FISCAL POLICY AND THE ENERGY CRISIS

HEARINGS

BEFORE THE

SUBCOMMITTEE ON ENERGY

OF THE

COMMITTEE ON FINANCE

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FISCAL POLICY AND THE ENERGY CRISIS

TUESDAY, NOVEMBER 27, 1973

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

The subcommittee met, pursuant to notice, at 10:05 a.m., in room 2221, Dirksen Senate Office Building, Senator Mike Gravel (chairman of the subcommittee) presiding.

Present: Senators Long (chairman of the full committee), Ribicoff, Mondale, Gravel, Bentsen, Curtis, Dole, and Roth.

Senator GRAVEL. The hearings will come to order.

The energy crisis is upon us, but unfortunately not perceived as what it actually is.

The immediate concern, quite properly, is for this winter. The country is pursuing a policy that will produce an immediately needed result: a reduction in energy consumption. The lowering of temperatures and driving speeds, the lessening of air service and display lighting, will make it possible to survive the shortfall in energy supplies this winter, hopefully without severe or lasting hardship.

But that is where the present policy stops. Its vision is limited only to the immediate. We must realize that the energy crisis is not just a passing emergency. It will be with us for some time. It demands the most far-sighted and creative solutions our Nation can provide.

The reductions in consumption will not add to our total energy supplies. They will only permit us to use what we have more efficiently and prudently. In spite of these reductions, the overall demand of the United States for energy will continue to grow. Without positive action to increase the amount of available energy, the reductions in consumption alone can be a step backward on the path of having our energy supplies consistent with our energy demand.

Next winter we may have to put on two extra sweaters instead of one. By the winter of 1980 any number of sweaters may not help.

The President has set an admirable and important goal for the Nation: to be self-sufficient in energy by the end of the decade. Unfortunately, he has charted no policies to accomplish this. Reductions in consumption will not bring more oil to market. They will not develop new sources of energy to relieve our almost total dependence on fossil fuels. They will not stimulate domestic energy production to remove our over-reliance on foreign supplies.

The Finance Committee has jurisdiction over legislation on taxation and trade, areas that can form the financial basis for the total

energy policy this Nation lacks. We intend, on the basis of the hearings this week, to develop legislation that will focus on the following areas:

In the public sector, we can establish a national energy trust fund, as the vehicle for the Government's activity. It can be supported by a tax on Btu's of energy. The funds can be disbursed to exploit fully existing energy resources and to research and develop alternate forms of energy. The trust fund is a "pay-as-you-spend" mechanism that can raise the funds on the scale needed without adding additional inflationary burdens to our already strained economy.

In the private sector, we can create new incentives for the production of energy, so that industry and business can be encouraged to do its part as well in exploiting existing energy and in developing new sources for the future. We must also look at the removal of current disincentives that actually discourage energy development. We can also discourage energy consumption through fiscal policies.

A variable import levy on foreign energy should be considered to protect and encourage investment in our own resources. We may also want to place restrictions on the exportation of energy.

The United States lacks a coherent energy policy. Yet, no one can doubt that if we dedicate ourselves to the task we can create one which is consistent with the Nation's environmental, domestic, and national security goals and one which can move the country toward energy self sufficiency.

Such a policy demands three things: national resolve, funds, and program. The Nation is developing the resolve, thanks in part to the Arab embargo on oil. Funds can be provided through incentives and a trust fund. With the resolve and the funds, a program of energy development will come easily.

We are fortunate to have with us a very distinguished list headed off by Governor Love. Before turning to you, Governor, I would like to note that we have a number of Senators here; I think it demonstrates the interest of the committee that we have with us this morning several members of the Committee on Finance, Senator Long, our chairman, and Senator Ribicoff, and, of course, my colleague who is the ranking minority Member, Senator Dole.

I would like to invite Senator Long to make the opening statement before the hearings start.

The CHAIRMAN. Governor, I must go to the Senate Chamber in a few minutes to manage the debt limit bill. I read your statement. I did want to ask you a few questions before I leave. In your statement you say that it will require about $1 trillion of capital expenditures to provide the energy that we are going to be needing in this country. That is a lot of money, $1 trillion. We have been accustomed to dealing in billion dollar figures, which I thought was fairly large, but a trillion dollar figure is sort of a new experience, even for the Finance Committee. If we expect to have this energy developed under the dominion and control of the United States—be it here or Alaska, Puerto Rico, or somewhere under our jurisdiction where we can make it available to our own people and to our allies—is that not going to require that we have some sort of arrangement to protect our industry against the competitive advantage of that low-cost oil in Saudia Arabia, for example, would have?

STATEMENT OF HON. JOHN A. LOVE, ASSISTANT TO THE PRESIDENT FOR THE ENERGY POLICY OFFICE

Mr. LOVE. Senator, perhaps I do not share in full measure the fear or forecase that you make that indeed there again will be truly low-cost oil from abroad, but it is at least one potential and would add, it seems to me, a further uncertainty which might act as a deterrent to the raising of the tremendous amounts of capital that are going to be necessary not only in the development of oil and gas but other energy sources.

I had hoped to be able to add to my written statement a concept that I have in mind but, unfortunately do not have worked out in detail yet, but with the tremendous amounts that are going to be necessary, I wonder whether we should not be considering some sort of energy banking facility which would have the power to provide, among other things, a secondary market for evidence of debt, perhaps provide for example an agreement, on a synthetic or substitute fuel that if the money is spent and it is developed and comes on line, that if the market will not react to whatever the appropriate price is, $5 or $6 a barrel, whatever it might be, that the energy bank would have the right to in effect, give a takeout. I think devices such as this and perhaps as you suggest are probably going to be necessary if we indeed are going to attract the tremendous amounts of capital necessary.

The CHAIRMAN. Well, I have been told by bankers of this country, such as the Chase Manhattan people, who know a great deal about this subject, that they estimate that between now and 1985, we need about $500 billion to provide what this Nation would require for its energy. But if you want it produced here, then you should make that decision and the decision should be such that the people who produce it could expect to make a profit, otherwise that would not be a good loan. And I see by the pamphlet prepared by Mr. Best for our committee that in Saudi Arabia, for example, and in Iran, their average cost of production, that is, to produce the oil, extracting, is 13 cents. Now, if you allow 50 cents for ocean freight to put it in here, their cost is about 63 cents. And I would think that anybody would be unwise to loan somebody $500 billion—or the $1 trillion you project which I think in the longer period will be correct—but that is a lot of money to expect somebody to risk if he does not have some reasonable assurance that he is not subject to Saudi Arabian oil putting him out of business just at the time those people decide they want to sell to us after all.

I just wonder whether you feel that we are going to have to find some way of assuring Americans, when they invest their money here, that their investment will be protected and used to build these coal gasification plants and to make all these huge investments that will be necessary to remedy this energy crisis.

Mr. LOVE. I think it is an item of legitimate concern, Senator, and I would add one other item to it. It seems unlikely to me that companies, investors, are going to invest hundreds of millions of dollars necessary to construct refinery capacity in the United States unless they have either some assured stable supply of crude or in the event that they do not feel that such an assured and stable supply can be achieved, again, some governmental intervention to help at least mod-

erate the risk that would occur if you build a refinery and then your source of crude is appropriated or otherwise preempted.

The CHAIRMAN. Thank you very much, Governor. I am going to stay as long as I can. I will review the record and see how you spot the questions.

Senator GRAVEL. Senator Ribicoff, do you have an opening statement?

Senator RIBICOFF. Just something for you to be thinking about when my turn for questioning comes.

I believe that the American taxpayer is paying through the nose for what the American oil companies are doing abroad. There are two breaks that American oil companies receive. No. 1, American companies are allowed a depletion allowance for the exploratory costs abroad. Is it fair for an American company to receive a tax credit for its exploration in Saudi Arabia and Saudi Arabia boycotts any of that oil coming to the United States? Do you think the time has come for the United States to cut off that break to the five major oil companies who explore for oil abroad? Think about it.

Mr. LOVE. I will think about it.

Senator RIBICOFF. Because that is a very—I do not know whether anyone has thrown this thought at you.

Mr. LOVE. Senator, give me just a little time but also a little assistance. The concept of the tax credit is indeed the amount, if I am correct—and you correct me if I am wrong—the amount paid by the oil company to the Saudies, for example.

Senator RIBICOFF. They get it two ways. In other words, an American oil company will pay, let us say, 50 percent of its earnings abroad to Saudi Arabia and then takes a tax credit for that 50 percent against the taxes it would owe the United States. So, therefore, it could earn a billion dollars, pay a half billion dollars in taxes to the Saudi Arabians, and pay nothing to the United States. The Saudi Arabians get the earnings from the American corporations and yet the Saudi Arabians boycott the United States with that oil.

In addition, there is a depletion allowance that they receive. So we have a situation of the American oil companies doing a fantastic amount of business abroad. They have large earnings. The only beneficiaries for those earnings are the Middle East countries who boycott the United States. So the American taxpayers are paying the foreign countries huge sums of money and at the same time we are boycotted from the oil that we should be receiving and our American taxpayers are paying for.

Mr. LOVE. I understand, Senator.

Senator GRAVEL. I would like to ask Senator Dole, do you have any opening statement?

Senator DOLE. If you are under some time pressure——

Senator RIBICOFF. No, no. I just wanted—these are the questions I am going to ask and in all fairness, I realize Governor Love has probably not been faced with this thought and this question and I think he ought to be thinking about it.

Mr. LOVE. I appreciate your fairness and recognition that I have other problems.

Senator RIBICOFF. Your staff might be thinking about that because I want some answers before we leave here.

Mr. LOVE. If I cannot respond fully and responsibly, we will be glad to provide something else for the record.

Senator DOLE. Mr. Chairman, I have an opening statement but will defer it in the interest of getting to the Governor's statement, and having an opportunity to ask the Governor questions; and I use the word Governor, thinking perhaps at this time you might wish you were still Governor. In any event, as you know, Governor Love, we are all going to be inundated with requests for exceptions and exemptions and flexibility. I think everyone agrees with the concept except when it strikes rather directly at a certain industry or agriculture where there perhaps should be certain priorities. And, of course, as the chairman, Senator Gravel, has pointed out, the purpose of this hearing is to look at incentives and disincentives in an effort to at least start down the road to help alleviate what has now become an energy crisis.

I have a number of questions; the first complaints to reach me came from the general aviation industry where, according to their tabulations and their experts, they would be taking a cut in fuel oil of around 42.5 percent.

