego, Calif., Sept. 1972.
7. Gregory, D. P., and Wurm, J., "Production and Distribution of Hydrogen as a Universal Fuel," paper No. 729208, Intersociety Energy Conversion Engineering Conference, San Diego, Calif., Sept. 1972.
8. Winsche, W. E., Sheehan, T. V., and Hoffman, K. C., "Hydrogen—A Clean Fuel for Urban Areas," paper No. 719006, Intersociety Energy Conversion Engineering Conference, Boston, Mass., Sept. 1971.
9. Winsche, W. E., Hoffman, K. C., and Salzano, F. J., "Economics of Hydrogen Fuel for Transportation and Other Residential Applications," paper No. 729213, Intersociety Energy Conversion Engineering Conference, San Diego, Calif., Sept. 1972.
10. De Beni, G., and Marchetti, C., "Hydrogen, Key to the Energy Market," *Euro Spectra*, pp. 46–59, June 1970.
11. "The Transmission of Electric Power," a report to the Federal Power Commission by the Transmission Technical Advisory Committee, p. 123, Feb. 1971

Prospecting for Energy

(By Jerry Grey)

This spring I chaired a session at the IEEE's International Convention and Exposition in New York on "Prospecting for Energy," a theme of moment. This special section of *A/A* presents its results, appropriately updated and edited. The authors concentrate on the technology and economics of energy sources which might satisfy the world's long-term needs: nuclear fusion, solar power, and the use of hydrogen to distribute power. Clearly, however, these long-term prospects will have little or no effect on the current energy crisis or, for that matter, on energy needs of the next few decades, other than in competing for R&D funds. Before plunging into the future, therefore, the reader should have in mind prominent short- and medium-term energy sources.

Power Demand

Estimates of demand during the coming decades, and centuries, vary widely, depending on the projected "mix" of possible energy-conversion programs. The range of uncertainty in total-consumption predictions for the year 2000, less than 30 years from now, exceeds the consumption in 1970. Some dire predictions project present growth rates to the point that waste heat from electric-power generation *alone* will outstrip the solar energy absorbed by all terrestrial vegetation in 2050. Even should the present ten-year doubling of electric-power consumption be substantially reduced—e.g., by proper architecture and design of appliances—prospects for drastic reductions in the growth rate of electric-power consumption look slim. For such obvious social necessities as mass transportation facilities, environmental-(pollution-)control equipment, and upgrading of the "quality of life" for the underprivileged require massive *increases* in electric power.

SHORT- AND MEDIUM-TERM ENERGY SOURCES

Fossil fuels.—In the fossil-fuel category, the obvious candidate for development will be gasification (or other purification) of coal, followed closely by extraction of oil from shale. A third and fascinating possibility (although limited in total energy availability) involves turning wastes to fuel. Nuclear explosions have been proposed to consolidate dispersed underground natural-gas deposits, but even if used will not likely make much more of this fuel available.

The coal-gasification program, coupled with the use of fluidized-bed coal combustors able to remove sulfur oxide, could by itself provide the necessary "tide over" until the long-term energy sources come through. Used in this way coal reserves could last us upwards of 50 years at *present* power-consumption levels.

Four processes for coal gasification already show laboratory feasibility. Pilot-plant demonstrations now being set up by the Department of Interior's Office of Coal Research should permit commercial operations on some of these to go ahead by 1977, with gas beginning to be delivered in quantity by 1980 or 1981.

One particularly interesting application, the hybrid powerplant, uses low-Btu "power gas" derived from a coal-gasification system integral with the powerplant. The gas fuels a high-temperature gas turbine, and the residual energy in the coal and exhaust gas fires a low-pressure steam generator. The power split runs about fifty-fifty.

Such extensive coal usage, however, will likely be opposed by people against strip-mining, the only commercially feasible method for large-scale extraction of low-grade coal. Thus, although coal gasification and efficient sulfur-extraction processes are technically and commercially feasible, they may suffer environmental problems similar to those facing nuclear-fission powerplants.

Somewhat similar problems would also face us in extracting oil from our enormous shale reserves (double even low-grade-coal reserves). But commercially feasible extraction of these reserves has not yet been demonstrated, so shale oil comes well behind coal as a short- or medium-term fuel reserve.

The use of wastes as fuel is, of course, highly desirable, but principally as a means of waste *disposal* rather than as a major source of "new" fuel. With several processes under study, it has been estimated that a commercially feasible solid-waste-fueled powerplant could be in operation in 15 years. (The waste-fueled powerplant concept must be distinguished from the large number of incinerators already in operation, primarily in Europe, which provide substantial quantities of process steam as a *byproduct.*) Because limited in *collectible* supply, compared with projected energy needs, wastes will probably never constitute more than a minor energy source.

Nuclear fission.—Several promising nuclear options might resolve difficult siting and licensing problems. One of these is underground siting, first seriously proposed by Edward Teller. A much more exciting near-term prospect, however, is the offshore floating powerplant, the first of which has already been ordered from Westinghouse by a consortium of power companies (led by New Jersey's Public Service Electric and Gas Co.) for stationing inside an enormous breakwater 2.8 miles off the southern coast of New Jersey. However designed—pressurized-water, boiling-water, or gas-cooled or, ultimately, a fission breeder—the offshore nuclear plant minimizes most of the safety and thermal-pollution problems now blocking both the licensing of existing ground-based plants and the siting of new ones.

It should also be pointed out that concern over possible loss-of-coolant accidents and the recent fuel-element degradation observed in U.S. commercial water-moderated reactors may favor the gas-cooled systems advocated by many European agencies. The impact on gas-cooled designs on offshore or underground reactor installations must be carefully considered.

The Nuclear-fission breeder.—Although fossil fuels and current fission-reactor designs appear to be the dominant power sources for the next two decades or so, it is already clear that limited uranium reserves and potential radioactive-waste accumulation dictate consideration of fission-breeder reactors, which generate not only thermal energy but also substantial quantities of "new" plutonium fuel from the plentiful natural nonfissionable isotope uranium-238.

The breeder concept is not at all new. The very first electric power generated with nuclear energy, in 1951, came from an experimental breeder reactor. Large-scale pilot breeder powerplants (60 Mw) have operated in the U.S. (Fermi) and in the United Kingdom (Dounreay) since 1964, and a commerical-scale power (150-Mw) and desalination breeder reportedly began operation on December 4, 1972, at Shevchenko in the USSR. Full-scale breeders are also nearing completion in France and Scotland; and both Germany and Japan, besides the U.S. have breeder-reactor programs underway. A recent court decision, however, requires the AEC to prepare an environmental-impact statement on the long-term effects of a natural breeder-reactor *program*—not just the single demonstration plant now planned. The results of this study may well affect the U.S. commitment to the breeder.

The breeder reactor in the U.S. program employs a liquid-metal coolant (other designs use either gas or water). There is still some question whether the benefits of the LMFBR (Liquid Metal Fast Breeder Reactor) over the gas-cooled and liquid-water designs are, in fact, real and can be realized. In any case, the U.S. announced plans for a demonstration LMFBR on January 14, 1972, and on November 22, 1972, awarded the reactor-development contract to Westinghouse. The demonstration plant will generate 350 to 400 Mw. It should enter operation by 1980. Full-scale commercial plants would go on the line in 1989. By the year 2000, breeder capacity should reach about 20 times today's water-cooled-reactor output: 95,000 Mw. Unquestionably, unless environmental and safety aspects prove to be an unexpected problem, the fission breeder represents the world's "best bet" for a primary source of energy in the medium-term (1990 to circa 2020), especially if the powerplants can be sited offshore.

High-efficiency conversion methods.—During the short- to mid-term period, when both fuel resources (coal, oil and uranium) and waste-heat discharges may impose significant limitations on energy release, power-conversion efficiency will become even more important than it is today. Several conversion devices offer substantial improvements in efficiency.

The magnetohydrodynamic (MHD) generator, perhaps the most widely publicized of these high-efficiency converters, uses as its "armature" either a high-speed jet of hot gas (seeded with metal vapor to make it a conductor) or a flowing liquid metal. The MHD generator, it is claimed, can produce powerplant thermal efficiencies up to 60%, compared to about 40% for conventional systems. On the negative side, however, the system generates DC output, involves the mechanical problems associated with high-temperature gases, needs either "clean" fuels (e.g., hydrogen and oxygen) or relatively elaborate stack-cleaning systems (although the system does facilitate sulfur oxide removal), and makes a lot of noise.

The most likely application for the MHD converter appears to be as a "topping" device or auxiliary for peak-power-period use in conjunction with conventional fossil-fuel powerplants. The USSR has an active MHD program, but U.S. efforts have been limited to research and laboratory-scale prototypes. The prospects for using MHD to increase the useful energy output of our limited fossil-fuel reserves remain quite attractive, and appear to warrant the relatively high development cost of a 100-Mw (the minimum practical size) MHD prototype powerplant.

Another "efficiency booster," the thermionic cell, can produce DC power directly from thermal-energy sources. In this cell a cathode having a low surface work function, upon being heated, emits electrons to a relatively cool anode collector. In the most practical of these cell designs, cesium vapor in the space between the electrodes prevents the buildup of current-limiting space charge.

Although the thermionic cell (along with its less efficient companion, the thermoelectric generator) has been the subject of intensive research and laboratory-scale testing for over ten years at Gulf General Atomic, Los Alamos, Thermo-Electron, GE, and RCA, and is quite appropriate to highly specialized applications such as space-based powerplants, its delicacy, high-temperature problems, low voltage, and DC output make it somewhat less attractive for ground-based power generators. Much attention has been given this device by the USSR, but a recent public announcement indicates progress not much further advanced than that in the United States.

The fuel cell, originally brought to a high level of development in the Apollo program, represents an important potential for low-power units sources (e.g., private homes). Fuel cells operate on the "reverse electrolysis" principle—a fuel and an oxidizer combine in an electrolyte to generate electricity, giving off heat and chemical products of "combustion."

Cells slated for commercial home use "burn" natural gas. But the hydrogen/oxygen cells used for Apollo (and now being uprated in both power and lifetime for the space shuttle) sparked an immediate interest for dispersed, low-power consumption in the "hydrogen economy" discussed by D. Gregory in this issue of *A/A*. Efficiencies of 55% are possible with hydrogen; however, the fuel cell has been touted as the most efficient energy-conversion device, and thus a *conservation* device, for our limited reserves of natural gas. Plans by Pratt & Whitney (the sole major fuel-cell manufacturer) and a group of 25 U.S. companies (TARGET: Team to Advance Research for Gas Energy Transformation, Inc.) call for completing extensive field testing of 12.5-Kw units by 1974, with possible commercial market entry in 1975.

In summary, near-term energy growth requirements will probably be met by a combination of coal gasification, shale-oil retrieval, and offshore nuclear powerplants, whereas medium-term growth depends heavily on the nuclear breeder reactors (probably also sited offshore), with substantial support possible from coal gasification and fluidized-bed "clean" combustors.

LONG-TERM ENERGY SOURCES

Of long-term potential sources not considered by the authors in the subsequent papers, only one—geothermal power—deserves special mention here (winds and tides are not yet considered as substantial energy sources for practical commercial powerplants).

"Geothermal" energy, as the name implies, means heat energy stored in the Earth's interior, and is commonly evidenced by volcanoes, geysers, and "hot springs." Geothermal sources were first tapped for steam to generate electricity in 1904 near Larderello, Italy. The Pacific Gas and Electric Co. now generates 237 Mw using geothermal energy from a field some 75 mi. north of San Francisco called The Geysers. A new field in Cerro Prieto, Mexico, reportedly exceeds that output.

Extracting geothermal energy involves drilling into underground steam reservoirs which supply geysers or hot springs and using the steam to spin turbines. Most such "wells" deliver wet steam, so the water must be separated and discarded, generally by evaporation to the atmosphere in a cooling tower. Waste water having a high content of contaminants or pollutants, must be reinjected, however, deep into the ground.

With geothermal sources of lower temperature, such as 200-F hot water, an intermediate fluid having a low boiling point (e.g., isobutane) is used in the turbine power cycle.

Methods are also being considered for pumping water down into dry areas of hot rock, and then drawing off the resulting steam for powerplant use. Research at Los Alamos on hydrofracturing and new thermal-drilling techniques could—open up enormous new areas for tapping this "dry" geothermal energy. Rock temperatures of 600-1400 F appear accessible and would permit much more efficient power generation.

Although some estimates of its potential capacity range up to 100,000 Mw by the year 2000 (about the same projected for nuclear-fission breeder plants), geothermal power does present problems:

—Removal of underground water could cause settling of surface lands.

—Geothermal water sources are heavily laden with chemical pollutants, particularly sulfur; and discharge of waste water either into the atmosphere or into local water courses would constitute a malor pollution hazard. (One estimate places the sulfur thereby released at about the same level as from a fossil-fuel-burning plant.)

—Low steam temperature causes low thermal efficiency, thereby requiring higher levels of waste-heat disposal than conventional powerplants, with consequent local fogging and noisy discharges.

—Some possibility exists for blowout due to pressurized pocket penetration or seismic disturbances caused by drilling or water-pumping near fault areas.

—Large tracts of scenic land will be removed from public access; e.g., the Department of the Interior plans to lease 58-million acres of California public lands for geothermal exploration.

Eliminating the need for fuel, however, just as with solar power, makes geothermal energy a highly attractive possibility. A spate of recent articles have sparked public interest in it, along with strong environmentalist opposition. There is no question, however, that geothermal energy represents a substantial *auxiliary*—rather than primary—sources for future power needs.

PROSPECTS FOR ADVANCED SYSTEMS

These shorter-range energy sources given their due, what briefly can be said about advanced prospects—fusion, solar power, and a hydrogen economy? Time scale, cost, and effect on manpower allocations? The authors of the five papers in this special section offer these estimates:

Nuclear fusion.—Could be available as a major commercial source of electric power in 25 to 40 years with present funding philosophies; in perhaps 20 years if the maximum useful funding rate were available. Total R&D cost (up to the first self-liquidating plant investment): $5–10 billion.

Solar power.—Major commercial electric-power output could be available in 30–35 years with present funding; in 20–25 with maximum spending; in 20–25 with maximum spending. Total cost (up to the first self-liquidating investment): $5–10 billion.

Hydrogen economy.—Will never be available in quantity at the present level of effort; but could become significant in 20 years if maximum funds were made available. Total cost (to self-liquidating point): $5–10 billion plus powerplant costs for electrolysis.

With regard to manpower needs, the time scale for these new and advanced capabilities implies little new demand on the world's supply line of technologists. The new skills will probably be made available both through new college curricula and "retreading" the established scientific and engineering corps.

But there *is* no question that this long-range research, development, and planning is essential. "Prospecting for energy," via fusion, solar power, and application of hydrogen technology, is the name of the game for the next few decades—because the potential "paydirt" can meet mankind's single most critical need.

REFERENCES

1. Drake, R. M., Jr., and Funk, J. E., "Energy: Problems, Prospects, and Priorities," AIAA Preprint No. 72-253, April 10–12, 1972.

2. Ritchings, F. A., "Trends in Energy Needs," American Society of Mechanical Engineers (ASME) Paper No. 71-WA/Ener 3, 1971.

3. Land, G. W., "Fossil Fuel: National Energy Supply and Air Pollution," ASME paper No. 71-WA/FU-4, 1971.

4. Hottel, H. C., and Howard, J. B., "New Energy Technology—Some Facts and Assessments," MIT Press, 1971.

5. Ehricke, K. A., "Extraterrestrial Imperative," *Bulletin of the Atomic Scientists,* Nov. 1971, pp. 18–26.

6. "The Potential for Energy Conservation," Office of Emergency Preparedness Report, Oct. 1972.

7. Bendiner, Robert, "A Word for Science," *The New York Times,* Feb. 15, 1971, p. 23.

8. Maugh, T. H., "Gasification: A Rediscovered Source of Clean Fuel," *Science,* Oct. 6, 1972, pp. 44–45.

9. Hammond, A. L., "Energy Options: Challenge for the Future," *Science,* Sept. 8, 1972, pp. 875, 876.

10. Maugh, T. H., "Fuel from Wastes: A Minor Energy Source," *Science,* Nov. 10, 1972, pp. 599–602.

11. Rogers, F. C., "Underground Nuclear Power Plants," *Bulletin of the Atomic Scientists,* Oct. 1971, pp. 38–41.

12. Lapp, Ralph E., "One Answer to the Atomic-Energy Puzzle—Put the Atomic Power Plants in the Ocean," *The New York Times Magazine,* June 4, 1972, pp. 20–22; 80–90.

13. "The Atlantic Generating Station," Dept. of Public Information, Public Service Electric and Gas Co., New Jersey, Jan. 1973.

14. Hammond, A. L., "Breeder Reactors: Power for the Future," *Science,* Nov. 19, 1971, pp. 807–810.

15. Shabad, T., and Smith, G., "Soviet Starts Up Breeder Reactor, Winning A Race," *The New York Times,* Dec. 5, 1972, p. 69.

16. Lyons, Richard D., "Nuclear Reactor Delayed by Court," *The New York Times,* June 13, 1973.

17. Cochran, T. B., "An Economic and Environmental Analysis of an Early U.S. Commitment to the Liquid Metal Fast Breeder Reactor," Resources for the Future, Washington, D.C. 1972.

18. "Environmental Pollution Control Through MHD Power Generation," AVCO-Everett Research Laboratory, Mass., May 1971.

19. "Development in the Design of MHD Power-Generating Facilities," *Heat Transfer*—Soviet Research, Vol. 2, No. 2, March 1970, pp. 128–137.
20. Thomsen, D. E., "MHD: High Promise, Unsolved Problems," *Science News*, Aug. 26, 1972, pp. 138–140.
21. Danilov, Yu. I., and Karetnikov, D. V., "Present State and Design Trends of Thermionic Converters," USSR *Atomnaya Energiya*, Vol. 28, No. 1, pp. 33–37, Jan. 1970.
22. Shabad, T., "Soviet Announces a Direct Converter for Atomic Power," *The New York Times*, March 26, 1971, p. 1.
23. Martin, Clark, "Apollo Spurred Commercial Fuel Cell." *Aviation Week and Space Technology*, Jan. 1, 1973, pp. 56–59.
24. "A Cell in every Home?" *Time*, May 31, 1971, p. 51.
25. Layton, J. P., and Grey, J. (Editors), "An AIAA Assessment of New Space Transportation Systems," AIAA, Jan. 9, 1973, p. 57.
26. Maugh, T. H., "Fuel Cells: Dispersed Generation of Electricity," *Science*, Dec. 22, 1972, pp. 1273–1274B.
27. Severo, Richard, "Mexico is Tapping Desert for Geothermal Energy," *The New York Times*, June 26, 1973, p. 63.
28. Goldsmith, M., "Geothermal Resources in California: Potentials and Problems," Environmental Quality Laboratory report No. 5, California Institute of Technology, Pasadena, Calif. 1971.
29. Wilford, J. N., "Search for Geothermal Energy on Public Land May Stir Fight," *The New York Times*, Jan. 13, 1973.

ECOTEC FOUNDATION,
February 6, 1974.

SUBCOMMITTEE ON ENERGY,
Senate Committee on Finance,
Dirksen Senate Office Building,
Washington, D.C.

DEAR SIRS: Thank you for giving us the opportunity to submit a statement to the subcommittee on energy. Our comments follow.

The energy predicament of the United States did not develop overnight, its occurrence was inevitable. The founders of Ecotec and other environmentalists have been warning of its coming for years with no effect. The government and the energy industry should have preceded us in these warnings, but they waited until the current situation was nearly upon us. Now some energy producers are putting the blame on environmentalists and saying we must weaken many of the laws that protect our health and initiate what is in reality a "drain America first" policy. While we recognize that we need to increase the production of domestic sources of fossil fuel over the next few years, we would like to see emphasis placed elsewhere.

We believe that our goal should be to achieve a stable state of energy production over the long run and care should be taken to preserve our fossil fuels for their most important uses, metallurgical, chemical, fertilizers, etc. We must respect the rights of future generations and allow the poorer nations of the world a fair share of its energy resources. A crash program to deplete our fossil fuels more rapidly and build fission reactors will not achieve this.

A system approach must be applied to the energy situation to achieve long term success. However, to start with, there are a number of measures that would put us in the right direction. They lie in two areas:

1. Encourage the efficient utilization of energy.
2. Develop safe sources of energy that will serve mankind far into the future.

ENCOURAGEMENT OF EFFICIENT UTILIZATION

Allow energy prices to increase gradually over a five to ten year period. There is no better way to encourage conservation as with cost. Much of our present waste is the result of artificially low energy prices. A program of gradual price increases should be announced to the public so that it can prepare itself. This would avoid sudden hardships but would encourage investment in energy conserving devices, solar collectors etc. Price increases should not become windfall profits to industry. Rather they should help them pay for environmental protection, etc. and part should be in the form of taxes. These taxes would compensate the nation for the depletion of its non-renewable resources and for damage to health, property and the quality of life by energy uses. Proceeds would be used for medical care, public transit, energy research etc.

Equalize the price structure of electrical energy to all consumers so that its consumption is not encouraged.

Eliminating advertising that encourage energy use—including travel adds by airlines, etc.

Eliminate government subsidies for building sewer and water lines in rural and urban fringe areas. Current policy encourages sprawl which is an irreversible consumer of petroleum.

Halt construction of freeways that will extend urban sprawl.

Provide low interest loans to developers and building owners to cover the cost of insulation, solar collectors, solar heat storage units, heat pumps and other energy conserving devices. Somehow allow these to be exempt from local real estate taxes.

Require FHA to offer lower interest rates on homes built within one half mile of existing or proposed transit routes.

Require FHA to offer incentives to building on small lots. This would help to reduce sprawl.

Provide adequate funds for a crash program in energy conservation. We believe there is far more potential in this area than generally thought. In 1971 General Electric's Evendale, Ohio plant instigated an energy conservation program aimed at reducing its energy requirements by 15%. It achieved a 30% reduction.

DEVELOPMENT OF ENERGY SOURCES

An organization, such as the AEC, which has strong interests in certain forms of energy should not become an umbrella organization for all energy research and development.

Too much money is being put into the development of fission and fast breeder reactors and not nearly enough into overcoming the problems associated with them, notably the storage of radio active waste, accident, sabotage and low level radiation. More money should be put into the development of fusion reactors.

As already mentioned we recognize the need for increasing fossil fuel, particularly coal, production, but we believe we must turn to a conservation policy as soon as possible. Much of the need for a crash program for their use can be replaced by a crash program in conservation.

Considerably more money should be put into studying alternative sources of energy. Recent budget increases are not nearly enough. We are basing our expenditures on potentials in these areas as we see them now. Our knowledge of these potentials is very limited because of meager research in these areas. Only through intensive study will we realize these potentials which may well bring the end of our energy crisis.

We thank you for allowing us to submit our comments.

Sincerely yours,

PETER SEIDEL, *President*
(FOR FREDERIC R. G. SANBORU).

INTERNATIONAL ASSOCIATION OF DRILLING CONTRACTORS,
Dallas, Tex., February 1, 1974.

SENATE FINANCE COMMITTEE,
Subcommittee on Energy, Dirksen Senate Office Building,
Washington, D.C.

STATEMENT CONCERNING SENATE BILL #2806 BY SENATOR MIKE GRAVEL (ALASKA)

At the end of 1973, membership of the International Association of Drilling Contractors (IADC) was composed of the following:

(a) 337 oil and gas contracting drilling companies, owning 1,796 drilling rigs, of which 1,347 were located in the United States and 449 were located outside the U.S.

(b) 93 oil and gas producing companies, including some with production outside the United States.

(c) 286 associate member companies engaged in furnishing equipment and services to oil and gas drilling contractors operating in the United States and operating outside the United States.

IADC is a non-profit organization. Primary functions of the Association are to improve oil and gas drilling skills through development and wider use of better operating techniques, to educate and train drilling personnel in the use of advanced methods and equipment, to provide safer working conditions and practices, and to improve government-industry relations and understanding.

IADC supports the basic aim of Senate Bill #2806 to encourage private industry to develop U.S. domestic oil and natural gas reserves. Thus, the Association supports those sections of Senate Bill #2806 which call for: (1) tax incentives to encourage development of the nation's oil and gas resources, including tax credits for exploratory drilling, secondary and tertiary recovery programs; (2) phasing out of price controls on crude oil, natural gas, coal and petroleum products; and (3) the opening of public lands, including offshore, for mineral development.

However, on the other hand, there are two sections in the Bill which we believe would be very damaging to the best interests of the United States. These are Title VIII and Title X. Actions proposed in both of these titles would undoubtedly retard oil and gas operations outside the United States by U.S. oil and gas producers and U.S. drilling contractors, and curb sales of U.S. oil and gas manufacturers and U.S. oil field service organizations. Title X would deny tax incentives to U.S. companies for development of foreign energy sources by repealing provisions granting percentage depletion and write-off to intangible drilling and development costs on oil and gas wells located outside the U.S. This would reduce the number of wells drilled by U.S. companies outside the U.S. The effect would be a drastic reduction in work available to U.S. drilling contractors and the amount of equipment and services furnished by U.S. companies. Title VIII would impose export controls on petroleum, petroleum products, and drilling and mining equipment if the Secretary of Commerce determines such equipment and services are in short supply in the U.S. Such action would impair the ability of U.S. companies to maintain their existing equipment in operating condition.

U.S. companies have long held a commanding or preeminent position in oil production, contract drilling and equipment-service sales outside the United States. This dominant position has been most beneficial to the U.S. foreign trade balance of payments, and has enabled U.S. companies to create new jobs in the United States. If Titles VIII and X of Senate Bill 2806 are enacted, U.S. companies would lose their dominant position in oil operations outside the United States, and the U.S. foreign trade balance of payments would suffer from this loss. At this time when there is an energy supply crisis in the United States, it is extremely desirable to encourage more development of the nation's oil and natural gas resources. However, it would be unreasonable to do this at the expense of an already healthy segment of the industry which is contributing positively to the foreign trade balance of payments while also furnishing a significant portion of the U.S. domestic oil requirements (an average of 6 million barrels per day during first 10 months of 1973, or 35.5 percent of the total oil available to U.S. consumers). To cut off such a large part of the nation's supply would be like cutting off our nose to spite our face.

In addition to the harmful impact on U.S. equipment manufacturers and U.S. drilling contractors, Title VIII also would be harmful to U.S. shipyards. The obstacles presented by Title VIII would deprive U.S. shipyards of a fair chance at getting the construction contract in the case of a drilling contractor wishing to build a new offshore drilling unit for use in foreign waters. This setback would come at a time when the competitive position of the U.S. shipbuilding industry is stronger, because foreign shipyards have a weaker economic position than any time in the last decade.

An enclosed tabulation shows the commanding position which U.S. companies held in offshore drilling operations throughout the world at the end of 1973. Of the Free World's 232 mobile oil and gas offshore drilling rigs in existence in December, 1973, U.S. companies owned all the 78 units in U.S. waters, and owned 113, or 73%, of the 154 units located outside the United States.

U.S. companies will continue to dominate the offshore drilling picture for some years to come if Titles VIII and X of Senate Bill 2806 are not enacted. The continued dominance of U.S. companies is reflected by figures showing U.S. companies own 64 of the 91 mobile offshore drilling units under construction in December, 1973.

Information is not available on the exact number of land rigs owned by non-U.S. companies. However, U.S. companies belonging to IADC operate 149 land rigs outside the United States and Canada, which are approximately one-third of the estimated land rigs located outside the United States and Canada.

From the beginning of overseas oil and gas operations until recent years, American drilling contractors have enjoyed an almost exclusive field and have repatriated substantial earnings and paid taxes thereon in this country. More recently, competition from foreign drilling firms, particularly Norwegian, French, Russian and Italian, is growing. The workings of these titles of this bill could well mark the beginning of the end to the leading U.S. position in this important activity.

Because of the benefits accruing to the U.S. foreign trade balance of payments and to U.S. companies engaged in oil production, drilling and equipment-service operations outside the United States, the International Association of Drilling Contractors recommends that proposed Titles VIII and X of Senate Bill 2806 not be enacted.

ALDEN J. LABORDE, *President.*

OWNERSHIP AND CURRENT LOCATION OF FREE WORLD MOBILE OIL AND GAS OFFSHORE DRILLING UNITS—EXCLUSIVE OF PLATFORM RIGS, DECEMBER 1973

Present water location	U.S. owned	Foreign owned	Total rigs
U.S. Gulf of Mexico	69	0	69
U.S. Pacific waters	9	0	9
Total, U.S. waters	78	0	78
Canadian waters	4	6	10
Mexican waters	0	3	3
Caribbean and South American	17	5	22
North Sea	27	8	35
Mediterranean waters	5	4	9
African waters	12	6	18
Middle East	19	5	24
Far East waters	24	3	27
Australian waters	5	1	6
Total, outside United States	113	41	154
Grand total, free world	191	41	232

MOBILE OIL AND GAS OFFSHORE DRILLING RIGS UNDER CONSTRUCTION, DECEMBER 1973

Location of shipyard	U.S. owned	Foreign owned
United States	30	3
Canada	2	0
Europe/United Kingdom	14	21
Far East	18	3
Total, free world	64	[1] 27

[1] U.S. companies own interest in approximately 8 of these drilling units.

Source of data: December 1973 issue of "Offshore" magazine.

BLYTH EASTMAN DILLON & CO., INC.,
New York, N.Y., January 23, 1974.

HON. CLIFFORD P. HANSEN,
U.S. Senate, Washington, D.C.

DEAR SIR: Enclosed is a copy of a paper I recently wrote which addresses itself to the possibility of becoming self-sufficient in energy. I utilized the National Petroleum Council studies on the energy outlook, having served on two of the Council's committees.

I think you and your staff might find it very interesting.

Sincerely,

KENNETH E. HILL.

Enclosure.

Toward Self-Sufficiency in Energy

I. INTRODUCTION

The sudden October war between Arabs and Israelis and the subsequent cutback and embargo of production have brought serious shortages of oil for consuming countries the world over. The Arab governments, led by Saudi Arabia, have implemented their threats to use oil as a political weapon with near solidarity and great effectiveness. They have furthermore abandoned all pretense at negotiation on price with the international oil producing companies and have unilaterally imposed unprecedented increases in oil prices and taxes, thus ensuring even higher revenues despite the production cutbacks. The importing countries now know they are dealing with a highly effective cartel of oil exporters which has the power to restrict supplies of oil, the most important international commodity after food, and thus hold the consumer at ransom with unconscionable prices. And now that the Arabs realize their power and the success of their methods, even a peaceful solution of the Israeli question will not ensure that embargoes and cutbacks would not be used on some other pretext again, as the embargo against South Africa for a different reason demonstrates. Furthermore, the Arab nations have little incentive to expand production since they now have revenues exceeding their needs by a substantial amount. Thus, an urgent and agonizing reappraisal of the energy policies of all consuming nations must be undertaken immediately.

As for the United States, the impending shortage was there for all to see several years ago. Many forecasts by industry observers suggested that the nation was on a collision course between rising consumption of energy and our ability to produce and import. It seemed apparent that long before 1980 our rate of growth in consumption would have to be cut back to lower levels under the twin impact of limited energy material in the earth's surface and consequent rapidly rising prices. This meant, eventually, sheer inability to pay for the less developed nations and very damaging outflow of funds for the industrialized countries. Even the United States, rich as it is, was expected to be included in this category with $30 billion a year the generally accepted cost of energy imports by 1980. But the United States is fortunate in that it has many alternative, though expensive, sources of energy and need not do without, given a willingness to consume at a more reasonable rate and at the same time pay more—much more eventually—than energy costs today.

From this point of view, the sudden occurrence of the energy shortage, instead of the expected slow arrival in the late 1970's, must be regarded as a blessing in disguise. For we now witness a great energy ferment in Washington and bills on energy are passed in weeks rather than years. And the Administration finally has gathered together all the various groups trying to administer energy programs into a single Federal Energy Office under a dynamic administrator. This group has begun the arduous task of allocating scarce supplies for the short term while guiding the United States toward greater self-sufficiency in the longer run. But perhaps the greatest boon to the United States will be the realization by the average American that he cannot continue consuming energy at a rate many times greater than his counterpart outside the United States. Our frivolous consumption habits must be curtailed and eventually eliminated. And if this crisis causes Americans to finally understand that (a) our ability to produce indigenous oil and gas is limited, (b) importation of oil and gas is both expensive and uncertain, and (c) development of domestic energy alternatives is quite expensive and requires a lead time of five to eight years, then much will have been accomplished. For not only is there a long period of restricted availability of energy facing the consuming countries, including the United States, but the era of cheap energy has ended. Furthermore, since energy is intimately linked with industrial growth, a much slower rate of economic expansion confronts the world with all this means in disappointed "rising expectations" and higher unemployment.

This paper will confine itself to an examination of the problem of self-sufficiency for the United States by 1980, while ignoring the short term impact on our economy and way of life.

II. CONSUMPTION

The sudden Arab-Israeli war with the subsequent cutback on oil production by the Arab nations, together with an embargo on shipments to the United States, have led to a shortage of energy of major proportions, both here and abroad. The Administration, with the aid of the Congress, has taken various short term steps to reduce consumption, many of them in accordance with an interim report of the

NPC on Emergency Preparedness,[1] as a result of a request by the Administration for advice by the industry about how to cope with an expected shortage of 2.5–3.5 MMB/D [2] during the first half of 1974. The principal thrust of these various actions will be to limit the impact on industry to minimize unemployment, but will have a major effect on the life style of Americans in that our affluent consumption patterns will be altered permanently.

It is imperative that if and when the Arabs resume the flow of oil to the Western world, the United States not let itself be lulled into a false sense of well-being. President Nixon has proclaimed a decade of massive effort leading to energy self-sufficiency by the early 1980's. Since this will be most difficult to attain, the nation should continue the program of reduced consumption for the remainder of the decade even if the Arabs relax their embargo. For a pattern of slow growth in energy consumption within the United States is just as important in approaching self-sufficiency as a crash program to develop new energy sources.

The United States in 1973 consumed an estimated 37 MMB/D of energy, up from a level of 32 MMB/D in 1970, a rate of increase during the first three years of the decade of about 5.0 percent per annum. This growth rate is unprecedented for such an extended period in the post-war era and was principally caused by a simultaneous worldwide boom and an accompanying inflationary binge. And nearly all the energy for this rapid expansion came in the form of imported Middle Eastern oil since there were no other important sources, either within or without the United States. Thus, our imports of oil more than doubled from 3.4 MMB/D in 1970 to an estimated 7.7 MMB/D in 1973, nearly all the increase from the Middle East. A 5.0 percent demand growth substantially exceeds the highest postulated growth of the thorough NPC study of 1972 [3] which expected energy consumption to grow between 3.5 and 4.5 percent annually between 1971 and 1980, with an intermediate estimate of 4.2 percent. With the interruption of supplies caused by the Arab-Israeli war and the conservation measures undertaken by the Administration, it can be expected that consumption next year is likely to show the first real decline since 1958 to about 36 MMB/D, then resume a much slower rate of growth for the last half of the decade.

The NPC study postulated a range of consumption in 1980 from about 45 MMB/D for the low estimate to nearly 50 MMB/D on the high side, with an intermediate level of 48 MMB/D. Despite the rapid growth of the first three years of the decade, a cutback in 1974, coupled with a slower rate of growth of about 4.0 percent for the next seven years, can bring consumption in 1980 back toward the intermediate level instead of exceeding the high level substantially, which was where we were heading. But it will require direction from Washington so that the measures of conservation undertaken to eliminate unnecessary consumption for 1974 continues throughout the remainder of the 1970's while impacting industry as little as possible.

III. SUPPLY

On the supply side of the equation not much can be done over the short term, although modest amounts of production can be furnished from the Elk Hills Naval Petroleum Reserve in California and in several prolific fields in Texas. But over the longer term much can be accomplished to increase production of domestic oil and gas, given economic incentives and absent unreasonable environmental constraints. Among the several supply scenarios utilized in the detailed study on energy outlook by the NPC, already referred to, Case III appears to be the most plausible. This case encompassed a continuation of the current trends in finding rates for oil and gas per foot drilled coupled with a modest annual increase in drilling of 3.5 percent. The finding rate assumption approximates the experience for the period 1971–1973 and seems logical to use for the remainder of the decade. Case III also assumed a 15 percent rate of return on average net fixed assets and estimated the average prices for all oil and gas production needed to attain this level of profitability over the period. The prices expected increased to \$4.95 per barrel for oil and 37.8¢ per MCF [1] for gas in 1980. With these parameters, it was postulated that the production rate for liquids in the United States in 1980 would be about 11.6 MMB/D, including 2.0 MMB/D from the North Slope of Alaska and a modest 100,000 b/d from shale oil production. At the same time, it was estimated that the production of natural gas would be about 20.9 TCF [2] per year, of which 1.3 TCF/Y would be from Alaska.

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[1] "Emergency Preparedness for Interruption of Petroleum Imports into the United States," a supplemental interim report of the National Petroleum Council, Nov. 15, 1973.
[2] MMB/D = million barrels per day of energy equivalent.
[3] "U.S. Energy Outlook," a report of the National Petroleum Council, December 1972.
[1] MCF = thousand cubic feet.
[2] TCF = trillion cubic feet.

Of course, much has happened in the oil industry since this report was published well over a year ago, particularly in the arena of prices. Foreign oil prices have been driven above $10 per barrel by the OPEC nations, and within the United States, despite a two-tier price control system, the average price now is about $6 per barrel, at least $1 per barrel above the Case III estimate for 1980. In the revised forecasts utilized in this paper, it has been assumed that prices of domestic oil will be allowed to rise slowly toward world levels, thus stimulating drilling effort so that exploration for oil will rise well above the NPC forecast.

In natural gas, the twenty year old control over interstate prices by the FPC is only slowly being relaxed so that most newly discovered gas is remaining within the state of discovery. Thus, prices of gas are rising, but slowly, and the average 1975 level of 27.9¢ per MCF, estimated by the NPC in their study, will probably not be much higher by then. However, there is an increasing awareness in the Congress and Administration of the great damage the continued regulation of gas prices has wrought on the supply side of the natural gas equation. Hopefully, prices of newly discovered gas will soon be deregulated while controls over old gas will be phased out over the remainder of the decade, thus allowing gas prices to rise substantially by 1980. This should stimulate the search for gas in the United States and production should be well above the NPC estimate by 1980.

Accordingly, revised estimates of production of oil and gas for 1980 can be made, utilizing the parameters in the NPC studies. These revised estimates are based on a continuation of the present finding rates, together with increased footage drilled of about 8 percent each year through 1980, stimulated by prices undreamed of when the studies were undertaken.

Table I shows an energy balance for the United States in 1980 as estimated by the NPC for the low finding rate and slowly increasing drilling rate of Case III. Under the assumed parameters of Case III and with the intermediate growth rate in consumption of 4.2 percent, energy demand was estimated to total over 48 MMB/D in 1980, equivalent to 102.6 Quadrillion BTU's. This would require at that time nearly 11 MMB/D of imported crude oil, together with 3.9 TCF a year of natural gas imports, a total of about 12.4 MMB/D of imported energy, or about 25 percent of estimated consumption. Under the new scenario writteu by Arab countries, encompassing cutbacks and embargoes, much higher prices for crude oil have been brought about outside the United States and are pulling our prices up also. Because of these higher prices, projected drilling activity will likely rise at twice the expected rate, which will eventually be reflected in increased discoveries and expanded production of domestic oil and gas. This, together with a smaller estimated consumption of energy in 1980, results in a much reduced and more manageable import requirement of over 6 MMB/D, including natural gas, approximately the same as the present level and half the original forecast. But even these reduced amounts of imports are likely to cost at least $30 billion, the same amount previously estimated for 1980, because of the very large increases in price for imported crude oil.

TABLE I.—ENERGY BALANCE FOR 1980

Source	Case III [1] Million barrels per day [2]	Case III [1] Conventional units	Revised estimate Conventional units	Revised estimate Million barrels per day
Domestic:				
Oil—Million barrels per day	11.6	11.6	14.6	14.6
Gas—Trillion ft³ per year	9.8	20.9	24.0	11.7
Geothermal and hydroelectric	1.7			1.9
Coal—Million tons per year [3]	8.5	734	800	9.4
Nuclear—Kilowatts electric [4]	4.6	150,000	153,000	4.6
Total	36.2			42.2
Imports:				
Gas—Trillion ft³ per year	1.8	3.9	2.8	1.3
Oil—Million barrels per day	10.6	10.6	5.4	5.1
Total	12.4			6.4
Grand total	48.6			48.6

[1] NPC Energy Study, December 1972.
[2] All energy units converted to million barrels per day of energy equivalent.
[3] Million tons per year.
[4] Megawatts.

To illustrate that this scenario is possible, Tables II and III indicate various key factors affecting a forecast of liquids and natural gas production through the rest of the decade. Tabulated are the Case III estimates of prices of oil and gas, estimated footage drilled, and production through 1980. Alongside are revised estimates for the same parameters with the principal changes stemming from a price for crude already above the 1980 Case III estimate and likely to reach $8 per barrel by 1980. This should stimulate expanded exploration and development drilling, which just began in 1973. The price of newly discovered gas has also started to rise substantially, principally because most new discoveries are sold intrastate, and a price of at least 75¢ per MCF is expected by 1980.

TABLE II.—FACTORS EFFECTING LIQUIDS PRODUCTION

Year	Average U.S. price (dollars per barrel)		Footage drilled (million feet per year)		Liquids production (million barrels per day)	
	Case III [1]	Revised estimate	Case III [1]	Revised estimate	Case III [1]	Revised estimate
1970	3.18	3.18	90	90	11.3	11.3
1973		3.80		95		10.9
1975	3.67	6.50	95	105	9.8	11.5
1978		7.50		125		12.8
1980	4.95	8.00	115	150	[2] 11.6	[3] 14.6

[1] NPC Energy Study, December 1972.
[2] Including 2,000,000 barrels per day from North Slope, starting in 1976.
[3] Including 2,000,000 barrels per day from North Slope, starting in 1978.

Apparent is the increased drilling rate for oil, reaching a level of 150 million feet a year in 1980, about 30 percent above Case III estimates for 1980. And there will be a cumulative improvement of about 200 million feet drilled for oil and gas over the seven-year period. This will result in increased reserves and production if the present finding rate continues, but only after the usual lag of three to five years. By 1980, 3 MMB/D of additional liquids production will be available over Case III, although much of this occurs late in the period when North Slope production comes in. If all of Alsaka has been opened up for further exploration, together with all the continental shelves of the United States, a momentum for discovery of reserves of oil through increasing exploration should allow production to continue to rise steadily after 1980.

TABLE III.—FACTORS EFFECTING NATURAL GAS PRODUCTION

Year	Average U.S. price (cents per thousand ft^3)		Footage drilled (million feet per year)		Natural gas production (trillion ft^3 per year)	
	Case III [1]	Revised estimate	Case III [1]	Revised estimate	Case III [1]	Revised estimate
1970	17.1	17.1	40	40	21.9	21.9
1973		22.0		45		22.3
1975	27.9	30.0	45	50	22.0	22.5
1978		55.0		65		23.0
1980	37.8	75.0	60	75	[3] 20.5	[2] 24.0

[1] NPC Energy Study, December 1972.
[2] Including 1,300,000,000,000 ft^3 per year from Alaska.
[3] Nothing from Alaska.

The same effect will be apparent in natural gas through increased drilling where greater production is estimated to total nearly 5 TCF more than Case III in 1980 on a comparable basis. And additional gas from northern Alaska should be coming to the United States either through Canada or along the Alyeska right of way by the early 1980's. This increment of gas, together with the momentum developed in exploration in the coming years by increased prices for new natural gas, should carry production slowly upward for quite a few more years, hopefully to reach the market clearing level if regulation of gas prices at the wellhead is abandoned before 1980.

These increased production rates will require the postulated annual discovery rate of reserves for both oil and gas in Case III to be somewhat larger as a result of the increased footage drilled. For oil, the average liquid reserves found should increase from the expected 3.5 billion barrels yearly to about 4.5 billion. And for natural gas the average increase must be from about 13.5 TCF a year to around 20 TCF a year. Since there is an inevitable lag in results from exploratory efforts of at least three years, it must be expected that the finding results will steadily climb from the recent average of 2.5 billion barrels for liquids and 12 TCF for gas, ex-Alaska, to something substantially beyond the average results by 1980. This I feel sure can be accomplished if the prices of gas and oil are freed to rise to market levels soon and all offshore continental shelves of the United States are opened for exploration.

Small, but meaningful, contributions to domestic energy supplies must also come from increased coal production from an estimated 734 million tons under Case III to about 800 million tons in 1980. And there must be a momentum built up for the early 1980's that will bring annual coal production up to at least 1,000 million tons by 1985.

IV. CAPITAL REQUIREMENTS

The increased prices for crude oil, which have already occurred, together with the anticipated level of about $8 per barrel during 1980, represents a two and a half fold increase of prices over the decade. And if control over natural gas prices is relaxed as anticipated, then they will more than triple by 1980 to about 75¢ per MCF at the wellhead, though this will still be somewhat less than parity on a BTU basis. Theoretically, this should result in a tripling of cash flow from oil and gas on a unit of production basis, but this is unlikely because of increased operating costs, additional taxes, and increased amortization of exploration costs, particulary offshore lease acquisition expenditures. Thus, it is estimated that cash flow will only double per unit of production for the estimated output in 1980. Since oil and gas production will increase about 25 percent for the industry—mostly from Alaska—total cash flow from production of gas and liquids will likely increase 2.5 fold between 1970 and 1980, a necessary occurrence if the United States petroleum industry is to perform its share of the task of becoming more self-sufficient. During the early years of the decade, cash flow for gas and liquids production, after royalty, was of the order of magnitude of $8 billion yearly, very roughly estimated by multiplying approximately 4.5 billion barrels of net equivalent production, after royalties, by about $1.80 cash flow per barrel equivalent. This should increase to at least $20 billion in 1980, representing nearly 6 billion barrels of net liquid equivalent production and a cash flow of about $3.50 per barrel equivalent.

For the last three years, the industry has been spending an average of about $6 billion in exploration and production, including lease acquisition costs, geological, geophysical, lease rentals, gasoline plants and production pipe lines, or about 75 percent of the available cash flow. The remainder has been allocated to other areas of the business, such as refining and marketing, which until recently could not earn enough to carry their own capital requirements. But aside from dividends to shareholders, all remaining available funds, together with large borrowings, have been plowed back into capital expenditures in the energy industry, principally in the United States. And it can confidently be expected that this would continue in the future and that capital outlays in exploration and production in the fifty United States will increase two and a half fold by 1980, particularly if offshore leases are sold on all the United States continental shelves. Evidence supporting this comes from the announced capital expenditure increases by many major oil companies, amounting to as much as 50 percent for 1974.

Case III had estimated exploration and development outlays would increase from $5.6 billion in 1971 to $10.2 billion in 1980, but the new price scenario outlined above should allow capital expenditures to reach $15 billion by 1980, fifty percent greater. And the availability of steadily increasing funds of this magnitude through internal capital formation, together with greater capital self-sufficiency in other segments of the industry, should allow these increased outlays to be made, though not without substantial borrowings.

Capital outlays for exploration and production are, therefore, likely to total about $75 billion from now through 1980, about 50 percent more than expected. This amount, together with another $15 billion for gasoline plants, coal gasification, shale oil and a pipe line from the North Slope, will bring the total outlays necessary to realize the estimated rates of production for 1980 to about $90 billion at 1973 prices. And it is probable that the amount will reach $100 billion if inflation continues at the present rate.

V. CONCLUSION

This paper, though admittedly rudimentary, attempts to assess whether the United States can indeed become self-sufficient in energy by 1980. Though it appears this will be impossible of achievement by then, or indeed ever, still the outlook for increased domestic supplies of all kinds of energy after 1978 is quite good. For it appears that we can supply all our demands for energy thereafter so long as increased consumption is kept to a level of no more than 3 percent per annum. We would, of course, continue to import 6–7 MMB/D equivalent, about the present level, but our dependence on imports from the Middle East should be less than half that amount. Estimated consumption for 1980 had been estimated at about 52 MMB/D before the Arab-Israeli war of October. Thus, the revised energy balance for 1980 consists of a contribution from savings in consumption of 3.4 MMB/D while increased production of oil, gas and coal amount to 5.4 MMB/D resulting in nearly 9 MMB/D less imports than expected.

Starting in 1978 the crude oil pipe line from northern Alaska will begin to deliver oil to the United States in amounts likely to supply annual increased energy demands for several years thereafter. Production from off Santa Barbara, coal gasification, and shale oil output should also be coming in by then. And shortly after 1980, natural gas from northern Alaska should begin to be delivered to the United States, together with gas from coal. And the momentum of discoveries by a rejuvenated petroleum industry should allow steady increases in production of oil and gas to continue for some time thereafter.

Of equal importance will be the momentum that should be developed by 1980 in opening new coal mines so that expansion of supplies from this abundant resource should reach at least 1,000 million tons by 1985. At the same time, numerous nuclear plants should be coming on stream in the early 1980's, so that nuclear electrical generating capacity should double from 1980 to 1985.

However, the next five years to 1978 will be very difficult, even if the Arabs relent on their embargo to the United States, for we were heading for a shortage within several years before the sudden Arab-Israeli war; and in any case, we simply cannot afford import costs of $40 to $50 billion a year, which 10 MMB/D at current prices would entail. Thus, it is imperative that all measures of conservation which have been implemented be continued for the next five to ten years, if not forever.

Another important aspect of a program freeing us from becoming hostage to Arab oil imports would be the storage program advocated by the NPC Emergency Preparedness committee in its preliminary report published in the summer of 1973. This would entail the preparation of massive underground storage for 600 million barrels of crude and products in leached out salt dome caverns in the Gulf Coast. When properly equipped with pumps and pipe line connections, these storage facilities could deliver 3 MMB/D for 180 days and thus preclude the type of short-term crisis we are experiencing.

As a result of a belt-tightening process in consumption in the United States, together with greater domestic production of oil and gas brought about by higher prices, would come an eventual reliance on the free pricing mechanism for all energy sources. Hopefully, this would bring prices throughout the world into equilibrium at the market clearing levels. But this will only occur if efforts by the United States to be self-reliant eliminates our import demands on Middle East production after 1978 which would have a restraining influence on the OPEC cartel's price demands.

JANUARY 7, 1974.

EXXON CORP.,
New York, N.Y., February 7, 1974.

Hon. MIKE GRAVEL,
Chairman, Energy Subcommittee, Senate Finance Committee, U.S. Senate, Washington, D.C.

DEAR SENATOR GRAVEL: During hearings of your Sub-Committee on Energy this past January 25, I understand interest was expressed in the effect of foreign exchange rate changes on our Company's 1973 earnings improvement and spefically regarding our firm's investment portfolio during the period surrounding the dollar devaluation a year ago. This letter and attachment respond to that interest and are respectfully submitted for inclusion in the hearing record which we understand is being held open through February 10.

The most significant impact of foreign exchange rate changes on Exxon's reported 1973 earnings improvement arose from the translation, into U.S. dollars, of foreign operating revenues at rates of exchange that, for the greater part of the year, reflected significantly stronger foreign currency values versus the dollar. The details of our long-established accounting procedures for converting foreign-currency values to dollars are complex, but in brief, current operating revenues are translated into dollars each month at averages of daily exchange rates during the month. Operating costs are similarly converted, but in general, the effect of a declining dollar exchange rate is not symmetrical because (1) imported crude oil and product costs to our foreign operations are usually dollar-priced and (2) depreciation of fixed assets is charged at the rate of exchange prevailing when the asset was built or acquired and, therefore, does not increase in accounting dollars when the dollar depreciates.

Consequently, the dollar countervalues of operating costs of our foreign operations did not increase to the same extent as the dollar countervalues of operating revenues. Through this effect, the operating margin in a given local currency was translated to a greater relative margin in U.S. dollars if the dollar exchange rate had fallen during the year.

There were foreign currency price and margin improvements in our foreign operations in 1973 as compared to 1972. However, in an effort to isolate the exchange rate movement from other factors, the best estimate we have been able to make on preliminary data is that Exxon's net earnings would have been $150 million less in 1973 had the rate of exchange between the dollar and foreign currencies remained the same throughout 1973. In other words, our 1973 foreign earnings when expressed in the U.S. dollar books of account can be said to have benefited by about $150 million from the average strengthening of currencies, principally in Europe, versus the dollar during the year 1973.

Of much less importance, in terms of the effect on Exxon's profit and loss, were the effects of changing exchange rates on our foreign-currency assets and liabilities during the year 1973. Broadly speaking, our asset positions in strengthening foreign currencies were more than offset by long-term debt exposures in such foreign currencies.

We attach hereto data regarding cash and marketable securities at each month-end during the first quarter of 1973, listed by currency. The great majority of these funds were operational cash balances or portfolio holdings of Exxon and major affiliates whose locations are determined by long-standing financial policy considerations; only small portions of these funds are considered to be moveable for foreign exchange rate risk considerations.

We hope you will find these comments and data responsive to your Committee's deliberations.

Very truly yours,

A. C. HAMILTON.

Attachment.

EXXON AND MAJORITY OWNED AFFILIATES CASH AND MARKETABLE SECURITIES HOLDINGS BY CURRENCY,[1] 1ST QUARTER 1973

[Million of dollars at month-end exchange rates]

	January	February	March
A. Exxon and majority owned domestic affiliates:			
U.S. dollar	1,313.4	1,333.7	1,249.0
Japanese yen	11.1	12.0	12.6
B. Exxon majority owned foreign affiliates:			
U.S. dollar	345.0	347.0	397.3
Canadian dollar	62.8	84.3	74.6
Australian dollar	1.2	1.4	1.3
Malaysian dollar	1.5	1.6	2.2
British pound	8.2	14.9	11.0
French franc	16.2	18.1	5.1
Belgian franc	1.9	2.0	2.2
German mark	12.7	15.8	41.8
Dutch florin	6.1	1.3	4.3
Italian lira	8.5	7.4	2.0
Norwegian krone	3.6	4.2	8.0
Danish krone	1.8	3.6	6.2
Indian rupee	4.2	5.1	4.3
Japanese yen	97.5	107.3	117.2
Swedish krona	5.4	5.8	8.9
Finnish markka	2.5	1.9	
Spanish peseta	2.0	1.9	2.7
Austrian schilling	1.7		
Nigerian pound	3.2	2.5	3.2
Philippine peso	3.1	2.0	3.3
Thai bhat	1.6	2.5	1.8
Brazilian cruzeiro	13.0	10.4	14.6
Argentine peso	4.1	4.5	5.4
Chilean escudo	1.3	1.6	2.5
Jamaican dollar	2.2	5.5	4.5
Venezuelan bolivar	4.5		2.5
Egyptian pound	3.8	4.2	4.1
Singapore dollar		1.8	1.7
Libyan dinar		1.3	
Tunisian dinar		1.7	
South Vietnamese piastre		1.6	
Swiss franc			4.5
Malagasian franc			1.0

[1] Excluding any item where the holdings amount to less than $1,000,000.

Statement of J. P. Murphy, President, Inexco Oil Co.

I. INTRODUCTION

Inexco Oil Company ("Inexco") welcomes the opportunity to submit its views on S. 2806, the Energy Revenue and Development Act of 1973. Inexco believes this proposed legislation contains many constructive proposals for dealing with the nation's energy shortage. It is evident that the members and staff of the Senate Finance Committee have given a great deal of thought to the matters to which this bill relates.

As clearly recognized in this proposed bill, it is essential that the domestic oil industry engage in an all-out effort to explore for and develop new domestic sources of oil; the bill provides substantial economic incentives toward this end.

As one of the leading companies in the independent sector of the petroleum industry, Inexco is principally engaged in oil and gas exploration and development. It has consistently been among the industry's leaders in domestic footage drilled. In 1972 Inexco drilled more domestic footage than any other independent oil company and even outdrilled such majors as Tenneco and Atlantic Richfield. Current production exceeds 17,500 barrels of oil per day from domestic on-shore operations. These operations are located principally in Wyoming, Texas, Oklahoma, Louisiana and New Mexico.

Much of this production comes from recently-discovered sources. Though no official statistics have been compiled, it is safe to say that Inexco has been, in recent years, one of the top five oil companies in terms of domestic exploratory footage drilled. Thus, Inexco is fully committed to the basic thrust of S. 2806, which is to stimulate exploration for and development of new domestic sources of oil.

If this objective is to be achieved, however, it is necessary for Congress to approach the problem in a comprehensive way. Providing adequate incentives for the exploration and development of new domestic sources of energy is a complex task. It will be very difficult to determine the appropriate measures to be taken and to avoid politically popular "reforms" that will be counterproductive in the long run.

This legislative objective of finding ways to increase domestic oil and gas production can only be accomplished if the subject is dealt with in a single comprehensive piece of legislation; it would be a serious mistake to deal with the problem on a piecemeal basis. Yet this is precisely what could happen unless there is adequate coordination among the various committees of Congress presently considering energy-related legislation.

As this Committee is aware, S. 2806 is not the only bill presently before the Congress that seeks to alleviate the energy shortage or otherwise deal with the oil industry. Over the past few months, Congress has been flooded with a host of proposed energy bills. Some of these are aimed not at increasing domestic oil and gas production, but at restricting the profits of oil and gas companies, irrespective of the effect of such legislation on future domestic production. During the first two weeks of February, for example, the House Ways and Means Committee held hearings on at least six different bills designed to tax "windfall" profits. Pending before the House Interstate Commerce Committee are another half dozen or more bills designed to roll back the prices of crude oil and refined petroleum products. Other bills pending before Ways and Means would adversely affect the oil companies by reducing or eliminating the percentage depletion allowance. Though these bills may be politically fashionable for the moment, they are more likely to discourage rather than encourage increased domestic production. As such, they run counter to the objectives of S. 2806.

This is not to say that all other bills are misguided. Constructive bills have been introduced as well. A leading example is Senator Ribicoff's proposal, S. 2937, which would stimulate domestic production by limiting the tax advantages of producing or refining oil abroad. Corresponding legislation has been introduced in the House. Another constructive piece of legislation is the Senate Commerce Committee's Working Paper on the Consumer Energy Act of 1974 (hereafter referred to as the "Working Paper"). This Act, which has not yet been formally introduced, is designed, through a variety of measures, to strengthen the independent sector of the petroleum industry and thereby restore competition to the entire industry. These measures include: deregulation of the independent sector, assuring that petroleum pipelines act as common carriers, and reforming the system of bidding for drilling rights on federal land to enable independents to compete for such rights. While Inexco has reservations as to other proposals contained in the Working Paper, the Company supports the above-noted provisions of that bill.

In sum, it is a mistake to proceed in piecemeal fashion. The constructive aspects of the Ribicoff bill, the Working Paper on the Consumer Energy Act of 1974, and S. 2806 should, at some appropriate point in the legislative process, be included into a comprehensive and constructive approach to this problem.

Because it approaches this area on a comprehensive basis and because of the soundness of many of its concepts, S. 2806 is a good beginning and could well serve as the foundation for an overall legislative approach to the energy problem.

TITLE II—ENERGY TRUST FUND: TAX ON ENERGY SOURCES

Although there have been many hypotheses that improved scientific tools will make finding oil and gas easier, in fact, all statistical analyses demonstrate that the only guaranteed method for discovering reserves of oil and gas is through additional drilling.

Thus, the thrust of any legislation should be to encourage additional exploratory drilling for oil and gas reserves. Few proposals have been made which will generate sufficient exploratory drilling. In fact, strangely enough, most suggestions seem to result in fewer wells (especially exploratory wells) being drilled in an effort to support the refining or marketing end of the petroleum business.

As far back as 1971, Inexco proposed the implementation of an "energy surcharge" with proceeds to be placed in a trust fund to be utilized for increased exploratory drilling. The proposed Trust concept in S. 2806 has many of the benefits which Inexco has sought for the past few years.

In order to increase substantially the domestic on-shore exploratory drilling and, thus, domestic supplies, Inexco Oil Company believes that there should be placed on the ultimate user of petroleum products a tax or surcharge of at least 2¢ per gallon and probably 5¢–10¢.

At present, the United States consumes approximately 14 million barrels of crude oil, or 588 million gallons of product per day. Approximately two-thirds of that is from domestic sources and the remainder is imported. If a 2¢ per gallon tax were placed on each gallon used, approximately $12 million per day or $4.3 billion per year in revenues would be generated.

Inexco proposes that that money be collected by the government and placed in an "Exploratory Drilling Trust Fund". The proceeds of this trust fund would then be distributed to those companies which have produced domestic on-shore crude oil.

Distributions would be made at the rate of 2¢ per gallon, or 84¢ per barrel, multiplied by the number of barrels each producer produced in the previous year from domestic on-shore wells. The proceeds from the Trust Fund would be utilized only for domestic on-shore exploratory drilling operations and not for geological or geophysical operations. The method for determining the expenditures would be consistent with the standard model 610 operating agreements used in the industry today by all oil companies. Thus, producers would be obligated to drill significant numbers of on-shore, domestic exploratory wells, if Inexco's hypothesis on the results of additional drilling is correct, a signifidant amount of new domestic oil would be found.

In order to insure that the trust funds are used only for *additional* drilling, producers would receive funds only for drilling expenditures which exceed the highest amount spent by a producer in any one of the last five fiscal years; subject, of course, to the maximum of 84¢ per barrel multiplied by the number of barrels produced by that producer.

If monies were received and not expended for the appropriate purposes, they would be subject to refund or 100% "tax".

Inexco Oil Company believes that the major drilling operations which would result from this program would materially curtail current dependence on imports as well as the shortage which exists today.

Title II of the proposed Act establishes the "Energy Trust Fund" and requires that funds collected be used for a massive public effort in energy development. We believe this is beneficial although, as previously stated, we feel the emphasis should be on increased drilling activities.

We think the Act's tax base is equally sound, but we believe that it is inequitable to require the producer to bear the entire load. Where producers have refining and marketing outlets, such tax will inevitably be passed on to the consumer. But, for the independent producer, the entire brunt of the tax will be borne by it.

This would be a highly inequitable result and would deter exploration by those in the independent sector, who have been most active in exploring for new domestic sources of oil and gas.

TITLE III

Inexco endorses the establishment of a Federal Agency Administration and the formation of a national energy policy. We support the concept of loan guarantees for increased exploratory drilling and for the development of non-conventional forms of energy.

TITLE V

Title V is of vital importance to the oil and gas industry and to Inexco.

Inexco believes that a total free market should obtain for all products. Inexco believes that the independent sector of the oil and gas industry should be deregulated. This would encourage those companies that are most active in exploration to increase their efforts and would result in many new entrants into the exploration and development market place. By thus strengthening the independent sector, competition would be strengthened throughout the entire petroleum industry. This concept is embodied in Section 102 of the Senate Commerce Committee's Working Paper.

At the very least, the ceiling price on new gas should be lifted. As a founding member of the Independent Gas Producers Committee, an organization whose members represent those independent companies whose primary business purpose is to explore for and develop new reserves of natural gas, Inexco has advocated the deregulation of new gas for many years. We believe that such action would quickly and materially increase domestic natural gas supplies to the interstate market at a minimal cost to consumers.

Inexco believes that low regulated pricing of natural gas began the vicious cycle of shortages among all important fuels, the supplies and demands for which are interrelated. Were new gas prices to be deregulated, thereby establishing a two-price system by the retention of a regulated price on old gas, the consumer would have more gas available for its most efficient uses—particularly in the interstate market—at a modest increase in gas rates of approximately 2¢ per mcf over the present city-gate prices. This is a reasonable price increase in return for a significant additional supply of the most desirable clean burning fuel.

At least three factors have served to increase the demand for and consumption of natural gas: its environmental advantages as a clean burning fuel, its economical mobility through a vast interstate pipeline system, and its artificially low price in comparison to prices of suitable alternative fuels. Obviously, these factors and others are closely interrelated. But regulation of wellhead prices by the Federal Power Commission is central among the factors leading to this country's natural gas shortage.

Natural gas, with its clean burning environmental advantages, occupies a position superior to other fuels. But in a situation of short supply, it makes fundamental good sense to allocate this wasting resource to its most efficient uses. Instead, its low regulated price has stimulated the use of this most desirable fuel for less efficient uses, such as manufacturing and the generation of electricity, where other fuels could and would be used but for the artificially low price of gas. As a result, natural gas often becomes unavailable for the uses for which it has unique advantages, such as residential heating.

The inefficient use of natural gas is the direct result of maintaining regulated prices over the years at unreasonably low levels. If one looks at the respective increases in the wholesale price index of various fossil fuels, the percentage increases in fuel oil and coal prices has been drastic, while natural gas has maintained a fairly steady price level when adjusted to reflect changes in the industrial commodity wholesale price index.

This steady pricing of natural gas as compared to its energy counterparts is responsible for both the increased use of natural gas and declining exploratory activity.

If new gas alone is deregulated, however, that deregulation would affect approximately 22% of the gas produced at the end of five years. The higher price for that new gas would be mixed in the pipeline with the price-regulated old gas and delivered to the consumer at the city-gate at an increase of approximately 5% to 6% annually. The consumers who rely on interstate sales of natural gas would, for that modest increase, be able to compete with the *intrastate* consumer who already has available most of the new gas being found and being sold intrastate because of the higher unregulated prices on those markets.

It makes sense from the consumer's standpoint to add to supply of new natural gas at an increase of 5% to 6% annually rather than to leave him solely relying for supply additions on alternative energy sources such as imported liquified natural gas and synthetic gas at much higher prices.

It is clear that consumers are going to pay for the reserves of natural gas they are already getting whether Congress takes action or not. Most regions of the country are serviced by the interstate pipeline system running from the southwestern Gulf Coast. In the rate base, consumers have partially paid for that expensive transportation system, but almost $16 billion of capital investment in that system remains to be amortized. As the volume of gas shipped in interstate commerce declines, the transportation costs per unit of gas shipped will increase the cost of gas required to amortize the fixed investment which must be paid out. An increase in gas rates for the consumer should not be viewed as a negative development. Modest increases in gas rates would discourage wasteful use of gas without penalizing those who use it only as needed. The Senate Commerce Committee's Working Paper recognizes this and proposes in § 601 the termination of wasteful rate structures by increasing the per unit cost of gas on the basis of the quantity consumed.

This pattern of increased completions began changing in 1970 in response to higher new contract prices, primarily in the *intrastate* market, which has seen new contract prices as high as $1.25/mcf. Moreover, changes in the regulatory policy of the Federal Power Commission allowing higher wellhead prices for new interstate sales has led to some increases in dedications of gas acreage to the interstate market. However, it should be noted that even under these changed policies of the Federal Power Commission, most of the increased exploratory activity is attributable to *intrastate* market prices.

Nevertheless, the importance of higher price as a means of inducing increased exploration cannot be understated. After drifting in the 15¢–16¢ range for more than ten years, the Bureau of Mines reports that the average price for all gas rose about 1¢ per year from 1969 through 1972, to reach 19.5¢ per mcf. As a result of this steadily increased pricing, gas wells increased to 13.6% of total drilling in 1970, to 14.8% in 1971, and to 18% in 1972.

We support the proposition and feel it is directly correlative to our surcharge proposal described above that increased funds received from deregulation of new gas be required to be "put back into the game" for additional exploration drilling.

As the Independent Gas Producers Committee has shown, the effect of higher wellhead prices for new gas mixed with regulated old gas would not be significant because wellhead prices will continue to constitute only a small percentage of the consumer's gas bill. Currently, the wellhead price is only 17% of the cost of gas to the average consumer. In addition, it is clear that significant amounts of gas have not been discovered in the domestic United States. The members of the Independent Gas Producers Committee have staked their corporate lives on such proposition. Moreover, if such conclusions are unsound and little "new" gas is found, as only new gas prices will be deregulated, it is those independent companies who will take the financial loss, not the consumer and not the Congress.

Thus, it appears clear that the consumer will derive the benefits of deregulating new gas and the only risk of loss involved would be to the gas producers who will be betting large amounts of venture capital on the search for such gas.

The costs of drilling for new gas reserves are high. First, this new gas lies primarily outside oil rich areas and will be discovered by those drilling for gas rather than being found in association with oil by those searching primarily for oil. This fact further demonstrates that the independent gas producer will be responsible for that exploration.

Moreover, the potential new gas lies for the most part in regions such as the Rocky Mountain basins, and in ultra-deep reservoirs, such as the Deep Permian and Deep Anadarko Basins of the Southwest, where drilling is difficult and drilling costs are high. This is, of course, the reason why the regulated price incentive has been inadequate to support exploration activities in these areas and, thus, is the reason why these reserves remain untapped.

For example, in the Rocky Mountain area, where Inexco conducts a major portion of its operations, the geology of the basins is complex. Drilling problems will be encountered, including impermeable geological strata, with difficult and expensive well siting. In the ultra-deep basins (below 15,000 feet) the costs are enormously high and the risks of blow-out in tapping this virgin area, are unknown.

It is also important to know that the Deep Anadarko Basin lies directly beneath the Guymon-Hogoton Field in Oklahoma, Kansas, and Texas. The average cost of a completed gas well in the relatively shallow formations of the Guymon-Hogoton Field is $100,000 to $125,000. One piece of equipment on the ultra-deep wells below that field, adequate to contain surface pressures as high as 18,000 psi, cost $125,000.

The days of easy and inexpensive drilling are over, but there is much gas to be found in these high-cost drilling areas.

Therefore, Inexo believes that deregulation of new gas prices is a specific, affirmative, and importantly, a simplifying step which will quickly increase the supply of natural gas during the critical near term. It is a step which will only involve minimal increases in cost to the consumer while the consumer bears no risk other than that occasioned by the gas producer failing to find significant new reserves.

Therefore, Inexco supports the recommendation contained in Title V of the proposed Act.

TITLE VI (AND OTHER TAX PROVISIONS)

There is a need for caution in enacting "tax reform" legislation directed at the oil industry. As the Wall Street Jounral has recently pointed out:

> Congress is worried about how to change the tax law in order to restrain oil profits. Clearly a number of items in the Internal Revenue Code work in the oil companies' favor, and it's worth thinking seriously about whether to change them. But serious thought quickly runs into certain realities.
>
> The commanding reality is that if the energy crisis is to be solved, the world's petroleum industry, which is largely the U.S. multinationals, will have to invest $1 trillion by 1985. Half of this will have to come out of industry profits. The Chase Manhattan Bank estimates that this will require an annual 18% earnings increase as an average over the 1970-85 period, a number some economists equate with a 15% to 20% return on shareholders' equity. For all the talk of "windfalls" and "record profits", the industry's average return on shareholders' equity in 1973 was roughly 16%; Exxon, the leader, was at 19%.
>
> These return-on-investment figures also tell quite a bit about the effects of oil-tax "loopholes". An industry benefitting from preferential tax treatment presumably would be an unusually profitable one. But prior to the current oil shortages, the oil industry's rate of return has been below average: in 1972, 9.6% for oil and 11.8% for all industry. In 1972, Exxon earned a return of 12.5%, Gulf earned 3.6% and so on, while Coca-Cola returned 22.8%. So far as we can see, the only possible interpretation of this is that profit margins in the oil industry have been under competitive pressure, and because of the same pressure the effect of tax breaks has been passed along in lower prices to the consumer. Higher taxes on oil companies are likely to mean that oil prices settle out at a level higher than they otherwise would.
>
> In other words, changes in the tax law would be harmful at worst and cosmetic at best.

The proposed tax (at the rate of 40%) on uninvested profits and tax credits (at the rate of 14%) on domestic exploration and secondary recovery expenditures provided for in S 2806 are logical means of employing tax incentives.

Assuming that exploration and exploitation drilling expenditures constitute a "qualified energy project", within the meaning of the proposed bill, an exploration and production company such as Inexco should benefit from the uninvested profits tax (while gaining added relief from the burden of income tax by utilizing the 14% exploration tax credit) despite the fact that a deduction for depletion would not be permitted in determining profits. Nevertheless, with deductions for qualified project expenditures and the statutory profit allowance equal to 20% of average investment (determined on tax basis) in energy sources, an aggressive exploration company's tax burden, if any, would be nominal. It would appear that this tax will operate affirmatively as an incentive to seek sources of energy.

However, the elimination of deductions for foreign depletion and intangibles is too drastic a proposal. With energy in short supply, incentives to create reserves, whether domestic or foreign, are desirable. Hence, total elimination of deductions for foreign depletion and intangibles may be unwise. Nevertheless, Inexco recognizes that incentives to meet this country's energy demands from domestic sources should be greater than those incentives held out for production from foreign energy sources. Thus, Inexco proposes allowing deductions equal to one-half of intangibles incurred on non-U.S. properties. Also, the domestic depletion percentage should be greater than the percentage applied to foreign production; Inexco proposes a 30% domestic depletion percentage and a 20% foreign depletion percentage.

TITLE XI

a. Federal Lands

Title XI provides *inter alia* for the expeditious exploration and development of federal lands. Inexco believes that one method for achieving this laudable goal is through the forced unitization of federal lands. Section 1104(b) embodies this concept.

In many instances a geological prospect covers many mineral leases held by many different companies. In most states, if a party wants to drill a well, it must negotiate a deal with the other owners. If such other owners do not wish to negotiate, the drilling party must drill his own well and pay the full price or postpone such drilling. Obviously, since drilling is a risky business, few oil people wish to permit owners a "free ride". Thus, drilling is delayed or abandoned if an agreement cannot be made.

We believe that delay is adverse to the country's present needs. Therefore, we support the forced unitization of geological prospects.

As Inexco envisions unitization, a party wishing to drill a well would have to go to a state conservation committee or federal agency to demonstrate the geological merits of his prospect. If it is sound, the agency would require each owner of leases on that prospect to pay a proportionate share of the well costs if he did not want to sell his mineral rights to the drilling party at a defined fair market value.

Since much oil and gas land in Wyoming, Montana, offshore and other places are federally owned, the proposal could be realistically inaugurated. We believe it is beneficial.

Congress has received testimony that 60% of the remaining potential domestic natural gas reserves of the United States, on-shore and off-shore, lie in the public domain. Federal leasing policy will determine who is to develop them: the major integrated companies alone, the major companies and the independents in a realistically competitive situation, or the private sector (either competitively or non-competitively) competing also with a Federal energy development corporation.

We advocate alteration of present Federal leasing policies, hopefully along lines similar to the more flexible and competitive policies of the United Kingdom which have stimulated the development of North Sea reserves.

We do not fear the creation or entry into competition of a Federal development corporation. First, we know that vast capital accumulation will be necessary over at least the next twenty years to meet the energy requirements of this nation. It may well be necessary that public funding be added to available private funding for this massive effort. Secondly, we can see the possibility for a healthy understanding to arise between the public and private sectors if a public corporation were competitively to enter the energy business, particularly in exploration and development. For these reasons, we support the proposal in Title III of the Working Paper for the establishment of a Federal Oil and Gas Corporation, and commend this proposal to the Senate Finance Committee.

b. Competition

Apart from potential reserves on the public domain, we are aware that Congress has heard testimony that the structure of the industry is so concentrated that an anticompetitive environment exists with respect to exploration, development, and sale of gas. Our total experience as an independent natural gas producer demonstrates that such is not the case with respect to new gas.

First, there are no barriers to entry of any independent into the business of exploring for and developing new gas reserves. The Independent Gas Producers Committee is living proof of this fact. Indeed, the only barrier confronted is the want of sufficient price to cover costs and provide incentive to attract the necessary venture capital for our operations from higly diverse and independent venture capital investors. Those diverse sources are prepared to invest adequate capital if the price incentive is present. Parenthetically, we point out that if that price incentive continues to be diminished by low regulated prices for natural gas, the result may well be to force us into the hands of major integrated companies for capital and additionally into the hands of the pipeline companies through the device of advance payments. Surely, this is precisely the opposite of what Federal policy should do.

Second, reliable statistics indicate that independent companies now account annually for approximately 80% of new gas discoveries on-shore in the lower 48 states. Those independents do approximately 75% of the exploration drilling.

In addition, Inexco believes that the government should not permit vast expanses of off-shore land to be tied up for long periods of time without continuous development of reserves.

Recently, we have witnessed the major oil companies and others spending exorbitant sums to acquire large prospective off-shore areas. This phenomenon precludes independent oil companies from participating. When this acreage is acquired, the drilling of one or two wells holds the remainder without the necessity for continuous development.

We believe that this results in inefficient operations, wastefulness and delayed development. Sealed bids require the wasteful and duplicative expenditure by numerous companies of enormous geological research time on tracts of land they will never acquire.

We believe that a small filing fee, followed by a requirement of expedited drilling and larger government participation will lessen the monopolistic tendencies of off-shore ownership and, at the same time, insure the development of oil and gas reserves.

Reform of the system of bidding for drilling rights on Federal land is necessary to allow independent companies an opportunity to bid and to thereby make the entire system more competitive. Inexco supports the spproach taken in the Senate Commerce Committee Working Paper. In Section 404 of that proposed legislation, it is provided that at least 50% of lease sales would be made on the basis of royalty rather than bonus bidding. This means that it will no longer be necessary to lay out huge sums of cpaital for drilling rights; a procedure which is only possible for major companies.