In my visits with representatives of general aviation from my State of Kansas, who also operate in many other States, they tell me they are willing to share as much of the sacrifice as commercial aviation does. My question is, is there some reason for this distinction or will some relief be provided which will have a direct economic impact? If general aviation has to cut 40 percent it is estimated 70,000 jobs will be lost, and this is a proper subject to address in this forum. I would like to know, will there be some adjustment or can there be some adjustment on the present program?

Mr. LOVE. Senator, I, too, had a delegation from the manufacturers of primarily small aircraft and agreed that we would look again, but let me tell you the problem at least conceptually.

The theory, it seemed to us, on this program would be to try to identify those activities and areas that could be curtailed with the least effect on the economy and on society, and we looked at, for example, the use of the automobile, the gasoline it burns. This seems to be an obvious first kind of target, but, for example, the recommended closing of stations on Sundays has created a response from the, at the moment, New England ski operators, the Rocky Mountain ski operators, and for that matter the entire State of Nevada, each of them—and, of course, the entire tourist and leisure business—each of them pointing out the economic impact it can have, the loss of jobs in these leisure or recreational industries, or as you suggest, in the aviation field when you look at the use of aircraft for pleasure or some—the proposal, by the way, was divided into three categories. There are some that fly pipelines or crop dusting, or whatever it may be, that are clearly necessary economic tools, and then the business use, such as the corporate jet, and then finally, just the purely recreational, and we had differing suggested cutbacks there.

Each of these things, of course, is going to impact on some portion of the economy and there may be some flexibility that we can devise, but let me caution you that the opposite conceptual sort of approach in which we do indeed simply cut a flat percentage across the board and make it apply to agriculture, steel and the basic industries, seems to

me a mistaken approach in that I think this would have greater impact on jobs than the approach that we are presently taking.

Senator DOLE. I have a number of questions in this general area, besides general aviation we are all getting inquiries from those who build pleasure boats. Boating has become a great pastime even in the arrid areas of America. In Kansas and some smaller States, areas that are not considered to be recreational spots by some, boating has become not only recreation but it has become big business. However, since they are in the pleasure category, I assume they will be required to make the greater sacrifice. They do not understand that and maybe plans are underway that there are some alternatives or at least some positive statement that will outline the impact and inform us whether there will or will not be any change in that decision. I think this is important so that these firms can make other plans and probably somehow seek some diversification in their business.

In the interest of time and other members who may have questions, and I assume there is a 10-minute limit, I would like to submit these questions for written response so that they may become a part of the record.

Mr. LOVE. We will be pleased to have them, Senator Dole.*

I also would say that if you have some suggestions that can get around the dilemma of—if you allocate to someone in a shortage, you have to take it away from someone else, it is a thing I would be glad to have.

Senator DOLE. In all fairness to the Congress. We spend a lot of our time talking about the fact that there is too much power in the administration, whether it be Republican or Democrat, yet I think when it comes to the unpopular area where we have to make decisions affecting the lives of people, we are very willing to pass that on to the administration. Hopefully, the Congress will accept some of the responsibility for whatever is done.

I think the Senate in particular has acted rather quickly in a couple of areas, but I think you would agree that the worst is yet to come.

Mr. LOVE. I am afraid that is true, yes. It seems to me that there is going to be a fairly long period—that is, the worst is yet to come. The first quarter of next year in the current analysis indicates for many reasons that that probably is the worst that we will see for a period of time until next winter, perhaps, because the summer season is a little bit different, a different kind of problem.

Senator DOLE. Do you think the first quarter of 1974 will be the worst at least under present projections?

Mr. LOVE. Present projections and, of course, it is impossible to forecast with any degree of certainty when and if the Arab oil-producing nations will release the embargo and if they do, whether indeed they will increase the rate of production or not or certainly some factors that we simply do not have as yet.

Senator GRAVEL. I think it would be fair to you, Governor, to let you go ahead and give you an opportunity to make your statement. Then we will go into questions and we will observe the 10-minute rule.

* Senator Dole's questions appear at p. 22. At press time the replies had not been received by the committee.

Mr. LOVE. Thank you, Mr. Chairman, members of the committee. I appreciate this opportunity.

I have, as you know, a written statement. I think perhaps it would serve the purposes of the committee best if I primarily paraphrase the burden of my comments and testimony today. As you know, it is my understanding you were interested in my response to some nine questions generally directed toward your search toward what part should fiscal policy or programs play in the middle- and long-term solutions to the energy crisis.

Certainly, I would agree that this is the subject of proper inquiry and that there is a very real need for a coherent fiscal policy in regard to our programs to produce on a basis that hopefully can be made to reach the capacity for self-sufficiency by the year 1980 and fiscal programs are going to need to play a very large part.

The alternative strategies are many. In general, I still believe that the free market economy, to the extent possible, the free enterprise system, historically and at the present time gives the best hopes for the kind of activities and capital investment and risks that will indeed be necessary if we are going to develop supplies in sufficient quantity not only of conventional petroleum and natural gas but the very capital intensive oil shale project, the very capital intensive series of activities that will have to be carried on in the area of coal that is possible with gasification, liquefaction.

I think the traditional market does provide the kind of financial incentives at least historically, that have stimulated this kind of activity. Let me make myself clear, however. I do not at the present time recommend a freeing of petroleum and petroleum products from the price controls that presently exist under phase IV. I think that this of necessity must be a phased movement because currently, even if we did in fact completely free petroleum and petroleum products from price control, although it might classically dampen demands, it also would not, in my opinion, immediately stimulate much in the way of increase in supply and as a consequence, the pressures would build and I would be fearful of where the prices might go. But over a period of time I do believe that it is not going to be possible to maintain a ceiling and a lid on the energy sources in view of a different and much higher worldwide market.

I believe it is going to be necessary, as painful as it may be, that we are going to have to pay more for energy down through the years ahead. And certainly, we are going to have some higher prices and the potential for profit, if we do expect people to invest their money in the kind of risk situations that will be necessary.

On the programs looking ahead, obviously it is very necessary, in my opinion, that the funding be made available for the research and development programs. The President has talked in terms of $10 billion over the next 5 years and I believe Senator Jackson has talked in terms of $20 billion over 10 years. Both of these numbers again, in my opinion, may be somewhat out of date in that I believe that in view of the current situation they may be indeed too small, but I do not believe there is any way to quantify them finally at the present time until we do assign specific programs to the numbers.

Insofar as the proposal or suggestion, Mr. Chairman, of a trust fund, I have some doubts and reservations. It is my belief that the so-called trust funds established in the past have not indeed turned out to be trust funds and I, of course, think about the Highway Trust Fund or I think in terms of perhaps the whole social security situation. It seems to me to have a further problem from the standpoint that a trust fund on a highway, for example, where you can rather accurately fund it with a user fee, perhaps makes—has more logic but in this situation in which energy has such broad usage, I cannot believe that the user fee concept would be terribly different from just general taxation.

This is not to say that I do not believe that either simply appropriation from the general funds available or indeed as I mentioned briefly a moment ago, some sort of energy banking facility would not—I believe it would be a thing that would have some advantage in the massive task ahead.

As my statement states, it is projected that internal financing on this trillion dollars that has been projected as the amount that will be necessary on a cumulative basis in the next 10 years, and this by the way, is for the non-Communist world, but large portions, of course, of it being required here and it applies just to the conventional oil and gas, internal financing can provide some of these massive sums but certainly not all of them and whether indeed without some help both in the price structure and also in some sort of governmental back-up, to provide take-outs or secondary market or other kinds of activities, I have some concern that that amout of capital indeed would not be forthcoming.

So, in summary and very briefly, Mr. Chairman, I believe rather than depletion or other tax approaches that I would rather see and would recommend for the consideration of this committee a policy that would move as quickly as is reasonably possible toward the kind of free market incentives, plus the research and development funds which would provide great help plus some sort of energy banking facility to provide secondary markets and otherwise aid and assist in the massive job that has to be undertaken.

Senator GRAVEL. Governor, I am confused. You stated earlier that you do not favor decontrol of the price of petroleum products by the Cost of Living Council, and then at the end you just stated that you were for a free market system. How do you reconcile the two?

Mr. LOVE. The reconciliation is the movement on the part of the administration to increments over a period of time move up the prices of the petroleum products that are allowed, moving toward ultimately a free economy, but I am not for the immediate freeing of price control of the products, petroleum and products.

I should add, too, by the way, to make sure there is no conflict or confusion, I still, of course, believe that the deregulation of new natural gas wellhead would serve to materially increase supplies in a comparatively short period of time in an area where it is vitally necessary.

Senator GRAVEL. Well, does the administration have a specific proposal, with which they can enlighten the Congress, regarding what a phasing out of price regulations will mean, so that some planning

can take place in the private sector? Are we to wait for the daily actions of the administration in this? In other words, is there some policy continuity that can be developed over a period of time?

Mr. LOVE. I believe that—I do not know whether he is scheduled to testify or not, but I believe Secretary Shultz will be better equipped to answer that question for you, Mr. Chairman.

Senator GRAVEL. Finally, let me propose one thought here, just philosophically, but it drives to a goal. Incentives, any kind of incentives, would increase supply and lower price. There has been a great deal of dialog within the administration about taxes which would have the effect of cutting down on consumption. It would also raise prices but the money would not go to the sector where we want it, that is, to the energy sector to do something about it.

Now, I am just wondering if we could not combine both of these with an immediate deregulation of gas and oil to, first, raise prices, get money into the private sector, and not have to worry about banking proposals or other bureaucratic ensnarements. So, one, you raise the price to get the money to where you want to get it. Second, the price raise would decrease consumption which we have come to look upon as a virtue today, and at the same time you would increase supply.

Now, the only bugaboo there, of course, would be the danger of excess profits. If we couple these proposals with an excess profits tax, could we not then drop all the sham of regulation, let the free enterprise system work its will and then cover ourselves with an excess profits tax and have a minimum amount of bureaucracy and the best amount of working toward what the consumer really needs?

Mr. LOVE. I see nothing wrong with it except two things. Timing. One, I would quarrel with the fact that a decontrol at the present time would increase supply very quickly. That is, by virtue of a good many things, as you well know, the shortage of drilling rigs, the very real shortage of pipe and other materials, the length of time that it takes to complete, put on line an offshore well, all of these things, it does not seem to me realistic to believe we are going to have any substantial increase in supplies for a period of 3 to 5 years and in the meantime, I would be somewhat concerned about what indeed would happen to prices.