AN ADDITIONAL PROPOSAL: "COMMON CARRIER" STATUS FOR GAS PIPELINES

One suggestion, not embodied in the proposed Act which Inexco believes might be beneficial is the creation of "common carrier" status for gas pipelines. This status is presently afforded to oil pipelines.

The Interstate Commerce Act defines an oil pipeline as a "common carrier", subject to the jurisdiction, rules and regulations of the Interstate Commerce Commission. While there may be defects in the ICC's supervision of these pipelines, it is clear that this common carrier status affords producers leverage in finding otherwise unavilable markets.

A producer can negotiate with an "end-line user" of his product to obtain the highest price possible. This increased price is then funneled back into increased exploration by companies, like Inexco Oil Comapny, which are exploration oriented.

Since a significant amount of oil is found by independent oilmen who do not need their crude to feed their refineries and supply their service stations, this leverage is a critical method for obtaining additional funds for exploration.

This leverage is just being recognized. For example, Inexco recently sold certain quantities of crude oil directly to Gulf Oil Company. The sale permitted Inexco to accelerate its exploration program. Without common carrier pipelines, however, it is arguable that such agreements could not be reached.

For gas, however, a producer is forced to sell (whether intrastate or interstate) only to the company laying the pipeline. As a result, the producer cannot go to an end-line user to sell his gas. During the past year, Inexco Oil Company attempted to sell gas to end-line users in return for exploratory financing. That effort was unsuccessful primarily because of our inability to guarantee gas delivery.

If we could obtain funds from end-line users (through guaranteed deliveries), such financing would benefit not only the end-line user but also (a) the public-at-large by decreasing fuel costs for the end-line user service; lowering pipeline charges through the amortization of full lines and, preferably, providing more gas as a result of such additional exploration; and (b) the pipeline by allowing more efficient use of the pipeline through full amortization of its facilities.

We, therefore, urge that gas pipelines be made common carriers. This is provided for in Section 402 of the Senate Commerce Committee Working Paper. We urge that the Senate Finance Committee adopt a similar measure.

CONCLUSION

Inexco commends this Committee, under the able leadership of Senator Gravel, on its efforts in dealing with a national problem. We believe a well reasoned long-range partnership between government and industry which recognizes the enormity of the task and which focuses on affirmative but carefully drawn programs which encourage additional exploration for oil and gas. The temptation will be great to blur this focus in the interests of political expediency, but the consequence of such a course will be the needless prolongation of the energy crisis.

HOUSTON, TEX., *December 7, 1973.*

Mr. MICHAEL STERN,
Staff Director, Senate Finance Committee,
Washington, D.C.

DEAR MR. STERN: As a Ph. D. research engineer I have considerable respect for, and some fear of, the technological feats that we can now accomplish. However, taken as a group, scientists and engineers are usually willing to let their professional enthusiasm blind them to history or questions of ethics . . . not willingly or knowingly, but without thought.

How, in view of the stability of political, social, and administrative organizations as we have seen them in history, can we seriously propose to bequeath steel tanks with radioactive contents with half-lives of hundreds or thousands of years to our future generations? And these wastes are presumably to grow esponentially as we shift from organic fuels to nuclear power! This sort of decision would not be just foolish, or even negligent. It would be an act of such premeditated infamy that, if ever the concept of "sin" should be revived, that word could not adequately define our society's failing.

Please, let us give more money and enthusiasm to wind, solar power, plasma technology, or other "clean" sources. And, however unpleasant it may be, let us face up to the *moral* problems inherent in nuclear plants and not disguise that long term, paramount issue with discussions of economics, politics, or even short-term problems of leaks and displays of technical virtuosity.

Yours truly,

JAMES D. COLTHART.

WESTERN OCEANIC, INC.,
Houston, Tex., February 13, 1974.

Re Senate bill 2806.

SENATE FINANCE COMMITTEE,
Subcommittee on Energy,
Dirkson Senate Office Building, Washington, D.C.

GENTLEMEN: Western Oceanic is engaged in the international offshore drilling business and currently operates or has under construction a total of nine off-shore drilling vessels. As a drilling contractor, we are very concerned about Title VIII of the above bill, which would make drilling equipment subject to export controls. This provision, if enacted, would have the opposite effect of that intended, i.e., it would force drilling contractors to construct their rigs overseas, rather than in U.S. shipyards.

With the cost of offshore drilling rigs now in the $30–40 million range, contractors could ill afford to risk building new units based solely on U.S. demand. These vessels are designed and equipped so that they may move freely from one area of the world to another, in order to take advantage of changes in demand and avoid disastrous (for the contractor) consequences such as resulted from the suspension of drilling operations offshore California after the Santa Barbara oil spill. In addition, if a contractor with a newer, more expensive unit were forced to compete with older, less expensive units by reason of not being allowed to take his rig foreign, he could be forced into a situation whereby he could realize little or no return on his investment. In order to avoid this risk, most or all drilling contractors would build their new units in overseas yards, where they would then be free to operate them in any area of the world where they were able to obtain contracts.

We, therefore, strongly urge that Title VIII be eliminated in its entirety from this bill.

Thank you for your consideration.

Very truly yours,

JERRY E. CHILES,
Vice President, Marketing & Sales.

DEPARTMENT OF ENVIRONMENTAL SCIENCES,
UNIVERSITY OF VIRGINIA,
Charlottesville, Va., February 14, 1974.

To: U.S. Senate Committee on Finance.
From: Professor S. Fred Singer.

I am pleased to comment on S. 2806 the Energy Revenue and Development Act of 1973 introduced by Senator Gravel. I will start with some general remarks and then comment section by section.

GENERAL REMARKS

1. Every competent analysis that I have seen of our current energy problems shows that one of the major causes is usurpation of the free market by government, either through legislation, through regulations, through ill-advised taxes and subsidies, through restrictions of free trade. Any legislation passed now should aim to produce a freer and more competitive market, rather than to burden us with more restraints.
2. A time of perceived crisis is often a poor time to pass legislation which has far-reaching future implications.
3. If legislation is considered which distorts the free market, through taxes, subsidies, controls, etc., then such legislation must have a built-in time-limit, phase-out, or other means of self-destruction.

DETAILED REMARKS

Sec. 102(1).—Our policy should not be to eliminate energy imports, if they are of low cost. Rather we should be in a position where imports are secure and not subject to cutoff. One way to achieve this goal is to have adequate and ready reserves, stockpiles, or other energy alternatives. I am convinced that the reason the Arabs imposed an oil embargo on the United States is that certain circles here gave them the (erroneous) impression that we would be badly hurt by such a cutoff. The Arabs therefore assumed that we would acquiesce to any demand put upon us. They evidently miscalculated and have, in effect, played their trump card prematurely.

Sec. 201 and 202.—I am firmly opposed to the earmarking of tax funds for specific purposes however desirable they may seem today. Taxes should go into the general fund and be spent in accordance with the appropriations voted by Congress.

The Energy Tax as proposed strikes me as being quite regressive. The tax money would come out of the pockets of those who could least afford it; and this would create inequities. I have calculated the consequences of such taxes through the use of input-output analysis and conclude that they would raise the cost of living, including food, heat, and shelter.

Sec. 301, 302, 303.—No special comments.

Sec. 304.—I approve of loan guarantees but under much more restrictive conditions. They should go to the owners of existing wells or fields who could increase production but who have a small financial base and therefore cannot secure loans. What I have in mind, typically, is a man who has a couple of wells that should be reworked or stimulated; he could pay for it out of increased production within a few months. Or a fellow who wants to set up a secondary recovery project on an existing field, or a tertiary project on a reasonably sure prospect, but is too small to raise the necessary capital on reasonable terms.

Sec. 310.—I would oppose the transfer of any *regulatory* function, from the AEC, FPC or elsewhere, to the proposed Federal Energy Administration.

Sec. 401.—The idea of a Commission to carry out economic modeling and provide an "adversary" function to the FEA is intriguing. However, the same functions could probably be performed by the new Office of Technology Assessment (in conjunction with GAO).

Sec. 501 and 502.—I completely support the early termination of price controls, in general, but especially for petroleum and products, and of course for natural gas.

Sec. 601.—An excise tax on uninvested profits would appear to be an improvement over a simple punitive and discriminatory excess profits tax. A great deal of thought should be given to the direct and indirect consequences of any such excise tax, and it certainly should be of limited duration.

Sec. 701 and 702.—The matter of oil imports is a very delicate one. Low cost imports benefit the consumer as well as industry, but discourage the domestic development of energy sources. There is scope here for some better analysis and long-range thinking before we jump to a pat solution which may have undesirable consequences in the future.

Certainly we should not again impose quotas, not even on Arab oil producers. We may be hurting ourselves in the future, and there are better ways to deal with the Arabs than by being petulant. (If the Senate does not like the Arab embargo, then why not come out and say so in a Resolution?) In any case, experience has shown that even a 5% quota can turn into a much higher dependence on imports for the Northeast.

Sec. 704.—I am quite dubious about the success of a "consumers' union", or even about the advisability of forming one. This whole matter had best be left out of any legislation. Anyway, the best way to achieve what we want, namely a lower world price for oil, is to lower consumption and increase our domestic supplies, and let the market handle the price question.

By far the best way to handle the world oil problem, with special benefits to the U.S. consumer, is to remove the distortions produced by taxes and subsidies (see Sec. 1001).

Title VIII.—What is so special about fuels that they should be subjected to export controls? If someone is willing to pay the necessary price, it probably means that the domestic price is too low. In any case, I am for free trade and look for the US to become an energy exporter.

Title IX.—Requires more detailed consideration.

Sec. 1001.—It is well and good to eliminate the foreign percentage depletion and intangible drilling expenses, but what about the foreign tax credit? This is particularly appropriate now since U.S. oil companies have lost ownership of concessions not only *de facto* but in many cases also *de jure*.

Sec. 1002.—A tax credit for residential energy conservation expenditures is of little help to poor people who do not pay income tax. I would prefer a government-guaranteed loan, similar to a home improvement loan, but energy-oriented.

CONCLUSIONS

The bill has some good aspects, plus a few sections that could bear discussion and expansion. However, the bill does not deal with a number of quite important topics. I will mention only a few:

(i) the treatment of the foreign tax credit.

(ii) the best way to exploit oil and other energy resources on public lands and offshore: (a) a government oil corporation vs. (b) private industry as a contractor, vs. (c) more imaginative methods of bidding for leases, such as royalty bidding in combination with bonuses, etc.

(iii) the building up of domestic reserves, stockpiles and excess production capability.

(iv) incentives for the use of coal, including a searching review of government regulations on mining, pollution, transportation, and land restoration, that make it difficult to switch from oil to coal.

(v) better methods of financing energy R&D, especially a greater contribution of private capital and of foreign capital.

Domestic Resources Can Satisfy the Energy Needs of the United States [1]

(S. Fred Singer) [2]

SUMMARY

The goal of energy self-sufficiency announced by the White House is entirely realistic, notwithstanding doubts expressed by many in the energy community.

[1] A paper prepared for the National Academy of Sciences Forum on Energy: Future Alternatives and Risks, Washington, D.C., January 29-30, 1974.

[2] Professor of Environmental Sciences, University of Virginia, Charlottesville, Virginia 22903. Formerly Deputy Assistant Secretary of Interior and Federal Executive Fellow, Brookings Institution.

In fact, the goal might be reached sooner than 1980, principally because of the rapid escalation of the costs of energy, and assuming that the present price of oil will be maintained. The higher price will dampen the demand for energy and increase the supply, provided a free market is allowed to operate with a minimum of government interference. Governmental action may be necessary to facilitate sectoral and geographic allocation problems, to prevent disruptions of the economy, and to alleviate genuine hardships. Such measures will be particularly necessary in the short-term, between now and 1977, but less so in the medium-term, up to 1985.

At the current price of oil, supplies can be increased (i) in the short-term (1–3 years) in a variety of ways: from existing wells; and existing fields; by secondary and tertiary recovery; and from known deposits of heavy crude oil; (ii) in the medium-term (2–5 years) principally from increased exploration and drilling, from offshore resources and from Alaska; and (iii) in the long-term by syncrude from shale and coal. It may not be necessary to develop these high-cost resources fully; the demonstration of spare production capability may be sufficient to assure the dependability of a certain component of lower-cost imports.

In addition to conservation of energy generally and oil in particular, fuel switching will reduce our needs for oil imports further. In the short-term it may be necessary to deplete our natural gas reserves further and to use high sulfur fuels in some circumstances. In the medium-term coal and nuclear energy will become more important. The US may become an energy exporter; more likely however the price of world oil will adjust downward. We will discuss the implications of various scenarios to the world community and to oil company investments.

An R & D program, sensibly apportioned by the private and public sectors, and participated in by foreign firms and governments, will assure the world of a continued supply of energy, even after fossil fuels are essentially exhausted.

However, new energy resources may appear more quickly—in the form of nuclear breeders, nuclear fusion, geothermal and solar energy—all because of a worldwide drive for self-sufficiency. In that case, certain fossil fuel resources may well be bypassed and become worthless. This question deserves further exploration.

CONTENTS

ACKNOWLEDGEMENTS

I owe a great debt to many individuals and organizations for information and critical discussion. I am particularly grateful to Professor Ralph Kehle and his colleagues at the University of Texas, and to Dr. Hubert Risser and other colleagues in the Geological Survey and Department of Interior. Most fruitful has been my association with The MITRE Corporation and my involvement in a number of energy conferences organized by Charles A. Zraket of MITRE. The individuals or organizations mentioned do not necessarily share the views and conclusions expressed in this paper.

WHOM SHOULD WE BLAME FOR THE ENERGY CRISIS?

The current energy crisis is really a series of energy crunches which are only slightly connected, but which happened to come to the foreground at about the same time. It is therefore not realistic to pinpoint a scapegoat: neither the oil companies, nor the Arabs, nor the environmentalists, nor Detroit, nor the consumer, nor any other single cause. Probably the most important single factor is our multi-faceted government itself which through various pieces of legislation and through often conflicting regulations has introduced pertubations into the energy market which have evoked supply and demand responses that eventually produced problems. For example, regulation of the wellhead price of natural gas at an artificially low level has greatly increased the demand without bringing in new supplies. It has also resulted in irrational allocations, diverting much of the supply into the intrastate market, where the price is not regulated; and also turning natural gas into a cheap boiler fuel, rather than reserving it for premium uses. The complicated tax subsidies and regulations regarding oil operations, such as the depletion allowance, the expensing of drilling costs, bonus bidding for federal lands, and especially the foreign tax credit have caused oil companies to operate in a certain way which in the long-run is not beneficial to the U.S. consumer.

Environmental legislation, and especially uncertainties as to whether and how and when it would be carried out, have delayed the siting of nuclear and fossil-fueled power stations, as well as oil refineries, have slowed down offshore production of oil and the Alaska pipeline, have introduced thereby greater risks into refinery construction, have eliminated much of our coal reserve and increased the use of fuel oil, and have contributed to increased gasoline consumption by lowering the efficiency of automobiles.

The oil import quota program may have been the root cause of many of our ills. It has, in the final analysis, not contributed to our national security, but has cost the taxpayer a great deal of money while draining much of our domestic oil. Fortunately, these problems have now been recognized by the current Administration and by the Congress, and we may indeed be moving towards a more rational energy policy in the United States.

Perhaps it is well to state some further points explicitly.

(1) The Arab oil embargo is *not* the cause of our energy problems, *nor will these problems go away after the embargo is stopped.* The embargo has served a useful purpose, however, in sharpening our awareness of these problems. More important is the large escalation of the world price of oil, with far-reaching effects which go beyond the U.S. domestic supply situation.

(2) We need to recognize that research and development, while important, is not going to solve many of our *immediate* energy problems. The current energy problem is not fundamentally an R & D problem but an economic and political problem. The lack of sufficient energy R & D, especially on coal, in the past two decades is of course deplorable and greatly aggravates the crisis. But this neglect is itself the result of insufficient economic incentives.

(3) Project Independence, i.e. self-sufficiency in fuels, especially oil, for the United States has been advanced as a national goal; the present paper suggests that this goal is realistic. But this does not mean that imports should not continue in reasonable amounts wherever they present an economic advantage. Project Independence should be viewed more as an insurance policy against the possibility of a future cutoff of vital fuel resources from abroad.

THREE FUNDAMENTAL QUESTIONS

In our discussion we really deal with three separate questions:

(1) Can we meet the total demand for energy in the United States with domestic energy sources over the next 25 years?

The answer to this question is a "Yes"; coal alone would be able to do the job if it could be substituted for other fuels.

(2) A more difficult question is: can we meet the US demand for *oil* to the year 2000 with domestic resources? This major question is resolved into subsidiary questions: What are the ultimate potential United States and world resources of petroleum and natural gas, both those discovered and those waiting to be found? Where are they? What part of them ca be found and exploited economically? What fraction of the total was originally within the territorial limits of the United States? How much of that fraction lies beneath the continental shleves—and where? To what extent will the United States be dependent in the future on imported petroleum and how can we be assured of an economical supply? What should be the national goal and policy toward encouraging domestic exploration on land and beneath the continental shelves? What part of our national research and investment capability should be devoted to programs aimed at utilizing coal resources or nuclear "fuels" more fully in the future in place of petroleum and natural gas?

The answer is a qualified "Yes". The recoverable crude oil resources alone, without synthetic oil from shale or coal, are two to three times the oil required. A demonstrated capability to produce would allow us also to take advantage of import opprtunities, especially by pipeline from Canada, in such a way as not to prejudice our national security.

(3) The most difficult question of all is: can we meet the demand for oil in the United States in a *timely* fahsion, i.e. can we meet the short-term demand between now and 1977, the medium-term demand [to 1985], and the long-term demand from 1985 to the year 2000? In other words: can we develop US oil resources in such a way that we do not need imports at any time during the next 25 years? The answer is that we can probably keep imports to a reasonable value over the next three years, but then bring domestic supplies into the market in sufficient quantities to make the US reasonably independent of foreign supplies.

HOW MUCH ENERGY (& OIL) WILL BE REQUIRED IN THE US?

One cannot discuss the matter of self-sufficiency without knowing or assuming something about the future demand for energy. While it is axiomatic that the energy consumed can never exceed the available supply, it is nevertheless important for government to act positively to dampen demand as much as possible, so as not to drive up higher the price of energy, so as not to disrupt the economy, and so as not to produce gross inequities.

With this in mind we can examine various projections for the future which have already been published. In particular, we will adopt the Low-Growth Demand Scenario of the Ford Foundation Energy Policy Project [1]. While this may have seemed "far out" a few months ago, it is no longer unrealistic considering the following factors: (1) the greatly increased price of oil; (2) the great effort by government to press for voluntary restraints in the use of energy, particularly of gasoline and fuel oil.

Additional factors which favor a low-growth demand projection are: (1) the current lowered fertility rate; (2) a "saturation effect" which becomes inevitable as a larger and larger fraction of the U.S. population achieves a level of affluence where they can afford a car and other energy-consuming devices; (3) the expectation of continued high energy costs which induces private households to make investments in smaller cars, more economical appliances, insulation for houses, better designed heating systems, etc.

A number of these projected actions in different sectors are shown in Table 1. The LGD projection is shown in Table 2. It should be noted that while the total energy growth rate is as low as 1.6% per year, a doubling time of 43 years, the growth rate for transportation is especially low, only 0.3% per year. The total energy consumption in 1985 would be 87 quadrillion BTU [3] compared to a forecast of 116.8 Q by the Department of Interior. [2] Also shown in Table 2 is a detailed comparison of where the energy goes and what the different energy sectors use in the way of fuels.

An interesting point emerges from these comparisons, relating especially to future demand for oil. If the transportation energy increase can be kept to the low value projected by the LGD, and if other conservation measures (to be discussed below) can be put into effect, then the oil demand growth might be kept to less than 1% per year.

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[3] We denote a quadrillion BTU $= 50^{15}$ BTU by Q, and a quintillion $= 10^{18}$ by $\bar{Q}$. Therefore $1\bar{Q} = 1000Q$.

TABLE 1.—CONSERVATION MEASURES FOR ENERGY SELF-SUFFICIENCY[1]

	Immediate	1975-80	1990
Transportation			
Personal car	Less driving; car pooling	Smaller car; efficient car	Better transit systems and urban design.
Freight	Greater use of rail		
Aviation	Higher load factors		
Electric generation	Revise rate structure to increase efficiency of utilization.	Increase nuclear construction rate.	Nuclear breeders.
	Gas turbines; natural gas, then Lo Btu gas from coal.	Increase conversion efficiency	
	Provide low-pressure steam for heating and process steam.	Off-peak power into methanol fuel (fuel cells for peaking power).	
Residential and commercial:			
Space heating	Lower temperatures	Include solar	Better design of buildings.
Air-conditioning	Use less; use more efficient units.	Better insulation	Do.
Lighting	Use less	Fluorescent	
Hot water	do	Include solar	
Industrial	Greater efficiency but also less growth of energy-intensive products.	Process changes; recycling	
	Use process steam from electric generating plants.		

[1] A more detailed discussion of this table, especially on the use of fuel switching, is given in app. A.

Note: Useful facts: Transportation uses 55 percent of all petroleum supplies (i.e., ~10 Mbbl/d). Personal cars consume 74 percent of this, or ~7Mbbl d. 10 gal/week ≈ 3.5 Mbbl/d. 1,000,000 barrel per day (Mbbl/d) ≈ 2.1 × 10^{15} Btu/yr ≈ 2.1Q/yr.

TABLE 2.—ENERGY DEMAND PROJECTIONS

[In percent]

Sector	Share of total 1970 consumption	Share of total 1985 consumption	Average annual growth rate: 1970-85
Residential	19	17	0.9
Commercial	15	14	1.3
Transportation	24	20	.3
Industry	42	49	2.9
Total	100	100	1.6

Note: The higher growth rate for industry is due to limited knowledge of energy conservation opportunities in industry. Total energy systems, especially those based on gas turbines, should be especially equipped to turn waste heat into useful process heat. No new or radical technologies, e.g. solar energy, are introduced into the residential and commercial sector—a conservative assumption.

[Quadrillion Btu per year] [1]

	1970	1985 high growth	1985 low growth
Residential sector fuel requirements:			
Oil	2.4	4.5	2.28
Gas	5.7	7.3	5.30
Coal and wood	.3		
Electricity at 3413 Btu per kWhe	1.5	4.6	2.28
Total	9.9	16.4	9.86
Commercial sector fuel requirements:			
Oil	4.1	4.9	5.4
Gas	1.9	2.1	2.3
Coal	0.4		
Electricity at 3413 Btu per kWhe	1.05	3.2	1.4
Total	7.45	10.2	9.1

	1969	1985 high growth	1985 low growth
Industrial energy demand and fuel mix:			
Oil	6.1	11.0	9.4
Gas	9.0	16.0	13.5
Coal	5.3	6.0	4.4
Electricity at 3413 Btu per kWh	2.0	6.0	4.7
Total	22.4	39.0	32.0
Total with thermal waste in electric generation included	26.7	53.3	43.2

[1] 1Q per yr = 10^{15} Btu per yr = 0.47mb/d (million barrels of oil equivalent per day).

In order to facilitate the discussion of consumption rates in the future, we show in Table 3 the multiplication factors corresponding to different annual growth rates. Table 4 shows the cumulative consumption for two time periods, 1974–1984, and a 25-year period starting in 1974, again under the assumption of different growth rates. If we choose, conservatively, an energy growth rate of 2.5% per year (rather than the LGD growth rate of 1.6%), then the cumulative demand to the end of the century will be $78Q \times 34.73 = 2.7\overline{Q}$ for all forms of energy (only about 13% greater than the $2.4\overline{Q}$ calculated for a 1.6% growth rate).

For oil the growth rate can be considerably less than 2.5% Depending on the effectiveness of conservation and fuel switching the growth rate could be held to 1% per year, or even less. At 1% the 25-year demand will be $33Q \times 28.4 = 0.94\overline{Q}$. As we shall see, we should have no difficulty in meeting these cumulative demands, and we might be able to meet the actual demands in a timely fashion by 1980.

One result of these projections and the discussions in Appendix A will be a reversal in the historical trends of fuel use shown in Fig. 1. The percentage taken by oil will diminish, to be taken up by (deregulated) natural gas (in the short term at least) and by coal, and later by nuclear.

TABLE 3.—MULTIPLICATION FACTORS CORRESPONDING TO CERTAIN ANNUAL GROWTH RATES (REFERRED TO 1974)

	1974	1979	1984	1999
Growth rate per year:				
0.5 percent	1.00	1.025	1.051	1.133
1 percent	1.00	1.051	1.105	1.284
1.5 percent	1.00	1.078	1.162	1.455
2 percent	1.00	1.105	1.221	1.650
2.5 percent	1.00	1.133	1.284	1.868
3 percent	1.00	1.162	1.350	2.117

Note: For example: if energy consumption is 75 Q in 1974, then it will be (75 times 2.117) in 1999 if the growth rate is 3 percent per year.

TABLE 4.—CUMULATIVE CONSUMPTION FACTOR CORRESPONDING TO CERTAIN ANNUAL GROWTH RATES

	1974-84	1974-99
Growth rate per year:		
0.5 percent	10.25	26.63
1 percent	10.52	28.40
1.5 percent	10.79	30.33
2 percent	11.07	32.44
2.5 percent	11.36	34.73
3 percent	11.66	37.23

Note: For example: Total energy consumption in the 10-year period 1974-84 will be (75 times 11.66) Q assuming a 3-percent growth rate.

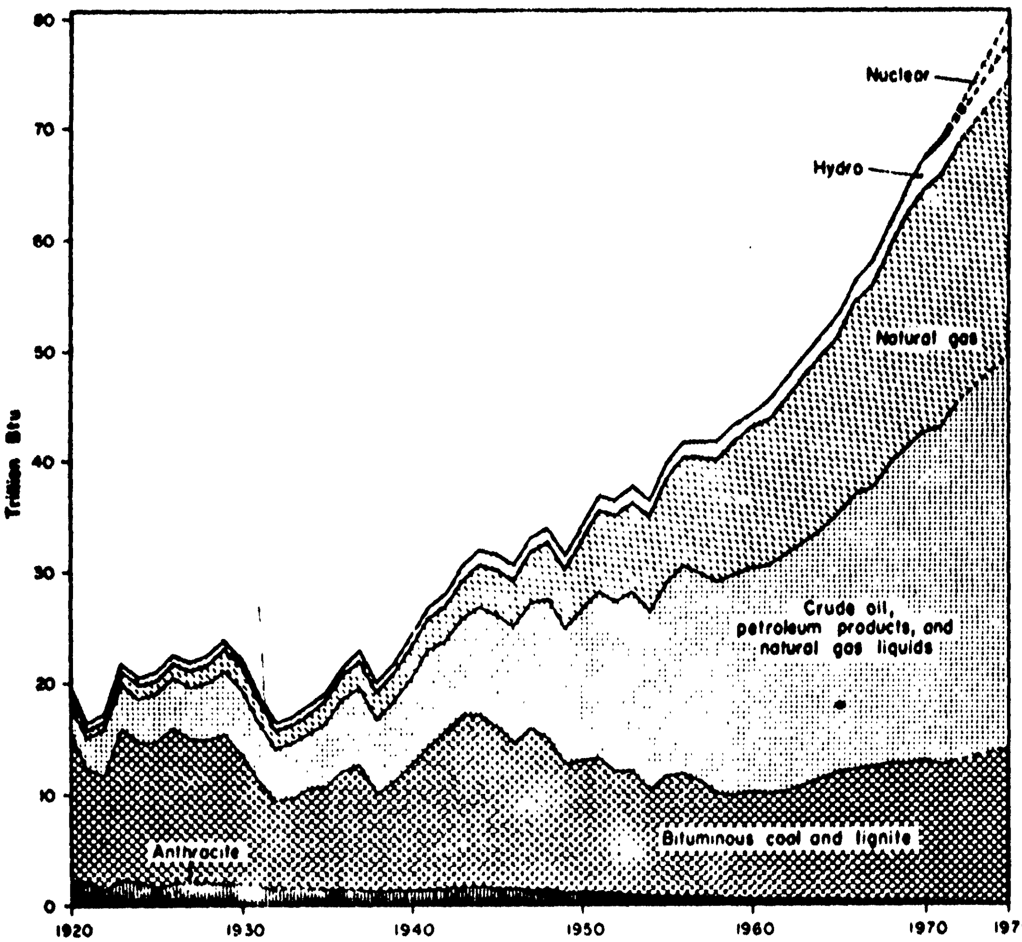

FIGURE 1.—Trends in energy consumption in the United States; 1920–1975. Actual data used for 1920–71 period; projection to 1975 based on projected energy consumption patterns in 1975 given by Dupree and West (1972, p. 50). [2]

1st: CAN WE MEET THE TOTAL ENERGY DEMAND FOR THE NEXT 25 YEARS WITH DOMESTIC ENERGY RESOURCES?

The answer to this question is "Yes" with slight qualifications. If we project the demand for energy to grow at a rate of 2.5%, then according to Table 4, our requirements amount to 2.7 $\bar{Q}$. If we use the more optimistic annual growth rate of 1.6% of the LGD scenario [1], then the amount required is only 2.4 $\bar{Q}$.

Coal is our most dominant resource and could in principle handle our energy needs for more than a century. Table 5 gives the most recent US Geological Survey data on US energy resources [3]. Note that we are dealing here only with resources currently in use, so-called developed resources. The Table therefore does not include oil shale, tar sands, thorium, geothermal and solar energy.[4] Note also that the recoverable resources refer to resources that can be extracted at 1971 prices and with 1971 technology. The recent price increases have put much of the submarginal identified sources into the recoverable category and by stimulating exploration will put much of the undiscovered into the identified category.

It is quite evident that the developed US energy resources can handle our needs, not only for the next 25 years but well beyond. However, by the year 2000 we can expect that new resources will be available to us. A listing of these, together with the energy contained in them is shown in Table 6 [For a more complete discussion see Ref. 4.].

TABLE 5.—ESTIMATES OF THE SIZE OF DEVELOPED U.S. ENERGY RESOURCES

	Identified		Undiscovered	
	Recoverable	Submarginal	Recoverable	Submarginal
Coal (billion tons)	390 [1] (9.0$\bar{Q}$)	1,200 (27.5$\bar{Q}$)	1,640 (37.5$\bar{Q}$)	
Oil (billion barrels)	52 (0.3$\bar{Q}$)	290 (1.7$\bar{Q}$)	450 (2.6$\bar{Q}$)	2,100 (12.2$\bar{Q}$)
Gas (trillion cubic feet)	290 (0.3$\bar{Q}$)	170 (0.2$\bar{Q}$)	2,160 (2.2$\bar{Q}$)	4,000 (4.1$\bar{Q}$)
U_3O_8 (thousand tons)	[2] 250 [3] (0.25$\bar{Q}$)	352 (0.35$\bar{Q}$)	460 (0.46$\bar{Q}$)	540 (0.54$\bar{Q}$)
Total	(9.85$\bar{Q}$)	(29.75$\bar{Q}$)	(5.26$\bar{Q}$) (+37.5$\bar{Q}$)	(16.84$\bar{Q}$)

[1] $\bar{Q}$ equals 10^{18} Btu (quintillion).
[2] At \$8 per pound. The resource increases somewhat faster than price.
[3] Assumes 1.5 percent utilization of U_3O_8. A nuclear breeder reactor, by using uranium at efficiencies as high as 70 percent, could increase the resource by a factor 40–50.
Source: U.S. Geological Survey Circular 650 [3].

TABLE 6.—*Summary of heat units in undeveloped U.S. energy resources*

Oil shale	0. 2 to 150$\bar{Q}$.
Tar sands	0. 1 to 0. 16$\bar{Q}$.
Thorium [1]	16. 7 to 42. 9$\bar{Q}$.
Geothermal [2]	0. 1 to 220.
Solar	40$\bar{Q}$ per year.
Fusion	Virtually limitless.

[1] Up to \$30 per pound; 100 percent efficiency of utilization. Both the nuclear breeder and the high temperature gas cooled reactor (HTGCR) could make use of thorium.
[2] In the form of electricity using 50 percent recovery of in situ thermal energy in hot water systems, 20 percent power conversion for vapor-dominated systems, and 14 percent for hot water reservoirs.

Source: Senate Interior Committee (4).

2ND: DO WE HAVE ENOUGH DOMESTIC PETROLEUM RESOURCES TO MEET OUR NEEDS OVER THE NEXT 25 YEARS?

The answer to this more difficult question is "Yes", but with certain qualifications.

The cumulative demand for oil is set not only by the intrinsic growth in activities like transportation which consume oil products, but also by the possibility of substitution for oil with coal, natural gas, and nuclear energy. The lowest growth rate is probably 0.5%, a high value would be 2%. A growth rate of 1% may be entirely realistic, especially if we consider also the effect of price increases. Table 7 shows the amount of oil required under these three growth rates.

[4] Hydroelectric energy has an installed capacity of 53,000 megawatts and now generates 16% [266 billion kilowatt-hours] of the total electric power. The potential capacity could be doubled.

TABLE 7.—CUMULATIVE DEMAND FOR PETROLEUM IN THE UNITED STATES

Growth rate per year	1974–84	1974–99
0.5 percent	0.34Q̄ 59bb	0.88Q̄ 152bb
1.0 percent	.35Q 60bb	.94Q̄ 162bb
2.0 percent	.36Q̄ 62bb	1.07Q̄ 184bb

Note: 1Q̄=10[18] BTU; 1bb=1 billion barrels; 1Q̄=172bb of oil.

The most recent, and perhaps most authoritative estimate of the energy resources of the United States is contained in US Geological Survey Circular 650 [3] from which we quote as follows:

Of the many estimates of petroleum liquids and natural-gas resources, those of the U.S. Geological Survey are the largest because, in general, our estimates include the largest proportion of favorable ground for exploration. We estimate the total resource base for petroleum liquids to be about 2,900 billion barrels, of which 52 billion barrels is identified and recoverable. Of the total resource base, some 600 billion barrels is in Alaska or offshore from Alaska, 1,500 billion barrels is offshore from the United States, and 1,300 billion barrels is onshore in the conterminous United States. Identified-recoverable resources of petroleum liquids corresponding to these geographic units are 11, 6, and 36 billion barrels, respectively.

The total natural-gas resource of the United States is estimated to be about 6,600 trillion cubic feet, of which 290 trillion cubic feet is identified and recoverable. In geographic units comparable to those for petroleum liquids, the resource bases are 1,400, 3,400, and 2,900 trillion cubic feet, and the identified-recoverable resources are 31, 40, and 220 trillion cubic fee respectively.

Oil shale is estimated to contain 26 trillion barrels of oil. None of this resource is economic at present, but if prices increase moderately, 160–600 billion barrels of this oil could be shifted into the identified-recoverable category.

Several things should be noted. The report was written before the recent price increases, and before the price increases were even contemplated. Therefore, the dividing lines between numbers shown in Table 8 should be shifted considerably. Many of the submarginal resources shown, i.e. 290 billion barrels, will prove to be recoverable, and many of the undiscovered sources, i.e. 450 plus 2100 billion barrels, will be discovered because of increased incentives.

The USGS estimates are considerably higher than other estimates and the differences are discussed in the USGS Circular. Generally speaking, there are two problems. One has to do with the definition of probable, possible, and speculative resources, and the other has to do with basic methodology. There are two basic methodologies, geologic and mathematical. The geologic methodology applies average petroleum content of sedimentary rocks to other favorable strata, while the mathematical method uses statistical data from past discoveries as a function of drilling effort.

The National Petroleum Council estimates use geological estimations but do not cover all potentially favorable areas. Their total estimate is 35% of the USGS estimate, while M.K. Hubbert's estimate, based on the mathematical method, is only 20%. These numbers, however, refer to more or less recoverable resources, discovered and undiscovered, so that the disagreement with the USGS figures is not really as large as it appears.

Table 8. Crude Oil and Natural Gas-Liquids (NGL) in the US (as of Dec. 31, 1970)

	Identified resources: Total resource	Identified resources: Alaska onshore and continental margin	Identified resources: Offshore	Identified resources: Onshore	Undiscovered resources: Total resource	Undiscovered resources: Alaska onshore and continental margin	Undiscovered resources: Offshore	Undiscovered resources: Onshore
Recoverable	52	11	6	36	450	100	200	230
Submarginal	290	20	17	220	2100	450	1250	800

Key to Table 8:

Total resource	Alaska onshore and continental margin
Offshore	Onshore

All values in billion barrels (1Q = 172bb).

Reliability of estimates decreases for submarginal and undiscovered resources. Compiled by S.P. Schweinfurth. USGS Circular 650 [3].

Another set of estimates based on geological methods was published in 1971 by the American Association of Petroleum Geologists [5]. Eleven regions were considered covering 3.2 million square miles. The total content of prospective rock in basins amounts to 6 million cubic miles or 25 million cubic kilometers. This includes sedimentary rock above basement [or 30,000 foot depth] and includes the Continental Shelf. The potential reserves of the basinal areas only, excluding known reserves, range from 227 to 436 billion barrels. The recovery rate is estimated as 30%, and ultimately as 60%. Including known reserves, the ultimate petroleum potential comes to something in excess of 432 billion barrels.

Potential natural gas reserves, exclusive of known reserves, come to 595 to 1,227 trillion cubic feet. Including known reserves the ultimate potential is in excess of 1,543 trillion cubic feet. The potential of natural gas liquids is in excess of 49 billion barrels.

It should be noted that the geological estimates for oil do not include oil shale, nor do they include tar sands which are mostly in Utah, nor do they include a certain proportion of heavy oil, i.e. oil which is so viscous that it can only be produced by tertiary methods. The U.S. Bureau of Mines has identified over 160 billion barrels of heavy oil in place in shallow deposits throughout the United States [6], but some of the deposits are included in the estimation of conventional oil.

On the basis of the numbers presented, one would estimate conservatively that some 400 billion barrels of oil remain to be produced in the United States. Most of this oil has yet to be found, and it can only be found by drilling. The relatively easy locations have already been exploited, those that are amenable to present geophysical exploration methods, such as anticlinal traps. But drilling is required to find oil in stratigraphic traps, in combinations of stratigraphic/structural traps, in reefs, and in more complex structural situations.

Even in structural traps one cannot tell whether oil is present until the formation has been tested by drilling. Just recently, leases off the Florida Gulf coast have been sold. Some of the geological formations remind one of medium-sized fields in the Middle East. While $3.3 billion has been paid, only drilling will tell whether oil is present; but the potential is huge. A field of 40 or 50 billion barrels could be present off Pensacola. A large discovery of the order of 10 billion barrels has just been made off the Shetland Islands in the North Sea. Just plain drilling has found such fields as the non-marine strata in the Cook Inlet in Alaska, the huge Groningen gas field in Holland, gas in overthrust belts of Alberta, gas in the deep Cambrian-Ordovician carbonate rocks in the Delaware basin, the Albian-Scipio trend of oil discoveries in Michigan, the Pleistocene beds of oil and gas off the Louisiana coast, and so on.