Second, I would think that coupling the excess profits tax at the appropriate time with some sort of an exemption that would exempt those funds that indeed are spent within 12 months for or committed within 12 months for further exploration or development might be a useful kind of amendment to that concept.

Senator GRAVEL. Well, let me ask in general terms, then, Governor, does the administration have a long-term game plan that it can present to the Congress at this point in time?

Mr. LOVE. I have no such specific game plan or program to present to you this morning, Mr. Chairman, no.

Senator GRAVEL. I am told you are the energy czar of the administration. If you have no game plan, then we can only conclude that the administration has no game plan.

Mr. LOVE. I have a program in the process of development, Mr. Chairman, that is generally in this area. I have established a series of interagency task forces which will be looking at the various compo-

nents of the solution to the energy shortage, that is, you can look at coal, you can look at the nuclear, and you know of the various component parts. In each of these areas under a time constraint, in this case 1980, and a more or less arbitrary decision about what part coal, for example, should play in the total mix of domestic energy production, we are attempting to identify what needs to happen in 1 year and the next year, within that timeframe, and what are the constraints. The constraints are in part fiscal. They are in part environmental in many instances.

There are other problems. We are working toward the program and we will bring it to you as quickly as we possibly can.

Senator GRAVEL. Have you begun to estimate, has the administration begun to estimate, for both the public and private sectors, what the capital costs would be to attain self-sufficiency? Is anybody putting together some figures? Senator Jackson came out with an original proposal of $20 billion as the Federal share. The President in his statement said $10 billion. What is going to be the cost factor for arriving at self-sufficiency?

Mr. LOVE. I think on the $20 billion figure. I think the Senator is talking about 10 years. On the $10 billion the President was speaking in terms of 5 years. But as I said a minute ago, I think perhaps in view of the current situation and the greater need and sense of urgency that has been brought by virtue of the Middle Eastern war, I believe that we would not necessarily consider those as top or ceiling figures but we do indeed continue to—need to continue to judge the amounts by the specific ways we propose they be spent. We will be up as a part of this budgetary process with a proposed program for the first year's research and development expenditures.

Senator GRAVEL. Good. I will come back. I yield to Senator Mondale.

Senator MONDALE. Governor, as I understood the President's message the other night, he anticipates about a 17-percent shortfall in energy resources and believes that his proposals would make up 10 of the 17 percent, still leaving a substantial gap between estimated shortfall and supply.

What is the administration plan to make up the difference?

Mr. LOVE. We are working on additional programs that I am not prepared to suggest in any detail at the moment. I think that it can be generalized in the overall strategy. As you know, as far as targets anyway—as you know, the shortages do not occur at the same percentage rate in the various fuels. For one example, our general projection is that we are going to have to decrease the use of gasoline by 25 to 30 percent. The current announcement indicates a lessening of 15 percent from the suppliers to the stations. We want to look at that, plus more accurately assess, for example, what effect a voluntary compliance indeed, is going to have. It may be that we are going to have to move rather quickly to do a larger percentage there.

Senator MONDALE. Well, as I understood the President, he said that the shortfall will be about 3 million barrels per day. His program will make up about 1.7 million, which would leave us about 1.3 million barrels per day short.

Mr. LOVE. I think it needs to be refined further. The shortage we forecast in this quarter is 1.4 million and we think it is about 3½ million barrels in the first quarter of next year.

Senator MONDALE. Which would make the shortfall without additional actions even worse. In other words the 1.7 million barrels made up under the President's program will leave us 1.8 million barrels short given the 3½ million that we expect to be short. Now, are you telling me that no decision has been made yet as to how to make up in effect, 50 percent of the shortfall?

Mr. LOVE. No final decision has been made for further suggested programs.

Senator MONDALE. Now, would you agree with me that each passing day that this decision is not made creates more and more difficulty? First of all, the very uncertainty of the situation is very debilitating for our economy.

Second, the Arabs must realize that we are having trouble and this must encourage them to believe that the boycott is successful.

And third, the longer we fail to face up to the shortfall, the more severe will be the repercussions when it finally hits.

With that in mind, would you tell us what alternatives you are now seriously exploring and how quickly you expect to make a decision?

Mr. LOVE. Let me first express my opinion that there indeed is very real need to move, continue to move as we have been, promptly, but I think that moving without knowing as accurately as we can the effects of that move would be perhaps a more debilitating thing for the economy. The attempt has to be to so manage this thing that it impacts on the economy and on jobs to the least extent necessary.

I perhaps would be repetitive when I indicate the—I mentioned briefly gasoline, possible strategies there.

Senator MONDALE. Well, could you——

Mr. LOVE. The whole thing of—we have a whole paper that I think is very hopeful on a series of actions that could be taken presumably with some rather simple existing technology that we perhaps will come out with very quickly, little things like an automatic flue damper.

Senator MONDALE. Automatic what?

Mr. LOVE. Flue closer.

Senator MONDALE. Will that help in the next half year?

Mr. LOVE. They tell me, and this is one of the things that we have to get a paper on—we are going to meet this afternoon among other things, to determine whether that kind of thing is really available and how quickly it could be installed, and so on. This is the kind of thing, Senator, that——

Senator MONDALE. Here is what strikes me, and tell me if I am wrong. It seems to me that there are some fundamental supply questions that are long term that are very hopeful, but expensive, and which involve lots of problems.

Mr. LOVE. Yes.

Senaotr MONDALE. But if we are going to meet this immediate, potentially disastrous shortfall between supply and demand with all the economic repercussions and the other problems, basically it is short-run conservation measures that have to be taken. The President made some proposals which would get us about halfway to the goal line. We still have got halfway to go.

Can you tell us what options are now receiving the most serious consideration and how quickly those decisions will be made?

Mr. LOVE. I cannot at this moment identify for you all the options and I——

Senator MONDALE. Well, what are the major ones? Are you thinking of rationing? Are you thinking of a steep tax? Is there some other alternative that is being seriously considered?

Mr. LOVE. Obviously, rationing and taxation have been under consideration. I would suggest it is my personal opinion that there is some temptation on the part of some people to think that gas rationing is the cure-all and I do not think it represents a panacea.

Senator MONDALE. I am trying to find out what the Government is thinking and not what others might be thinking. Or would it be the case that basically, you are hoping that the Arabs will relent?

Mr. LOVE. Certainly, that is not the basis of policy at the present time because I believe that even if they turned on the spigots next week, say, that the hiatus, the gap, plus the disruption in the normal distribution channels worldwide, is still going to bring us a problem for some time to come.

Senator MONDALE. Would it not be a better posture to be in vis-a-vis the Arab boycott if we had now in place conservation measures that clearly made up the gap so we could tell the Arabs that it is not hurting and that we can handle it? Now they know we are only handling half of it and they read about U.S. economists predicting 8 percent unemployment and a loss in gross national product of $100 billion. The Arabs, unless they are foolish, think they have got us until we get a program to meet that problem.

Now, when are we going to get it?

Mr. LOVE. Senator, I think that just makes the point. In other words, you say immediately give us a program that will not cause this unemployment. Now, if there were some quick, easy way to do that, obviously you would be right, but it seems to me the approach we are taking in trying to analyze the steps that we are taking to insulate to the extent possible the cutbacks from the economy and the jobs I think is the wise way to proceed.

Senator MONDALE. Well, how soon do you think we will have that decision? Next week?

Mr. LOVE. Next week or 10 days, I think we will have additional programs to recommend.

Senator MONDALE. One final point, if I may, relating to the question of United States-Canadian relations as it applies to oil supplies. You know that all across the Northern tier of the United States the refineries depend almost exclusively on Canadian crude and these are the areas that are going to be the hardest struck with heating oil problems and the rest. Since early spring of this year, the Canadians have reduced exports of crude by approximately 300,000 barrels a day and are now shipping some of that around through the Panama Canal to supply Eastern Canada which is in short supply because of the boycott.

Do you see any short-term hope that the Canadian might increase exports? Do we have negotiations underway to encourage than to do so, and what is the prospect for getting exports increased from Canada to those refineries?

Mr. LOVE. Some weeks ago I visited Ottawa and called on my counterpart, Mr. MacDonald, and explored this kind of possibility.

We have a working group exploring some of the more specific details, meeting today. Mr. MacDonald intends to—he had intended to come either the 4th or 5th of December. It has been delayed a little bit. We are examining it. As far as the optimism that we should have at the current time, I think it is highly unlikely that we can expand and count on any material increase in the exports from Canada.

In the longer term we have some high hopes insofar as natural gas, particularly from the McKenzie Delta, if we combine it with the Prudhoe Bay. Even in the Western Provinces there is some additional production that might be present. We still have pipeline constraints, and so on, that would make it difficult to increase.

Senator MONDALE. Are there negotiations underway now with the Canadians to try to at least restore export levels to where they were?

Mr. LOVE. Yes; we are in the process.

Senator MONDALE. Who is handling those negotiations?

Mr. LOVE. I, together with Mr. Casey of the State Department.

Senator MONDALE. Thank you, Mr. Chairman.

Senator GRAVEL. Senator Dole.

Senator DOLE. I think Senator Bentsen is a member of the subcommittee. I have been here once.

Senator BENTSEN. I would like to defer to Senator Ribicoff. If I might subsequently——

Senator RIBICOFF. Thank you very much.

Governor, in 1970 the total depletion allowance to American oil and gas companies amounted to $3.6 billion. About one-half of that, $1.8 billion, was a depletion allowance for extraction outside of the United States.

Do you think it is fair and proper to give American oil companies this depletion allowance for extraction in foreign countries that embargo oil and gas to the United States?

Mr. LOVE. Senator, as you yourself noted, I in all likelihood have not had the opportunity to think at length or to analyze this situation. I had not a prepared statement on it. I would be glad, if you would like, to provide at a later date some more specifics but I would talk to it just generally now.

It seems to me that in view of the situation that has occurred, one, the continued expropriation of larger amounts of the ownership of the wells, the companies, the unilateral pricing situation that has occurred, ultimately the embargo, I think that the whole concept needs to be reexamined. A concept that perhaps was logical and had some merit at one time seems to me to look in a much different light to me at the present time.

Senator RIBICOFF. Now, in addition to the oil depletion allowance under American tax laws, in 1970 U.S. corporations earned $1,085 million from foreign mining operations which included crude petroleum. American companies paid foreign taxes of $725 million and claimed a foreign tax credit of $701 million. As a result American companies doing business in oil and gas abroad paid zero taxes to the U.S. Treasury.

In view of the embargo by foreign governments of oil and gas shipments to the United States, should American corporations be given this tax credit? What we are actually doing is paying foreign

governments out of American tax dollars for earnings abroad on embargoed products to the United States.

Mr. LOVE. As I understand it, Senator, even though the embargo is effective enough that the product or the oil is not moving to the United States, they still, for example, in Saudi Arabia are producing something like 6½ million barrels a day which is flowing and the—whether you call it a tax, the amount paid by the companies to Saudi Arabia for that oil they are deducting from their tax liability here in the United States, is that correct?

Senator RIBICOFF. That is right, but, you see, for all practical purposes, American tax dollars are a fee being paid to Kuwait and Saudi Arabia which ordinarly would belong to the United States.

Now, if the United States is getting the advantage of the oil extracted from Saudi Arabia and Kuwait I could understand the argument that we should give these oil companies a tax credit. Why should we give these tax breaks for a product we will never get?

Mr. LOVE. Well, the only two reasons I could think could justify the kind of arrangement we have been discussing here are, one, to stimulate the creation of supply. Now, with the current situation in the Arab producing nations, that no longer seems to me——

Senator RIBICOFF. That is right, and there is an objective to stimulate supply. I read in the paper the Saudi Arabians claim they still have untapped resources the equivalent of what has been discovered to date. Now, if the United States explores and pays for these untapped resources, under the present tax system the oil companies will get tax breaks for oil that may never reach our homes and factories. Why should we continue this policy?

Mr. LOVE. I also—just to add one further consideration, I find it hard to describe the payments being made to the producing nations as a tax, really.

Senator RIBICOFF. That is right. Now, you have put your finger on one of the great mysteries and rackets of the American tax system. Somebody very smart about 30 or 40 years ago got the oil companies a great break by creating royalties as taxes thus allowing them to gain a credit against taxes paid to the United States. The result was that the Arab countries were the beneficiaries of billions of dollars taken from the American taxpayers. So, therefore, do you believe under the circumstances, the time has come to review the relationship of the entire tax structure of the American oil industry as it relates to the production of oil and gas in foreign countries?

Mr. LOVE. Yes, I would agree it is time to reexamine.

Let me add one caveat, though. I strongly believe that we would not be well served in the long term by actions designed to make the companies not profitable. That is, the amount of money it takes to build a refinery or to build an offshore field, and so on, requires, as we have been saying, large amounts of capital. They do need to make profits. The profits should be taxed in most instances in consonance with our other forms of taxation. But I mean the caveat is that in reexamining I do not think the objective should be simply to weaken the companies financially.

Senator RIBICOFF. All right, but you have been talking about a trillion dollars being needed for the production of energy in the United States and much of it would have to come from both Government and

private sources. But if the depletion allowance or other incentives were only given for the exploration in the United States or countries that do business with us, would not the oil companies spend their money for exploration and for developing alternate sources of energy in the United States and its dependencies rather than in countries that embargo the United States.

Mr. LOVE. The only practical problem, and it may not be controlling, is—at least on the advice and information that I have, the sad fact is that most of the reserves that we know about exist in those Persian Gulf countries. I hope that we can find that is not true and that we can find the kind of fields that would prove me wrong in that.

Senator RIBICOFF. Well, but, oil companies today are concerned with alternate sources.

Mr. LOVE. Yes.

Senator RIBICOFF. They are interested in oil shale. They are interested in tar sands.

Mr. LOVE. Coal.

Senator RIBICOFF. Coal and geothermal and other sources. They are looking ahead.

Now, if they were given the tax break for domestic production as against foreign production, then more American capital would be going into domestic production instead of foreign production, and is this not the time to look at all of the weapons in our arsenal in dealing with the Arab countries or any other nation that might boycott us?

Mr. LOVE. I certainly cannot quarrel with that. We need every tool available to us.

Senator RIBICOFF. One more question. There has been some talk about authorizing the President either by himself for the United States or in concert with other nations to cut off exports either unilaterally or in combination with other countries to nations which embargo needed resources to the United States or its trading partners. How would you react to giving the President that authority?

Mr. LOVE. Congress, of course, could give him the authority. He certainly should have broad discretion as to the use of that authority.

Insofar as Arab nations are concerned, the amounts of food and machinery, and so on, that are indeed imported according to some opinions, could be made up from other portions of the world, even assuming that we could put together a consortium or agreement among the non-Communist nations.

Senator RIBICOFF. If I have any time left, one final question. Do you think it is fair to New England or the upper reaches of the Midwest to have a uniform policy of reducing the percentage of heating oil when the problem is greater because of the cold weather in New England, Connecticut, Minnesota, North Dakota, South Dakota, Illinois? Do you think it is fair to have such a policy under the complete control of the oil companies themselves and not put into place by the Government to assure a fairness of treatment to all sections of the Nation?

Mr. LOVE. Well, first, the program as first devised prior to the Middle Eastern war attempted to relate it to the historical usage. This has been a problem but nevertheless historically, New England and the upper Midwest would have used more and there is, therefore, that emphasis there.

The allocation program now, cut back as we expect it to be at the distributor level some 15 percent, is to be managed according to the distributors in New England in their representations to me and that they will look at a 3-day kind of formula and they perhaps know better than any of us what their customers indeed have used, et cetera—I would be fearful of attempting to put in place, particularly on any kind of crash basis, the kind of governmental organization that would indeed attempt to allocate to the individual user an amount. I would think that it would be an administrative monstrosity.

Senator RIBICOFF. My thanks to Senator Bentsen and you, Mr. Chairman, for your courtesy and consideration, and Senator Dole. I want to thank you for giving me this opportunity to ask questions. Thank you very much.

Senator GRAVEL. Senator Bentsen.

Senator BENTSEN. Thank you very much, Mr. Chairman.

Governor Love, I would like to pursue again this thought about how we meet the gasoline shortage this year. I for one, do not believe that a voluntary program will work and I have heard two rather unpleasant alternatives offered. One of them is a very high tax and the other is gasoline rationing.

I have heard the comment I believe attributed to you that for a tax to have an appreciable effect in the reduction of gasoline conumption, that your estimate would be that we need a tax in the area of some 30 cents a gallon.

One cent a gallon results in about a billion dollars of tax money. So this would mean something up to $30 billion of reduction in consumer spending. I would think that would lead to a recession in this country if you took another $30 billion out of the consumer's pocket, in addition to the other slowdowns that we are going to see in our economy.

Therefore, although I know that gas rationing is not a total solution, it certainly seems to me it is the lesser of the two evils.

Would you care to comment on that?

Mr. LOVE. Yes. I have one other rather practical problem with the taxation route, or two problems. One, with all due respect to the Congress, I do not really believe that a tax bill of that sort would move through the Congress in time——

Senator BENTSEN. Governor, you are absolutely right. I would oppose it all the way because I think the poor would pay that tax and I think it would result in a disproportionate burden being placed on them. I also think it would bring about a recession.

Mr. LOVE. I further have a little cynicism that indeed it would dampen demand as much as we would hope. I would expect that some people would go ahead and pay the 30 cents and drive.

But the problem, if I can address myself to the problem of rationing for just a moment, it seems to me, one, that just the limitation of gasoline as you well recognize, is not the total answer. We have to get the other products, such as the residuals and the very difficult and sensitive areas of the middle distillates, diesel and the heating oil, and so on.

As you well know, our refineries have some limitations on how much shift in mix they really can make on the limitation of amount of gaso-

line that we are going to let them distribute, 15 percent less, some people talk in terms of at least a storage problem that they would meet, but we think that this plus some other things would cause force to gather winds and change the Cost of Living Council rules, forcing the kind of shift on the other products which we need more as far as the essential economy is concerned.

If we do that, we are moving toward supporting the economy and insulating it to the extent possible, but it then leaves us with the problem of, instead of the inconvenience and perhaps catch-as-catch-can results at the station, how do you then attempt to bring some equity in that distribution, and again, until you—I hope that we will be able to publish some proposed plans before long because I think it is important that the debate go on on the specifics rather than the general.

I am afraid that most people in thinking of rationing say, well, that would take care of me, when it may or may not.

Senator BENTSEN. Let me ask you this. In talking about the mechanics, have you been able to get through the Office of OMB your request, total request for personnel for staffing?

Mr. LOVE. Not—that is as far as my office is concerned?

Senator BENTSEN. Yes.

Mr. LOVE. We are in the process at the moment of, I think, satisfying that demand. It has not been——

Senator BENTSEN. It has not been accomplished.

Let me ask you the next one. My concern goes to the point also in listening to the President's energy message earlier this month, when he was talking about his support of research and development for alternative sources of fuel. At that time the Office of OMB had $60 million impounded. As of last week I noticed they still had $20 million for research and development impounded. That seems to be at cross purposes and that is why it concerns me whether or not they are really staffing you and the other offices that are necessary for implementation of this.

Let me give you another one. We have a problem on drilling pipe and other tubular steel these days as was mentioned earlier. What do we do about it? You have a 2.4-percent increase in price of flat steel, another price increase scheduled for January, probably. It is more profitable for the companies to produce the flat steel than it is for tubular steels, but here is an inequity that results in further aggravating the problem we have on energy. It seems to me first, we ought to be giving them the price increase on pipe that is comparable to flat steel so they produce it. Second, we ought to resort to something comparable to the Korean war situation where we stockpiled pipe around the country to be provided on an immediate need basis. They set aside, let us say, 5 percent of the production and then if someone had a well that they wanted to drill, they could get the pipe.

The problem you run into now, there is not enough pipe being produced and some of the major companies apparently have bought up some of the pipe. The independent fellow that is really ready to drill a well has not been able to get it. This set-aside program worked during the Korean war. Why would it not work now?

Mr. LOVE. I have asked the Cost of Living Council and should have a report this afternoon on what can be done insofar as price mix to stimu-

late the tubular goods that are in short supply. The thought that through some means we would purchase and stockpile is a new thought to me and we will certainly look at it.

Senator BENTSEN. It was done during the Korean war and was fairly effective. A man could not get the pipe unless he showed he had a permit and was ready to drill.

One of the things I had in the way of amendment to the emergency energy bill was a request that the Council of Economic Advisers to the President give us a report within 60 days of the economic impact of this energy shortage, what it meant in the way of loss of jobs, what it meant to transportation, what it meant to production in this country. We saw the stock market go off a substantial amount of money yesterday and that was because of the uncertainty. We are not going to be able to have a remedial situation and remedial programs until we fully understand the impact on our economy and I do hope they do not wait for the legislation to finally be signed by the President before they move on this kind of a recommendation.