To sum up, given the incentives to drill deeper wells, to take risks on wildcats, to take risks offshore and in the Arctic, more oil will be found and produced in the United States. Some of the oil will be relatively low cost. A large offshore field can be produced at something like 40¢ a barrel. But if the price of oil stays at present levels, $8 to $10, or even if the price drops to what is considered to be the oil shale level of approximately $7, most conventional oil will still be profitable to produce.

Therefore, not counting oil from shale, coal or tar sands, or imports from Canada, we can expect to produce in the United States more than twice the oil to be consumed in the next 25 years. We will have oil "coming out of our ears" soon, in the US and throughout the world.

3RD: HOW SOON CAN WE ACHIEVE SELF-SUFFICIENCY?

With the matter of general self-sufficiency settled, subject to incentives and prices being maintaind, we now approach the most difficult question, namely "Can we produce domestic oil in a timely fashion to meet our oil need not only in the long-term beyond 1985, but also in the medium-term and in the short-term?"

The answer to the question can best be discussed with reference to Table 9 which attempts to classify new oil supplies according to time scale.

In my view an immediate supply increase will come from *existing wells* which are not being produced because they have been uneconomic. Many wells just require pumping; others require small capital investments to make them profitable, ranging from a simple reworking, to acidizing, fracturing, etc. There are in the United States alone more than 2.2 million wells which have been drilled in the search for petroleum and natural gas. It is hard to estimate how much will be added to our proven reserves by bringing old wells into production. The Oil and Gas Journal has estimated that stripper wells have a reserve of 4.8 billion barrels but we are dealing here with more than just stripper wells and many that are not even counted as strippers.

Table 9. Classification and Time Schedule for Increasing Oil Supplies*

1974 — 75 — 76 — 77 — 78 — 79 — 80 — 90

Existing wells	Operate stripper wells Rework marginal wells Frac marginal wells
Existing fields	Drill marg. locations Secondary recovery Tertiary recovery
	Heavy oil resources →
New fields	More wildcat drilling onshore
Offshore	Gulf, Fla., Calif. Atlantic coast Arctic
Alaska	North slope →
Syncrude	shale oil → coal liquefaction → Tar sands →

*See text for discussion.

Another important method for increasing our reserves comes from *existing fields* that have only been partially drilled up. In many cases there are uneconomic locations in fields at places where the oil-bearing sand was too thin to justify the drilling of a well. Many of these fill-ins and field extensions have now become economic and will undoubtedly be drilled up. With modern methods of well stimulation and fracturing, some of these can be quite productive.

Similarly we can expect to see a great increase in *secondary recovery* and even *tertiary recovery* from existing fields. Secondary recovery consists mainly of water flooding which of course requires a certain capital investment and generally adds 25¢ to 50¢ to the cost of lifting oil. Tertiary recovery includes a variety of techniques, such as steam flooding, fire flooding, use of miscible and immiscible fluids, detergents, etc. and is more expensive than secondary recovery, but can raise the percentage of oil recovered to 50 to 60% from the average of 30%. Each percent increase in recovery adds 4 billion barrels to our reserves. The Oil and Gas Journal estimated that some 50 billion barrels will be added to our reserves if tertiary recovery is instituted wherever it is not more than about $1 per barrel. At present prices this is not an excessive amount to pay.

Also economic is the the recovery of *heavy oil*, a rather neglected resource. The Bureau of Mines has identified a large number of deposits throughout the United States, mainly in California, Utah, and Wyoming, containing over 160 billion barrels of heavy oil in shallow deposits [6]. Heavy oil is defined as having a specific gravity higher than corresponding to 25° API. Much of the oil produced in California is in fact a heavy oil, but in most areas it cannot be pumped because its viscosity is too high. Some giant deposits in Utah in the multi-billion barrel range are often classed as tar sands deposits but are in fact heavy oil and should be produceable by *in situ* tertiary recovery.

We should also see the discovery of *new fields.* Wildcat drilling will immediately step up in the United States, especially in regions that have not been drilled very extensively. While we may not discover giant fields, the addition to reserves could be appreciable. Large discoveries are likely to be made offshore in the Gulf, in the Pacific, and in the Atlantic. The Arctic has been barely explored. There are statements from knowledgeable geologists that the 10 billion barrel Prudhoe Bay field is only a first in what may be a series of oil pools extending along the North Slope and offshore into the Arctic Ocean. Increased offshore oil might begin to flow by 1976, increased Alaska oil and Arctic oil by 1977. If these discoveries are borne out, then a reasonable measure of self-sufficiency in oil might be achieved before the end of this decade and certainly by 1980.

Special mention must be made of the work of the National Petroleum Council and especially of its Oil Supply Task Group Report [7]. This report has been widely quoted as demonstrating increasing US dependence on imported oil, especially on oil from the Middle East. These conclusions, however, depend on the assumptions, and these in turn were conditioned by an expectation of 1970 prices, with slow escalations. The Report therefore is extremely conservative about the introduction of secondary and tertiary recovery projects and about new discoveries. Oil-in-place discovered is roughly proportional to footage drilled (Fig. 2). But footage drilled is likely to spurt much more rapidly than shown in Fig. 3 in response to higher oil prices.[5]

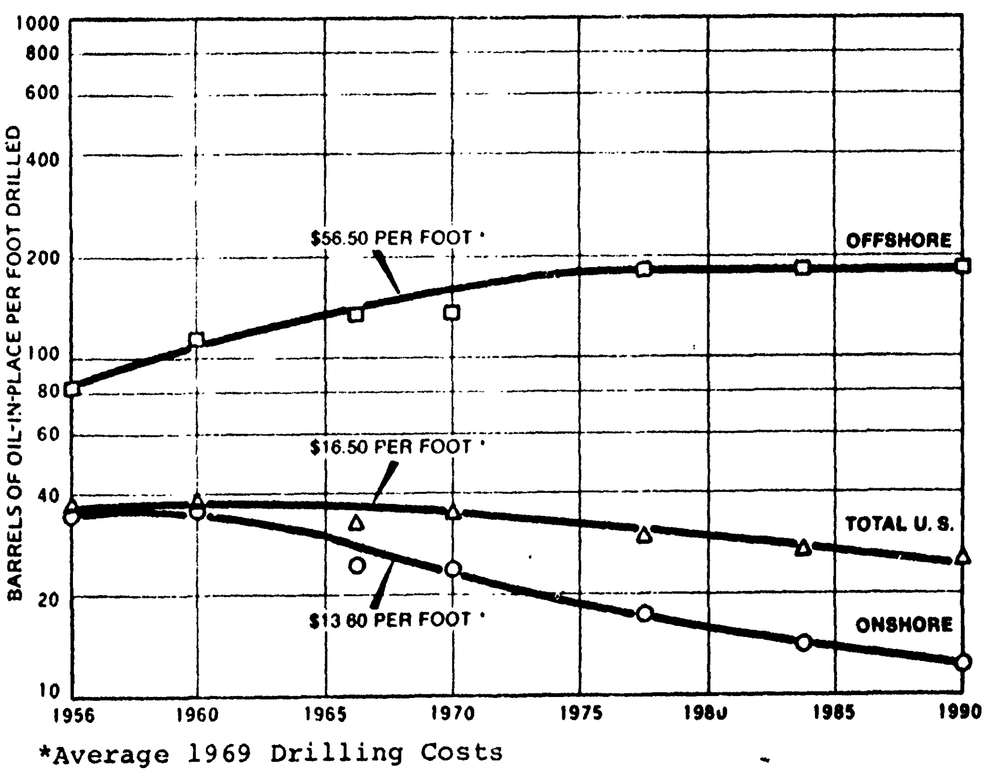

FIGURE 2.—*Oil finding rate.*

[5] The decline in drilling activity during the 60's reflects the view of the oil industry that oil prices would not rise in real terms.

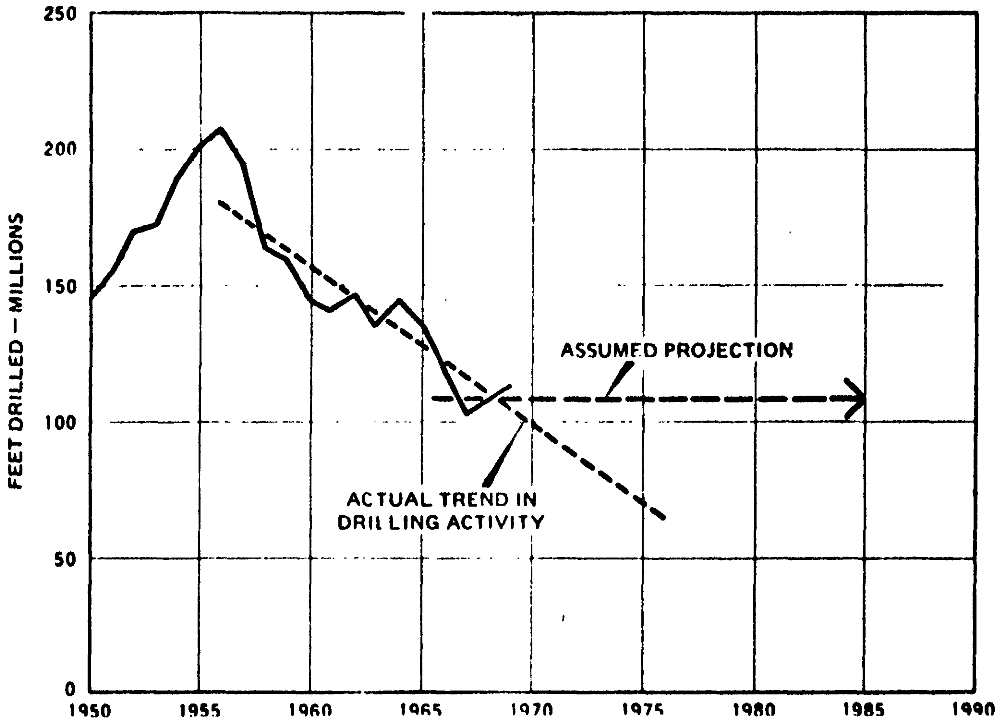

FIGURE 3.—*Oil well drilling activity, total United States.*

(3) Canadian imports: The NPC Report establishes levels of surplus Canadian oil as follows:

	Mb/d
1975	0. 45
1980	1. 04
1985	2. 05

But these levels are likely to be much higher in view of the higher world price of oil which will depress Canadian demand but increase supply. There may be mutual advantages in arranging a long-term supply contract between the US and Canada.

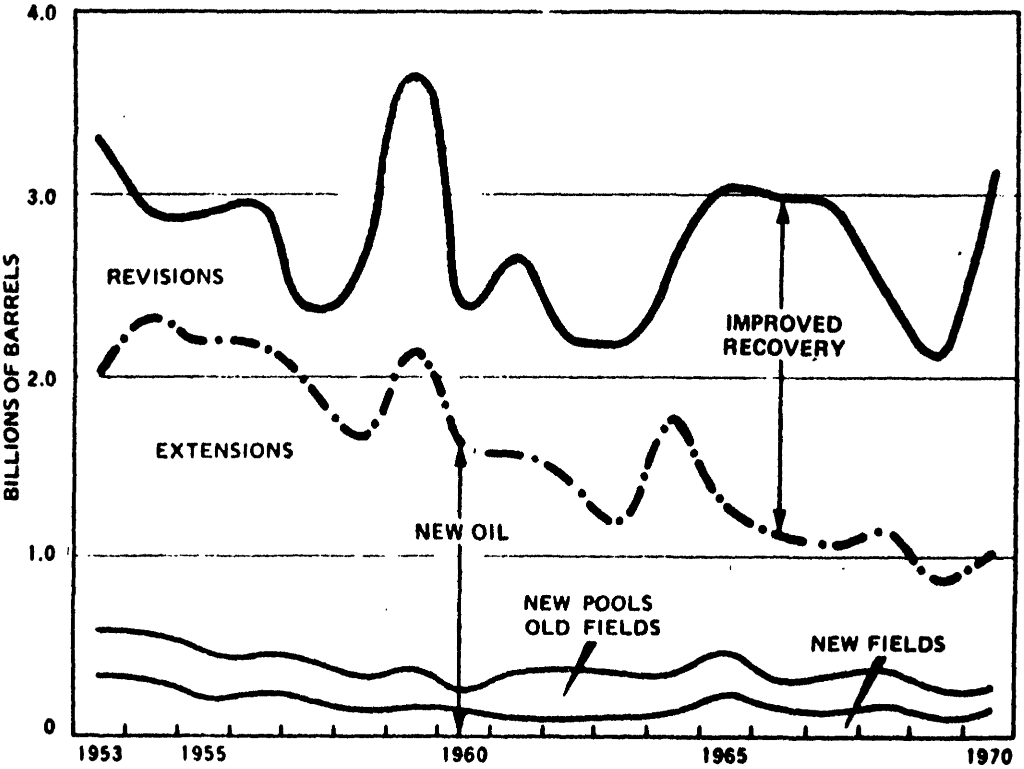

FIGURE 4.—*U.S. crude oil supply reserves, year-end additions (excluding North Slope).*

What is likely to happen therefore is a "telescoping-in-time" of both discoveries, and of extensions and revisions, leading to larger reserve additions than levels shown in Fig. 4. Put another way, we can expect to reach levels of oil-in-place discoveries as well as recovery efficiences at earlier times than shown in the NPC Report.

Three sources of supply need to be discussed separate :

(1) Alaska oil is limited by pipeline capacity. Oil from the Prudhoe Bay field is likely to start flowing in 1977, increasing from 0.6×10^6 bbl/day to 2 mb/d by 1982. Before then, additional pipelines may carry additional oil from other North Slope discoveries.

(2) An immediate input can come from the production of the Elk Hills Naval Petroleum Reserve, increasing to 0.5 to 0.75 mb/d. For a number of reasons it would be advisable to produce this low cost field and establish more extensive reserves in higher cost fields.

HOW DOES WORLD OIL AFFECT US SELF-SUFFICIENCY?

I have attempted to show that the US will become self-sufficient in energy resources and even in oil resources by about 1980, with perhaps a little help from Canadian imports, but without a contribution from synthetic crude from shale and coal. It should be noted that this self-sufficiency can be achieved with what I would call low-cost oil resources requiring modest capaital expenditures.[5] In my view we should be very cautious before going ahead on a full-scale basis with high cost energy resources, such as oil shale and coal liquefaction. The reasons are as follows.

[5] It should be pointed out again that the behavior of individual consumers as well as suppliers is based not only on price but also on price expectations. Both consumers and oil companies make long-term investments. People buy smaller cars if they are convinced that the cost of energy is going to remain high. Suppliers will make large capital investments for the same reason. But high energy costs act to diminish our welfare. Herein lies the paradox which, however, can be resolved by imaginative governmental action.

A huge investment locks the US into a high-cost energy resource. Once the capital expenditures have been made, it becomes important to amortize them by maintaining production, and of course by selling the oil at a high price. In my view the world situation is one in which we may not only have self-sufficiency for oil in the United States in a few years, but a continuing surplus in the world.[7] There are vast resources that have not been drilled up, many discoveries that have not been made but will be made because of the increased price of oil. The markets for high-priced oil are very limited. Over-production must therefore lead to pressure on the world price. The only question is to what level will it go down and how soon.

The OPEC countries are in a difficult position because a monopoly is not stable. If in their greediness they keep the price too high, they will thereby encourage the setting up of high-cost domestic resources in the consumer countries which will then be protected by their respective governments.[8] This could then lead to an oversupply of oil and a collapse of the price to a very low value set by the basic cost of lifting oil plus transportation, of the order of $1.00 a barrel [9] (see Fig. 5).

If cheap oil floods the world, then it could wipe out our domestic oil industry and recreate the situation of the 1950's where an oil import quota was in fact imposed to prevent this from happening. The oil import quota program was a great mistake and the alternatives suggested, mainly import tariffs, may not be that much better. They will still lead to high-cost oil for the United States, while allowing other countries which do not have a domestic industry to import cheap oil and gain a trade advantage.

A far better scheme might be to allow the influx of cheap oil, but at the same time pay a subsidy to keep the domestic industry alive. Perhaps government could just purchase oil in the ground and pretend it had been lifted, encourage our domestic industry to discover further oil wells by wildcatting, pay them for the oil found, and so on. The net result would be that we could use cheap oil for as long as it lasts, while keeping our reserves and actually increasing them. There would be a cost involved, but it would simply result in money circulating within the United States without affecting our trade balance.

We have heard a great deal recently about Arabs wanting to limit their production of oil and even decrease production because "oil in the ground becomes more valuable, while dollars depreciate." This of course is complete nonsense! Oil in the ground does not earn any interest, but money does. (If anyone is concerned about dollars per se, he can exchange into another currency.) Oil should be kept in the ground only if its price (and revenue) can be expected to increase faster than revenue invested at a commercial interest rate. This point is illustrated in Fig. 5 which shows the situation as it existed a year ago. Even then it would seem that oil could not increase in price beyond the ceiling or lid given by competing fuels such as shale oil, at least in the medium and long-term. At the present time with the price of oil well above the long-term price of competitive fuels, oil can only decrease in price. The significance of these facts seems to have been grasped mainly by Iran which is producing as much oil as they can and selling it at the highest price while they can.[10]

Again I must warn that if we want to achieve oil self-sufficiency we will have to somehow guarantee the domestic oil producer a stable oil price in excess of cost for a period of at least 5 years. Conversely, if we do not, then I believe that the political pressure of thousands of independent oil producers would be sufficient to achieve the same results. Knowing this, I think it is better to have a policy in advance which recognizes these realities and provides a measure of certainty so that the industry can make its plans and operate knowing that the government will provide stability to its operation.

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[7] It should be pointed out explicitly that there was, as of 1971, a 233bb surplus of world oil reserves, sufficient to cover world demand beyond 1985 even without any further reserve additions. The current spurt of worldwide exploration is certain to raise this "free-world" surplus to even higher levels.

[8] This is not the place to dwell on the tragic consequences of the artificially raised price of world oil on the more than 80 developing countries that do not have native energy resources.

[9] If by then OPEC countries own the oil concessions, they might not even collect royalties, nor enough funds to develop additional reserves.

[10] It is worth noting that Saudi Arabia which has the largest reserves appears interested in lowering oil prices to protect its long-range market (after 1985), while Algeria and Lybia with much smaller reserves have different objectives.

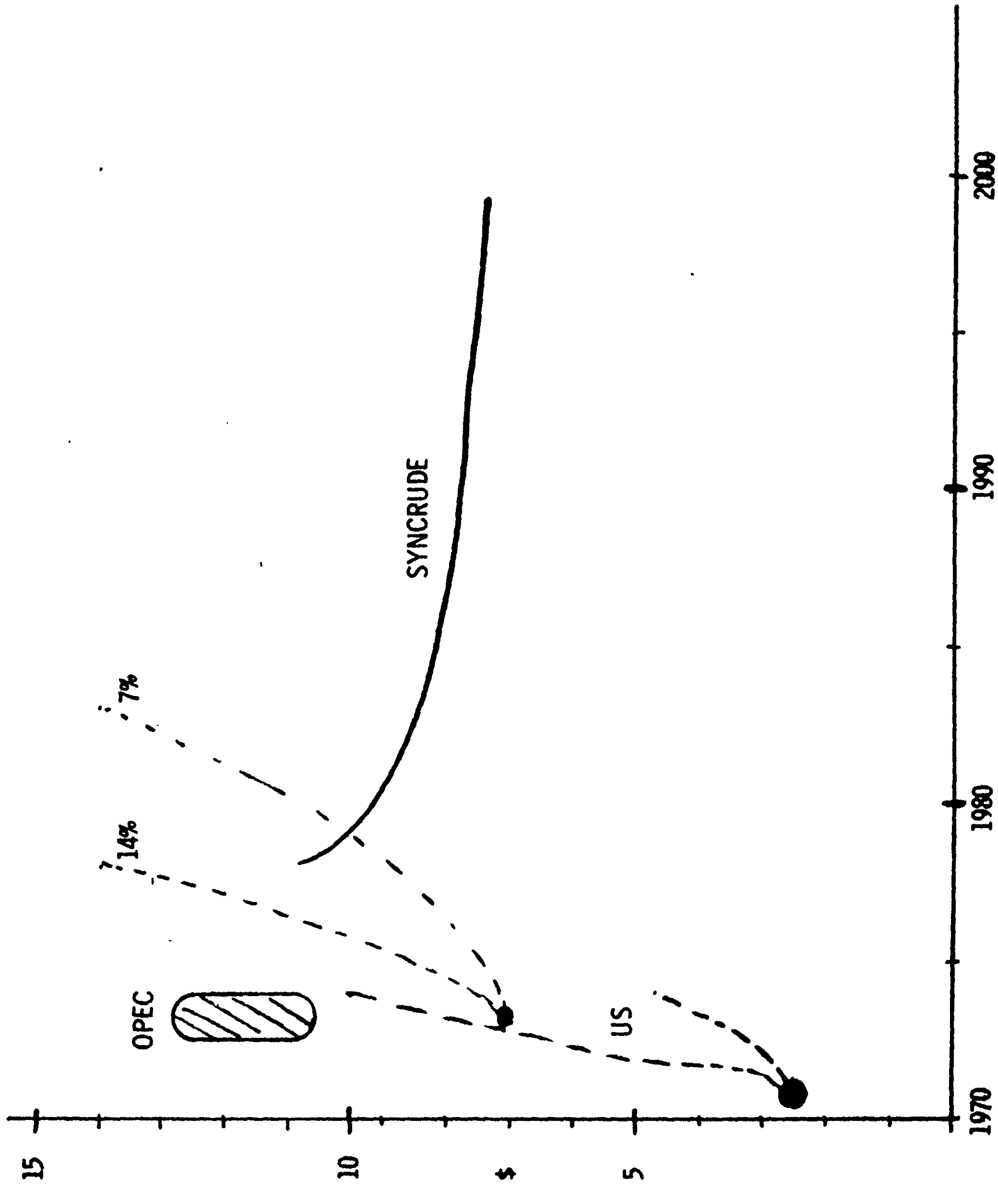

FIGURE 5.—Price Relationships of Domestic Oil, OPEC Oil, and Synthetic Oil (from shale and coal). Also shown is the value of present OPEC revenue (~$7) invested at 7% compound interest (10 year doubling time) and 14% (5 year doubling time.)

WHAT RESOURCES WILL BE PASSED?

As the world moves towards abundant and presumably low-cost non-fossil fuel energy sources after the year 2000, an interesting question can be raised: Which hydrocarbon resources will be bypassed? Will it be US coal (as has almost happened twice earlier), or oil shale, or the Canadian or Venezuelan tar sands, gas in Arctic, or the vast oil and gas resources of Siberia?

This question becomes even more acute if the major consumer countries move to substantial self-sufficiency earlier than 2000, perhaps by the extensive use of nuclear breeders. If, for example, Western Europe and Japan begin to rely on nuclear energy, supplemented by native coal and by oil imports from reliable sources, then there will be little incentive to devote large amounts of capital to drill for oil and lay pipelines in the Soviet Arctic.

It is important to recognize that what we do and plan today will determine whose resources will be valuable and whose resources will be worthless in the future. Thus the technological options selected by the United States and by other consumer nations, acting in concert or even acting separately, can settle the energy future of the world and recast the energy and economic relations of developed and developing nations.

References

1. Ford Foundation Energy Policy Project Low Growth Demand Scenario (to be published 1974).
2. United States Energy Through the Year 2000, by Walter G. Dupree, Jr. and James A. West, U. S. Department of Interior, Washington, D. C., December, 1972.
3. Energy Resources of the United States, Geological Survey Circular 650, by P. K. Theobald, S. P. Schweinfurth, and D. C. Duncan, Washington, 1972.
4. Energy Research and Development—Problems and Prospects, prepared by H. Perry for U. S. Senate Committee on Interior and Insular Affairs, Serial 93-21 (92-56), Washington, 1973.
5. Future Petroleum Provinces of the United States—Their Geology and Potential, edited by Ira Cram; American Association of Petroleum Geologists, Tulsa, Oklahoma, 1971.
6. "Extraction of Energy Fuels," prepared for the Committee on Energy R&D Goals, Federal Council on Science and Technology, Washington, D. C., September, 1972, see p. I-37 and references.
7. U. S. Energy Outlook (An Interview Report of the National Petroleum Council), Vol. 2 (Summaries of Task Group Reports), November, 1971.

Appendix A

How to use less oil: an interpretation of Table 1

In order to dampen demand beyond just the effect of higher prices, very specific measures have to be introduced by government, particularly in connection with personal transportation. In urban areas, a significant increase must be made in the use of buses, small cars must be emphasized, the automobile load factor must be increased. One way to accomplish some of these measures is to charge drivers fully for all the external costs which they place upon others through the use of streets for driving and parking, and through the noise and pollution which are inflicted upon pedestrians. In lieu of use taxes for streets, one might have heavy charges for parking, but at the same time provide faster, more convenient bus service. One measure which would cut consumption considerably and also lower the accident rate would be to raise the driving age from 16 to 18 years. The efficiency of cars can and will increase when the consumer demand becomes quite clear. Smaller cars are certainly a step in the right direction and can be encouraged by various measures, such as taxes. The load factor of cars can be increased by car pooling which in turn can be encouraged by providing faster lanes for driving or special parking privileges to those cars used for car pools. Inter-city passenger traffic and freight transport will go to rail transportation if the proper incentives are provided or if the present disincentives are removed.

In the generation of electricity, the use of oil has increased more rapidly than any other fuel in the past few years, partly because of pollution problems with coal. This trend must be reversed and can be reversed by a more sensible application of emission standards which take advantage of geography and meteorology, without harming the contemplated ambient standards. Ways must then be found for using more coal and nuclear energy [1] for electricity production, and especially for increasing the efficiency of generation from its present 35-40% to beyond 50%. "Dual-cycle systems" based on Lo BTU gas produced from coal and using a gas turbine as the first stage may provide the best approach. These systems, which are efficient in small sizes, lend themselves also to the construction of "total-energy systems" which in turn save on transmission costs and provide a way of using waste heat for industrial, commercial and even residential heating.

Solar energy can and should be used, even at this stage, for hot water in residential and commercial applications. In a few years it should become economical for space heating and air-conditioning.

[1] A 1000 megawatt nuclear plant saves more than 0.01 billion barrels of oil per year.

At present, 55% of petroleum is used as a motor fuel, and about three-quarters of it for personal transportation. These fuel requirements could be obtained directly through the production of methanol from coal by way of a commercial gasification process, as a lower cost alternate to the production of syncrude from coal followed by refining into gasoline. About 200 gallons of methanol are produced per ton of coal, at a cost much less than the present cost of gasoline.[2] Methanol not only makes a good motor fuel, but is a clean fuel generating less pollution.[2]

Finally, the sensible use of natural gas, especially for residential and commercial space heating, would eliminate a large amount of the fuel oil use in the United States. But since natural gas is also a fossil fuel in short supply, several steps would have to be taken:

(1) Deregulation of the price of natural gas would switch it away from intrastate use and make it economic only for residential and commercial applications but uneconomic for electric power generation and for process heat in industry.

(2) A higher wellhead price would also encourage drilling up of gas fields and searching for gas in deeper formations. Although gas is often associated with oil, deep wells beyond 15,000 feet are more likely to contain just gas and would not be pursued unless the price is right.

(3) Another large potential resource is the de-gassing of coal beds, a new and rather unexpected source which should now be economically feasible.[3]

(4) A higher cost of gas would also encourage efforts to obtain it from tight formations where underground explosions must be used; from offshore sources where drilling costs and transportation costs are much higher; from Alaska and the Arctic where gas may have to be transported in the form of LNG or in the form of methanol before it can be delivered to the final user.

(5) Finally, synthetic natural gas (SNG) can be made from coal by a variety of processes. It may eventually be possible to produce it *in situ* and save the mining costs involved in the present production process.[4]

(6) But if we want to cut oil consumption and make the Umited States less dependent on imports, then we must oppose the production of gas from naphtha and similar feed stocks, as well as the import of LNG. The latter is especially bad since it involves very large capital outlays which would tie us to using LNG as a base load fuel rather than for peak-shaving purposes.[5]

THE CONFERENCE BOARD,
New York, N.Y.

INFORMATION FOR THE PRESS

RELEASE #2587, FOR RELEASE THURSDAY, JANUARY 31, 1974

New York, January 31 . . . As a result of restraints on petroleum demand in the United States, coupled with increased supply, it appears likely that the first half of this year will see no oil shortfall at all on a nation-wide basis, although various regions of the country will have specific problems.

This is the consensus of a group of eminent university economists who met as an "energy forum" under the auspices of The Conference Board Energy Information Center. The group reached these other major conclusions:

The principal impact of America's energy problems will be felt through higher fuel prices, affecting the entire economy. Low-income individuals will be hardest hit, but the more prosperous who are heating large homes and driving big cars will feel the pinch too as expenses climb and the market values of their energy-consuming assets fall.

World-wide, the less developed countries will suffer most from inflated petroleum prices. Some may have to choose between importing food and importing oil, and in some instances economic development may be impaired.

There is no world-wide shortage of crude petroleum in the sense of a physical lack of this resource. Government policies here and abroad have limited the availability of crude oil for some time, and most sharply in 1973.

[2] W. D. Harris and R. R. Davison, Oil and Gas Journal, December 13, 1973, p. 70.
[3] See current publications of the Bureau of Mines, e.g. M. G. Zabetakis and M. Duel, *U.S. Bur. Mines Inf. Circ.* 8600 (1973).
[4] A. D. Little, Inc., *A Current Appraisal of Underground Coal Gasification* (Report No. PB-209-274 Nat'l. Tech. Inf. Serv., Springfield, Va., 1972). See also current publications of the Bureau of Mines.
[5] For a discussion of problems of natural gas supply, and especially of LNG, see a series of articles by S. F. Singer in the Christian Science Monitor, from June 18 to Aug. 17, 1973, and esp. June 29.

There is ample petroleum refining capacity world-wide to meet current needs of the entire world, including the United States.

The energy forum met January 10 at Conference Board headquarters in New York City. Participating were:

Kenneth J. Arrow, Professor of Economics, Harvard University and winner of the Nobel Prize in economics.

Gerard M. Brannon, Research Professor of Economics, Georgetown University.

Peter B. Kenen, Walker Professor of Economics and International Finance, Princeton University.

Paul W. MacAvoy, Professor of Economics, Sloan School of Management, Massachusetts Institute of Technology.

S. Fred Singer, Professor of Environmental Sciences, University of Virginia, and former Deputy Assistant Secretary, Department of the Interior.

In addition, William P. Tavoulareas, President, Mobile Oil Corporation, took part in a portion of the meeting as a lunchtime guest of the forum.

A summary of the economists' views was prepared and released today by The Conference Board. Alexander B. Trowbridge, president of the independent business and economic research institution, explained that the forum was designed "to bring together economists who have thought deeply about the energy problem, and who are not employed by the government or a major oil company."

Members of the forum believe that substantial reductions have been made in U.S. demand for petroleum. Public cooperation in lowering thermostats and reducing driving speeds has played an important part in this, as have the Sunday closing of gas stations, reimposition of daylight time, changes in airline scheduling, and shifts from oil to coal by power plants. Other major restraints on demand have been the skyrocketing price of petroleum and a weakening economy.

On the supply side, the forum sees indications that Arab nations have been "leaking" substantial amounts of petroleum in violation of their own embargo. In addition, Indonesia has increased its oil exports to the U.S., and there has been no reduction in exports by Venezuela and Canada, two other major suppliers. Moreover, domestic production is increasing.

The net result, the economists estimate, will be a balance in oil demand and supply in the first half of this year.

The economists note, however, that there is a serious regional problem, particularly in New England which relies almost entirely upon imports, and to a lesser extent in the mid-Atlantic states.

Facing the likelihood that there will be no overall petroleum shortfall, and lacking precise supply and demand data, government should not attempt to allocate or ration petroleum products, the economists believe. "The market can allocate much more efficiently than the government," the forum summary states, but the government has an important role to play in ensuring fairness of private distribution by surveillance to prevent antitrust violations.

Members of the forum are convinced that government price controls have contributed substantially to present energy problems. The upward price creep of recent weeks, permitted by government, creates a tremendous incentive to hold back supplies in anticipation of even higher prices later.

In the longer term, the economists see an abundance of oil being brought forth in response to today's high prices. They caution against developing high-cost sources of energy during the present "crises" because such sources are likely to prove uneconomic when oil production increases and oil prices inevitably drop. There would then be great pressure to protect high-cost energy industries from low-cost oil imports, and the result could place an enormous burden on the consumer and reduce the nation's ability to compete in world markets.

"The present crisis atmosphere is ill-suited to the formation of long-term energy supply policy," the forum summary concludes.

THE CONFERENCE BOARD,
New York, N.Y., January 24, 1974.

To Conference Board Associates:

Energy issues currently dominate the national political and economic scene. This tremendous focus of attention creates a very difficult atmosphere within which to create totally accurate assessments of the nature of the problem, the reasonableness of proposed solutions, and the probable effects on the U.S. economy and foreign economies. The assessment problem is further exacerbated by the paucity of solid data and the plethora of public opinion, objective and otherwise.

It was in the interest of meeting this need that The Conference Board's Energy Forum met on January 10 for the first time. The Forum was designed to bring together economists who have thought deeply about the energy problem, and who are not employed by the government or a major oil company. The hope was that areas of general agreement could be mapped out, and the real areas of difference of opinion noted. William P. Tavoulareas, President, Mobil Oil Corporation joined the group for luncheon and expressed his views.

In these highlights, prepared by John G. Myers, Research Director of the Board's Energy Information Center, we have attempted to set forth the points of consensus, emphasizing that they are partly based on informed opinion and judgment, rather than statistical fact. The full reasoning and supportive detail cannot, of necessity, be included in this brief report. We should further emphasize that, in keeping with The Conference Board's nonadvocacy policy, the staff participants—economists Myers and Nakamura, and I—took back seats in the deliberations so far as it was possible to do so.

Even as this report was being prepared, events were overtaking some of the conclusions. Federal Energy chief Simon and President Nixon have expressed guarded optimism that the oil gap has been closed, the first point in the summary. And a recent IMF statement underscored the tremendous problems oil prices represent for developing nations, point five in the summary.

A transcript of the results of this important and timely session will be published as quickly as possible. In the meantime, I hope that this communication will be useful in informing you of these considered opinions.

ALEXANDER B. TROWBRIDGE,
President.

THE CONFERENCE BOARD ENERGY FORUM

PARTICIPANTS

Kenneth J. Arrow, Professor of Economics, Harvard University, *Theory and Industrial Studies.*

Gerard, M. Brannon, Research Professor of Economics, Georgetown University *Energy Tax Policies.*

Peter B. Kenen, Professor of Economics, Princeton University, *International Trade and Finance.*

Paul W. MacAvoy, Professor of Economics, Sloan School of Management, Massachusetts Institute of Technology, *Energy Economics.*

S. Fred Singer, Professor of Environmental Sciences, Universtiy of Virginia, *Geophysics and Oil Economics.*

William P. Tavoulareas (luncheon guest), President, Mobil Oil Corporation.

CONFERENCE BOARD STAFF

Alexander B. Trowbridge.
John G. Myers (Chairman).
Leonard I. Nakamura.

SUMMARY FOR ENERGY FORUM RELEASE

The focus of attention in this first meeting of the Energy Forum was on the short-run problems arising from the Arab oil boycott. The discussion was concentrated on the situation in the first six months of 1974, but also drew implications for the future, up to the turn of the century. Some of the most striking conclusions that came from the discussion are presented here. These conclusions will be stated first and then discussed in more detail, including the rationale that led to each of them.

1. Although we do not have the complete information necessary to prove this assertion, it appears quite likely that the demand for petroleum products has been sufficiently reduced, and the supply increased, so that there is no remaining shortfall for the first half of 1974. This conclusion does not apply to each region within the United States, for there appears to be a shortfall in New England, for example, and an excess in the Southwest; but an over-all balance apparently exists for the nation as a whole.

2. A worldwide shortage of petroleum refining capacity does not exist. It is an error to consider refinery capacity solely within the 48 or 50 states, for there has been a long-run shift toward constructing refineries abroad, for which the entire

output, or a major portion of it, is specifically intended for the United States market. While refinery capacity within the continental United States is not sufficient to produce all the products we use, this is irrelevant given normal world oil trade patterns.

3. There is no worldwide shortage of crude petroleum, in the sense of physical lack of this resource. Government actions, both in the United States and abroad, have limited the availability of crude oil for some time, and most sharply in 1973. Without political restrictions, crude petroleum supplies would be adequate to meet world demand at expected growth rates until 1990.

4. Starting from the conclusion (No. 1) that supply and demand have adjusted to eliminate the over-all shortfall of oil in the United States, the principal impact of our energy problems will be through higher prices of fuels. This impact will be general throughout the economy, affecting the prices of all goods and services, but in varying degrees. The price impact will also be felt very sharply in many asset values—such as homes and automobiles. There will be sharp impacts on many low-income persons, which may call for remedial government action.

5. In the world, the impact will be greatest not on Europe and Japan, but on the less developed countries. The sharp rises in prices of petroleum products will make it very difficult for these nations to provide for their current needs, such as importing food, as well as reducing their ability to raise their living standards in the long run.

6. In view of the considerable degree of uncertainty regarding the demands for and supplies of specific petroleum products and all products combined, as well as the strong likelihood that there is no remaining over-all shortfall, the government should not attempt to allocate or ration petroleum products. Instead, the market should be allowed to perform this function. Government allocation programs will most likely increase the difficulties of adjustment, and worsen the impact on users of petroleum products—both business and private consumers.

7. Rather than attempting to allocate petroleum supplies, the government should be checking on the fairness of allocation of petroleum and products supplied by private distributors. There may be antitrust problems arising in current distribution practices that should be carefully examined by the government.

8. The price policies followed in recent years have accentuated our energy problems. And this is particularly true since last October. Prices of energy have been under price control since 1971, while the forces of demand and supply have been such as to raise them significantly in relation to prices of other goods and services. In recent months, as world oil prices rose sharply, petroleum product prices have been allowed to increase slowly. But it has been apparent that greater increases were both necessary and forthcoming. Thus recent government price policy gives incentives to hold back supplies in anticipation of further gains.

9. Within a very few years, supplies of petroleum will expand very rapidly in response to recent sharp price increases. This supply response will take place both at home and abroad. It is, in fact, happening now, and it will accelerate in coming years. The result will be a "glut" of petroleum that will have significant consequences for its own price and for the prices of alternative sources of energy.