Mr. LOVE. The Council of Economic Advisers is hard at work and I would expect that to be out relatively soon. I would add, too, the uncertainty about the impact depends in part on how we manage this thing but there has been as you well know, uncertainty that different claims on the figures and so on. I believe that the figures, the analysis of the situation we put out should be a help in that regard, that this is indeed where it will impact.

Senator BENTSEN. Governor Love, I have one more. In the question of finding an alternative source of energy. I know it is not a quick resolution of that problem, but coal—we understand we have 853 billion tons of known recoverable reserves, possibly as much as 3 trillion tons in this country. I know some of the reports I have seen show that they are going to be able to produce synthetic natural gas through the gasification of coal at $1.46 an MCF. Now, you are landing Algerian liquified gas in these shores in the area of $1.25. How do you get capital to commit the hundreds of millions of dollars necessary if the Arab nations can turn on and off the spigot at a price that is substantially less and destroy those capital commitments?

Mr. LOVE. I believe—I do not know whether you were here at the time, but Senator Long was asking me, I think, a very similar question, asking whether indeed we should not have some sort of governmental take-out or guarantee to protect the major investment if indeed the Arab producing nations choose to attempt to lower the price and, therefore, harm our economy.

I expressed further my opinion that I would not have the same fear that the Arab producing nations will attempt to ever again or will—I almost hope they would bring the price of petroleum down to the dollar a barrel or whatever it was when we were attempting to protect the domestic industry, but it certainly is a potential that is there and I think it is well worthwhile taking a look at because the risk capital that is involved, I think in terms of refinery, how are you going to get the investment to build a refinery unless you have got some stable supply of crude, and it may be that some governmental intervention or guarantee is going to be necessary to do that.

Senator BENTSEN. Governor, this question is asked on behalf of Senator Long and myself. I have seen some numbers that say approxi-

mately 32 percent of the oil in place is being recovered in this country. Now, what is the administration doing in research and development on secondary and tertiary recovery?

Mr. LOVE. We do not have a program to present today. We have been hard at work on not only tertiary recovery but the whole series of—it will be a part of the package we will be presenting as the first increment in the so-called $10 billion program that will be a part of our recommendation in this next budget.

Senator BENTSEN. Mr. Chairman, I would like to introduce in the record at this time a study on the subject of tertiary recovery. It was done for AEC by the Gulf Research Corp.

Senator GRAVEL. Very well.*

Senator Dole.

Senator DOLE. Mr. Chairman, first of all, I think we should make a part of the record the factsheet issued by the White House on new energy emergency actions, including those voiced by the President. I would ask permission that this be made a part of the record.

And secondly I think there should be a part of the record of the Finance Committee hearing, information and facts on what we have done to the oil industry in this Congress and prior Congresses. I go back to the 1969 Reform Act where we lowered the depletion allowance, made significant changes in expensing and tangible drilling costs and other "tax reforms" that cost industry hundreds of millions of dollars. I think it should be kept in perspective as we look at new ways to help provide incentives for exploration and drilling. We need to take a look at what we did to really dim those prospects less than 4 years ago. I do not say that in total support of the oil industry but Senator Bentsen has alluded to independents in my State who are nearly out of the business. I assume the activity in Texas has also been greatly curtailed, much of it a direct result of some of the legislation passed by Congress because at that time there was no concern about a shortage. There was only a concern about anyone engaged in the oil industry of somehow having an unreasonable profit. And so I would hope and I would ask that that be made a part of the record when available.

Senator GRAVEL. The address and the factsheet will appear in the record.

[The fact sheet follows. The address by the President appears at p. 33.]

CHANGES IN THE TREATMENT OF OIL AND GAS UNDER THE REVENUE ACT OF 1969

1. *Percentage depletion.*—The rate at which depletion may be taken was reduced 5½ percentage points, from 27½ percent to 22 percent, effective for taxable years beginning after October 9, 1969.

2. *Minimum tax.*—A minimum tax on tax preferences of 10 percent was imposed, effective January 1, 1970, on the preference items of both individuals and corporations. The tax applies to the sum of preferences in excess of (a) $30,000 and (b) the amount of regular Federal income tax paid by the taxpayer. Tax preferences include the amount of percentage depletion claimed in excess of cost depletion (sec. 57(a)(8)).

3. *Production payments.*—"Carved out" and "retained" production payments created after August 7, 1969, are treated as mortgage loans, and not, as under previous law, as economic interests in the property (sec. 636). As a result, the

*See appendix A, p. 569.

sale of such a production payment does not result in the realization of gain by the seller-operator of an oil property. Payments to the buyer of the production payment out of the income from the property are not depletable income to the buyer, nor are they deductible by the seller-operator. The new rule prevents (a) the shifting of mining income from one year to another to avoid limitations on percentage depletion (50 percent of taxable income from the property), and (b) the financing of the purchase of oil properties with before tax dollars (ABC transactions).

4. *Foreign tax credit.*—In tax years beginning after December 31, 1969, the foreign tax credit is reduced for foreign taxes paid on foreign mineral income to the extent such taxes are attributable to income shielded from U.S. tax by the percentage depletion deduction (sec. 901(e)). This rule applies on a country-by-country basis.

5. *Sale of oil and gas properties.*—In a minor technical change, the maximum tax imposed on the proceeds received by individuals from the sale of oil and gas properties proven by work done personally by the taxpayers is limited to 33 percent of the selling price, as opposed to a "normal tax" of 30 percent and a "surtax" of 3 percent (sec. 632).

6. *Contientnal Shelf areas.*—The continental shelf of the United States is defined to extend out to the limit of the United States' exclusive rights of exploration for, and exploitation of, natural resources. The same definition applies to a foreign country or to a United States possession only if that country exercises taxing jurisdiction to as far as it has such exclusive rights for exploration (sec. 638).

Senator DOLE. I would also comment that I think Governor Love's comments indicate the complexity of the whole energy problem. We have had questions directed with reference to taxation which probably should go to Treasury officials. We have had questions that get into the cost of living area. These questions cover the whole gamut of responsibilities, and I certainly commend the Governor for being as responsive as he can because I understand the broad implications of some of the questions.

In foreign tax credit, for example, if that should be changed and if there is a strong feeling for that, we could do that today on the debt ceiling bill which generally ends up as a Christmas tree in any event.

Getting back to policy which I believe you are directly responsible for; what is the administration's policy with reference to drilling off the Atlantic coast? Has there been any policy, have there been any studies to indicate there are any potential reserves off the Atlantic seaboard?

Mr. LOVE. Yes. As a matter of policy we believe that the kind of seismic and other investigation followed by leasing programs that will as quickly as possible bring on the exploration not only off the Atlantic coast but the full gulf coast, the Gulf of Alaska, the west coast, is necessary as a part of the overall solution to the problem.

Senator DOLE. I think you will recall, in 1969 following the oil spill off the coast of Santa Barbara, there was a rather wide restriction placed on offshore drilling in that area. Has there been some reconciliation with the proper interests, I might say, of some of the environmentalists and with the problem in hand—how do we quickly produce known sources of oil and gas reserves?

Mr. LOVE. On Santa Barbara, we again presented, are in the process of presenting to the President the kind of—bring it to his attention, to look at it again. I do not know the ultimate decision on that yet.

Mr. DOLE. I think it is fair to say, I think you have said it before, the one question that probably you cannot answer at this point is, the

allegations that we have not gone far enough in this administration, that we are taking the easy steps by cutting back the speed and otherwise lowering allocations to industry and others and by suggesting we turn down thermostats. Do you consider that to be a good assessment, that we have not gone far enough and that other things of a significant nature will happen?

Mr. LOVE. I do not think it is a good assessment that we have not moved swiftly enough or gone far enough or that we have taken easy actions. I would suggest that we still on many of the actions we have taken, do not believe we have the legal authority to make them mandatory and we still are, of course, waiting for and expecting and we do appreciate the prompt reaction of Congress on the emergency bill that we badly need these powers and authorities. If you believe that the present actions are easy, I would gladly refer you to my telephone calls and my mail and the people who call on me and that there is nothing, believe me, in the use of energy that you do that does not affect very vitally the way people live and the economy as I think we perhaps discussed a moment ago. The Sunday closing of filling stations is threatening to have a major impact on the tourist, recreational, and leizure time economy and there are a great many jobs involved in that. The problems of speed limits have complexities insofar as trucking, moving of perishable goods, just small examples of the fact that this needs to be done carefully and it needs to be done with full realization that what you do can have impact far beyond what seems to be true on the surface.

Senator DOLE. I think getting to Senator Mondale's question, which I think everyone is asking, if there is an answer, it would not be easy to implement. This is the answer. Now, how do we implement it?

Mr. LOVE. Yes.

Senator DOLE. I think the suggestion in his question that if we wait, say, for 30 days and then you are getting into the first quarter of 1974, which promises to be the worst quarter of next year, then how much of an added burden will there be on that first quarter if we wait until January 1 to do what some suggest should have been done 2 weeks ago, or 6 months ago, rationing.

Mr. LOVE. I do not think gasoline rationing would have that quick an impact on the heating oil for the first quarter of next year. So, if you think that that is—if they think or whoever thinks that simply by rationing gasoline that you immediately increase the supplies of distillates, I think they are mistaken there. We are, as you know, moving with the refineries to maximize their production of distillates. I think it needs to be said, too, it needs to be realized that we have already with the 15-percent reduction, taken action and this is designed to spread the low thermostat setting, the problem, over the winter. If we had not moved quickly in that area we would have come along with the normal usage and then hit a more severe drop in the first quarter of next year.

Senator DOLE. I think you would conclude, then, that these are real efforts and not strictly cosmetics or some suggested rhetoric on the part of the President. Would you agree with that?

Mr. LOVE. I should say so. That is, again, the move we are taking to cut back on just the supply of gasoline, the move we are taking to cut back on heating oil to the ultimate consumer, the very substantial cut-

back in airline schedules, a whole series of actions that I believe have great substance and will indeed help, but let me again express that no programs, whether obviously voluntary, but I also would say mandatory, indeed are going to work unless the people of the United States recognize the seriousness of the problem and indeed do join in what has to be a massive and cooperative conservation movement and program.

Senator DOLE. Thank you, Governor Love.

I would ask permission that the question I indicated earlier would be presented to you for answer, be made a part of the hearing record and that I provide you with a copy of those now. They refer to the special problem which I am certain is only one of many special problems presented by the General Aviation Manufacturers Association.