10. There is considerable danger in embarking on the development of high-cost energy supplies at the present time. Once the price of oil comes down, in response to long-run increases in oil supplies (No. 9), major investments undertaken in high-cost energy supply sources will prove uneconomical. There is a danger that this will lead to demands for protection against low-cost imports of oil and other energy sources. The present crisis atmosphere is ill-suited to the formation of long-term energy supply policy.

CLOSING THE GAP

The Conference Board estimate of the shortfall in oil supplies for the first quarter of 1974 is 2.2 million barrels per day for a weak economy and 2.4 million barrels per day for a strong economy; for the second quarter of 1974, estimated shortfalls are 2.2 and 2.6 million barrels per day, respectively, under the weak and strong economy assumptions. These projections are based on assumptions of normal supply and demand, that is, without taking into account the effects of price increases brought about specifically by the Arab boycott, or of voluntary or legal restrictions on demand as a result of government action. Similarly, these estimates do not take into account any possible "leakage" of oil embargoed by Arab members of the Organization of Petroleum Exporting Countries, of possible expansion of exports from non-Arab oil exporters to the United States, or of increases in domestic oil production brought about by rising prices of oil. Finally, they do not take into account the possibility of greater than normal reduction in inventories to assist in making it through the winter.

When such activities are taken into account, they seem adequate to eliminate the estimated "normal" shortfalls completely. In fact, they may be adequate to produce a small excess of supply over demand. Under the heading of voluntary and legal restrictions, the important factors include changes in airline scheduling, reduced speed limits, Sunday closing of gasoline stations, allocation of gasoline to service stations, reductions in thermostats, the reimposition of daylight time, shifts from oil to coal by power plants, etc. This long list of factors has been estimated by the government to reduce demand by as much as 2.4 million barrels per day, nearly the entire "normal" shortfall. Secondly, prices of petroleum products have risen very steeply, 30% in 12 months, and this has resulted in substantial cutbacks in demand, by perhaps 1.2 million barrels per day. In addition, the economy may be even weaker in the first quarter than was forecast under the weak-economy assumption by The Conference Board. This could further reduce the demand.

On the supply side, we have had indications of substantial amounts of leakage of oil from the Arab countries at a rate of 600,000 to 700,000 barrels per day.

"TROWBRIDGE. Libyan oil goes to Roumania; Roumania sends it to the United States and calls it Roumanian oil. This is what they call 'leakage,' and it is why the Census Bureau is no longer giving out information as to the country of origin of American oil imports.

"High government officials use the figure, at least they did in mid-December, of an estimate of 700,000 barrels a day leakage, Arab origin oil, to the United States.

"SINGER. All they [Arabs] seem to be asking is that we help them 'save face.' They have realized right along that a cutoff cannot hurt the United States, but may actually improve the U.S. position relative to other industrialized countries which depend more on Middle East oil. The oil companies seem to be going through an elaborate charade, pretending that the cutoff is damaging but doing all they can to minimize any damage."

Further, there has been an increase in exports by Indonesia to the United States, and no reduction in exports by our other two main suppliers: Venezuela and Canada. The Indonesian increase is 200,000 to 300,000 barrels a day. Moreover, domestic production is increasing. We do not know the full extent of this but it is rising and there is substantial physical capacity to increase domestic production. Finally, domestic inventories of petroleum products can be drawn down well below the normal seasonal pattern. This normal pattern calls for a 1-million barrel per day reduction in the first quarter of the year and a 750,000 barrel buildup in the second quarter. While we do not know what total inventories (that is, including stocks held by manufacturers, farmers, and others) are at the present time, it is very likely that a safe drawdown of more than the normal amount can occur without creating a danger of supply disruption.

The sum of all these possible changes, reductions in demand, increases in supply, and greater than normal inventory drawdowns, could easily wipe out the "normal" shortfall and produce a surplus. It is the better part of valor to assume that not all these will occur, that some of the demand factors are possibly not additive, and that the net result will be a balance in oil demand and supply in the first half of this year.

"MACAVOY. Is there a shortfall in crude or products as a result of the embargo and the growth of domestic demand? I would propose that there is not, that the evidence is in the process of being transformed to, perhaps, a slight surplus in the next few weeks.

"If we were to account for a reasonable drawdown of inventories, if we were to make an initial assessment of the impact of the various voluntary and nonvoluntary curtailment measures affecting demand, and if we were to take account of the price elasticity of demand when we notice prices have gone up 30 percent, we must be able around this table, with the back of an envelope, to produce a surplus."

There is, however, a serious regional problem. New England is a very heavy user of residual fuel oil for home heating, industrial use, and power generation. The same is true, to a lesser extent, of the Middle-Atlantic states. Nearly all of New England's residual fuel oil supply has come from foreign sources. The reason for this dependence lies in the past import control program. But the present problem is a serious one. Estimates of the shortfall in petroleum products for the New England region, on a "normal" basis, are very high, and for residual fuel oil they approach 50%. Extensive reallocation will be necessary to meet this shortfall, in addition to restriction of demand in the region. It is not at all clear that government allocation programs are operating successfully to provide the necessary reallocation.

REFINERY CAPACITY AND CRUDE OIL SUPPLIES

Expansions of petroleum refinery capacity within the continental United States reached a postwar peak in the second half of the 1960s. But after an increase of 800,000 barrels per day in 1970, annual increments in capacity fell sharply to a low of 200,000 in 1973. This has aroused much concern and has been one of the reasons behind talk of a "refining shortage." The slowdown in additions to domestic refining capacity was related to a number of factors, such as uncertainty about sources of supply, related to the import control program, and environmental difficulties associated with refinery siting and the location of deep-water ports. Also, the strength of the boom in late 1972 and early 1973 was apparently unanticipated by oil companies that otherwise might have expanded their capacity more rapidly. Yet in a broader sense, it is erroneous to consider domestic refining capacity alone. To an increasing degree, the United States has imported petroleum, both in crude and product form, because domestic production has not risen sufficiently to meet demand. As the United States has come to rely more and more on imports of oil, it has been found economical to construct refineries outside the continental United States to process much of the imports. The main shift has been toward refineries in the Caribbean, Central and South American region, and also in Europe, and, to a small extent, in the Middle East.

There are many other reasons for this shift of refinery capacity, for production for the American market, away from the continental United States. These include: (1) price controls keeping the U.S. price below the international price for products, (2) the Santa Barbara blowout, (3) overoptimism on the timing of the receipt of Alaskan oil, (4) competition between the oil companies and the utilities for highly skilled construction workers, (5) tax incentives and lack of pollution legislation in the Caribbean (exporting our pollution), and (6) increasing demands by petroleum producing countries for refineries within their borders.

The main point is that if there were no political restrictions of production by the oil exporting nations, we could get the products we need—some of these would be refined abroad, mostly in the Caribbean, Central and South American region, but also in the Eastern hemisphere. It is political decisions that have caused the problems of petroleum supply, and these decisions have resulted in a lack of crude oil, not of refining capacity.

"TAVOULAREAS. If we could refine anywhere in the world—Italy, the Caribbean—there is no problem . . . there's enough refining capacity in the world to meet the world's demand."

Restructions of oil production by governments here and abroad limited supplies of crude petroleum before the actions of the Arab nations in October, 1973. Examples are the limitations in 1973 production rates in Libya to 1.9 million barrels per day, in Nigeria to 2.5 million, and in Kuwait to 3 million. These nations had been expected to increase production substantially last year, but their governments prevented such expansion. In the United States environmental restrictions, particularly on offshore wells and on Alaskan development, have prevented expansion of crude production by more than 3 million barrels per day. Such restrictions were the causes of the supply difficulties in the United States during the first 9 months of 1973. Without governmental restrictions, known reserves of petroleum would be adequate to meet world demand well into the future.

"TAVOULAREAS. Last winter our basic problem was a crude shortage. If we had no restrictions—worldwide restrictions—I'd see no problem into the early 1990s on oil alone, and hopefully we'll find it . . . if we see no governmental restrictions, we have enough oil in the world until then."

PRICE IMPACTS AT HOME AND ABROAD

The rapid increase in fuel prices, particularly of petroleum products, will push up the prices of food stuffs, utility rates, housing, and industrial commodities, among others. And, of course, the rapid increases in gasoline prices have direct impacts on the consumer, as well as on prices of nearly all goods and services. Prices of assets, such as large houses that are costly to heat, large automobiles, and many household appliances, will also be affected, because of the amounts of fuel that are required to use them. The impact of energy problems on the consumer, therefore, will be pervasive and severe, raising daily living expenses while lowering the values of many consumer assets.

The effects will be unevenly felt, however, and there may be solid grounds for some form of reimbursement to those who suffer considerable hardship. One group that should be singled out for particular attention is the poor, who will likely be the hardest-hit—suffering declines in living levels through both lower purchasing power and reduced values of homes and appliances. Remedial action through some form of income subsidy may be both necessary and justified for the poor.

"KENEN. I'm worried about the effects of any very large increase in the cost of fuel on the capital values of all kinds of assets, whether they be secondhand automobiles whose value plummets because they are gas-eating monsters, or whether they be large houses.

"SINGER. I think that the effect of increased fuel cost is going to be found in food, in housing, in heating . . . in everything that affects poor people much more than gasoline. Don't forget there are many poor people who don't drive cars because they are so poor they cannot have a car. Gasoline rationing does not help them."

Internationally, industrial nations may enter a period of intensive rivalry for export markets in order to pay for the increased cost of fuel imports. This may well result in realignment of international exchange rates of many currencies. There are signs that this is already in progress, as with the West German mark and French franc. But the impact of higher fuel prices will be greatest on the less developed countries. In 1974, for example, nations such as Bangladesh may be faced with a choice between importing food or oil. India may have nearly as serious a problem. And many LDC's will face serious problems in importing the goods necessary for their economic development plans. Rising prices of fertilizer, made from petroleum products, and of tractor fuel are just two examples of key items in economic development that will be harder to come by for have-not nations. It is obvious that these nations will suffer the most from the sharp rise in oil prices, now at $10 per barrel compared with $3 a year ago.

"KENEN. What we are going to see is economic rivalry among the developed countries to increase their exports, whether directly to the Arab states, or generally, to third world countries.

"Some of the developing countries this year will face the choice of importing food or importing oil.

"SINGER. The 'green revolution' will come to an end because prices of fertilizers and tractor fuel will go sky-high I don't know what is going to save these countries."

GOVERNMENT POLICIES TO MEET THE SHORT-TERM PROBLEM

Allocation or rationing requires knowledge of the magnitudes of demand, supply, and the difference between them, or shortfall. Adequate information is not available to determine these magnitudes with any precision. And given the strong likelihood that for petroleum products the gap between demand and supply has already been closed, the basis for any allocation scheme, let alone rationing, may have been eliminated.

In view of these considerations, government efforts could be much better directed toward ensuring fairness of allocation by the private sector rather than toward attempting to take over, or intervene in, the allocation process. The market can allocate much more efficiently than the government, but the government has an important role to play in ensuring fairness. There have been many reports of attempts to increase market concentration by driving out independent petroleum product dealers and to concentrate retail outlets. Careful government surveillance of antitrust practices would be very beneficial at the present time.

The ability of the economy to adjust to the problems arising from, and related to, the Arab boycott has been greatly reduced by price controls. It has been obvious for some time that energy prices, and in particular those of petroleum products, must rise in order to bring about adjustments of demand and supply. The government has permitted small price increases in response to these forces, but it is widely anticipated that prices must be further increased in the near future. This upward price creep creates a tremendous incentive to hold back supplies in order to realize larger future gains. And such hoarding accentuates the problem by actually reducing available supplies at present.

While some doubts were raised as to whether a completely uncontrolled market price would be appropriate and fair, it was agreed that current price policies do not lead to appropriate and fair pricing.

The upshot of these considerations is obvious: the government should permit erergy prices to rise and should cease attempts to allocate supplies, but should vigorously investigate and prosecute possible antitrust violations.

"MacAvoy. The process by which (The Federal Energy Office) has allowed these prices to increase—saying, 'I'm going to give you two pennies more now as a retailer but it's going to be another dime in three weeks'—maximizes the hoarding.

"Brannon. Well, doesn't the same kind of effect come in on the tax policies? Since the oil price has gone up quite a bit, this is an excellent time to get rid of percentage depletion. Instead, we come up with this windfall profits thing, which is precisely of this character—if you just keep the oil in the ground a little longer, you won't have to pay it.

"MacAvoy. We have almost complete agreement with a strong consenus all around the table on the dynamics.

"Kenen. That nothing works.

"Singer. If the government wants to get into the business of simulating the free market, you've got to know [the size of the shortfall] quite accurately, which means that you must predict changes in demand and supply. If you don't know these facts, the best thing to do is not try to substitute for the market."

"Kenen. I have no way myself of knowing how true the reports are, but we have seen enough reports of the use of shortages and allocations by wholesalers to drive independents out, to concentrate retail outlets, and things of this nature. I think one of the functions of government in any situation of this kind is a very careful surveillance of antitrust practices . . . to make sure that allocations by the private sector in a time of scarcity by those who have command of the large resources are not used for those purposes."

EXPANSION OF OIL OUTPUT—ITS LONG-RUN IMPLICATIONS AND CONSEQUENCES

The price of oil is now so high relative to the cost of production that there is a tremendous incentive to expand production, both in the U.S. and abroad. Domestically this expansion will begin in the present year, and will accelerate so long as prices stay up. Wells that are not presently operating have become profitable and will be producing soon. Low-output wells will be reconditioned, marginal locations in existing fields will be drilled, secondary and tertiary recovery will rise, etc. Later, offshore production will grow and Alaskan oil will come to market. The potential is enormous, and high prices will bring it forth.

Once oil supplies are expanded both at home and abroad, the present high prices will be untenable. And if high-cost sources of energy are developed in response to the present "crisis" atmosphere, they are likely to prove uneconomic in the future. In such a situation, there would be great pressure to protect high-cost energy industries, emanating from both labor and business. The protection would be directed toward low-cost energy imports, and might easily result in long-run disadvantage to the nation, by placing an enormous burden on the consumer and reducing our ability to compete in world markets.

"Singer. They keep talking about this oil shortage as if this is something that is going to persist. There may be a temporary oil shortage today, but I really believe that there is going to be oil coming out of our ears, not only throughout the world, but in the U.S. in the next 3–5 years.

"Kenen. If you build up an enormously expensive, capital intensive, domestic energy industry, and the international price of energy falls substantially, you have an enormously powerful lobby that will make some of our present industrial lobbies, including the oil lobby, look pretty weak by comparison, demanding intensive protection for the investment in domestic energy production."

[From Business Week, Feb. 2, 1974]

THE NEW SHAPE OF THE U.S. OIL INDUSTRY

The good profit news coming out of the headquarters of U.S. oil companies this week is turning into a monumental problem for oil executives almost as fast as they issue it. Last year's profits for the top 10 companies in the industry were the best in half a decade—up 51.2% over 1972 to a total of $7.8-billion. But the good performance has triggered a massive storm of criticism from consumers and Congress, and the storm is generating demands for stringent legislation to curb the oil companies' operations.

The exhortations for regulation, for tax reform, for splitting up the companies, and even for establishment of a national oil company could not come at a worse time for the oil industry. For oil is already caught up in a violent revolution that is changing not only the way that the companies do business but also the structure of the industry and its economics.

"The Arab oil embargo has produced a revolutionary change," declares Rawleigh Warner, Jr., chairman of Mobil Oil Co. "It is questionable whether we'll get the ever-increasing volume of oil out of the Middle East that we were counting on. And suddenly we're having to pay prices we didn't think we would have to pay until the 1980s."

One conclusion that the public jumped to was that oil's sudden wealth resulted from the Nixon Administration's decision to permit big oil price rises as a way to alleviate fuel shortages. But that accounts for only a small part of oil's huge profits jump in 1973. In fact, the bulk of the rise stemmed from strengthening prices in Europe, where U.S.-based international oil companies have a big share of the market. This was a sudden turn. As recently as 1971 there was an oil glut on the Continent, and over-supply drove prices to profitless levels.

A far smaller part of the profit increase can be traced to the gains that U.S.-based oil companies were able to make, on an accounting basis, for the devaluation of the dollar. Increased profits made in marks in West Germany, for example, were further fattened when they were transferred into dollars, because the value of the mark rose from 31¢ in 1972 to as much as 42¢ last summer. Exxon Corp., for one, estimates that $120-million of its $2.4-billion profit came from this source.

THE CRITICAL PROBLEMS

The swing that took place in Europe last year and helped produce the big jump in profits is only the start of the radical changes in store for U.S. oil producers. These changes look different to different companies, because each company has its own strengths and weaknesses and its own strategy. The major internationals have one set of problems, the domestics have another. Those internationals that have a high percentage of their crude oil coming from the Middle East, such as Gulf Oil Corp. and Standard Oil Co. of California, have a different set of problems from those of Exxon, which gets a far lower percentage of its oil from that area. But there are some critical problems that everyone in the U.S. oil business has to cope with:

Finding huge sums of money needed to explore for new sources of oil, build synthetic oil plants that process shale or tar sands, construct coal gasification and liquefaction plants build new pipelines, and expand refining capacity. The industry figures it needs to raise $800-billion for capital spending from 1970 through 1985, four times its capital outlay during the previous 15 years.

Responding to a dual threat that promises to end the dominance of the U.S.-based majors in the overseas oil business. The oil-producing countries are accelerating the pace at which they are determined to become majority owners of their resources. And the oil-consuming countries, frantic to secure their supplies, are making government-to-government deals with the Arab states, which may undercut the U.S. oil giants' role as suppliers to Europe and Japan.

Warding off punitive legislation in the U.S. that would cut profits, end the depletion allowance, bring oil companies under regulation, split up the major companies, establish a national oil company. Today, the oil industry is facing the greatest threat from Washington since the breakup of the Standard Oil monopoly 63 years ago.

POLISHING A PUBLIC IMAGE

To counter the legislative threats, the oil companies are making adjustments on still another front: their approach to the public and the press. To improve their battered public image they are mounting a massive public relations effort that promises to open up what has been one of the most secretive of all industries. Says J. Kenneth Jamieson, chairman of Exxon: "We are embarking on the oil industry's version of Project Candor."

The first order of business will be to justify the huge increase in 1973 earnings. For 30 oil companies whose performance is charted by the Chase Manhattan Bank, earnings on foreign operations nearly doubled from $3.2-billion in 1972 to an estimated $6.1 billion last year, while domestic oil earnings merely crept up from $3.6-billion to about $4.4 billion.

THE TOP 10 U.S. OIL COMPANIES: THEIR RECORD ON PROFITS AND RATE OF RETURN

	Sales (billions)	In millions			Return on invested capital (percent)
		Net income	Capital expenditures	Invested capital	
1. Exxon:					
1964	$10.8	$1,050.6	$1,046.5	$9,630	12.2
1965	11.5	1,035.7	971.3	10,054	11.5
1966	12.2	1,090.9	1,204.8	10,482	11.6
1967	13.3	1,192.3	1,618.6	11,361	11.9
1968	14.1	1,276.7	1,944.1	12,803	11.8
1969	14.9	1,242.6	1,690.7	13,207	10.9
1970	16.6	1,309.5	1,793.6	14,418	10.8
1971	18.7	1,516.6	1,810.8	15,360	11.5
1972	20.3	1,531.8	1,984.0	16,173	10.9
1973 estimate	[1] 28.5	2,440.0	2,252.0	[2] 17,706	[2] 14.0
2. Mobil:					
1964	4.5	294.2	460.2	3,812	8.3
1965	4.9	320.1	557.3	3,999	8.7
1966	5.3	356.1	682.2	4,147	9.3
1967	5.8	385.4	678.5	4,568	9.4
1968	6.2	430.7	713.2	5,027	9.8
1969	6.6	456.5	800.0	5,274	9.6
1970	7.3	482.7	879.5	5,729	9.5
1971	8.2	540.8	1,037.6	6,183	9.7
1972	9.2	574.2	1,180.0	6,482	9.6
1973 estimate	[1] 12.7	842.8	1,340.0	[2] 6,958	[2] 11.7
3. Texaco:					
1964	3.6	577.4	604.8	4,300	14.4
1965	3.8	636.7	718.9	4,591	14.8
1966	4.4	709.9	737.4	5,265	14.9
1967	5.1	754.4	893.7	5,945	14.2
1968	5.5	835.5	1,065.3	7,358	13.4
1969	5.9	769.8	791.9	7,928	10.9
1970	6.3	822.0	906.1	8,363	10.9
1971	7.5	903.9	1,162.2	9,219	11.0
1972	8.7	889.0	1,192.9	9,798	10.2
1973 estimate	11.8	1,292.4	1,600.0	[2] 10,734	[2] 12.1
4. Gulf:					
1964	3.2	395.1	781.8	4,038	10.5
1965	3.4	427.2	783.5	4,408	10.7
1966	3.8	504.8	1,035.2	4,923	11.5
1967	4.2	568.3	783.0	5,349	11.7
1968	4.6	626.3	1,182.9	6,305	11.3
1969	5.0	610.6	1,551.7	6,786	10.4
1970	5.4	550.0	989.8	7,325	8.9
1971	5.9	561.4	891.0	8,016	8.3
1972	6.2	447.0	959.9	7,738	6.6
1973 estiiate	([3])	775.0	1,632.0	([3])	([3])
5. Standard oil of California:					
1964	2.3	345.3	570.0	3,299	11.1
1965	2.4	391.2	654.0	3,513	11.8
1966	2.7	401.2	557.0	4,029	11.0
1967	3.3	421.7	643.0	4,477	10.4
1968	3.6	451.8	651.0	4,830	10.3
1969	3.8	453.8	775.0	5,143	9.7
1970	4.2	454.8	788.0	5,391	9.2
1971	5.1	511.1	857.0	5.974	9.7
1972	5.8	547.1	789.0	6,253	9.6
1973 estimate	[1] 8.9	843.6	1,200.0	[2] 6,986	[2] 11.4
6. Standard Oil (Indiana):					
1964	2.3	194.8	487.8	2,978	7.3
1965	2.5	219.3	475.5	3,087	7.9
1966	2.7	255.9	569.5	3,364	8.6
1967	2.9	282.3	638.7	3,513	9.0
1968	3.2	309.5	796.9	4,102	9.1
1969	3.5	321.0	857.2	4,334	9.0
1970	3.7	314.0	713.3	4,478	8.5
1971	4.1	341.7	720.4	4,838	8.6
1972	4.5	374.7	940.6	5,138	8.6
1973 estimate	[1] 6.5	511.2	1,000.0	[2] 5,826	[2] 9.5
7. Shell:					
1964	2.3	198.2	432.0	1,880	11.4
1965	2.6	234.0	530.7	2,166	12.2
1966	2.8	255.2	564.0	2,451	11.9
1967	3.1	284.8	618.4	2,786	11.9
1968	3.3	312.1	554.1	3,473	10.9
1969	3.5	291.1	628.8	3,632	9.0
1970	3.6	237.2	634.8	3,854	7.2
1971	3.9	244.5	450.5	3,944	7.3
1972	4.1	260.5	590.9	4,243	7.5
1973 estimate	[1] 5.8	332.7	([3])	[2] 4,342	[2] 8.8

See footnotes at end of table.

THE TOP 10 U.S. OIL COMPANIES: THEIR RECORD ON PROFITS AND RATE OF RETURN—Continued

	Sales (billions)	In millions: Net income	Capital expenditures	Invested capital	Return on invested capital (percent)
8. Continental:					
1964	1.3	100.1	225.0	1,278	9.7
1965	1.4	96.1	199.8	1,356	8.7
1966	1.7	115.6	282.4	1,561	9.2
1967	2.1	136.1	383.5	1,904	9.2
1968	2.3	150.0	389.0	2,025	9.2
1969	2.4	146.4	337.3	2,327	8.4
1970	2.7	160.5	366.2	2,377	8.4
1971	3.1	140.1	387.5	2,425	7.4
1972	3.4	170.2	458.1	2,534	8.4
1973 estimate	(3)	225.0	375.0	(3)	(3)
9. Atlantic Richfield:					
1964	0.6	47.1	(4)	825	6.5
1965	0.7	66.2	(4)	866	8.4
1966	1.1	113.5	(4)	1,370	10.8
1967	1.3	130.0	(4)	1,541	10.0
1968	1.4	148.9	(4)	1,999	9.6
1969	2.7	230.1	418.4	3,324	10.5
1970	2.7	205.6	466.6	3,699	7.0
1971	3.1	210.5	543.9	3,800	6.7
1972	3.3	192.5	363.5	3,777	6.1
1973 estimate	[1] 4.5	270.2	(3)	(3)	(3)
10. Phillips:					
1964	1.3	115.0	195.0	1,607	7.9
1965	1.5	127.7	232.4	1,740	8.3
1966	1.8	138.4	271.1	2,083	8.4
1967	2.0	164.0	279.8	2,269	9.0
1968	2.1	129.9	289.2	2,351	6.9
1969	2.2	127.8	316.6	2,526	6.8
1970	2.3	117.1	239.4	2,433	6.3
1971	2.4	132.3	225.0	2,619	7.0
1972	2.5	148.4	264.7	2,678	7.2
1973 estimate	3.1	230.4	(3)	(3)	(3)

[1] Includes excise taxes and other income.
[2] First 9 months of 1973.
[3] Not available.
[4] Not meaningful.

Note: Sales—Revenues minus other income and consumer excise taxes. Net income—Income after taxes and before extraordinary items. Invested capital—Sum of long-term debt, minority interest, preferred stock, deferred taxes and investment tax credit, and common equity. Return on invested capital—Sum of net income, income of minority interest, and fixed charges (minus tax on fixed charges) divided by average invested capital.

Source: Investors Management Sciences, BW est.

By contrast, this year the companies will get their big profits from the U.S., and this will add to the furor in Congress. The price of domestic oil from established wells has risen in the last year from \$3.50 to \$5.25 a bbl., and the profit on it has jumped from around 75¢ to \$2.25. Oil from newly discovered wells was freed from controls last August, and oil from marginal stripper wells was decontrolled last December. Last month, the price of this oil soared to \$10 a bbl., producing profits as high as \$6.50. With about 30% of U.S. production now free from controls, the average price of domestic oil has reached \$7, twice the average of a year ago. As a result, oilmen say, profits on domestic oil operations could rise be at least one-third..Declares James P. Murphy, president of Houston's Inexco Oil Co.: "The romance of finding great riches has returned to oil."

That is not exactly the way executives of the oil giants view it. They concede that U.S. profits could be up sharply this year. But they see many uncertainties abroad. They say foreign earnings could drop partly because of the strengthening of the dollar. Their margins in Europe may also fall, they say, as governments use price controls to ease the blow of high-priced Middle East crude. "The industry might be doing very well this year to equal its performance of last year," says Harold H. Hammer, senior vice-president of Gulf Oil Corp.

PLENTY OF MONEY TO SPEND

The oilmen staunchly insist on their need for higher profits. The far higher profits that the industry earned last year provided a higher rate of return for most companies than any year since 1968. As a result, the industry's biggest problem of a year ago—raising enough capital to find new supplies of oil and gas—

may well have been solved. Oil executives say that until last year the industry's poor performance was leading it into a period of no growth. From 1968 through 1972, its return on investment dropped steadily from 12.4% to 8.7%, putting it 2.4 percentage points below other manufacturing.

Meanwhile, capital requirements of the business were growing rapidly as oilmen sought to replace dwindling reserves with vastly more expensive oil from the North Sea, the Gulf of Mexico, and Alaska. As a result, the industry's ratio of debt to capital climbed in the last decade from 16% to 24%—close to what many believe is the practical limit for a high-risk industry.

Now that picture has changed, too. Oil returns last year equaled those of other industries. "A year ago we were cutting each other's throats in price wars while crude prices were being held down by cheap foreign oil," saying Harry Bridges, president of Shell Oil Co. "It's incredible that in one year those pressures are turned all the way around. Our financial concerns have evaporated."

Capital problems also may be eased because less capital may be needed. Says oil consultant Richard J. Gonzalez: "All the forecasts about the huge capital needs of the oil industry are worthless now because, at these high prices, we are going to consume a lot less energy, so the financial requirements will not be nearly as great." Gonzalez believes that the growth rate in energy consumption may be cut in half, to 3% a year.

Still, not all oilmen agree that their financial troubles are over. They insist that in the years ahead oil will require much more capital than other industries, so its return must also be better than average—perhaps around 16% instead of 12%. Mobil's Warner argues: "If we're going to do the job, even these [1973's] prices and profits fall short." This kind of talk infuriates the industry's many critics. "Those guys are like horses that don't know how to stop when the race is over," declares Lee C. White, former chairman of the Federal Power Commission.

While oil executives may disagree on the adequacy of returns, they are not hesitating to apply their higher profits to huge increases in their capital budgets. Capital spending by the nation's oil companies is likely to jump 20% this year, and many companies' capital budgets, which include projects that extend over more than one year, are up an estimated 50% from a year ago.

Even more important is the direction that the spending is taking. For years, investment in foreign operations boomed while that in domestic operations stagnated. In the last 10 years, corporate investment in oil abroad rose from \$6-billion to \$16-billion while oil investment in the U.S. edged up only from \$6-billion to \$10-billion. Now the balance has shifted in favor of U.S. projects. "There now is improved financial attraction for us in this country and greater risk outside," says Mobil's Warner. "So the money will begin to flow back here." That is precisely where the Nixon Administration wants it to flow, as a step toward energy self-sufficiency. "The tilt has definitely come back to this side of the Atlantic," says federal energy chief William E. Simon.

RICHER PROSPECTS AT HOME

The shift in spending is encouraged, too, by the domestic oil prospects that higher prices have opened up. There were poor oil prospects at \$3.50 a bbl., but there should be hordes of them at \$10. Says Edward B. Walker, executive-vice president of Gulf: "This could be the biggest boom in oil exploration that this country has seen."

Drilling has already been stepped up. Late last year, the number of rigs in operation in the U.S. rose to more than 1,400—the highest since the mid-1960s. There could be another 25% increase in domestic drilling this year, reversing a 15-year decline that cut by half the number of wells drilled each year. "With these prices," says Shell's Bridges, "everyone is taking risks that three years ago they never would have taken." The revival of drilling also gives new life to domestic independent oil producers, whose numbers have dropped in 20 years from 20,000 to fewer than 8,000. "The Arabs gave us an oil price that our own Congress would never have given, and we're no longer dying on the vine," beams Joseph C. Walter, Jr., president of Houston Oil & Minerals Corp.

Oilmen are also trying to revitalize oil wells because increased production from them can be sold at the \$10 price. By water flooding as a secondary recovery technique, oilmen ordinarily can recover about 34% of the oil in the ground. With chemical treatment, they can boost recovery to 40%, but this expensive tertiary production technique is not economical for \$3.50 oil. With \$10 oil, it is. Shell, Gulf, and many others are rapidly stepping up tertiary recovery. The potential gain is enormous because an increase of six percentage points in oil recovery would produce an additional 25-billion bbl., roughly 70% of the nation's current reserves.

Still, most oilmen insist that President Nixon's 1980 target for U.S. self-sufficiency in fuel is completely unrealistic. They say 1985 is more likely, and some question even that. "I don't think we'll ever be independent in oil supplies," says Exxon's Jamieson. "And the time lag in shifting to new oil sources, such as shale, is inherently there. Even at these prices there isn't much you can do to speed it up." Jamieson says that the first oil from shale plants will not flow until around 1980 and that to rely on them for a significant part of the nation's energy needs would require massive investments in time and money. Just to make up 10% of the nation's oil production by utilizing shale, he says, would require setting up a mining operation as large as that of the present U.S. coal industry.

TROUBLES MULTIPLY ABROAD

While the prospects for domestic oil brighten, it is hard to imagine how the outlook for the majors' foreign operations could be more threatening. Last month, the Organization of Petroleum Exporting Countries raised the f.o.b. cost of oil to $7 a bbl. That is more than twice the $3.05 price in October, and more than four times the price of a year ago. Moreover, OPEC is giving clear signs that it will not increase oil shipments as fast as the concession-holders would like. The majors had hoped to double production to 45-million bbl. a day by 1985, but that goal now apparently is out of the question.

Even more uncertain is how Europe and Japan are going to pay for their oil. Total payments to OPEC countries for oil could hit $90-billion a year, compared with the $25-billion projected before the two latest price increases.

This quick turn of events puts the majors' foreign earnings in serious jeopardy. Last year, the companies' profits on Eastern Hemisphere operations were roughly double the depressed 27¢ per bbl. they got in 1972. But these profits could drop this year. The majors will not find it easy to pass along the $3.95 cost increase when they sell the refined products from Middle East crude to European countries, many of which have price controls. "There's a serious question whether we'll be able to maintain our margins on that oil and also whether Europe will continue to buy as much," says Bob R. Dorsey, Gulf's chairman. "These prices could put Japan and Europe into a tailspin, so how can we say we're going to invest more money over there under these conditions?"

Dorsey believes that the new Arab prices also threaten the profits that the majors had expected to get from foreign oil production outside the OPEC countries. Oil-importing nations are making such big payments for Arab oil that they are not likely to permit companies to make bit profits on oil discovered in areas that they control. They will levy high taxes on the oil, just as the Arabs do. Dorsey expects that oil from the North Sea and other non-OPEC areas soon will be hit by such high local taxes that profits will be cut to the same low levels as those on Middle East crude. "That's why the only safe and profitable place to invest in oil is in the U.S.," he says.

An even greater threat to the U.S. international oil giants is the possible loss of their dominant role as suppliers of oil to Europe and Japan. To begin with, they face the prospect that OPEC will claim a bigger share of the oil production for itself. More than a year ago, some OPEC countries negotiated a minimum of 25% participation with the oil companies, to rise to 51% by 1982. But already a few have nationalized a bigger portion; the largest oil producer, Saudi Arabia, is demanding equity control of more than 50%.

While the oil companies have arrangements to buy back the equity oil from the Arabs, OPEC increasingly is selling it directly to the consuming nations, cutting the majors out of the deal. By selling directly, the Arabs can claim the oil companies' brokerage profits. And the consuming countries can buy oil in exchange for goods and services to the Arabs, reducing the drain on their treasuries.

The deals already made are only the beginning. Britain, for example, hopes to obtain 1-million bbl. of oil a day, half its consumption, through deals with Iran, Saudi Arabia, Kuwait, and others. Last week it signed the first of these deals, a $242-million barter with Iran under which it will get 100,000 bbl. of oil a day in exchange for British products.

This pattern, Jamieson warns, "could create chaos because the Arabs can play one country against another and drive the price up even more." But despite such warnings and despite a meeting of oil-consuming nations planned in Washington next week, most European oil experts expect the deals to continue. In fact, they say that the consuming countries will ultimately take over from the oil companies as the direct contact with OPEC, leaving the oil giants in the role of hired agents to produce oil for OPEC and to ship and refine the oil for the consuming countries.

CUT OUT OF A BUSINESS

Initially, the trend threatens to push the oil companies out of wholesaling crude between the Middle East and the state-owned oil companies, independent refiners, and other bulk purchasers. This business accounts for about 20% of the oil that the companies take out of the Middle East; they feed the other 80% into their own refineries abroad. "Wholesaling of Middle East oil is a role we'll no longer play," Mobil's Warner admits. "The producing countries will move into that market."

Still, the majors control about half the refineries in Europe, and they hope to use this trump card to retain their strong marketing position there even if direct deals between governments grow. "The majors still have big transportation and refining systems in Europe," says Jamieson. "For the consuming countries to shut them down and replace them with higher-cost facilities wouldn't make economic sense." Now that the Arabs are grabbing more of the oil companies' profits on crude, the companies will be looking to those big refineries for more of their foreign profits.

"For a long time," says Warner, "our foreign profits were on crude oil because our taxes in the Middle East were so low. Now those profits are going to have to shift downstream for the simple reason that the Middle East governments now control prices and our profits on crude."

AN EXCESS PROFITS TAX?

Just as foreign governments may put a rein on U.S. oil companies' profits abroad, so may Congress stand in the way of the majors' attempts to capitalize on their new domestic opportunities. Congress has become a hotbed of oil critics, each of them with a proposal to curb the power and profits of the oil companies.

The mood plainly frightens oil executives. "No other industry has served this country better," argues C. Howard Hardesty, Jr., executive vice-president of Continental Oil Co., "but in the space of three months everyone has forgotten our record, and people are trying to discard the very foundation of the industry." John Winger, head of Chase Manhattan's energy economics division, says flatly: "There just has never been a greater chance than now of the oil industry in this country being nationalized."

The initial threat from Congress is an added tax on oil company profits. "I'm for reasonable increases in profits for the oil companies," says Senator Walter F. Mondale (D-Minn.), "but they are taking advantage of this shortage, and their profits have gone beyond reasonable incentive." There is now little doubt that an excess profits tax will be passed; the only question is what form it will take.

Oil executives fear most the windfall profits provision included in the Energy Emergency bill that was recommitted to a conference committee by the Senate this week. That provision would hold oil company profits to the average level from 1967 through 1971. Oilmen insist that such a base period is unfair because it includes years in which the industry had some of the lowest returns in its history. "That bill would have clobbered us," says Jamieson.

Oil executives maintain that any excess profits tax that reduces oil company returns below last year's levels will prompt the companies to cut the big capital spending budgets that they have just approved. "If they are going to put the screws to us, the development work we are planning won't be done," fumes Continental's Hardesty. "That's not a threat—it's economic realism."

THE DRAMATIC JUMP IN MIDDLE EAST CRUDE PRICES

Period	Posted price [1]	Arab tax	Total cost (production cost plus tax)
1960-65	$1.80	$0.82	$0.92
1966-67	1.80	.85	.95
1968-69	1.80	.88	.98
Jan. 1 to Nov. 14, 1970	1.80	.91	1.01
Nov. 15, 1970 to Feb. 14, 1971	1.80	.99	1.10
Feb. 15 to May 31, 1971	2.18	1.26	1.37
June 1, 1971 to Jan. 19, 1972	2.28	1.32	1.43
Jan. 20, 1972 to Jan 1, 1973	2.48	1.44	1.55
Jan. 1 to Mar. 31, 1973	2.59	1.51	1.62
Apr. 1 to May 31, 1973	2.75	1.61	1.71
June 1973	2.90	1.70	1.80
July 1973	2.95	1.74	1.84
August 1973	3.07	1.80	1.90
Oct. 1 to Oct. 15, 1973	3.01	1.77	1.87
Oct. 16 to Dec. 31, 1973	5.12	3.05	3.15
Jan. 1, 1974	11.56	7.00	7.10

[1] Posted price is the base on which OPEC countries figure their tax; it bears little relationship to the producers' selling price.

Source: International Crude Oil & Product Prices.