[The questions of Senator Dole.* a fact sheet on general aviation and the Senator's prepared statement, follow:]

Governor Love, we are all concerned about the tax and fiscal impact of the recent announcement by the President concerning fuel allocations. As you know, my state, Kansas, is heavily involved in the production of aircraft for general and business use all over the world.

It appeared to me that the specifics on fuel allocation were more severe for this industry, General Aviation, than any other form of transportation.

1. Could you tell me why?
2. What will be the impact on this industry in terms of people, dollars or sales?
3. What will be the tax loss to the Airport-Airways Fund? What are the estimated sales loss? Taxes lost on these sales?
4. What are the estimated sales loss? Taxes cost on these sales?
5. What will be the effect on exports by these companies which have maintained a favorable balance of trade for so many years?
6. To what extent do you see cuts in the FAA budget to compensate for the decrease in flying activity and the loss of sales lease?

The survival of an industry which contributed over 200 million dollars to the U.S. balance of payments in 1973 and which will be forced to lay off approximately 100,000 employees within six months is important to the Senate Finance Committee, and the country.

1. What judgment factors were used to single out and treat the general aviation industry unequally with the automobile industry and the airline industry in arriving at the 44% restriction cutback in aviation gasoline and the 40% cutback in kerosene, compared with the 15% cutback in auto gasoline and the 15% cutback in airline fuel.
2. The general aviation industry used approximately seven-tenths of one percent of all transportation fuels used. Why kill an industry by requiring them to make substantially greater cutback than other industries when the result will have a very very negligible effect on the solution of the fuel problem.
3. What is the impact you have generated on the general aviation industry?

The White House release on the type of actions to be taken to conserve fuel included the statement that by turning off ornamental, memorial and store signs approximately 20,000 barrels of oil will be saved daily. General aviation service operators and fixed base operators at the more than 5,000 airports through the country equals the 47,000 barrels of oil products daily. What consideration was given that a 50% cutback to these operators who operate essentially for the same profit margin as automobile service stations would not have a calamative affect on their survicability.

A cut of 50% in the fuel allocated to personal and instructional flying has been indicated by The White House. What considerations were given to the line of credit financing arrangements of the thousands of dealers and distributors

*At presstime the replies to Senator Dole's questions had not been received by the Committee.

who now face a minimum of a 50% cut in their cash flow to meet their debt amortization commitments? Does this not spell financial collapse, repossessions, and bankruptcy to these small businesses?

Last year general aviation transported 70 million passengers in the United States—serving all of America's 12,500 airports—95% of which do not have scheduled airline service.

Won't a 40% reduction in general aviation fuel require a comparable reduction of essential service to these rural areas?

FACT SHEET—GENERAL AVIATION: AIR TRANSPORTATION ROLE

Seventy percent (70%) of all general aviation flying is for business and commercial purposes . . . it includes business flying, agricultural flying, emergency and health services, air taxi and commuter, law enforcement, pipeline patrol and other industrial and commercial purposes.

The active U.S. general aviation fleet consists of 145,000 non-airlines, non-military aircraft with ownership divided equally between individuals and businesses . . . general aviation flying is broken down into the following categories... business/executive, personal, instruction, air taxi (commuter), rental, aerial application, industrial, special, and other. (See table #1)

General aviation's economic and social benefits are well recognized and used by the public according to a recent ORC national survey. (See table #2)

General aviation balances the nation's air transportation system by serving all of America's 12,500 airports including the 95% that do not receive scheduled airline service . . . in addition it is serving a larger role of airports where airline service has been reduced.

Small communities have developed a need for scheduled air service and general aviation's air taxi and commuter carriers efficiently fulfill this vital requirement.

In 1972, over 5.2 million passengers were carried by the commuter carriers . . . cargo carried increased 46% . . . mail carried was up 25% over previous year.

General aviation is carrying about 1 of every 3 (80 million) air passengers on intercity flights each year . . . 60% of those carried are between communities not served by the airlines.

Hundreds of American businesses have decentralized to the nation's smaller communities, and have come to rely on the business airplane as an essential part of their everyday conduct of business and their productivity.

There are 38,000 aircraft (2,400 turbine powered) that are operated by businesses . . . in addition thousands of other aircraft are regularly chartered or rented for business purposes. Business aircraft range from small single and twin airplanes to heavier twin, turboprop and turbojet aircraft.

NBAA Data Bank shows that 29.5% of all business flights interconnect with scheduled air carriers to deliver or pickup passengers or cargo . . .

Employment in the general aviation industry is at an all-time high with an estimated 150,000 people employed in manufacturing, (50,000) sales and service.

Recently recovering from the recessionary effects of 1970/1971, general aviation manufacturers forecast total 1973 year-end production of 14,000 aircraft with factory net billings exceeding $820 million.

Retail sales of airframes, engines, avionics, maintenance support, fuel, aircraft rental, flight instruction and other services for general aviation will approximate $5 billion in 1973.

Exports of general aviation aircraft are running 61% ahead of 1972 with deliveries anticipated to reach 3,400 units producing a positive U.S. balance of payment of more than $225 million . . . historically, 1 in 4 aircraft produced domestically is exported . . . 85% of free world civil aircraft fleet is U.S. manufactured . . . American engines and avionics have even a larger world market share.

FACT SHEET—GENERAL AVIATION: FUEL CONSUMPTION

General aviation uses .7% of "all fuels" consumed in transportation . . . U.S. transportation consumes 40% of total nation's petroleum . . .

General aviation uses 6% of "total civil and military aviation fuels, both kerosenes and gasoline" (23 million barrels of 381 million barrels annually).

GASOLINES

In 1972, "aviation gasolines" accounted for .7% of "all gasolines" consumed (45 thousand of 6.4 million barrels daily) . . . general aviation consumed .4% of all gasolines (26 thousand barrels each day).

KEROSENES

"Aviation kerosenes" both military and civilian accounted for 80% of "all kerosenes produced" (1 million barrels of 1.25 million barrels daily) . . . general aviation consumption of kerosenes accounted for 8% of total U.S. kerosene consumption (87 thousand barrels daily).

According to Department of Transportation figures, general aviation kerosene consumption accounted for 1.7% (20 thousand barrels daily) . . . discrepancy between API and DOT figures as explained by reason that some general aviation fuel dealers sell their kerosene to supplemental and scheduled for carriers.

Since 1971, general aviation kerosene consumption has increased by 16%.

DEPARTMENT OF TRANSPORTATION

GENERAL AVIATION FUEL CONSUMPTION BY USE

	Percent of aviation gas	Barrels per day	Percent of kerosine	Barrels per day
Business executive	35	9,450	80.0	16,000
Personal	25	6,750	----	----
Instruction	14	3,780	----	----
Air taxi	10	2,700	1.1	2,200
Other including aerial application, industrial special, etc.	16	4,320	9.0	1,800
Total	100	27,000	100.0	20,000

Note: All figures are from American Petroleum Institute unless otherwise specified.

IMPORTANT BENEFITS FROM GENERAL AVIATION

Q. 7 "As I read each of the following, please tell me whether or not you see it as an important social or economic benefit brought about by General Aviation?"

[In percent]

	Total public		
	Yes, important	No, not important	No opinion
It provides emergency services in the event of disasters such as floods or earthquakes	95	3	2
General aviation provides people with jobs	95	4	1
It saves the businessman time in his work	93	6	1
It helps move mail and cargo efficiently	92	4	4
It allows people who live far away from major airports to travel more conveniently	89	8	3
It helps the industrial growth and development of rural areas	76	17	7
The light aircraft which we make here and sell to other countries helps our balance of trade	75	10	15

PERSONAL EXPERIENCE WITH GENERAL AVIATION

Q. 12 "Have you ever flown in a private or business plane, or used a commuter or air taxi service?"

Table 2

	Percent
Total public:	
Yes	41
No	58
Don't know	1

DEPARTMENT OF TRANSPORTATION

GENERAL AVIATION HOURS FLOWN BY PRIMARY USE

	Percent of hours	Estimated hours flown, 1972
Business/executive	28	8,200,000
Personal	28	8,100,000
Instruction	17	4,950,000
Air taxi (commuter)	9	2,620,000
Rental	8	2,330,000
Aerial application	5	1,450,000
Industrial special	3	870,000
Other	2	580,000
Total	100	29,100,000

STATEMENT OF HON. BOB DOLE, A U.S. SENATOR FROM THE STATE OF KANSAS

Mr. Chairman, this week's hearings of the energy subcommittee are most timely but they are also ironic.

They are timely in that energy matters constitute the most pressing and complex business before Congress this year. But they are ironic in that Congress and America, generally, have never really paid much attention to the broad and comprehensive range of issues which are covered under the umbrella of the term "energy." But now we must pay attention if we are to cope with the immediate situation facing us and avoid outright disaster in the months and years ahead.

To give one illustration of what "energy" means in America, consider the fact that our population is expected to increase from 215 million in 1975 to 266 million in 2000—something on the order of 25%. But over the same period energy consumption is expected to more than double from about 87,000 *trillion* Btu to nearly 192,000 *trillion* Btu. This means going from 412 million Btu *per capita* to 720 million Btu for every man, woman and child in the United States.

No responsible public official or informed leader today doubts that America is up against a major energy crisis. It is not so much that we do not have sufficient energy resources as that those resources are not available for utilization. But the situation is critical, nonetheless.

Decades of having ready supplies of cheap energy spoiled us and dimmed our perception of U.S. energy requirements and their realities. Time and again over the years, when faced with decisions on energy we have taken the easy path to meet the demand and have done little to limit it either through planning or conservation.

We kept the price of domestic sources—oil and natural gas—low and each year relied more and more on inexpensive (we thought) imports. We have neglected conservation and ignored basic research. But events are catching up with us. The chickens are coming home to roost. Our supplies have not even kept pace with demand. Instead they have declined steadily even in the face of huge increases in the actual and forecast demand. The total number of exploratory wells drilled in the U.S. has declined from a high of 16,000 in 1956 to fewer than 8,000 in 1970. And new field wildcat wells have fallen from about 8,500 to around 5,000.

Natural gas discoveries showed an even more serious—nearly 80% decline—in the same period.

Thus we lost our self sufficiency in energy and became a net importer of energy producing materials. There was no way that this trend of lower domestic activity and rising imports could continue without serious consequences. The middle eastern war and the Arab oil restrictions which grew out of it have brought the crisis to a head. But even without the war and the cutback on foreign supplies, we would have faced the same situation sooner or later.

But face it, we must—and soon. America must develop and implement a comprehensive national policy which will deal with all aspects of energy in our country. This national energy policy must address the discovery, production, use and conservation of every type of energy. It must coordinate these elements and direct them according to a basic strategy for seeing to our national needs.

It will not be an easy task to formulate this policy, nor will it be a quick or simple job to put it into effect. But we must do so to make the political, military,

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social and economic future of the United States secure. For without adequate energy this nation—or any other—will see its farms, factories, cities and its basic strength wither away and die.

COOPERATION REQUIRED

As we look at the challenge which lies before us, we must realize that success in this endeavor requires cooperation from everyone involved. Government must work with business and industry. Citizens must work with each other. The East must work with the West; rural areas, with cities; and Democrats with Republicans. It is just not possible to over-emphasize the necessity for cooperation. And no more important example can be found than here in Congress and the Senate.

Many individual Senators, committees and subcommittees are highly concerned with energy matters, and much work is being done. But in the course of doing this work it is important that each committee keep in mind its own areas of special competence and unique capacities for making contributions to the overall effort. We must make maximum use of our time, our resources and capabilities to avoid wasteful duplication of effort. There is a great deal to be done in Congress, but only by directing and focusing our individual and committee efforts can we do the best and most effective job of dealing with the work before us.

BASIC POINTS

When approaching the development of a national energy policy, some may throw up their hands in hopelessness that it can even be understood, much less made to work. But, actually, all the technology and complexity and conflicting theories of energy policy boil down to two basic elements: restraining demand and increasing supply. Now there are lots of side issues, and there are many areas of black and white and gray surrounding them. But those two factors are the starting points for building a national policy of energy.

And they should be kept in mind by anyone who is attempting to deal with them—particularly by the committees of Congress as they work within their respective jurisdictions.

We of the Finance Committee are in a unique position. Other Senate committees' jurisdictions lead them to the business of identifying problems and proposing programs to deal with them. We have this job, too, particularly in the area of trade. But we also have the job of raising the money to pay for the programs designed by the committees.

And these programs to solve the energy crisis will require billions of dollars. The President has proposed his project independence and the expenditure of $10 billion on energy research and development over the next 5 years.

Another proposal has been introduced in the Senate to spend $20 billion over 10 years. Thus it is apparent that the price tag is going to be significant.

Large sums of Federal money will be required to secure our country's equally large energy requirements. And this committee will have to decide how to raise the money and who to raise it from.

These decisions will not be simple or easy, but they will have to be made. The Finance Committee's responsibility is to see that our decisions on national energy policies are based on the best information available with the utmost degree of fairness and objectivity. Therefore, I consider the energy subcommittee to be highly important to the work of the full Finance Committee's energy policy efforts.

As we consider the many policy questions which will arise I believe especially careful consideration must be given to the following areas:

(1) Where to best and most effectively provide incentives for the discovery, and production and of conventional energy sources? Should we increase the depletion allowance, deregulate natural gas, provide an exploratory drilling tax credit, or pursue other possibilities?

(2) How to most effectively stimulate activities to develop new energy sources such as solar, geothermal, tidal and thermonuclear?

(3) What sort of disincentives to apply for reduction of energy demands? Should a much higher tax be imposed on gasoline; should weight and horsepower of automobiles be levied against?

(4) What steps are required to control exports of scarce and much needed fuels, other petroleum products, and coal?

These and many other areas will require our careful attention and close study. Our decisions will have far reaching and long lasting effects, so we must approach these question with great seriousness and appreciation for the importance of our work.

I look forward to hearing our distinguished list of witnesses and discussing these matters with them.

This is the start of a big job and one of the utmost important not only to our nation but to the entire world as well.

Mr. LOVE. I would be delighted to.

Senator GRAVEL. Governor, I want to concur with Senator Dole's statements and say from a personal point of view, I have great sympathy for the task that you have. In fact, I can only characterize it by saying the Nation is in the soup and you are rowing around on a noodle. So I really do not want the severity of my questions to reflect on my personal regard for you. But I am deeply concerned about one statement you made. I can understand the disagreement with respect to my suggestion of an energy trust fund. We all have our varying views. But I think we have not focused as to where the money is going to come from. I think all proposals are rhetoric unless we are willing to put up the bucks to do the job. When you look at the next 5 years and say, "OK, we will put up $10 billion for R. & D., that is, if we can develop an R. & D. program, and we will wait for that to come forward from the administration, that is $2 billion a year. That is twice as much as we are spending this year which is our high water mark.

We are going to experience revenue shortfalls in this country, because of a recession occasioned by the energy crisis. We are going to experience additional social costs also because of that recession. So here you will have less money coming into the Treasury and more demands on the present Treasury as it is presently constituted, yet you are talking about doubling an effort which in your own words, and I quite agree, is certainly no ceiling and that is an understatement because I think that before we are done we are going to see a doubling and a trebling of this $20 billion. So where is the money going to come from? That is the obvious question. Otherwise, all proposals that are made are rhetoric.

Mr. LOVE.—Well, Senator, the only thing I intended to say, and I am not sure I expressed it well, if you attempt to establish a trust fund, and I do not know in specifics at the moment—perhaps I should—where you intended to get the money for the trust fund, if you relate it to energy, I simply am making the point that the use of energy is so broad that it is very comparable just to a general tax, that is, would be shared by all the people. If you put the tax on the energy producing companies, it obviously has to be passed along to the people in any event, and it again goes broadly that I do not see the distinction between that and a general tax.

Senator GRAVEL. Well, perhaps I can best illustrate it by a comparison of what has happened in this country since the Second World War. We developed a resolve to accomplish two things which were major undertakings. One was putting a man on the moon. Now, that was in essence what you might call an ego trip. We decided we wanted to do it and the Congress put up the necessary appropriations annually. (Expenditures for the space program followed bell-shaped curve.

They went up and went down. The high point was $6 billion a year. That money came right off the hides of the taxpayers. There was no problem getting those appropriations.

The other major undertaking occurred after the Second World War when our Nation's transportation system was choked because we did not have the highways upon which to place the automobiles. Somehow a plan was designed and Senator Jennings Randolph, who is presently a Member of the Congress, was one of the persons instrumental in establishing the Interstate Highway Trust Fund. They set up a trust fund where the money would go right from the people who used the highways to this fund, to service the need and to pay the cost of the highways on a formula basis. The result was the highway program did not have to vie annually for appropriations. Congress set up a mechanism where it went from the source right to the need and that was the genius of what happened.

In fact, we probably have overdone it to a degree with respect to our highways. But it got done.

Now we have got a task that is before us that is of a gargantuan nature. My thought is that maybe we should adopt a similar approach to meet our energy needs. Take it right from the source.

Now, I think we are kidding ourselves if we think we are going to fund an energy program within the existing budget because as I have outlined, we are going to have shortfalls. We are going to have increased social demands. So who is going to be cut? What Members of Congress are going to cut the amounts of money for education to put it in energy research? I think we are going to find it difficult to do that. So, the way to solve the inflationary problem that will be occasioned by these increased costs is to pay as you spend. That is, go out and tax it and then raise the money as you spend it, and face up to the fact that we have got a serious problem for the next 7 years or longer.

Not just this winter, but for the next 7 years or longer. We used to ridicule the Russians about their 5-year plans where nobody could get any consumer goods because they wanted to develop the capital infrastructure necessary to become a producing nation. Maybe we are caught in the same bind, maybe we must now turn around and set up the capital intrastructure to do the job.

There is no easy way to do that, and it will require some severe belt tightening. If that is the case, why be cosmetic? Let us again say we have got to tighten the belt two notches, live that way for 7 years, so that after we have met the challenge we can then enjoy the fruits of what society may have to offer. So all I am suggesting is we are going to need billions of dollars, and we need a reliable way to raise it. We all know how to spend the money. I think you will not lack for any proposals on that. The question is how are we going to raise the money, and that is why I suggest the trust fund and I am chagrined that the seed is falling on very hard and rocky soil.

Mr. LOVE. Explain to me again just—when you say we go to the source, what is the proposal? What is to be taxed?

Senator GRAVEL. I would suggest this, Governor, that if we want to be fair, we cannot discriminate against the automobile. Yet that is the talk that has come out so far: to curtail the use of the auto-

mobile and put a tax on gasoline. Why not tax the Btu? Certainly the poor design that is in the electric mixer that my wife uses at her house is just as much in its increments, in its percentage, a drag on our energy supply as a poorly designed automobile. Now, why not tax that as well? Certainly anybody consuming electricity produced by atomic energy is using energy. So if we went right to the energy source and imposed a Btu tax, we could raise any amount of money we want just by setting up a formula and say that this year we will have a 6 cents per million Btu's—raise $8 billion a year.

First, we have to inventory what the cost of energy R. & D. will be in the public sector. That is what we are waiting for you to come forward with. We are doing our research. We know as you stated, the administration is doing its research. So we must inventory the cost of R. & D., put a time frame on it. I think the President is right. We must become self-sufficient. We can put a 7- or 10-year time frame on it, and estimate the amount of money we need this year, next year, the year after, and set a fluctuating tax rate to support a trust fund, paying the costs as they are incurred, without contributing to inflation. It would not be a difficult tax. We know what the per capita Btu consumption is. In fact, the per capita Btu consumption right now is probably about 300 million per person.

If you had a tax of 10 cents per million Btu, it probably would cost the citizen about $40 per year to do the job. I do not think there could be a better way to do it.

I think we are playing with mirrors when we say we are going to do all these great things without saying how we are going to put up the money to do it. We have got to face up to the problem; we have got to get the money. My proposal is to create a trust fund, which is a proven mechanism both with social security and with the Interstate Highway System. Why not do it with the energy system?

Mr. LOVE. Are you going to be charged with being regressive in that tax?

Senator GRAVEL. Regressive in what respect? How would you propose to do it?

Mr. LOVE. In fact, that is, at least at the bare minimum or at the basic minimum I suppose that there is some variation but related to income, the variation in Btu's may not be that great. It would not be as steeply graduated as the income tax, for example.

Senator GRAVEL. Well, in point of fact it would not be regressive. It would contribute to energy efficiency because it is going right to the source. For example, Btu's coming out of a hydroelectric plant should be taxed. That is energy. We should also tax fossil fuels, tax anything that is energy right at the source so you do not carry the inefficiencies forward. When you tax the consumer then you build in all the inefficiencies that came through the system.

It would be easy to collect. It would not take a lot of tax collectors and obviously will be passed on. I do not know of any industry that carries taxes. They all pass them on to the consumer. So we know the consumer has to get it, so let us do it the cheapest way possible with the least amount of governmental bureaucracy.