This furor has helped to produce several alternative proposals that would exempt from an excess profits tax any earnings that a company reinvests in producing domestic energy. "I want to be sure that the tax will not limit investment in developing reserves," says Representative Wilbur Mills (D-Ark.), chairman of the House Ways & Means Committee. "If they increase spending, they should avoid the tax." But some critics see a major flaw in this so-called plowback provision. A Congressional aid observes: "It virtually mandates that they spend their profits to avoid the tax, and it could mean plowing money into more corporate jets and other wasteful things."

While many oilmen say they could live with a tax that included a plowback provision, some are still leery of it. Says Maurice F. Granville, chairman of Texaco, Inc.: "We're not naive enough to think that a plowback provision would be flexible enough to allow us to counter the excess profits tax with a reasonable capital investment program." The plowback provision, he says, is sure to be restricted to certain types of investment.

Many oil executives protest that there is no reason for an excess profits tax at all. "Our returns are just pulling even with the rest of American industry," Gulf's Dorsey argues. "If that's an excess profit, I'll eat my hat."

ROUGHER TAX TREATMENT?

There is also mounting pressure in Congress to grasp this moment to make broad-based reforms in the tax treatment of oil, the least taxed of all industries. Senator Henry Jackson (D-Wash.) has in mind a major reform package that would deal with oil's three major tax breaks: deduction of drilling costs, the foreign tax credit, and the 22% depletion allowance. Some argue that, rather than imposing an excess profits tax, depletion and drilling deductions should be dropped entirely. These tax breaks, they say, are no longer needed as an incentive for drilling.

Indeed, the industry's own attachment to the depletion allowance may be weakening. Last December, Thornton F. Bradshaw, president of Atlantic Richfield Co., recommended that the allowance be scrapped in exchange for free-market pricing. "It's an albatross around our neck, and far more trouble than it's worth," Bradshaw said. Critics retort that this is hardly a concession, because free-market oil prices would be high enough to more than compensate oilmen for the 50¢ a bbl. that the depletion allowance is worth to them.

Some independent oilmen, however, were furious at Bradshaw for making the proposal. Unlike major oil companies, the independents attract much of their drilling capital from wealthy outside investors. Without the quick depletion write-off, they say, much of that money would dry up. "A higher price for crude oil doesn't shelter an outside investor who is taking a flier in oil to get a tax write-off," declares Houston independent George Mitchell. And elimination of the

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drilling deduction, he claims, would lead independents to cancel at least half of their drilling plans for this year.

Also under attack is the foreign tax credit under which U.S. taxes due on foreign earnings can be offset by tax payments to OPEC countries for crude oil. All industries receive credits for taxes paid abroad, but critics argue that, with tax payments to OPEC running four times what they were last year, the tax credit will more than wipe out oil's U.S. tax liability on foreign income.

The industry's response to such reform proposals has a common theme. "If they take away a tax benefit and decrease our profits, then we can't raise enough capital," declares Exxon's Jamieson. "Do they want an oil industry that is profitable enough to do the job, or not?"

SURELY MORE REGULATION

Already, in the present oil shortage, the federal government is advising refineries what products to make. And it is possible that when the shortage eases, the oil companies will face even more government regulation.

For openers, Jackson last week proposed a rollback in the soaring prices of domestic crude oil. Suprisingly, some oilmen are talking about the need for controls to keep oil prices from going too high. "For us to stand on our soapbox and talk about going back to free market," Shell's Bridges concedes, "would be political suicide—the surest way to be nationalized."

Increased regulation will probably also force oil companies to provide the government with much more information about their operations. That process has already begun. A dozen Congressional committees are investigating the industry, including Jackson's permanent investigations subcommittee. Last week's fiery session was only the beginning of much deeper probe that committee staffers hope will rival some of the committee's hearings on labor racketeering. To some oilmen, the accusatory manner of questioning last week bore a resemblance to the rackets hearings. "For God's sake," cries Mobil's Warner, "we're being treated like criminals."

The committee investigations will probably lead to more formal reporting systems. Jackson and Senator Gaylord Nelson (D-Wis.) are co-authors of a bill calling for creation of a Bureau of Energy Information, which would collect and verify the profits, costs, reserves, production figures, and inventories of energy companies.

Some congressmen are even demanding that oil be regulated much like a utility. Under a major bill to be introduced by Jackson soon, all large oil companies would be chartered by a federal agency. This body would not regulate prices but would prescribe certain principles of operation, put one public member on the board of each company, and possibly require prior clearance of major oil company actions, such as acquisitions and any withdrawal from markets. Jamieson says of the bill: "It would produce a rigid system of operation in our business and eliminate the benefit of individual companies testing different ideas."

The most extreme Congressional threats to oil are the measures designed to make the industry more competitive by changing its structure. Only a few months ago, oil executives believed such action was very remote, but the anti-oil mood in Congress has them taking the proposals seriously now. According to the critics, total integration of the major oil companies—their involvement in crude oil production, pipelines, refining, and marketing—has produced an anti-competitive structure. Critics point to product exchange agreements and joint exploration efforts as anti-competitive practices, and they charge that the majors have the power to set artificially high prices on crude oil, where their control is greatest. That allows them, the argument goes, to take most of their profits in that segment of the business while maintaining very low margins in refining and marketing to restrain competition there.

Some members of Congress put enough stock in such charges to push harder for bills that would promote competition in the oil industry. One such bill, sponsored by Senator Adlai E. Stevenson III (D-Ill.), would set up a federal oil and gas corporation that would get free leases to explore federal acreage that had the best prospects. The oil that it produced would go to independent refiners, few of which have their own sources of crude. Says Stevenson: "Most of our oil—about 70%—is located under public lands, and I want to see it developed to benefit the public, not just the oil industry."

Stevenson believes that in the angry mood of Congress his bill's chances have gone from zero to very good in the last few months. Says he: "If the oil industry had any sense, it would support the bill—and head off utility regulation." But the industry is not about to take that kind of advice. Oilmen argue that a federal oil company would be inefficient and would be guided by political consideration. Says Continental's Hardesty: "Unmask the idea for what it is—the first step toward nationalization of oil."

BREAKING UP THE MAJORS

Meanwhile, a far more serious threat is taking shape: a plan to break the majors up into separate producing, refining, transporting, and marketing companies. Already the states of Florida and Connecticut have filed antitrust suits against the majors, charging that they used their control over all segments of the business to squeeze out the independents. The two states seek court orders breaking up the giants. Colorado, Minnesota, and several others are considering similar suits. And last summer the Federal Trade Commission brought suit against eight majors, making much the same charges; FTC staffers suggest one objective is to seek some form of divestiture.

Antitrust law holds a precedent for such a move: the antitrust cases of 1948 that split apart the production and distribution segments of the movie industry. But litigation of this issue could take upward of seven years, and many in Congress are seeking faster action against the oil majors. Four different bills have been introduced that call for the oil giants to divest themselves of one or more parts of their business in order to stimulate more competition in the oil industry.

"If you broke the majors into separate segments, it would introduce an arm's-length bargaining between different levels that does not exist at the present time," says Charles Bangert, general counsel of the Senate antitrust and monopoly subcommittee. "There would be competitive bidding for crude oil by refiners, and for refined products by marketers."

"Right now," he adds, "people are so mad at the oil companies that the chances of such divorcement legislation are pretty good."

To fend off such legislative challenges, the oil companies are working fast to improve what has overnight become the worst image in American business. A Gallup poll taken last month indicated that more Americans (25% of the sample) blame the oil companies for the shortages than any other possible cause, including the Arabs.

In dealing with their image problem, the companies are having second thoughts about the industry's deep-rooted secrecy. Oilmen in the past may have talked freely to an uncritical trade press, but they seldom were willing to discuss their business with the general press and the public.

"We became members of an introspective group and talked only to each other," confesses Murphy of Inexco Oil. "We made the serious mistake of agreeing that the real villains had to be guys like Senator Proxmire and that if he and others would not appreciate the great job we were doing, then to hell with them."

A public-be-damned attitude was fostered by the industry's close ties with such one-time powers in Congress as Sam Rayburn, Lyndon Johnson, and Robert Kerr, all from oil-producing states. "We were lulled into a false security in those days," Continental's Hardesty explains, "because we knew that the leaders in Congress understood our business. We reacted far too slowly when Congress changed and all of a sudden we had to deal with people who didn't understand us." The chairman of another major adds: "Whenever we got into trouble, we always went to Sam and Lyndon to get us out. We never prepared for the day when the liberals would be in charge in Congress. That day has come."

WOOING PUBLIC OPINION

Ironically, despite the charge of conspiratorial togetherness, one of the industry's big public-image problems has been its internal divisiveness. Oilmen lately have not only debated such things as Arco's stand on depletion allowances but have also sharply disagreed on the wisdom of making unleaded gasoline and the merits of trying to make the U.S. self-sufficient in energy. And because their companies have different status in oil reserves, they have argued the relative merits of coal gasification, importing LNG, and developing oil shale. "We have a wide divergence of views and lack a common voice," says Jamieson. "It confuses Congress and the public about what we want."

Today, the industry can no longer be accused of being secretive. For the first time ever, the majors are revealing inventory statistics that once were guarded as competitive secrets. Last week they held press conferences for the first time to explain their earnings. In fact, much of an oil executive's time these days is spent in interviews with the media.

Oilmen are now convinced that, more than ever, they must win the public's favor. Energy shortages have a major impact on the lives of people, and it is already clear that how Congress handles the industry depends on the views of the constituents back home. If oil is to retain its big profits and avert government interference with its effort to cash in on new opportunities, it must first convince people that today's shortages are real and not contrived. Then it must show that the way to solve the shortages is to protect the incentives that have now developed. Even this year's profit increase, they must show, is a better price to pay than the alternative cost of a long-range energy drought.

Comments of American Textile Manufacturers Institute, Inc., on S. 2806 and S. 2589 and Tax Incentives for Energy Conservation

The American Textile Manufacturers Institute, Inc. (ATMI) has been aware of the growing shortage of energy sources in the world and the urgent need for American industry to drastically reduce its energy consumption. Accordingly, ATMI on November 2 adopted a resolution recommending enactment of Federal income tax incentives for industrial expenditures for energy conservation.

Recently numerous proposals have been the subject of consideration dealing with the use of the tax system to promote energy conservation and exploration for new energy sources. For the most part, these proposals would entail the imposition of excise taxes on the use of certain fuels, machinery and equipment and an excess profits tax on certain energy producers.

ATMI is mindful of the result which can probably be obtained through the use of the tax system to make inefficient energy consumption uneconomical for American industry. Nevertheless, ATMI is of the view that energy conservation can also be stimulated dramatically and much more fairly through the use of positive tax incentives to promote the acquisition of energy-conserving machinery and to promote efforts to upgrade existing plants and equipment in order to avoid the wasting of energy.

Accordingly, is Accordingly, it is proposed that S. 2806 and S. 2589 be amended to provide for investment credit and a two-year amortization with respect to the cost of certain energy-conserving expenditures. Such expenditures might include additional insulation of plants and equipment, conversion of plants and equipment to energy sources which are not in short supply, and the acquisition of equipment which would recycle energy for reuse and simultaneously avoid environmental pollution through discharge of hazardous wastes. The expenditures would be required to be certified by an appropriate Federal agency as meeting certain standards for energy conservation.

Although ATMI's experience is limited to the textile industry, the possibilities for energy conservation in this industry probably represent a reasonable cross-section of American business. In the textile industry alone, substantial energy savings could be obtained by expenditures for better insulation, for purification and recirculation of hot air, and for heat transfer units to use exhaust hot water and gases to partially heat incoming cold water. In like fashion, it may be possible to reduce significantly the burning of natural gas and propane in finishing and dying plants by conversion to steam radiators which, in turn, will be heated by boilers fueled by coal or $6 fuel oil. One can well imagine the enormous potential for energy conservation if these illustrations are expanded to include the entire range of American commerce.

Under current law, some of the foregoing expenditures might be treated as additions to real property for which no investment credit would be available. Furthermore, many of the expenditures would be required to be capitalized and depreciated over extended periods of time. For the most part, the expenditures would be too large for companies to undertake economically without some form of tax incentive.

This problem is substantially aggravated by the present ADR rules applicable to buildings and other Sec. 1250 property. If an expenditure in 1974 is capitalized as a building component, the write-off period under ADR may be as long as 45 years in the absence of the long awaited promulgation of new lives for buildings by the IRS. Further, under the ADR rules, in many cases a taxpayer will not get a loss deduction for the old building component which has to be replaced to effect energy conservation; instead the taxpayer will have to continue to depreciate the cost of the replaced component over its original class life, despite the fact that it is no longer in service.

In this respect, ATMI believes that the foregoing types of commercial energy conservation expenditures are particularly deserving of special tax treatment. Commercial energy conservation and conversion expenditures will generally not increase productive output, and in many cases will give rise to a reduction in productivity. Moreover, expenditures for plant and equipment conversions to more plentiful fuels will not necessarily result in cost savings for fuels. This is particularly true where the use of such fuels would have adverse environmental effects, thereby necessitating greater expenditures for pollution control.

Based on these considerations, enactment of a special investment credit and two-year amortization provision for the cost of qualified energy-conserving expenditures would appear fully justified. It is recommended that the proposed change in the tax laws be made applicable to all qualified expenditures incurred subsequent to December 31, 1973, in order to provide an immediate stimulus to energy conservation.

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APPENDIX B

Oil Company Profitability—Data Compiled by the Staff of the Senate Committee on Finance, February 12, 1974

Preface

The Federal Government turns out a vast array of corporate profits statistics. The Internal Revenue Service, the Office of Business Economics in the Commerce Department, the Securities and Exchange Commission, and the Federal Trade Commission, all publish profitability data of varying timeliness and comprehensiveness. Nevertheless gaps exist and the data must be interpreted with caution.

The First National City Bank has been publishing annual and quarterly reports on corporate profits for major industries, together with rates of return on net worth for over 40 years. Since banking institutions must use "profitability" as a key test for the extension of credit it is natural for a bank to collect and publish such statements. The First National City Bank data are widely used indicators of comparative performance.

The data compiled in the tables that follow were all derived from public sources—the Department of Commerce, the Federal Trade Commission, the Securities and Exchange Commission and the First National City Bank of New York.

No attempt was made to interpret or analyze the data in these tables. The staff attempted to obtain a broad range of profit comparisons over a sufficiently long historical period to enable the Senate and the public to derive their own conclusions on profitability in the oil industry. The data deal with the overall earnings and profits of U.S. corporations. There is no attempt to segregate out the domestic versus the foreign operations of U.S. multinational corporations.

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TABLE 1.—NET INCOME AS A PERCENT OF NET WORTH: PETROLEUM, OTHER SELECTED INDUSTRY GROUPS, TOTAL MANUFACTURING AND TOTAL MINING, 1963 THROUGH 1972

[In percent]

Industrial groups	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972p	10-year average, 1963–72
Drugs and medicines	18.7	19.8	21.2	22.5	20.3	19.8	17.7	18.8	19.0	19.7	19.5
Soap and cosmetics	16.9	17.6	17.0	17.9	19.4	18.9	18.6	18.7	19.3	20.4	18.7
Instruments, photo goods, etc	13.4	16.6	19.2	21.2	20.3	19.2	18.7	15.8	15.4	16.8	17.6
Office equipment and computers	18.0	17.9	18.7	18.1	17.8	19.0	17.4	13.9	12.5	13.8	15.8
Autos and trucks	19.6	19.9	23.4	17.8	12.0	16.6	13.8	5.8	15.0	17.2	15.6
Tobacco products	14.0	13.4	13.3	13.9	14.8	14.6	14.6	16.4	16.6	16.2	14.9
Printing and publishing	12.4	14.6	16.9	17.9	15.4	14.9	14.8	12.5	12.6	13.7	14.3
Household appliances	12.8	14.1	15.0	15.0	14.7	14.0	13.5	11.9	12.1	15.4	13.8
Clothing and appa el	12.0	13.6	16.3	16.2	13.6	15.7	13.3	10.7	10.8	11.1	12.8
Electrical and electronic equipment	10.7	11.1	14.8	16.7	15.4	14.1	13.0	10.1	10.7	13.0	12.7
Dairy products	11.2	12.2	12.5	12.6	11.8	11.7	11.8	12.0	12.6	12.6	12.1
Chemical products	13.2	14.2	15.4	14.6	11.5	11.7	11.4	9.5	9.7	11.3	12.0
Automotive parts	11.4	12.2	13.4	14.0	11.4	12.6	13.0	8.9	10.4	13.1	11.9
Lumber and wood products	8.1	11.5	11.5	11.0	9.4	14.1	15.2	10.2	11.2	13.9	11.9
Petroleum production and refining	*11.5*	*11.5*	*11.9*	*12.6*	*12.8*	*13.1*	*11.9*	*11.0*	*11.2*	*10.8*	*11.8*
Glass products	11.6	12.1	13.5	12.7	11.1	11.9	12.2	9.0	11.1	12.5	11.7
Farm, construction equipment	9.4	13.7	14.4	14.7	10.9	8.4	10.4	9.3	8.8	12.1	11.1
Aerospace	11.7	13.1	15.4	15.7	13.4	13.9	11.4	6.7	6.3	8.8	11.0
Rubber and allied products	9.9	11.4	11.8	12.8	10.8	12.7	11.1	7.6	9.8	11.7	10.9
Nonferrous metals	7.1	9.2	11.8	15.7	11.4	11.1	12.5	10.6	5.0	7.2	10.0
Distilling	7.9	8.5	9.6	10.4	10.5	10.2	10.4	10.1	10.3	10.7	9.9
Building, heating and plumbing equipment	6.4	8.9	10.6	12.0	11.3	11.3	8.5	7.0	8.4	11.6	9.6
Paper and allied products	9.2	10.5	10.5	11.8	9.5	10.7	10.3	7.4	5.6	8.7	9.2
Textile products	7.1	8.9	11.6	12.3	8.8	9.8	8.8	6.4	6.6	7.8	8.7
Iron and steel	7.3	9.0	9.6	9.4	7.4	8.5	7.4	4.6	4.6	6.2	7.3
Total mining	9.1	10.4	12.2	13.9	16.2	15.0	12.6	11.7	8.5	9.6	11.7
Total manufacturing	*11.6*	*12.6*	*13.9*	*14.2*	*12.6*	*13.3*	*12.4*	*10.1*	*10.8*	*12.1*	*12.2*

p: Preliminary.

Source: First National City Bank, monthly letter, April of each year; May 1973.

(1)

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TABLE 2.—NET INCOME AFTER TAXES: PETROLEUM VERSUS TOTAL MANUFACTURING, 1963-72

[Dollar amounts in millions]

Period	Petroleum production and refining		Total manufacturing	
	Total	Percent change	Total	Percent change
1963	$3,967.8		$16,308.3	
1964	4,228.5	+7	18,564.7	+14
1965	4,630.1	+9	22,000.9	+19
1966	5,161.3	+11	24,429.2	+11
1967	5,679.4	+10	23,394.4	−4
1968	6,088.0	+7	26,098.3	+12
1969	6,008.3	−1	26,627.7	+2
1970	5,937.5	−1	23,900.8	−10
1971	6,400.8	+8	26,942.3	+13
1972	6,525.0	+2	31,958.8	+19

Source: First National City Bank, "Monthly Economics Letter," April of each year; revised data except for 1972.

TABLE 3.—AFTER-TAX PROFITS OF LEADING CORPORATIONS FOR THE 4TH QUARTER 1973

Number of firms	Industry groups	4th quarter 1973, net income (millions)	Percent change: 4th quarter 1972 to 4th quarter 1973	Percent change: 3d quarter 1973 to 4th quarter 1973
47	Food products	$265.1	+19	+16
9	Beverages	57.9	+10	+11
2	Tobacco	66.5	+10	−16
22	Textiles	69.0	+36	+18
10	Apparel	3.0	−77	−83
10	Rubber and products	28.6	+25	+26
20	Paper and products	149.9	+38	−1
18	Printing and publishing	34.4	+16	+67
38	Chemicals, paint, etc.	452.3	+36	−2
27	Drugs, soap, and cosmetics	385.5	+10	+3
31	Petroleum production and refining	2,535.2	+61	+22
19	Cement, glass, and stone	65.7	+9	−12
27	Iron and steel	291.8	+48	+12
17	Nonferrous metals	201.8	+77	+46
36	Fabricated metal products	75.3	+29	−20
54	Machinery	179.5	+22	+4
19	Office and computing equipment	574.1	+37	+21
85	Electrical equipment and electronics	412.9	+6	+15
19	Automobiles and parts	581.9	−20	+82
11	Aerospace	84.8	+7	−11
35	Instruments, photographic goods	186.4	+19	+2
47	Other manufacturing	194.8	+21	+6
603	Total manufacturing	6,896.2	+29	+17

TABLE 3.—AFTER-TAX PROFITS OF LEADING CORPORATIONS FOR THE 4TH QUARTER 1973—Continued

Number of firms	Industry groups	4th quarter 1973, net income (millions)	Percent change: 4th quarter 1972 to 4th quarter 1973	Percent change: 3d quarter 1973 to 4th quarter 1973
7	Mining and quarrying...	$61.3	+180	+28
89	Trade..................	164.9	+31	+45
94	Services and amusements.................	121.0	+21	+12
12	Railroads...............	189.3	+19	+45
11	Common carrier trucking....................	53.7	+12	+52
11	Air and other transportation................	13.5	–60	–87
67	Electric power and gas..	722.2	+10	–8
2	Telephone and telegraph.................	752.5	+12	0
58	Commercial bank holding companies........	658.8	+15	+16
351	Total nonmanufacturing.................	2,737.1	+14	+7
954	Grand total............	9,633.3	+25	+13
	Excluding petroleum production and refining:			
572	Manufacturing excluding petroleum.	4,361.0	+16	+14
923	Total excluding petroleum...........	7,098.1	+15	+10

Source: Preliminary tabulation by First National City Bank.

TABLE 4.—RETURN ON NET ASSETS OF LEADING UNITED STATES CORPORATIONS—PETROLEUM VERSUS OTHER MANUFACTURING 1937–72

	Number of companies	Net income after taxes (thousands)	Book net assets Jan. 1 (thousands)	Percent return on net assets
1972: Larger producing companies	6	$159,994	$843,831	19.0
Other producing and related companies	68	281,244	2,125,049	13.2
Refining and integrated companies	34	6,083,760	57,263,293	10.6
Total	108	6,524,998	60,232,173	10.8
Manufacturing—Excluding petroleum	2,306	25,433,800	204,184,300	12.5
1971: Larger producing companies	6	144,021	810,954	17.8
Other producing and related companies	57	243,491	1,976,864	12.3
Refining and integrated companies	33	6,031,709	54,291,521	11.1
Total	96	6,419,221	57,079,339	11.2
Manufacturing—Excluding petroleum	2,223	20,552,051	191,504,378	10.7
1970: Larger producing companies	5	123,578	649,920	19.0
Other producing and related companies	55	174,439	1,606,360	10.9
Refining and integrated companies	37	5,593,785	51,621,107	10.8
Total	97	5,891,802	53,877,387	10.9
Manufacturing—Excluding petroleum	2,031	17,435,300	177,568,100	9.8

TABLE 4.—RETURN ON NET ASSETS OF LEADING UNITED STATES CORPORATIONS—PETROLEUM VERSUS OTHER MANUFACTURING 1937-72—Continued

	Number of companies	Net income after taxes (thousands)	Book net assets Jan. 1 (thousands)	Percent return on net assets
1969: Oil and gas producing	53	343,438	2,313,567	14.8
Integrated operations	38	5,743,405	47,832,824	12.0
Total	91	6,086,843	50,146,391	12.1
Manufacturing—Excluding petroleum	1,977	20,563,100	162,646,500	12.6
1968: Oil and gas producing	61	369,923	2,310,281	16.0
Integrated operations	38	5,757,891	45,233,757	12.7
Total	99	6,127,814	47,544,038	12.9
Manufacturing—Excluding petroleum	2,151	19,938,800	151,186,000	13.2
1967: Oil and gas producing	65	327,380	2,054,730	15.9
Integrated operations	42	5,368,379	42,156,722	12.7
Total	107	5,695,759	44,211,452	12.9
Manufacturing—Excluding petroleum	2,185	17,611,700	142,168,400	12.4
1966: Oil and gas producing	61	291,379	1,914,132	15.2
Integrated operations	45	4,883,249	39,139,696	12.5
Total	106	5,174,628	41,053,828	12.6

Manufacturing—Excluding petroleum	2,173	18,899,400	129,351,600	14.6
1965: Oil and gas producing	62	268,350	1,810,700	14.8
Integrated operations	47	4,369,179	37,000,552	11.8
Total	109	4,637,529	38,811,252	11.9
Manufacturing—Excluding petroleum	2,189	17,115,700	118,374,600	14.5
1964: Oil and gas producing	73	254,021	1,568,754	16.2
Integrated operations	49	3,985,479	35,015,397	11.4
Total	122	4,239,500	36,584,151	11.6
Manufacturing—Excluding petroleum	2,206	14,534,800	111,800,500	13.0
1963: Oil and gas producing	69	177,314	1,345,960	13.2
Integrated operations	46	3,742,867	33,065,503	11.3
Total	115	3,920,181	34,411,463	11.4
Manufacturing—Excluding petroleum	2,165	12,340,600	107,510,300	11.5
1962: Oil and gas producing	80	208,655	1,694,774	12.3
Integrated operations	42	3,089,821	29,648,615	10.4
Total	122	3,298,476	31,343,389	10.5
1961: Oil and gas producing	80	206,567	1,628,910	12.7
Integrated operations	44	3,018,597	29,386,129	10.3
Total	124	3,225,164	31,015,039	10.4

TABLE 4.—RETURN ON NET ASSETS OF LEADING UNITED STATES CORPORATIONS—PETROLEUM VERSUS OTHER MANUFACTURING 1937-72—Continued

	Number of companies	Net income after taxes (thousands)	Book net assets Jan. 1 (thousands)	Percent return on net assets
1960: Oil and gas producing	82	189,291	1,616,186	11.7
Integrated operations	43	2,834,818	28,016,654	10.1
Total	125	3,024,109	29,632,840	10.2
1959: Oil and gas producing	88	192,377	1,571,018	12.2
Integrated operations	43	2,621,957	26,564,949	9.9
Total	131	2,814,334	28,135,967	10.0
1958: Oil and gas producing	76	199,991	1,688,244	11.8
Integrated operations	45	2,397,492	23,711,808	10.1
Total	121	2,597,483	25,400,052	10.2
1957: Oil and gas producing	71	219,290	1,331,796	16.5
Integrated operations	45	3,020,272	22,480,202	13.4
Total	116	3,239,562	23,811,998	13.6
1956: Oil and gas producing	58	182,433	1,138,438	16.0
Integrated operations	43	2,962,389	20,313,065	14.6
Total	101	3,144,822	21,451,503	14.7
1955: Oil and gas producing	50	148,611	916,241	16.2
Integrated operations	42	2,621,941	18,572,736	14.1
Total	92	2,770,552	19,488,977	14.2

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1954: Oil and gas producing	51	190,100	1,243,333	15.3
Integrated operations	43	2,266,133	16,487,795	13.7
Total	94	2,456,233	17,731,128	13.9
1953: Oil and gas producing	52	174,262	1,060,744	16.4
Integrated operations	43	2,187,878	15,341,547	14.3
Total	95	2,362,140	16,402,291	14.4
1952: Oil and gas producing	48	155,698	955,853	16.3
Integrated operations	43	2,016,707	14,043,139	14.4
Total	91	2,172,405	14,998,992	14.5
1951: Oil and gas producing	46	159,157	816,997	19.5
Integrated operations	45	2,102,871	12,715,442	16.5
Total	91	2,262,028	13,532,439	16.7
1950: Oil and gas producing	36	[1] 110,004	600,527	18.3
Integrated operations	45	1,730,484	11,618,635	14.9
Total	81	1,840,488	12,219,162	15.1
1949: Oil and gas producing	40	[1] 107,888	496,154	21.7
Integrated operations	44	1,420,689	10,761,367	13.2
Total	84	1,528,577	11,257,521	13.6

See footnotes at end of table.

TABLE 4.—RETURN ON NET ASSETS OF LEADING UNITED STATES CORPORATIONS—PETROLEUM VERSUS OTHER MANUFACTURING 1937-72—Continued

	Number of companies	Net income after taxes (thousands)	Book net assets Jan. 1 (thousands)	Percent return on net assets
1948: Oil and gas producing	44	[1] 143,751	400,051	35.9
Integrated operations	44	1,954,277	8,844,742	22.1
Total	88	2,098,028	9,244,793	22.7
1947: Oil and gas producing	41	[1] 69,983	351,980	19.9
Integrated operations	40	1,215,947	7,712,538	15.8
Total	81	1,285,930	8,064,518	15.9
1946: Oil and gas producing	44	[1] 36,504	289,089	12.6
Integrated operations	40	760,592	7,092,034	10.7
Total	84	797,096	7,381,123	10.8
1945: Oil and gas producing	40	[1] 35,379	272,110	13.2
Integrated operations	37	447,778	5,322,478	8.4
Total	77	483,157	5,594,588	8.6
1944: Oil and gas producing	43	[1] 30,911	247,882	12.5
Integrated operations	39	624,922	6,443,010	9.7
Total	82	655,833	6,690,892	9.8

1943: Oil and gas producing	40	[1] 24,381	225,774	10.8
Integrated operations	37	289,623	3,650,662	7.9
Total	77	313,004	3,876,436	8.1
1942: Oil and gas producing	46	[1] 24,594	272,682	9.0
Integrated operations	35	258,961	3,693,152	7.0
Total	81	283,555	3,965,834	7.1
1941: Oil and gas producing	44	[1] 22,937	275,537	8.3
Integrated operations	34	462,431	4,655,316	9.9
Total	78	485,368	4,930,853	9.8
1940: Oil and gas producing	42	[1] 12,740	297,823	4.3
Integrated operations	40	251,955	4,689,854	5.4
Total	82	264,695	4,987,677	5.3
1939: Oil and gas producing	41	[1] 13,266	275,636	4.8
Integrated operations	39	222,493	4,126,218	5.4
Total	80	235,759	4,401,854	5.4
1938: Oil and gas producing	46	[1] 15,352	234,745	6.5
Integrated operations	47	250,888	4,972,115	5.0
Total	93	266,240	5,206,860	5.1
1937: Oil and gas producing	46	[1] 20,522	224,228	9.2
Integrated operations	47	471,299	4,695,445	10.0
Total	93	491,821	4,919,673	10.0

[1] Before depletion in some cases.

Source: FNCB—Monthly Economic Letter.

TABLE 5.—AVERAGE ANNUAL RATES OF RETURN—NET INCOME AFTER TAXES AS A PERCENT OF NET WORTH[1] OF LEADING MANUFACTURING CORPORATIONS FOR THE YEARS 1966–72

Industry groups	Number of corporations in 1971–72	1966	1967	1968	1969	1970	1971	1972
Baking	13	13.9	15.7	13.4	7.9	11.0	12.8	[2] 10.4
Dairy products	12	12.6	11.8	11.7	11.8	12.0	12.6	12.6
Meatpacking	38	5.2	9.2	8.3	9.4	6.6	7.7	7.1
Sugar	12	9.1	10.2	9.3	4.6	7.5	10.5	8.8
Other food products	89	13.3	12.3	12.7	12.1	12.8	12.3	13.1
Soft drinks	17	22.0	23.2	22.7	22.5	22.7	23.1	22.4
Brewing	13	13.4	12.2	13.2	13.2	16.0	15.8	14.7
Distilling	10	10.4	10.5	10.2	10.4	10.1	10.3	10.7
Tobacco products	12	13.9	14.8	14.6	14.6	16.4	16.6	16.2
Textile products	82	12.3	8.8	9.8	8.8	6.4	6.6	7.8
Clothing and apparel	108	16.2	13.6	15.7	13.3	10.7	10.8	11.1
Shoes, leather, etc	32	13.5	13.6	15.7	12.4	10.6	11.0	10.6

Rubber and allied products	63	12.8	10.8	12.7	11.1	7.6	9.8	11.7
Lumber and wood products	29	11.0	9.4	14.1	15.2	10.2	11.2	13.9
Furniture and fixtures	41	14.3	11.9	11.3	12.4	8.4	11.9	11.6
Paper and allied products	63	11.8	9.5	[2]10.4	10.3	7.4	5.6	8.7
Printing and publishing	101	17.9	15.4	14.9	14.8	12.5	12.6	13.7
Chemical products	81	14.6	11.5	11.7	11.4	9.5	9.7	11.3
Paint and allied products	24	14.3	11.6	11.5	10.2	6.2	8.1	10.6
Drugs and medicines	42	22.5	20.3	19.8	20.0	18.8	19.0	19.7
Soap, cosmetics	36	17.9	19.4	18.9	18.6	18.7	19.3	20.4
Petroleum production and refining	***108***	***12.6***	***12.8***	***13.1***	***11.9***	***11.0***	***11.2***	***10.8***
Cement	18	7.8	6.5	7.5	7.1	6.1	7.6	8.8
Glass products	14	12.7	11.1	11.9	12.2	9.0	11.1	12.5
Other stone, clay products	43	9.2	7.3	8.9	9.3	7.0	8.7	10.6
Iron and steel	70	9.4	7.4	8.5	7.4	4.6	4.6	6.2
Nonferrous metals	52	15.7	11.4	11.1	12.5	10.6	5.0	7.2
Hardware and tools	36	19.3	17.2	16.7	16.5	12.5	12.5	15.9
Building, heating, plumbing equipment	52	12.0	11.3	11.3	8.5	7.0	8.4	11.6
Other metal products	66	14.1	13.8	13.3	12.5	10.4	8.9	10.2

See footnotes at end of table.

TABLE 5.—AVERAGE ANNUAL RATES OF RETURN—NET INCOME AFTER TAXES AS A PERCENT OF NET WORTH [1] OF LEADING MANUFACTURING CORPORATIONS FOR THE YEARS 1966-72—Continued

Industry groups	Number of corporations in 1971-72	1966	1967	1968	1969	1970	1971	1972
Farm, construction, material-handling equipment	49	14.7	10.9	8.4	10.4	9.3	8.8	12.1
Office equipment, computers	72	18.1	17.8	19.0	17.4	13.9	12.5	13.8
Other machinery	184	16.9	14.7	13.5	12.9	10.5	10.3	10.9
Electrical equipment and electronics	340	16.7	15.4	14.1	13.0	10.1	10.7	13.0
Household appliances	17	15.0	14.7	14.0	13.5	11.9	12.1	15.4
Autos and trucks	12	17.8	12.0	16.6	13.8	5.8	15.0	17.2
Automotive parts	43	14.0	11.4	12.6	13.0	8.9	10.4	13.1
Railway equipment	6	14.2	11.9	8.8	10.9	9.4	8.8	10.0
Aerospace	44	15.7	13.4	13.9	10.3	6.7	6.3	8.8
Instruments, photo goods, etc	148	21.2	20.3	19.2	18.7	15.8	15.4	16.8
Miscellaneous manufacturing	122	12.1	13.2	15.2	12.8	8.5	9.6	13.3
Total, manufacturing	*2,414*	*14.2*	*12.6*	*13.3*	*12.4*	*10.1*	*10.8*	*12.1*

[1] Net worth at the beginning of each year; equivalent to "book net assets" or stockholders' equity.

Source: First National City Bank, Economics Department.

TABLE 6.—AVERAGE ANNUAL RATES OF RETURN—NET INCOME AFTER TAXES AS A PERCENT OF NET WORTH[1] OF LEADING MANUFACTURING CORPORATIONS FOR THE YEARS 1960–65

Industry groups	1960	1961	1962	1963	1964	1965
Baking	11.6	9.7	9.9	11.0	11.3	11.9
Dairy products	11.3	11.0	10.5	11.2	12.2	12.5
Meatpacking	6.4	4.6	5.7	6.1	8.6	5.3
Sugar	6.3	6.6	7.8	9.6	8.1	9.5
Other food products	11.4	12.8	12.5	12.1	11.8	12.6
Soft drinks	16.8	15.6	16.6	17.9	20.1	21.1
Brewing	7.7	9.5	8.9	9.1	10.0	11.1
Distilling	7.4	8.1	7.8	7.9	8.5	9.6
Tobacco products	14.9	14.8	14.2	14.0	13.4	13.3
Textile products	7.9	5.8	7.2	7.1	8.9	11.6
Clothing and apparel	10.2	10.7	12.0	12.0	13.6	16.3
Shoes, leather, etc	8.8	5.4	9.9	8.1	11.0	11.8
Rubber and allied products	10.3	10.2	9.4	9.9	11.4	11.8
Lumber and wood products	7.5	6.6	7.6	8.1	11.5	11.5
Furniture and fixtures	7.9	7.1	7.8	8.1	10.4	13.0
Paper and allied products	9.1	8.1	9.3	9.2	10.5	10.5
Printing and publishing	13.9	11.9	10.5	12.4	14.6	16.9
Chemical products	12.4	11.8	12.3	13.2	14.2	15.4
Paint and allied products	13.0	12.5	11.6	12.0	13.6	14.1
Drugs and medicines	20.4	18.4	17.8	18.7	19.8	21.2

See footnotes at end of table.

TABLE 6.—AVERAGE ANNUAL RATES OF RETURN—NET INCOME AFTER TAXES AS A PERCENT OF NET WORTH [1] OF LEADING MANUFACTURING CORPORATIONS FOR THE YEARS 1960–65—Continued

Industry groups	1960	1961	1962	1963	1964	1965
Soap, cosmetics	16.8	17.2	17.0	16.9	17.6	17.0
Petroleum production and refining	***10.3***	***10.4***	***10.6***	***11.5***	***11.5***	***11.9***
Cement	11.3	11.3	10.2	9.3	9.8	8.8
Glass products	13.4	11.1	11.6	11.6	12.1	13.5
Other stone, clay products	12.1	10.7	9.0	9.1	10.5	9.9
Iron and steel	7.8	6.4	5.4	7.3	9.0	9.6
Nonferrous metals	7.2	6.8	7.1	7.1	9.2	11.8
Hardware and tools	12.0	12.6	14.2	14.6	16.1	17.1
Building, heating, plumbing equipment	5.3	4.6	6.3	6.4	8.9	10.6
Other metal products	6.8	7.3	9.0	9.3	10.4	12.9
Farm, construction, material-handling equipment	5.8	5.8	7.9	9.4	13.7	14.4
Office, computing equipment	14.2	16.1	17.2	18.0	17.9	18.7
Other machinery	9.9	8.9	9.9	9.7	12.3	14.4
Electric equipment and electronics	11.4	10.0	11.3	10.7	11.1	14.8
Household appliances	10.0	9.2	11.5	12.8	14.1	15.0
Autos and trucks	16.9	13.2	19.4	19.6	19.9	23.4
Automotive parts	7.3	6.8	10.2	11.4	12.2	13.4
Railway equipment	7.1	5.1	6.4	7.9	11.2	12.7
Aircraft and space	6.6	4.4	12.9	11.7	13.1	15.4
Instruments, photo goods, etc	12.9	12.4	13.0	13.4	16.6	19.2
Miscellaneous manufacturing	12.4	11.6	11.2	9.5	12.3	13.5
Total, manufacturing	***10.6***	***9.9***	***10.9***	***11.6***	***12.6***	***13.9***

[1] Net worth at the beginning of each year; equivalent to "book net assets" or stockholders' equity.
[2] Corrected.

Note: Industry group titles revised starting in 1960 to conform more closely to the Standard Industrial Classification; figures for most groups still generally comparable with former data. For additional footnotes, see Table 8.

Source: First National City Bank, Economics Department.

TABLE 7.—AVERAGE ANNUAL RATES OF RETURN—NET INCOME AFTER TAXES AS A PERCENT OF NET WORTH [1] OF LEADING MANUFACTURING CORPORATIONS FOR THE YEARS 1953–60

Industry groups	1953	1954	1955	1956	1957	1958	1959	1960
Baking	12.0	11.3	11.9	12.1	12.6	11.5	11.4	11.4
Dairy products	11.0	12.1	12.2	12.4	12.1	11.8	12.0	11.2
Meatpacking	6.7	3.3	6.7	7.7	4.3	4.4	7.8	6.3
Sugar	4.0	4.9	5.5	6.7	8.9	6.1	5.8	5.6
Other food products	10.9	11.3	11.7	11.8	11.3	11.4	11.7	11.4
Soft drinks	12.0	12.5	14.1	13.9	14.2	14.0	15.7	15.6
Brewing	10.3	8.6	6.5	8.1	7.2	7.8	8.6	8.1
Distilling	7.3	6.3	6.4	6.3	7.3	7.0	7.9	7.3
Tobacco products	10.0	10.2	11.7	12.0	12.7	14.6	15.0	14.6
Cotton goods	6.8	3.6						
Silk and rayon	5.5	4.7						
Woolen goods	−4.6	−5.1	7.1	6.6	5.9	4.3	8.0	6.9
Hosiery, knitted goods	6.5	4.2						
Carpets, floor coverings	7.6	6.3						
Other textile products	6.8	4.5						
Clothing and apparel	6.8	5.1	7.0	7.7	6.6	6.0	9.7	10.0
Shoes, leather, etc	10.1	10.1	11.5	10.3	10.8	8.7	11.1	8.9
Tires, rubber products	13.9	12.0	15.1	13.6	12.4	10.5	12.8	10.6
Lumber	10.3	9.7	14.2	13.2	9.1	9.0	11.6	8.0
Furniture, wood products	10.3	10.1	12.6	11.8	10.5	7.4	11.1	7.9

See footnotes at end of table.

TABLE 7.—AVERAGE ANNUAL RATES OF RETURN—NET INCOME AFTER TAXES AS A PERCENT OF NET WORTH[1] OF LEADING MANUFACTURING CORPORATIONS FOR THE YEARS 1953–60—Continued

Industry groups	1953	1954	1955	1956	1957	1958	1959	1960
Paper and allied products	12.1	12.2	13.8	13.8	10.8	9.1	10.5	9.2
Printing and publishing	10.4	10.9	12.9	14.0	14.4	11.4	12.1	12.3
Chemical products	13.3	14.5	17.7	15.6	14.0	11.1	14.4	12.9
Drugs and medicines	13.7	15.8	18.3	22.4	24.0	21.9	21.9	20.0
Soap, cosmetics, etc	12.4	14.6	16.0	16.2	17.8	15.7	16.8	17.0
Paint and varnish	12.6	13.0	16.4	17.5	15.9	12.8	14.8	10.0
Petroleum production and refining	***14.4***	***13.9***	***14.2***	***14.7***	***13.6***	***10.2***	***10.0***	***10.2***
Cement	14.7	18.8	20.3	19.5	15.9	16.0	17.2	11.6
Glass products	14.9	16.3	20.5	16.6	15.3	11.9	16.7	13.5
Other stone, clay products	12.0	13.0	16.4	15.8	13.3	11.6	14.5	12.0
Iron and steel	11.6	9.4	15.2	13.9	13.2	8.2	8.4	7.8
Agricultural implements	8.1	6.9	8.8	8.3	6.9	7.3	10.8	4.2

Building, heating, plumbing equipment	10.5	9.7	11.5	11.2	9.7	7.6	9.2	7.7
Electrical equipment, radio and TV	15.1	15.4	12.8	11.9	13.7	12.2	14.4	11.8
Hardware and tools	9.5	8.2	10.7	12.2	10.4	6.2	8.6	8.2
Household appliances	10.8	9.6	11.6	12.1	10.0	8.6	10.9	10.9
Machinery	13.6	11.6	11.6	14.9	13.4	8.0	9.9	8.8
Office equipment	12.8	15.1	16.9	17.3	17.5	14.1	14.0	14.2
Nonferrous metals	10.8	10.3	16.7	17.8	9.8	6.7	8.2	7.8
Instruments, photo goods, etc	13.5	16.9	17.7	16.4	14.6	12.2	16.4	14.1
Other metal products	11.6	11.0	12.8	12.1	11.1	9.1	11.3	8.7
Automobiles and trucks	18.0	21.1	29.1	15.7	16.4	8.8	17.4	15.8
Automobile parts	13.3	10.4	15.3	13.3	11.9	6.8	12.5	8.7
Railway equipment	9.0	7.3	9.0	9.9	10.2	5.8	7.9	6.8
Aircraft and parts	21.0	27.4	24.7	21.6	20.1	14.5	8.9	6.1
Miscellaneous manufacturing	10.6	12.7	11.8	10.3	9.3	8.7	12.5	9.2
Total, manufacturing	***12.5***	***12.4***	***15.0***	***13.9***	***12.8***	***9.8***	***11.6***	***10.5***

[1] Net worth at the beginning of each year; equivalent to "book net assets" or stockholders' equity.

— Deficit.

TABLE 8.—AVERAGE ANNUAL RATES OF RETURN—NET INCOME AFTER TAXES AS A PERCENT OF NET WORTH [1] OF LEADING MANUFACTURING CORPORATIONS FOR THE YEARS 1945-52

<table>
<tr><th>Industry groups</th><th>1945</th><th>1946</th><th>1947</th><th>1948</th><th>1949</th><th>1950</th><th>1951</th><th>1952</th></tr>
<tr><td>Baking</td><td>10.0</td><td>21.8</td><td>20.2</td><td>21.4</td><td>17.8</td><td>16.1</td><td>12.2</td><td>12.2</td></tr>
<tr><td>Dairy products</td><td>11.7</td><td>18.9</td><td>15.4</td><td>14.0</td><td>15.2</td><td>13.9</td><td>10.8</td><td>10.5</td></tr>
<tr><td>Meatpacking</td><td>5.4</td><td>10.8</td><td>12.0</td><td>7.2</td><td>3.8</td><td>6.4</td><td>5.5</td><td>3.8</td></tr>
<tr><td>Sugar</td><td>7.2</td><td>9.5</td><td>18.6</td><td>12.2</td><td>8.3</td><td>10.8</td><td>12.1</td><td>8.4</td></tr>
<tr><td>Other food products</td><td>11.0</td><td>18.1</td><td>20.9</td><td>17.4</td><td>14.4</td><td>15.5</td><td>11.6</td><td>10.0</td></tr>
<tr><td>Soft drinks</td><td>19.6</td><td>19.5</td><td>22.6</td><td>20.4</td><td>15.7</td><td>15.5</td><td>12.7</td><td>12.2</td></tr>
<tr><td>Brewing</td><td>13.5</td><td>23.4</td><td>25.6</td><td>22.8</td><td>18.8</td><td>14.7</td><td>11.8</td><td>10.4</td></tr>
<tr><td>Distilling</td><td>19.8</td><td>42.1</td><td>26.6</td><td>25.4</td><td>15.4</td><td>17.9</td><td>12.9</td><td>7.8</td></tr>
<tr><td>Tobacco products</td><td>9.2</td><td>11.4</td><td>12.8</td><td>14.3</td><td>14.4</td><td>12.6</td><td>9.8</td><td>9.2</td></tr>
<tr><td>Cotton goods</td><td>7.7</td><td>27.1</td><td>36.1</td><td>31.5</td><td>9.9</td><td>12.7</td><td>12.1</td><td>5.3</td></tr>
<tr><td>Silk and rayon</td><td>7.1</td><td>24.5</td><td>26.1</td><td>30.0</td><td>12.1</td><td>19.7</td><td>11.7</td><td>6.6</td></tr>
<tr><td>Woolen goods</td><td>10.3</td><td>25.2</td><td>21.2</td><td>20.9</td><td>5.0</td><td>8.1</td><td>8.3</td><td>−3.2</td></tr>
<tr><td>Hosiery, knitted goods</td><td>9.9</td><td>28.2</td><td>23.4</td><td>22.3</td><td>11.0</td><td>18.1</td><td>10.1</td><td>5.2</td></tr>
<tr><td>Carpets, floor coverings</td><td rowspan="2">9.3</td><td rowspan="2">20.8</td><td rowspan="2">26.0</td><td rowspan="2">24.7</td><td rowspan="2">10.9</td><td>13.1</td><td>3.5</td><td>6.2</td></tr>
<tr><td>Other textile products</td><td>15.8</td><td>12.0</td><td>5.6</td></tr>
<tr><td>Clothing and apparel</td><td>9.5</td><td>23.3</td><td>20.1</td><td>13.8</td><td>7.8</td><td>10.7</td><td>7.5</td><td>6.2</td></tr>
<tr><td>Leather tanning</td><td>8.0</td><td>10.8</td><td>21.2</td><td>13.6</td><td>3.3</td><td rowspan="2">12.1</td><td rowspan="2">9.6</td><td rowspan="2">8.0</td></tr>
<tr><td>Shoes, leather products</td><td>8.2</td><td>12.7</td><td>16.2</td><td>14.7</td><td>10.2</td></tr>
<tr><td>Tires, rubber products</td><td>10.5</td><td>20.6</td><td>16.1</td><td>14.0</td><td>9.0</td><td>15.7</td><td>16.1</td><td>13.4</td></tr>
<tr><td>Lumber</td><td>9.0</td><td>14.1</td><td>31.9</td><td>29.3</td><td>11.3</td><td>16.2</td><td>15.8</td><td>11.5</td></tr>
<tr><td>Furniture, wood products</td><td>6.1</td><td>10.8</td><td>16.5</td><td>17.9</td><td>11.2</td><td>15.4</td><td>13.9</td><td>11.1</td></tr>
<tr><td>Paper and allied products</td><td>6.8</td><td>14.4</td><td>22.6</td><td>20.4</td><td>12.4</td><td>16.9</td><td>16.1</td><td>12.2</td></tr>
<tr><td>Printing and publishing</td><td>9.3</td><td>17.9</td><td>21.3</td><td>17.4</td><td>11.1</td><td>15.1</td><td>12.3</td><td>11.1</td></tr>
</table>

Chemical products	10.2	14.7	17.2	17.7	16.5	21.3	16.3	13.7
Drugs and medicines }	15.4	23.6	20.6	19.0	16.2	21.9	19.2	14.0
Soap, cosmetics, etc. }						20.9	15.4	12.6
Paint and varnish	7.7	13.8	19.0	14.2	10.3	17.0	13.1	10.7
Petroleum products and refining	***8.4***	***10.7***	***15.8***	***22.1***	***13.2***	***15.2***	***16.7***	***14.5***
Cement	2.5	9.7	12.2	16.6	18.1	18.2	14.1	14.1
Glass products	10.2	14.8	17.4	16.0	18.5	23.6	15.3	14.7
Other stone, clay products	6.2	13.4	17.7	18.9	13.7	18.5	14.7	12.4
Iron and steel	5.0	7.5	11.3	14.0	11.5	15.3	12.3	8.8
Agricultural implements	7.1	5.7	11.1	14.8	15.6	15.6	11.9	10.9
Building, heating, plumbing equipment	8.0	11.4	19.0	21.0	12.7	17.7	13.7	10.8
Electrical equipment, radio and TV	11.9	8.9	19.3	20.5	17.2	23.0	16.8	14.8
Hardware and tools	10.2	14.0	18.9	17.1	9.7	14.7	14.0	10.8
Household appliances	10.2	18.4	34.3	27.8	13.9	22.3	13.0	12.2
Machinery	9.8	11.3	16.8	19.8	12.7	14.1	14.9	14.1
Office equipment	9.6	18.9	27.1	25.6	18.5	19.0	16.9	14.8
Nonferrous metals	5.9	7.1	14.0	14.9	8.2	14.2	13.5	11.5
Other metal products	9.7	9.5	15.4	17.7	10.9	16.2	14.7	11.4
Automobiles and trucks	13.6	6.9	20.8	26.0	30.8	32.3	17.5	18.5
Automobile parts	14.6	8.9	23.5	23.5	18.7	22.7	15.6	13.2
Railway equipment	8.6	9.3	10.5	10.2	7.2	7.3	9.8	8.9
Aircraft and parts	18.4	0.9	−3.7	3.1	8.6	14.1	8.9	17.6
Shipbuilding	19.7	17.4	13.3	11.7	9.0	−1.8	9.6	10.8
Miscellaneous manufacturing	13.2	14.4	16.3	16.3	11.0	15.6	11.9	10.5
Total manufacturing	***9.1***	***12.1***	***17.0***	***18.9***	***13.8***	***17.1***	***14.4***	***12.3***

[1] Net worth at the beginning of each year; equivalent to "book net assets" or stockholders' equity.

Source: First National City Bank, Economics Department.

TABLE 9.—PROFITS AND DIVIDENDS OF MANUFACTURING CORPORATIONS, 1950–73

[In millions of dollars]

Year	Net profit after taxes																Dividends paid, all industries
	Manufacturing corporations, all industries	Food and kindred products	Textile mill products	Lumber and wood products	Paper and allied products	Chemicals and allied products	*Petroleum refining*	Stone, clay, glass	Primary nonferrous metals	Primary iron and steel	Fabricated metal products	Machinery (except electrical)	Electrical machinery	Transportation equipment	Motor vehicles and equipment	All other	
1950	12,864	1,063	610	299	558	1,364	*1,808*	481	500	1,007	594	1,014	668	193	1,515	1,190	5,650
1951	11,869	859	496	299	536	1,080	*2,105*	430	522	690	604	1,104	608	189	939	1,145	5,540
1952	10,714	817	264	218	437	1,018	*2,009*	379	461	687	493	1,044	635	255	953	1,044	5,487
1953	11,340	870	286	178	450	1,053	*2,177*	405	464	912	503	934	681	302	1,010	1,114	5,594
1954	11,232	883	114	156	479	1,199	*2,230*	466	460	728	394	853	684	402	1,097	1,092	5,940
1955	15,099	997	346	280	604	1,665	*2,529*	631	711	1,305	543	1,096	702	426	1,933	1,334	6,812
1956	16,153	1,113	342	226	657	1,779	*2,885*	681	889	1,335	640	1,511	737	464	1,252	1,641	7,357
1957	15,438	1,063	253	121	521	1,792	*2,866*	619	537	1,327	602	1,405	892	503	1,432	1,505	7,563
1958[1]	12,670	1,141	189	153	506	1,646	*2,467*	514	367	884	488	854	888	371	842	1,361	7,383
1959	16,340	1,251	416	268	619	2,141	*2,625*	685	541	1,041	549	1,230	1,205	282	1,670	1,818	7,908

1960..	15,198	1,224	329	105	587	2,011	*2,877*	573	493	945	404	983	1,026	223	1,676	1,741	8,280
1961..	15,311	1,325	280	114	583	2,045	*3,090*	543	488	803	445	1,061	1,024	298	1,488	1,722	8,551
1962..	17,719	1,369	354	163	628	2,239	*3,236*	581	533	720	608	1,308	1,219	442	2,289	2,033	9,281
1963 [1].	19,483	1,449	354	246	634	2,427	*3,831*	593	563	938	668	1,432	1,299	444	2,562	2,041	9;868
1964..	23,211	1,692	507	314	754	2,857	*4,094*	681	758	1,225	842	2,001	1,512	546	2,808	2,617	10,810
1965..	27,521	1,896	694	338	753	3,188	*4,442*	761	970	1,401	1,151	2,499	1,926	721	3,496	3,285	11,979
1966..	30,937	2,102	702	345	911	3,474	*5,055*	799	1,298	1,487	1,395	3,058	2,379	821	3,053	4,058	12,958
1967..	29,008	2,130	540	333	796	3,261	*5,497*	672	1,061	1,165	1,316	2,893	2,297	809	2,356	3,884	13,262
1968..	32,069	2,209	654	635	889	3,525	*5,794*	769	1,149	1,186	1,320	2,947	2,518	1,025	3,222	4,229	14,189
1969..	33,248	2,382	621	640	987	3,591	*5,884*	822	1,414	1,221	1,326	3,138	2,594	945	2,845	4,835	15,058
1970..	28,572	2,549	413	304	719	3,434	*5,893*	627	1,297	692	1,066	2,689	2,349	593	1,424	4,522	15,070
1971..	31,038	2,754	558	603	501	3,780	*5,829*	853	621	748	1,070	2,489	2,563	585	3,097	4,990	15,252
1972..	36,467	3,021	659	1,012	941	4,499	*5,151*	1,060	687	1,022	1,569	3,481	2,999	780	3,639	5,944	16,116
1972 [2].	26,342	2,214	463	778	662	3,342	*3,673*	808	519	695	1,195	2,604	2,043	605	2,524	4,214	11,557
1973 [2].	[3] 35,127	2,659	645	1,387	1,063	4,251	*5,094*	951	905	1,205	1,637	3,668	2,819	702	3,321	4,872	12,516

[1] Beginning with 1963 data, the industry classification is based on the standard enterprise classification; prior thereto it was based on the SIC manual (1958–62 on the 1957 edition; 1957 and earlier years on the 1945 edition). The figures from 1958 forward are therefore not entirely comparable with earlier figures, except in the case of the lumber and wood products industry and the petroleum refining industry.

[2] 3d quarter.

[3] Latest data available for 1973.

Source: Federal Trade and Securities and Exchange Commissions.

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TABLE 10.—INDEX OF PROFITS AND DIVIDENDS OF MANUFACTURING CORPORATIONS, 1950–73

[1950=100]

Year	Net profit after taxes																Dividends paid, all industries
	Manufacturing corporations, all industries	Food and kindred products	Textile mill products	Lumber and wood products	Paper and allied products	Chemical and allied products	*Petroleum refining*	Stone, clay, glass	Primary nonferrous metals	Primary iron and steel	Fabricated metal products	Machinery (except electrical)	Electrical machinery	Transport equipment	Motor vehicle and equipment	All other	
1950	*100.0*	100.0	100.0	100.0	100.0	100.0	*100.0*	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1951	*92.3*	80.8	81.3	100.0	96.1	79.2	*116.4*	89.4	104.4	68.5	101.7	108.9	91.0	97.9	62.0	96.2	98.1
1952	*83.3*	76.9	43.3	72.9	78.3	74.6	*111.1*	78.8	92.2	68.2	83.0	103.0	95.1	132.1	62.9	87.7	97.1
1953	*88.2*	81.8	46.9	59.5	80.6	77.2	*120.4*	84.2	92.8	90.6	84.7	92.1	101.9	156.5	66.7	93.6	99.0
1954	*87.3*	83.1	18.7	52.2	85.8	87.9	*123.3*	96.9	92.0	72.3	66.3	84.1	102.4	208.3	72.4	91.8	105.1
1955	*117.4*	93.8	56.7	93.6	108.2	122.1	*139.9*	131.2	142.2	129.6	91.4	108.1	105.1	220.7	127.6	112.1	120.6
1956	*125.6*	104.7	56.1	75.6	117.7	130.4	*159.6*	141.6	177.8	132.6	107.7	149.0	110.3	240.4	82.6	137.9	130.2

1957	*120.0*	100.0	41.5	40.5	93.4	131.4	*158.5*	128.7	107.4	131.8	101.3	138.6	133.5	260.6	94.5	126.5	133.9
1958	*98.5*	107.3	31.0	51.2	90.7	120.7	*136.4*	106.9	73.4	87.8	82.2	84.2	132.9	192.2	55.6	114.4	130.7
1959	*127.0*	117.7	68.2	89.6	110.9	157.0	*145.2*	142.4	108.2	103.4	92.4	121.3	180.4	146.1	110.2	152.8	140.0
1960	*118.1*	115.1	53.9	35.1	105.2	147.4	*159.1*	119.1	98.6	93.8	68.0	96.9	153.6	115.5	110.6	146.3	146.5
1961	*119.0*	124.6	45.9	38.1	104.5	149.9	*170.9*	112.9	97.6	79.7	74.9	104.6	153.3	154.4	98.2	144.7	151.3
1962	*137.7*	128.8	58.0	54.5	112.5	164.1	*179.0*	120.8	106.6	71.5	102.4	129.9	182.5	229.0	151.1	170.8	164.3
1963	*151.5*	136.3	58.0	82.3	113.6	177.9	*211.9*	123.3	112.6	93.1	112.5	141.2	194.5	230.1	169.1	171.5	174.7
1964	*180.4*	159.2	83.1	105.0	135.1	209.5	*226.4*	141.6	151.6	121.6	141.8	197.3	226.3	282.9	185.3	219.9	191.3
1965	*213.9*	178.4	113.8	113.0	134.9	233.7	*245.7*	158.2	194.0	139.1	193.8	246.4	288.3	373.6	230.8	276.1	212.0
1966	*240.5*	197.7	115.1	115.4	163.3	254.7	*279.6*	166.1	259.6	147.7	234.8	301.6	356.1	425.4	201.5	341.0	229.3
1967	*225.5*	200.4	88.5	111.4	142.7	239.1	*304.0*	139.7	212.0	115.7	221.5	285.3	343.9	419.2	155.5	326.4	234.7
1968	*249.3*	207.8	107.2	212.4	159.3	258.4	*320.5*	159.9	229.8	117.8	222.2	290.6	376.9	531.1	212.7	355.4	251.1
1969	*258.5*	224.1	101.8	214.0	176.9	263.3	*325.4*	170.9	282.8	121.3	223.2	309.5	388.3	489.6	187.8	406.3	266.5
1970	*222.1*	239.8	67.7	101.7	128.9	251.8	*325.9*	130.4	259.4	68.7	179.5	265.2	351.6	307.3	94.0	380.0	266.7
1971	*241.3*	259.1	91.5	201.7	89.8	277.1	*322.4*	177.3	124.2	74.3	180.1	245.5	383.7	303.1	204.4	419.3	269.9
1972	*283.5*	284.2	108.0	338.5	168.6	329.8	*284.9*	220.4	137.4	101.5	264.1	343.3	449.0	404.1	240.2	499.5	285.1

Source: Federal Trade and Securities and Exchange Commissions.

TABLE 11.—NET INCOME OF MAJOR OIL COMPANIES FOR SELECTED PERIODS

[Dollar amounts in millions]

Company	Net income, 9 months 1972	Net income, 9 months 1973	Net income 1960	Net income 1972	Percentage increase over 1972	Average annual percentage increase, 1960 to 1972
Exxon	$1,039.0	$1,656.0	$688.6	$1,531.8	59.4	6.9
Texaco	662.4	838.9	391.8	889.0	26.6	7.0
Mobil	412.7	571.2	182.6	574.2	38.4	10.0
Gulf	106.0	570.0	330.3	197.0	437.8	([1])
Standard Oil of California	401.3	560.5	266.1	547.1	39.7	6.2
Standard Oil (Indiana)	295.3	389.8	144.8	374.7	32.0	8.2
Atlantic Richfield	130.3	178.5	46.6	195.6	37.0	12.7
Phillips Petroleum	110.3	143.7	112.9	148.4	30.3	2.3
Sun Oil Co	108.2	154.9	49.3	154.7	43.2	10.0
Standard Oil of Ohio	40.4	77.8	24.7	57.5	92.6	7.3

Ashland (year)	68.0	85.2	14.9	68.0	25.3	13.5
Murphy Oil Corp	9.3	34.6	5.0	14.3	272.0	9.2
Belco Petroleum Corp	5.5	9.5	[2] 3.7	8.0	72.7	7.3
The Superior Oil Co	4.9	20.4	21.6	5.1	316.3	([3])
Kerr McGee Corp	36.8	44.1	14.1	50.6	19.8	11.2
Crown Central Petroleum Corp	.8	2.8	[4] .8	2.8	250.0	11.0
Petroleum production and refining industry (40 corporations) [5]	3,882.6	5,694.8	46.7			

[1] Gulf had extraordinary loss in 1972. Average annual percentage increase 1960 to 1971 for Gulf is 419 percent.

[2] Belco Petroleum Corp.'s income of +3,700,000 is for the fiscal year ending in 1961. Similarly, the average annual increase is for the period 1961 to 1972.

[3] The Superior Oil Co. had a decrease of 76.4 percent in 1972 over 1960.

[4] Crown Central Petroleum Corp.'s net income of $800,000 is for the fiscal year ending in 1963. Similarly, the average annual percentage increase is for the period 1963 to 1972.

[5] From First National City Bank's sample of 1,551 corporations.

Source: U.S. Department of Commerce.

TABLE 12.—NET INCOME, EARNINGS PER SHARE AND DIVIDENDS PER SHARE OF MAJOR OIL COMPANIES, 1960–73, BY COMPANY

	Net income (millions)	Earnings per share	Dividends per share
Exxon:			
1960	$688.6	$3.18	$2.25
1961	758.1	3.50	2.30
1962	840.9	3.88	2.50
1963	1,019.5	4.74	2.75
1964	1,050.6	4.87	3.00
1965	1,035.7	4.81	3.15
1966	1,090.9	5.06	3.30
1967	1,232.3	5.54	3.45
1968	1,276.7	5.94	3.65
1969	1,047.6	5.78	3.75
1970	1,309.5	5.85	3.75
1971	1,461.6	6.76	3.75
1972	1,531.8	6.83	3.80
1972 (9 months)	1,039.0	4.64	
1973 (9 months)	1,656.0	7.39	
1973	2,440.0	10.89	4.25
Texaco, Inc.:			
1960	391.8	1.59	.71
1961	430.1	1.74	.73
1962	481.7	1.89	.93
1963	545.7	2.15	1.05
1964	577.4	2.19	1.15
1965	636.7	2.36	1.23
1966	709.9	2.62	1.25
1967	754.4	2.79	1.35
1968	835.5	3.08	1.45
1969	769.8	2.83	1.55
1970	822.0	3.02	1.60
1971	903.9	3.32	1.60
1972	889.0	3.27	1.66
1972 (9 months)	662.4	2.29	
1973 (9 months)	838.9	3.09	[1] 1.73
Mobil:			
1960	182.6	1.88	1.00
1961	211.3	2.18	1.13
1962	242.3	2.49	1.18
1963	271.9	2.72	1.30
1964	294.2	2.90	1.40

See footnotes at end of table.

TABLE 12.—NET INCOME, EARNINGS PER SHARE AND DIVIDENDS PER SHARE OF MAJOR OIL COMPANIES, 1960–73, BY COMPANY—Continued

	Net income (millions)	Earnings per share	Dividends per share
Mobile—Continued			
1965	$320.1	$3.16	$1.53
1966	356.1	3.51	1.65
1967	385.4	3.80	1.85
1968	428.2	4.23	2.05
1969	434.5	4.28	2.25
1970	482.7	4.77	2.40
1971	540.8	5.33	2.55
1972	574.2	5.65	2.65
1972 (9 months)	412.7	4.06	
1973 (9 months)	571.2	5.61	[1] 2.80
Standard Oil of California:			
1960	266.1	2.11	1.00
1961	294.4	2.26	1.00
1962	313.8	2.30	1.00
1963	322.1	2.25	1.00
1964	345.3	2.30	1.03
1965	391.2	2.55	1.14
1966	424.0	2.76	1.25
1967	421.7	2.66	1.25
1968	451.8	2.80	1.35
1969	453.8	2.18	1.40
1970	454.8	2.68	1.40
1971	511.1	3.01	1.40
1972	547.1	3.23	1.45
1972 (9 months)	401.3	2.37	
1973 (9 months)	560.5	[2] 3.30	[1] 1.55
Standard Oil Co. (Indiana):			
1960	144.8	2.03	.70
1961	153.8	2.15	.70
1962	162.4	2.27	.90
1963	183.1	2.58	.95
1964	194.9	2.75	1.33
1965	219.3	3.10	1.55
1966	255.9	3.62	1.70
1967	282.2	3.98	1.90
1968	[3] 308.7	4.36	2.10
1969	319.2	4.51	2.30

See footnotes at end of table.

TABLE 12.—NET INCOME, EARNINGS PER SHARE AND DIVIDENDS PER SHARE OF MAJOR OIL COMPANIES, 1960–73, BY COMPANY—Continued

	Net income (millions)	Earnings per share	Dividends per share
Standard Oil Co. (Indiana)—Continued			
1970	$311.4	$4.51	$2.30
1971	340.6	4.94	2.30
1972	374.7	5.37	2.39
1972 (9 months)	295.3	4.24	....
1973 (9 months)	389.8	5.59	[1] 2.58
Atlantic Richfield Co.:			
1960	46.6	5.00	1.00
1961	46.1	4.92	1.10
1962	46.3	4.89	1.20
1963	44.0	4.42	1.20
1964	47.1	4.74	1.20
1965	90.1	5.57	1.25
1966	113.5	2.84	1.35
1967	130.0	3.23	1.48
1968	[4] 148.9	3.69	1.68
1969	227.2	4.41	1.90
1970	209.5	3.70	2.00
1971	198.7	3.73	2.00
1972	195.6	3.31	2.00
1972 (9 months)	130.3	2.30	....
1973 (9 months)	178.5	3.15	[1] 2.00
Gulf Oil Corp.:			
1960	330.3	1.60	.49
1961	338.5	1.61	.54
1962	340.1	1.64	.73
1963	371.4	1.78	.80
1964	395.1	1.91	.85
1965	427.2	2.06	.93
1966	504.8	2.43	1.05
1967	578.3	2.74	1.25
1968	626.3	3.02	1.40
1969	610.6	2.94	1.50
1970	550.4	2.65	1.50
1971	561.4	2.70	1.50
1972	[5] 197.0	.95	1.50
1972 (9 months)	106.0	.51	....
1973 (9 months)	570.0	2.88	[1] 1.50

See footnotes at end of table.

TABLE 12.—NET INCOME, EARNINGS PER SHARE AND DIVIDENDS PER SHARE OF MAJOR OIL COMPANIES, 1960–73, BY COMPANY—Continued

	Net income (millions)	Earnings per share	Dividends per share
Phillips Petroleum Co.:			
1960	$112.9	$1.65	$0.85
1961	113.8	1.66	.85
1962	107.0	1.56	.93
1963	105.5	1.70	.99
1964	115.0	1.72	1.00
1965	127.7	1.92	1.03
1966	151.6	2.18	1.10
1967	164.0	2.38	1.18
1968	[3] 133.8	1.83	1.28
1969	130.1	1.76	1.30
1970	111.2	1.50	1.30
1971	132.3	1.78	1.30
1972	148.4	1.98	1.30
1972 (9 months)	110.3	1.47	....
1973 (9 months)	143.7	1.90	[1] 1.30
Sun Oil Co.:			
1960	49.3	3.78	[6].75
1961	49.8	3.60	[6].75
1962	53.2	3.67	[7].75
1963	61.2	4.04	[6].75
1964	68.5	4.30	[7].75
1965	85.5	5.03	[6].75
1966	100.6	4.23	[6].93
1967	[8] 159.3	6.34	[7] 1.00
1968	165.6	5.83	[6] 1.00
1969	153.5	3.92	[6] 1.00
1970	139.1	3.16	[7] 1.00
1971	151.6	3.42	[7] 1.00
1972	154.7	3.42	[7].99
1972 (9 months)	108.2	2.33	....
1973 (9 months)	154.9	3.68	[1, 6].98
Ashland Oil Inc.:			
1960	14.9	1.00	.50
1961	15.2	1.17	.58
1962	15.3	1.53	.60
1963	18.1	1.98	.60
1964	23.7	2.01	.68

See footnotes at end of table.

TABLE 12.—NET INCOME, EARNINGS PER SHARE AND DIVIDENDS PER SHARE OF MAJOR OIL COMPANIES, 1960-73, BY COMPANY—Continued

	Net income (millions)	Earnings per share	Dividends per share
Ashland Oil Inc.—Continued			
1965	$35.8	$2.36	$0.80
1966	45.0	2.44	1.00
1967	48.4	2.41	1.20
1968	49.6	2.39	1.20
1969	56.9	2.40	1.20
1970	37.8	2.08	1.20
1971	23.8	1.48	1.20
1972	68.0	2.64	1.20
1972 (9 months)			
1973 (year)	85.2	3.37	[1] 1.25
Standard Oil of Ohio:			
1960	24.7	1.13	.63
1961	25.5	1.16	.63
1962	26.7	1.22	.63
1963	33.9	1.40	.64
1964	43.8	1.81	.75
1965	49.7	2.05	.93
1966	56.9	2.32	1.13
1967	63.9	2.61	1.24
1968	[9] 70.1	2.64	1.25
1969	51.9	1.92	1.35
1970	69.0	2.56	1.35
1971	54.7	2.01	1.35
1972	57.5	2.11	1.35
1972 (9 months)	40.4	1.11	
1973 (9 months)	77.8	2.12	[1] 1.35
Murphy Oil Corp.:			
1960		1.36	
1961	5.0	1.43	.50
1962	3.1	.72	[10] .50
1963	4.8	1.16	.50
1964	4.3	1.03	.50

See footnotes at end of table.

TABLE 12.—NET INCOME, EARNINGS PER SHARE AND DIVIDENDS PER SHARE OF MMAJOR OIL COMPANIES, 1960–73, BY COMPANY—Continued

	Net income (millions)	Earnings per share	Dividends per share
Murphy Oil Corp.—Continued			
1965	$6.4	$1.47	$0.50
1966	8.4	1.92	.50
1967	8.2	1.79	.50
1968	7.9	1.57	.58
1969	6.6	1.19	.60
1970	9.4	1.83	.60
1971	11.1	2.01	.60
1972	14.3	2.47	.60
1972 (9 months)	9.3	1.59	....
1973 (9 months)	34.6	5.94	[1] .63
Belco Petroleum Corp.:			
1960	....	....	....
1961	3.7	.69	....
1962	4.0	.74	.25
1963	4.4	.81	.38
1964	5.0	.90	.63
1965	6.0	1.08	.50
1966	5.5	.97	.50
1967	8.6	1.36	.25
1968	10.6	1.68	.50
1969	13.0	1.96	.50
1970	2.0	.29	.50
1971	9.7	1.39	[10] .75
1972	8.0	1.13	.25
1972 (9 months)	5.5	.77	....
1973 (9 months)	9.5	1.33	([11])
The Superior Oil Co.:			
1960	21.6	5.12	.75
1961	21.1	5.01	.75
1962	20.8	4.94	.75
1963	21.7	5.16	.75
1964	13.3	3.17	.75

See footnotes at end of table.

TABLE 12.—NET INCOME, EARNINGS PER SHARE AND DIVIDENDS PER SHARE OF MAJOR OIL COMPANIES, 1960–73, BY COMPANY—Continued

	Net income (millions)	Earnings per share	Dividends per share
The Superior Oil Co.—Con.			
1965	$3.0	[12] $0.91	$0.75
1966	13.8	3.31	.95
1967	25.9	6.25	1.40
1968	18.7	4.50	1.40
1969	15.6	3.80	1.40
1970	12.3	3.02	1.40
1971	4.3	1.06	1.40
1972	5.1	1.27	1.40
1972 (9 months)	4.9	1.21	
1973 (9 months)	20.4	5.06	[1] 1.40
Kerr-McGee Corp.:			
1960	14.1	1.89	.22
1961	22.2	3.18	.25
1962	21.8	2.94	.27
1963	23.0	3.16	.33
1964	25.4	3.48	.38
1965	29.7	3.93	.40
1966	33.0	1.34	.43
1967	31.7	1.39	.48
1968	36.4	1.60	.50
1969	33.6	1.47	.50
1970	35.9	1.57	.50
1971	40.7	1.78	.53
1972	50.6	2.14	[13] .60
1972 (9 months)	36.8	1.58	
1973 (9 months)	44.1	1.76	[1] .60
Crown Central Petroleum Corp.:			
1960			.25
1961			.25
1962			.25
1963	.8	.96	.25
1964	.5	.56	.25

See footnotes at end of table.

TABLE 12.—NET INCOME, EARNINGS PER SHARE AND DIVIDENDS PER SHARE OF MAJOR OIL COMPANIES, 1960–73, BY COMPANY—Continued

	Net income (millions)	Earnings per share	Dividends per share
Crown Cntral Petroleum Corp.—Continued			
1965	$1.5	$1.83	$0.35
1966	2.8	3.34	.50
1967	2.9	3.53	.60
1968	1.6	1.90	.60
1969	.5	.59	([14])
1970	3.5	3.98	([15])
1971	.7	.50	([15])
1972	1.3	.90	([15])
1972 (9 months)	.8	.53	
1973 (9 months)	[16] 2.8	1.94	[7] .25

[1] Per year.
[2] Adjusted for 2-for-1 stock split, December 1973.
[3] 1968–71 restated in 1972 to reflect change from cost to equity method of accounting for less than majority owned companies. 1967 and prior years not restated to reflect this change.
[4] 1968 and prior accounts do not include Sinclair Oil Corp., merged Mar. 4, 1969.
[5] Includes $250,000,000 ($1.20 per share) extraordinary loss.
[6] Plus 6 percent stock.
[7] Plus 5 percent stock.
[8] 1967–71 restated in 1972 to conform to 1972 presentation of crude oil exchanges.
[9] Years prior to 1969 not restated to reflect acquisition of British Petroleum (Holdings) Inc., Jan. 1, 1970.
[10] Plus 4 percent stock.
[11] 2 percent stock.
[12] 10-for-1 stock split in 1965.
[13] $0.60 per share dividend rate is in compliance with the Dividend Guidelines because the company raised its quarterly rate to $0.15 before Aug. 1, 1971.
[14] 3 percent of stock (dividend restriction under terms of loan agreement).
[15] 5 percent of stock (dividend restriction under terms of loan agreements).
[16] Includes charge to expense of $935,278, out of previously capitalized expenditures on Middle East projects.

Source: U.S. Department of Commerce.

TABLE 13.—RANK IN PROFITABILITY OF OIL COMPANIES AMONG 843 LEADING CORPORATIONS SURVEYED BY "FORBES" MAGAZINE

Company	Ranking on basis of return on equity	
	5-year average	Latest 12 months
Amerada Hess	59	190
Tesoro Petroleum	66	70
Clark Oil & Refining	120	10
American Petrofina	160	196
Texaco	235	221
Exxon	269	138
Pennzoil	281	308
Ashland Oil	371	121
Mobil Oil	400	298
Marathon	404	331
Kerr-McGee	424	509
Standard Oil of California	427	331
Standard Oil (Indiana)	479	420
Continental Oil	495	426
Sun Oil	505	359
Gulf Oil	512	385
Shell Oil	526	490
Union Oil of California	543	442
Murphy Oil	557	63
Occidental Petroleum	577	717
Cities Service	603	668
Diamond Shamrock	618	426
Phillips Petroleum	633	622
Getty Oil	637	713
Atlantic Richfield	646	689
Standard Oil (Ohio)	685	758
Signal Companies	760	682

Source: "Whose Where in Profitability," *Forbes*, Jan. 1, 1974. Rankings for latest 12-month period derived by API.

TABLE 14.—INVESTMENT PLANS OF MAJOR PETROLEUM COMPANIES:[1] INCREASE IN 1974 OVER ESTIMATED 1973 EXPENDITURES

[Dollar amounts in millions]

Company	1973	1974	Percent increase
Atlantic Richfield	$550.0	$1,100.0	100.0
Exxon	3,500.0	6,100.0	74.3
Getty	270.0	272.6	0.9
Gulf	1,500.0	2,000.0	33.3
Marathon	166.0	265.0	59.6
Murphy	NA	172.0	NA
Skelly	NA	140.1	NA
Standard Oil Co. of California	1,200.0	1,600.0	33.3
Standard Oil (Indiana)	1,050.0	1,400.0	33.3
Standard Oil (Ohio)	175.0	300.0	71.4
Sun	375.0	650.0	73.3
Texaco	1,600.0	1,800.0	12.5
Total	[2] 10,386.0	15,799.7	[2] 49.1

[1] Announced through Jan. 22, 1974.
[2] Excludes Murphy & Skelly.

Source: Moody's Industrial, News Reports.

TABLE 15.—NET INCOME AFTER TAX AND THE RATE OF RETURN ON EQUITY OF SELECTED OIL COMPANIES (1963–73)

[In millions of dollars]

Company	1973 Net income	1973 Percent return [1]	1972 Net income	1972 Percent	1971 Net income	1971 Percent	1970 Net income	1970 Percent	1969 Net income	1969 Percent
Total	9,087.3	15.1	5,951.7	9.7	6,007.3	10.2	5,556.7	10.4	5,549.9	10.9
Amerada Hess Corp [2]	151.8	23.5	46.2	8.3	133.3	24.0	114.0	25.7	86.5	23.7
Ashland Oil Corp.zz	98.3	17.3	68.0	13.5	40.5	8.8	52.0	11.7	56.9	13.3
Atlantic Richfield Co.	270.2	8.9	192.5	6.5	210.5	7.3	209.5	7.5	230.1	8.5
Cities Service Co	135.6	9.8	99.1	6.9	104.5	7.7	118.6	8.9	127.2	10.0
Clark Oil & Refining Corp.	30.5	29.9	8.3	9.8	3.6	4.7	10.8	14.0	13.0	18.7
Continental Oil Co	242.7	14.0	170.2	10.4	140.1	9.1	160.3	10.7	146.4	9.8
Exxon Corp	2,440.0	18.5	1,531.8	12.5	1,516.6	13.1	1,309.5	12.0	1,242.6	12.3
Getty Oil Co	135.0	8.8	76.1	5.2	120.1	8.5	103.2	7.8	105.8	8.3
Gulf Oil Corp [2]	760.0	14.0	447.0	8.3	561.0	10.2	550.0	10.4	610.6	12.1
Kerr-McGee Corp [2]	58.8	10.8	50.6	10.1	40.7	10.8	35.9	10.3	33.6	10.3
Marathon Oil Co	129.4	15.2	79.8	10.2	88.7	11.7	86.5	11.8	89.4	12.1
Mobil Oil Corp	842.8	15.7	574.2	10.9	540.8	10.9	482.7	10.4	456.5	10.4
Murphy Oil Corp	53.6	24.4	14.3	7.6	11.1	6.2	9.3	6.5	6.2	4.5
Phillips Petroleum Co.	230.4	12.1	148.4	8.1	132.3	7.6	132.3	7.8	127.8	7.7
Shell Oil Co	332.7	10.9	260.5	8.9	244.5	8.7	237.2	8.6	291.2	10.9
Skelly Oil Co	44.0	7.5	37.6	6.8	38.3	7.0	36.1	7.0	38.4	7.7
Standard Oil of California	843.6	14.4	547.1	10.5	511.1	10.4	454.8	9.8	453.8	10.3
Standard Oil Co. (Ind.)	511.2	12.4	374.7	10.0	340.6	9.6	314.0	9.3	321.0	10.0
Standard Oil Co. (Ohio)	74.1	6.6	59.7	5.6	58.8	5.7	64.4	6.3	51.9	5.3
Sun Oil Co	230.0	12.3	154.7	8.8	151.6	8.9	139.1	8.4	152.3	9.4
Texaco Inc	1,292.4	25.0	889.0	12.4	903.9	13.4	822.0	13.1	769.8	13.1
Union Oil of California	180.2	10.6	121.9	7.6	114.7	7.4	114.5	7.6	138.9	9.5

Footnotes at end of table.

TABLE 15.—NET INCOME AFTER TAX AND THE RATE OF RETURN ON EQUITY OF SELECTED OIL COMPANIES (1963–73)—Continued

[In milions of dollars]

Company	1968 Net income	1968 Percent	1967 Net income	1967 Percent	1966 Net income	1966 Percent	1965 Net income	1965 Percent	1964 Net income	1964 Percent	1963 Net income	1963 Percent
Total	5,539.4	11.8	5,175.6	12.0	4,701.9	11.7	4,203.7	11.2	3,846.9	10.8	3,579.7	11.0
Amerada Hess Corp [2]	89.8	19.8	76.8	22.2	73.1	22.6	63.4	22.2	59.4	23.0	52.4	22.7
Ashland Oil Corp	53.6	14.6	48.4	15.5	45.0	17.6	35.8	15.5	23.7	14.0	18.1	11.7
Atlantic Richfield Co	105.8	7.8	130.0	10.2	113.5	9.4	90.1	8.1	47.1	7.3	44.0	7.0
Cities Service Co	121.3	9.9	127.8	10.9	120.1	11.0	100.6	10.2	84.5	9.1	77.5	8.6
Clark Oil & Refining Corp	12.1	20.4	11.5	23.4	9.6	24.2	8.7	27.8	2.1	8.9	1.5	6.8
Continental Oil Co	150.0	10.6	136.1	10.1	115.6	10.3	96.2	10.2	100.1	11.1	87.4	10.5
Exxon Corp	1,276.7	13.0	1,155.0	12.3	1,090.1	12.1	1,021.4	11.9	1,050.6	12.6	1,019.5	12.8
Getty Oil Co	98.3	8.3	118.2	10.5	92.3	9.0	57.7	6.9	43.0	5.6	43.0	6.1
Gulf Oil Corp [2]	626.6	13.2	568.3	12.9	504.8	12.3	427.2	11.2	395.1	11.0	371.4	10.9
Kerr-McGee Corp [2]	36.4	12.0	32.1	11.5	33.0	12.9	25.1	14.6	20.7	14.7	18.8	15.8
Marathon Oil Co	83.3	12.7	73.9	12.3	68.8	12.3	60.1	11.3	60.4	11.8	49.1	10.2
Mobil Oil Corp	430.7	10.3	385.4	9.8	356.1	9.5	310.2	9.1	294.2	8.8	271.9	8.6
Murphy Oil Corp	7.3	5.4	8.2	6.2	8.4	7.6	6.4	6.1	4.3	4.9	4.8	5.7
Phillips Petroleum Co	129.9	8.0	164.0	11.0	138.4	10.3	127.7	9.9	115.0	9.3	108.1	8.9
Shell Oil Co	312.1	12.3	284.9	13.8	255.2	13.4	234.0	13.4	198.2	12.3	179.9	12.0
Skelly Oil Co	40.3	8.5	42.0	9.3	37.0	8.8	34.0	8.8	25.7	7.1	24.2	7.0
Standard Oil of Calif	451.8	10.7	409.4	10.3	401.2	10.8	391.2	11.1	345.3	10.5	322.1	10.5
Standard Oil Co. (Ind.)	309.5	10.1	280.9	9.6	255.9	9.1	219.3	8.1	194.9	7.5	183.1	7.3
Standard Oil Co. (Ohio)	70.1	13.0	67.1	14.5	56.9	13.3	49.7	12.7	43.8	12.0	38.9	11.4
Sun Oil Co	164.4	10.9	156.2	15.2	100.6	10.8	85.5	10.1	68.5	8.8	61.2	8.4
Texaco Incorporated	819.6	14.5	754.4	14.8	692.1	15.0	636.7	14.9	577.4	14.6	547.6	15.6
Union Oil of Calif	149.8	10.9	145.0	11.2	134.2	11.2	112.8	10.4	92.9	14.7	55.2	9.9

[1] Equity as of September 30 1973.
[2] Full years income estimated on the basis of income reported for the first nine months of 1973.

Source: Standard and Poors' Industrial Survey, Moody's Industrial Manual' Quarterly Financial Statements Filed with the Security Exchange Commission (10 Q forms). Office of the Secretary of Treasury, Office of Tax Analysis, Feb. 1, 1974.

EXHIBIT A

FEDERAL POWER COMMISSION

AREA RATE MAP

AS OF JUNE 1, 1972

☐◀ Indicates just and reasonable ceiling rates for "New Gas" as determined by Commission opinions and orders in area rate proceedings.

ROCKY MOUNTAIN AREA

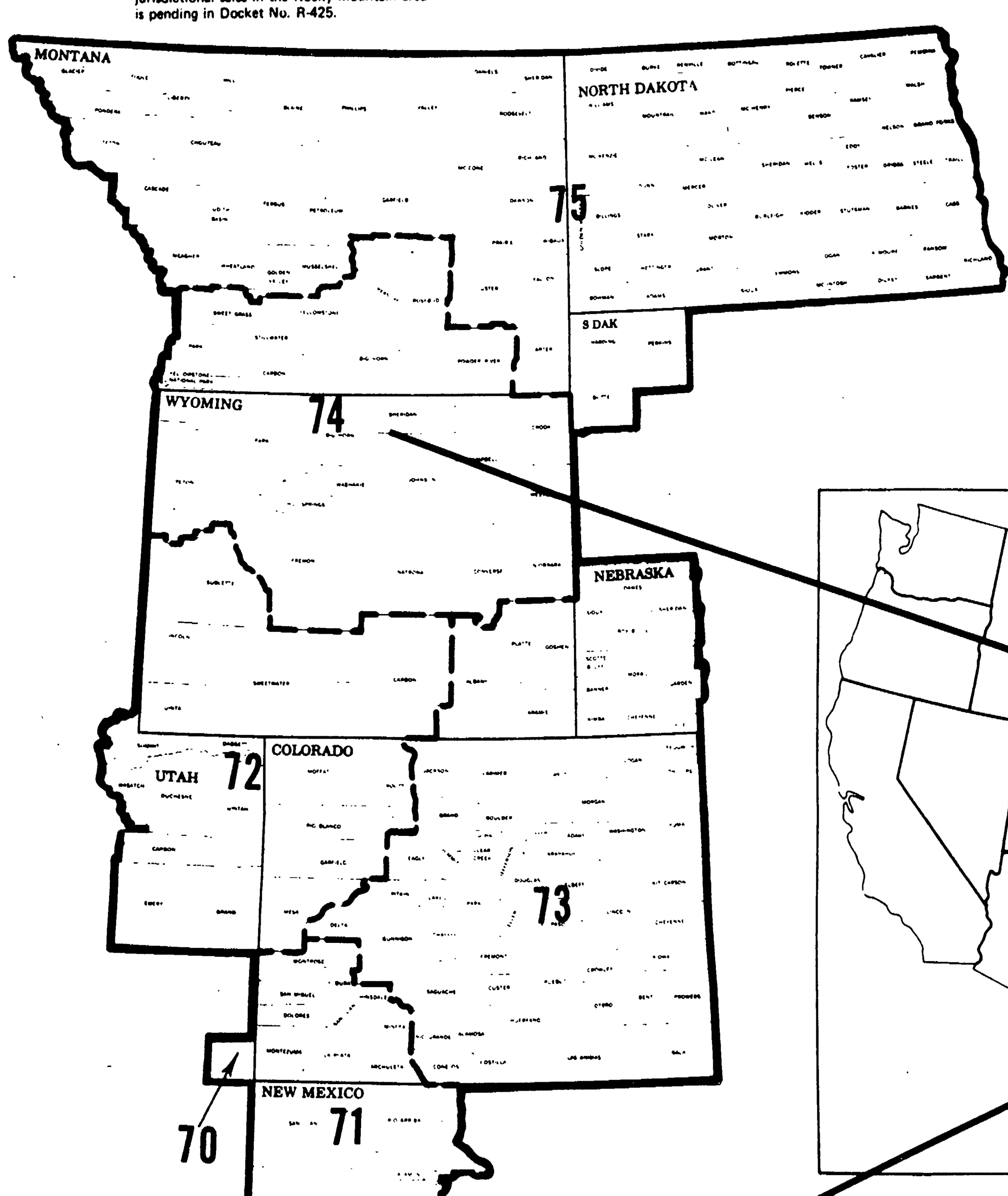
Initial rates 1/ for new sales of natural gas, in cents per Mcf at 15.025 psia, under contracts dated after June 17, 1970, pursuant to Order No. 435, issued July 15, 1971, in Docket Nos. R-389 and R-389A.

Aneth Field	22.50¢
San Juan Basin	24.00
Uinta-Green River Basin	23.75
Colorado-Julesburg Basin	23.50
Montana-Wyoming Area	22.75
Montana-Dakota Area	23.50

Statement of General Policy No. 61-1 price levels for increased rates in the Rocky Mountain Area, at 15.025 psia:

Wyoming	13.0¢
Colorado	13.0
New Mexico (San Juan Basin)	13.0

1/ A rulemaking proceeding to determine the just and reasonable rates and otherwise regulate jurisdictional sales in the Rocky Mountain area is pending in Docket No. R-425.



HUGOTON-ANADARKO AREA

Base area rates 1/ in cents per Mcf at 14.65 psia, subject to quality and tax adjustments, pursuant to Opinion No. 586, issued September 18, 1970, in Docket No. AR64-1:

	Contracts Dated before November 1, 1969 Panhandle and Hugoton Fields	Contracts Dated before November 1, 1969 Other Fields	Contracts On or After November 1, 1969 (All Fields)	Minimum Rates
Kansas 2/	12.50¢	17.50¢	19.00¢ ◀	10.00¢
Oklahoma 2/	13.25	18.50	20.00 ◀	10.50
Texas	13.50	19.00	20.50 ◀	10.75

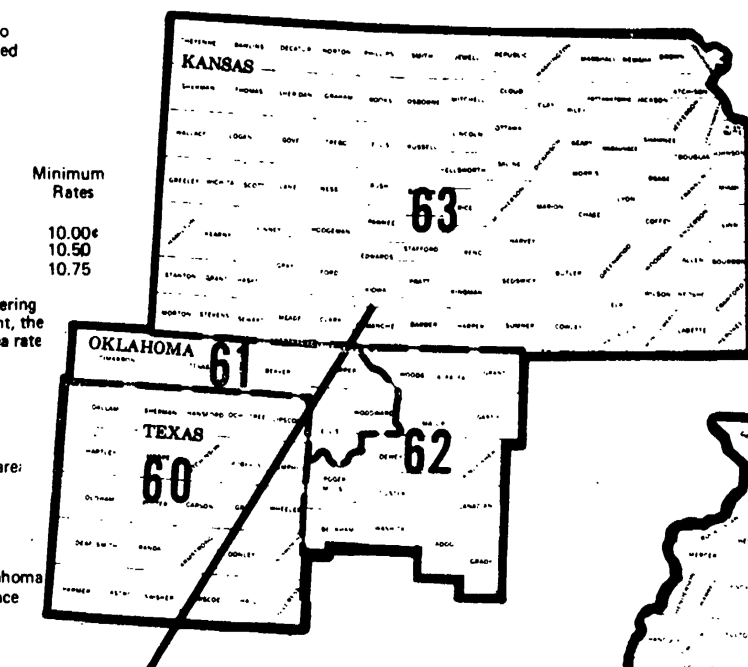
Where delivery of gas is made after subetantial off-lease gathering by the producer, whether at a plant tailgate or at a central point, the applicable area rate shall be adjusted upward above the base area rate

(1) For gas produced in the Panhandle and Hugoton Fields:
  (i) Prior to July 1, 1972, 2 cents per Mcf.
  (ii) On or after July 1, 1972, 2.5 cents per Mcf.
(2) For gas produced from fields or reservoirs other than the Panhandle or Hugoton Fields, 1 cent per Mcf.

A moratorium of filing price increases above the applicable area rates is imposed until July 1, 1977.

1/ All area rates will be increased by one cent per Mcf on July 1, 1972.

2/ Add 0.013125 ¢ per Mcf to Kansas rates and 1.5% to Oklahoma rates to reflect allowable portions of tax increases imposed since date of issuance of opinion.



APPALACHIAN AND ILLINOIS BASIN AREA

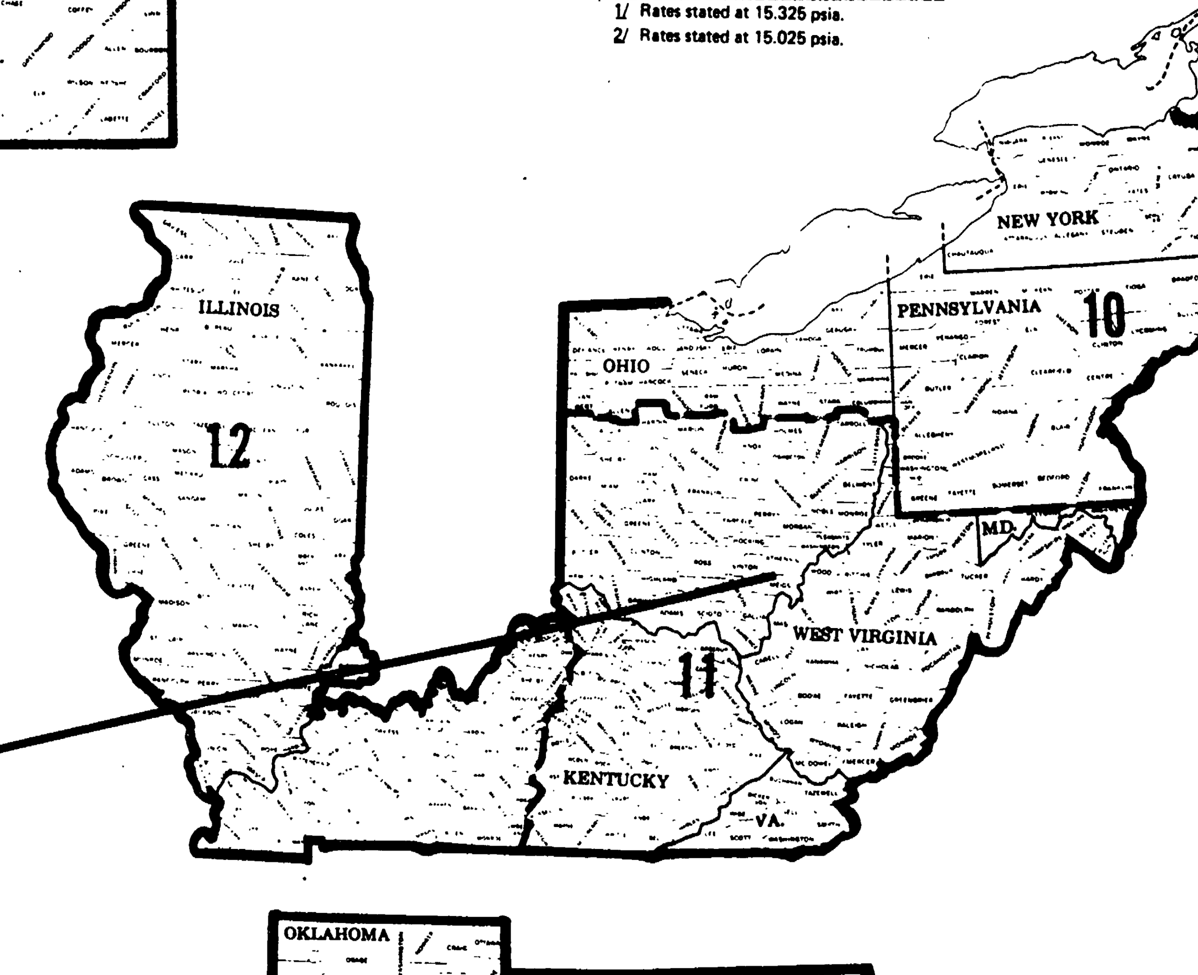
Base area rates in cents per Mcf for pipeline quality gas, pursuant to Commission Order No. 411, issued October 2, 1970, in Docket R-371:

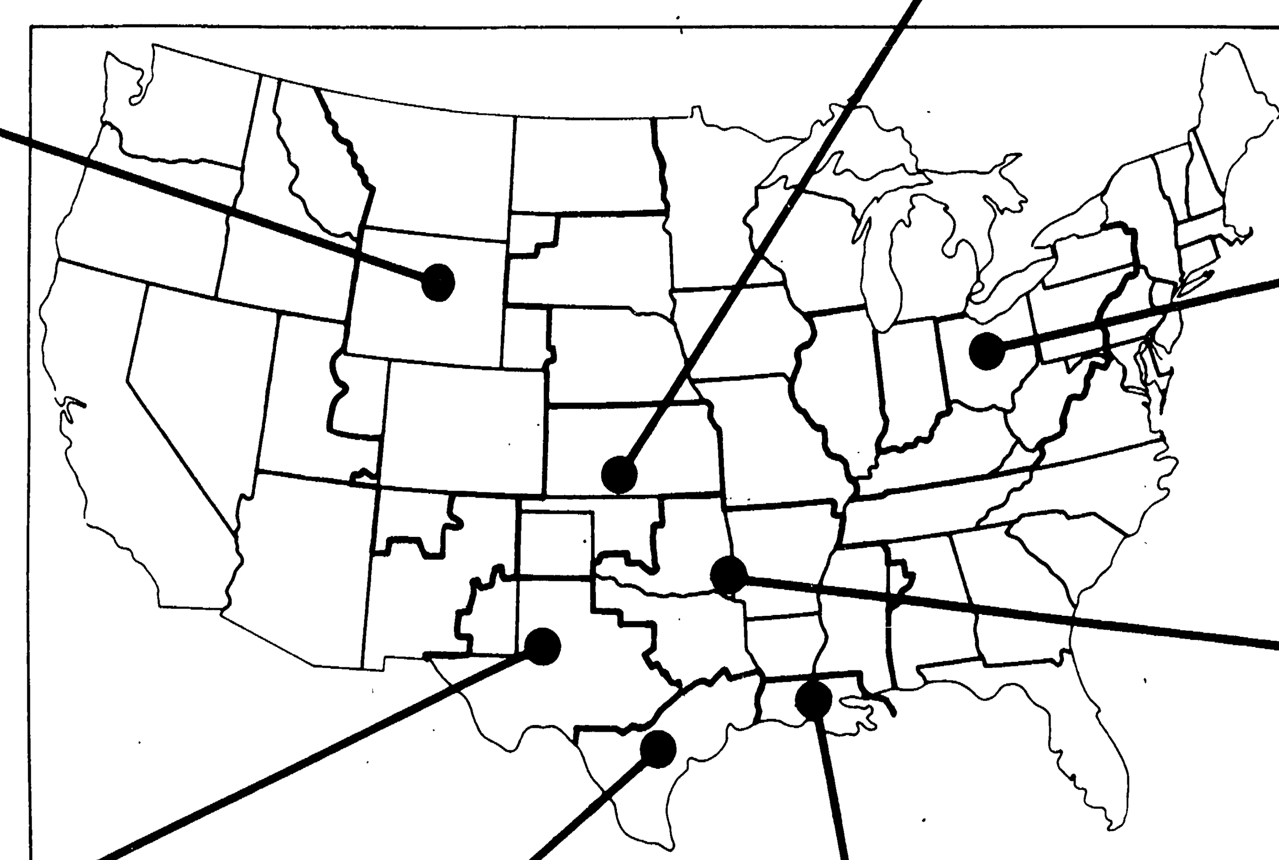
Appalachian Basin 1/	Contracts Dated Prior to October 8, 1969	Contracts Dated After October 7, 1969
(1) North Subarea	32.0¢	34.0¢ ◀
(2) South Subarea	30.0	32.0 ◀
(3) Minimum Rate	20.0	20.0¢
Illinois Basin 2/		
(1) Area Rate	24.0	24.0¢ ◀
(2) Minimum Rate	16.5	16.5¢

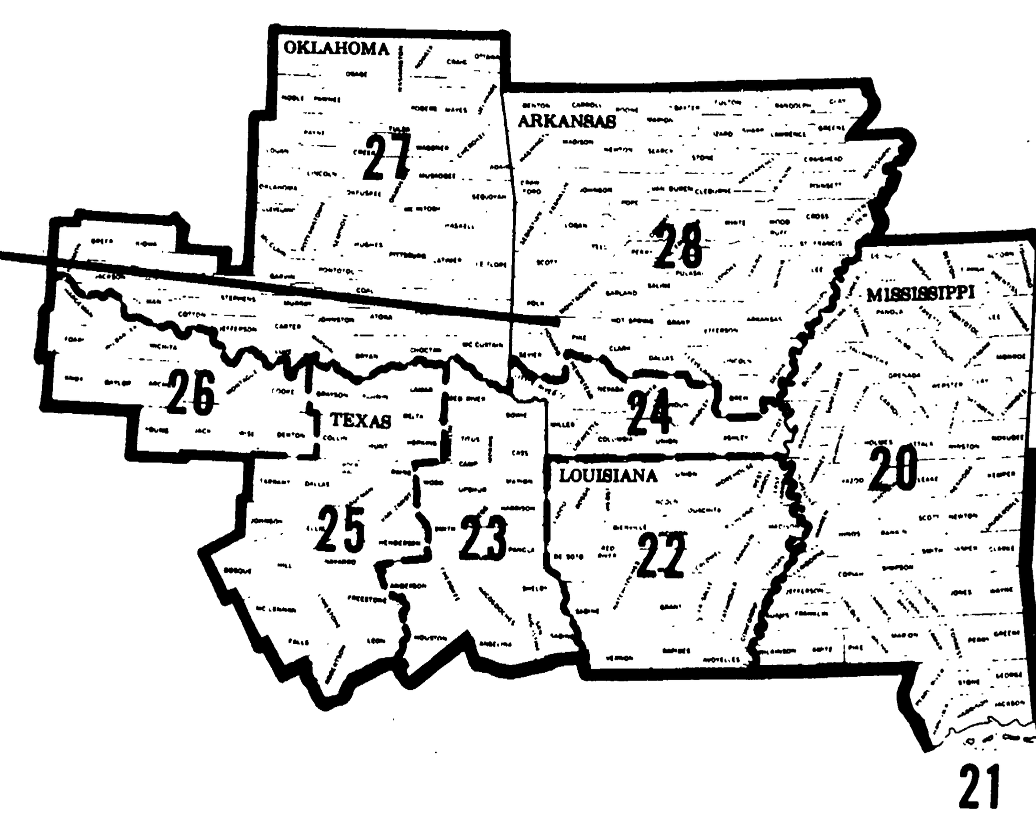
In addition to establishing just and reasonable rates, the order also issued small producer certificates to all small producers in the area without the need for each producer to make special application. An indefinite moratorium on price increases above area ceilings was also provided.

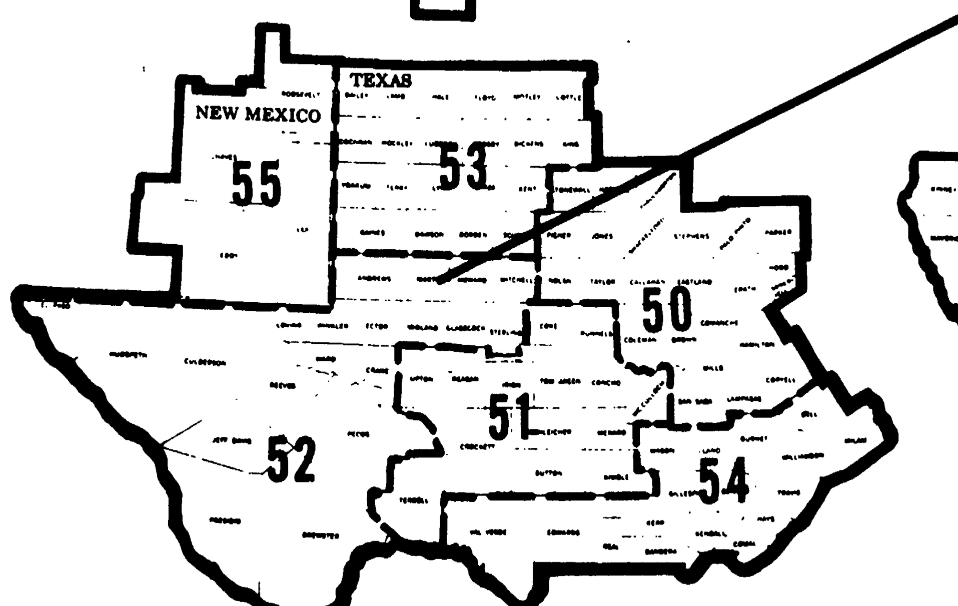
1/ Rates stated at 15.325 psia.

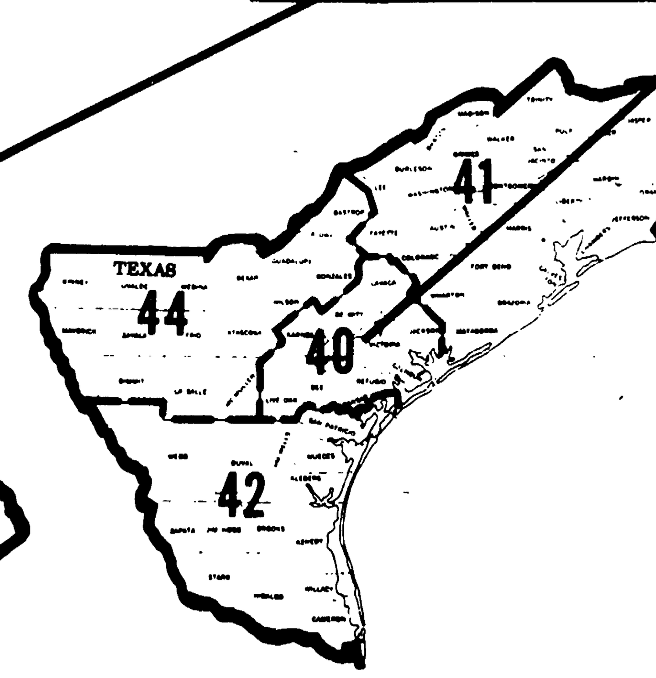
2/ Rates stated at 15.025 psia.

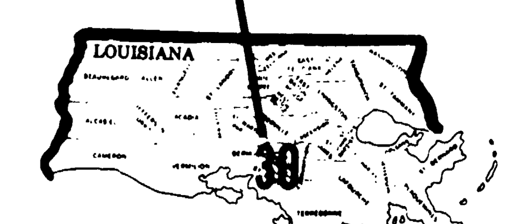












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PERMIAN BASIN AREA*

Base area rates in cents per Mcf at 14.65 psia, subject to quality adjustments, pursuant to Opinion No. 468, issued August 5, 1965, in Docket No. AR61-1. All casinghead gas is subject to the ceiling rates for gas sold under contracts dated prior to January 1, 1961.

	Contracts Dated Prior to 1/1/61	Contracts Dated On or After 1/1/61
Texas RR District Nos. 7-C, 8 and 8-A	14.5¢	16.5¢ ◀
New Mexico	13.5 1/	15.5 ◀
Minimum Rate	9.0	9.0¢

1/ Plus applicable state and local production taxes.

* The area rate proceeding in Docket No. AR70-1 expanded the Permian Basin Area to include Texas RR Commission District No. 7-B, 17 counties in the northern portion of Texas RR District No. 1 and Roosevelt County, New Mexico. The rates established by Opinion No. 468 are subject to change in this proceeding. Rates in the northern portion of RR District No. 1 and RR District No. 7-B are subject to Statement of General Policy No. 61-1 price levels until issuance of a Commission opinion in this proceeding.

TEXAS GULF COAST AREA

Base area rates in cents per Mcf at 14.65 psia, subject to quality adjustments, pursuant to Opinion No. 595, issued May 6, 1971, in Docket No. AR64-2, for gas gathered and delivered by the seller at either a central point in the field, the tailgate of a plant or a point on the buyer's pipeline:

	Contracts Dated Prior to 10/1/68	Contracts Dated On or After 10/1/68
From October 1, 1968 to September 30, 1973	19.0¢	24.0¢ ◀
On and After October 1, 1973	20.0	25.0¢ ◀

The applicable area rate shall be adjusted downward by 0.4 cent per Mcf for gas delivered closer to the wellhead than a central point in the field, the tailgate of a plant or a point on the pipeline.

There are no minimum rates set for the area. Also, a moratorium on filing price increases above the applicable area rates is imposed until January 1, 1976.

By order issued May 15, 1972, the 16 southeastern counties of Texas RR Commission District No. 1 were included in the Texas Gulf Coast Area for area rate purposes.

SOUTHERN LOUISIANA AREA

Base area rates in cents per Mcf at 15.025 psia, subject to quality and tax adjustments, pursuant to Opinion No. 598, issued July 16, 1971, in Docket Nos. AR61-2 and AR69-1:

	Contracts Dated Prior to October 1, 1968 1/	Contracts Dated on or After October 1, 1968 and Newly Discovered Reservoirs Discovered On or After October 1, 1968 2/
Gas Subject to Louisiana Production Tax	22.375¢	26.0¢ ◀
Gas Not Subject to Louisiana Production Tax	21.375	26.0¢ ◀

The base area rates shall be adjusted downward by 0.51¢ per Mcf for deliveries made closer to the wellhead than a central point in the field, the tailgate of a natural gas processing plant, an offshore platform to the buyer's line, or a point on the buyer's pipeline.

A moratorium on filing price increases above the applicable area rates is imposed until October 1, 1977, for contracts dated on and after October 1, 1968, and until October 1, 1976 for contracts dated prior to October 1, 1968.

1/ These rates will escalate 0.5¢ per Mcf on October 1, 1973.
2/ These rates will escalate to 27.0¢ per Mcf on October 1, 1974.

OTHER SOUTHWEST AREA

Base area rates until July 1, 1976, in cents per Mcf, at 14.65 psia, for gathered gas 1/ pursuant to Opinion No. 607, issued October 29, 1971, in Docket No. AR67-1.

Rates Effective 10/1/68 - 9/30/73

	Contracts dated prior to 10/1/68 2/	Contracts dated on or after 10/1/68 3/ ◀
Other Oklahoma	19.4¢	23.75¢
Texas RR Dist. 9	19.7	24.0
Northern Arkansas	18.8	23.0
Texas RR Dist. 5	·	23.5
Texas RR Dist. 6	19.1	23.5
Northern Louisiana*	20.6	25.0
Southern Arkansas	18.25	22.5
Miss.-Alabama*	20.0	25.0
Federal Domain* (Offshore Miss.)		26.0 4/

* at 15.025 psia

A moratorium on price increases above the applicable area rates is imposed until July 1, 1976. For ungathered gas, 1.5¢ per Mcf should be subtracted from the area rate for gathered gas in Other Oklahoma, Texas District No. 9 and Northern Arkansas; 1.25¢ per Mcf in the state domain in Mississippi and Alabama; and 1.0¢ per Mcf in Texas District Nos. 5 and 6, Northern Louisiana and Southern Arkansas.

The base area rates for gas produced on or after November 1, 1969, from a new reservoir on previously committed acreage shall be determined by utilizing the date of discovery in lieu of the contract date.

1/ "Gathered" gas refers to gas delivered at a central point, the tailgate of a plant or a point on the buyer's pipeline. All rates are subject to adjustments for quality.
2/ These rates will escalate 1.0¢ per Mcf on October 1, 1973.
3/ These rates will escalate 1.0¢ per Mcf on October 1, 1973, except for the Federal Domain offshore of Mississippi, where the rate will escalate on October 1, 1974.
4/ Effective January 1, 1972.

CODE	AREA NAME
10	APPALACHIAN BASIN - North Sub-area
11	APPALACHIAN BASIN - South Sub-area
12	ILLINOIS BASIN
20	MISSISSIPPI - ALABAMA
21	FEDERAL DOMAIN (Offshore Mississippi)
22	NORTHERN LOUISIANA
23	TEXAS RAILROAD COMM. DIST. 6
24	SOUTHERN ARKANSAS
25	TEXAS RAILROAD COMM. DIST. 5
26	TEXAS RAILROAD COMM. DIST. 9
27	OTHER OKLAHOMA
28	NORTHERN ARKANSAS
30	SOUTHERN LOUISIANA - Onshore
31	SOUTHERN LOUISIANA - Offshore
40	TEXAS RAILROAD COMM. DIST. 2
41	TEXAS RAILROAD COMM. DIST. 3
42	TEXAS RAILROAD COMM. DIST. 4
44	TEXAS RAILROAD COMM. DIST. 1 - South
50	TEXAS RAILROAD COMM. DIST. 7-B
51	TEXAS RAILROAD COMM. DIST. 7-C
52	TEXAS RAILROAD COMM. DIST. 8
53	TEXAS RAILROAD COMM. DIST. 8-A
54	TEXAS RAILROAD COMM. DIST. 1 - North
55	SOUTHEASTERN NEW MEXICO
60	TEXAS RAILROAD COMM. DIST. 10
61	OKLAHOMA PANHANDLE
62	OKLAHOMA ANADARKO
63	KANSAS
70	ANETH FIELD
71	SAN JUAN BASIN
72	UINTA-GREEN RIVER BASIN
73	COLORADO-JULESBURG BASIN
74	MONTANA-WYOMING
75	MONTANA-DAKOTA

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