Mr. LOVE. Well, I will be glad—I apologize for not doing it sooner—I have had some demands on my time—I will be glad to take a much closer look at this.

Senator GRAVEL. I can sympathize with the demands on your time, and I certainly did not mean to harass you in that regard, Governor, because like I say, you are the man on the noodle in this country today and are going to be there for some time. But I did want to impress upon you the energy trust fund proposal which I think is a viable solution and hope the administration will look at it.

I would like to touch upon some other areas. One, maybe we will hit it tomorrow with other representatives of the administration, but I am concerned about the way the price of oil is going up in a skyrocketing fashion. Would it not make sense for you, since you are the energy czar, to have the power to negotiate with the producing countries, so that we do not have our companies kicked from pillar to post as they try to negotiate with the Arab countries. Now, that has a two-pronged effect.

One is we would negotiate price but then what would stop other countries from playing off against us or the Arabs playing off France and Britain against us? Then, my suggestion would be if we were to appoint somebody in our Government to negotiate as a Nation on price, then I think we should also prod the consuming nations of the world to form a consuming organization which would be an organization that would meet with OPEC and handle the pricing problems in a much more orderly fashion than is presently going on.

I am not saying this in derogation of the Arab situation. I think that unless we do not bring some order to the pricing of oil in the international markets we are going to continue in the chaotic situation which could plunge the world into a depression.

Mr. LOVE. Pricing on the part of the producing nations to date has been—just recently it has been unilateral and as you well know, the increased price already is having severe effects, one, on particularly the developing nations, but as time—in a very short time I would think it could have major impact on the balance of payments situation and the fiscal viability of some of the developed nations. We have indeed—the administration looks at both of those portions, of the question. I think it is a close call whether it indeed is better to have the companies in the first line or whether indeed we should negotiate country-to-country, but to date again I am pessimistic that we could on a realistic basis given the present situation, put together a group of the consuming nations and agree that we would act in concert.

The problems, as you know, that exist as far as energy supply in such nations as Japan are, as difficult as our situation is, much more severe there.

Senator GRAVEL. Well, I can understand that but, if we do not see leadership we will not follow leadership. I might suggest to you, as the administration's representative, that there might be a real leverage in the most-favored-nation clauses of our trade argeements. Perhaps the Congress might be willing to give the President the power to deny MFN treatment, if they do not come into a consuming organization. I suggest that for your thought.

Mr. LOVE. We will certainly take a look at it, Senator.

Senator GRAVEL. Senator Bentsen mentioned something which I believe should be pursued. In your role as the energy czar, what has happened to these impounded funds for R. & D.? If there is ever a

time to start spending money on energy, it is now, and the figure I get is $20 billion overall and I know of $7 million in geothermal that should be going at breakneck speed right now.

Mr. LOVE. I am sorry I do not have the specifics. In talking in general to the representative from OPEC, I indicated that, although it was an internal shift, that is, it may have gone to the National Science Foundation rather than to Interior, wherever it was, he represented that indeed the amounts of money and some additional were being spent, being committed, I will be glad to——

Senator GRAVEL. This is something that has existed for the last 6 months.

Mr. LOVE. I will be glad to give you the specifics on that.

Senator GRAVEL. I think that would be very important for us to get a record. We will accept it if you can submit it to us as soon as possible, a statement of which funds are impounded.* The impoundment exists, of course, because of the competing forces of other parts of the budget. That is the reason I suggest a trust fund, so we will not compete with the budget in getting the moneys to do the job.

On another topic, what would be your thoughts on setting up a variable tariff or a variable fee on oil coming into this country so that we can provide an economic umbrella of certainty and continuity with respect to capital investments that must be made by the private sector?

Mr. LOVE. I would be somewhat fearful of it because of the experience that we have had in the past on import quotas. Any deterrent to the imports would need to be—importation of crude and/or product would have to be looked at, in my opinion, very carefully. That is, it certainly is not going to be our intent in the near term to impede in any way the amount we can import.

Senator GRAVEL. Well, Governor, I respectfully disagree and quite strongly. I have been one to criticize the quota system at times. In fact, I think it was late in being removed. But the President did have a task force that did recommend an end to quotas and recommended a tariff. I do not know how we are going to become self-sufficient if we do not have some kind of barrier at our artificial national boundaries to guarantee the continuity.

Mr. LOVE. It seems to me, Senator, that the circumstances are different now. Unless we can find some solution to that pricing policy that the producing nations have made we are no longer faced with the fleet of cheap foreign oil. There is not any more cheap foreign oil.

Senator GRAVEL. Well, I submit that if I were a petroleum administrator for an Arab country I would advocate about every 2 years just dropping the floor on the price of oil just so we can make sure we can keep the price up all the time. I think it would raise havoc with our energy capital market if the United States did have some kind of a barrier. What would happen? OK. Somebody is going to commit $50 million in a program that is going to supply x barrels. The Arabs can read what goes on on Wall Street. They can read the various annual reports of the companies and see we are becoming self-sufficient. All they have got to do is drop the price of oil for a couple of years and you would tear up Wall Street and the energy capital market until there would be no end to the disaster that would occur.

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*At presstime the information requested had not been received by the Committee.

Mr. LOVE. At the present time, we are looking at, as a result of the pricing policies in the producing nations and the very great increase in the cost of lifting or transporting the crude and the product, we are looking at price that are going $10, I have heard some $12 per barrel kind of prices. At the moment, and I recognize the problem, that it is the obverse of shutting the valve, if they opened it, and so on, they could perhaps create havoc, but it would be difficult for me to see the wisdom of putting a fee on top of that $10 or $12 at the present time.

Senator GRAVEL. Well, if we could set up a variable tariff, call it a float, so that we can guarantee that whoever does anything in the private sector can be assured that there will not be capricious disruption of the energy market it would make it possible for him to make that capital investment.

Mr. LOVE. That may be the same concept that I was expressing in the energy banking kind of agency, a takeout that if you cannot sell it at $6 on the market, that the Government would buy it. It is that same concept, is it not?

Senator GRAVEL. Right, and I was confused when you brought up the energy banking proposal. That is how you are going to fund the private sector. I would like to get that confusion squared away so that all would know that the administration has no plan to develop any money for the public sector.

Mr. LOVE. No.

Senator GRAVEL. But there is some thinking going on with respect to a banking program for the private sector.

Mr. LOVE. Right.

Senator GRAVEL. I would like to ask the $64 question. We know now what the Arabs can do to bring pressure with respect to energy. A statement was made by an Arab official at the Algerian meeting which is taking place right now, at this very moment, that what they ought to do is explore the pressure they can bring upon the United States through the manipulation of the dollar since they are now the repository of such large sums of dollars. Now, has there been any thinking within the bowels of the administration as to what disaster this would wreak on our free enterprise system?

Mr. LOVE. I am sorry, but I am simply not competent in that area to respond at this time. Obviously, I recognize just as a citizen, not as part of my responsibility, that tremendous amounts of capital that are held in the hands of these nations do represent some potential threat but the extent, I do not know.

Senator GRAVEL. Well, what disturbs me is they are talking about the use of this tool. They used to talk about using oil as a weapon. We have seen how that works. Now, what else is in store for us? You know, how soon are we going to react? In fact, I just want to end my questioning on this one note, that is, that the administration at present has no answer for the treat of monetary disruption.

Mr. LOVE. All right.

Senator GRAVEL. We are going to examine how our foreign policy handles these other aspects of the energy crisis because I think the whole Nation has focused on this one thing and I think that we are all fearful that there is probably too much rhetoric and not enough action in solving the problem, not only for this winter, which I know is

at our doorstep now and cries out for solution, but I am more concerned about the winters that will follow and about long-term viability of the free enterprise system.

Mr. LOVE. I certainly understand and agree.

Senator GRAVEL. Thank you.

Mr. LOVE. Thank you.

Senator GRAVEL. Thank you very much, Governor.

[The prepared statement of Mr. Love, the address by the President, and the fact sheet referred to by Senator Dole at page 191 follows:]

ADDRESS BY THE PRESIDENT ON NATIONWIDE RADIO AND TELEVISION ON THE NATIONAL ENERGY POLICY

THE OVAL OFFICE, NOVEMBER 25, 1973

Good evening. Three weeks ago, I spoke to you about the national energy crisis and our policy for meeting it. Tonight I want to talk with you again to report on our progress and to announce further steps we must take to carry out our energy policy.

When I spoke to you earlier, I indicated that the sudden cutoff of oil from the Middle East had turned the serious energy shortages we expected this winter into a major energy crisis. That crisis is now being felt around the world, as other industrialized nations have also suffered from cutbacks in oil from the Middle East.

Shortages in Europe, for example, are far more critical than they are in the United States. Already seven European nations have imposed a ban on Sunday driving. Fortunately, the United States is not as dependent upon Middle Eastern oil as many other nations. We will not have a ban on Sunday driving, but as you will hear later, we are going to try to limit it. Nevertheless, we anticipate that our shortages could run as high as 17 percent. This means that we must immediately take strong, effective countermeasures.

In order to minimize disruptions in our economy, I asked on November 7 that all Americans adopt certain energy-conservation measures to help meet the challenge of reduced energy supplies. These steps include reductions in home heating, reductions in driving speeds, elimination of unnecessary lighting. The American people, all of you, you have responded to this challenge with that spirit of sacrifice which has made this such a great Nation.

The Congress has also been moving forward on the energy front. The Alaska pipeline bill has been passed. I signed it into law 9 days ago right here at this desk. The Congress has passed a fuel allocation bill which I will sign into law on Tuesday. An additional emergency bill providing special authority to deal with this problem has now passed the Senate. When the House returns from its recess, I am confident the House will move promptly so that this vital legislation can be signed into law by the middle of December.

And so we have made some encouraging progress, but there is much more to be done, and that is what I want to talk to you about tonight.

I have appointed an Energy Emergency Action Group, under my chief energy adviser, Governor John Love, to analyze our situation on a continuing basis and to advise me of all actions required to deal with it.

And upon the action and the recommendation of this group, I am announcing tonight the following steps to meet the energy crisis:

First, to increase the supply of heating oil that will be available this winter, we must adjust production schedules and divert petroleum which might normally go for the production of gasoline to the production of more heating oil.

To accomplish this, the amount of gasoline which refiners distribute to wholesalers and retailers will be reduced across the Nation by 15 percent. As we reduce gasoline supplies, we must act to insure that the remaining gasoline available is used wisely, and conserved to the fullest possible extent.

Therefore, as a second step, I am asking tonight that all gasoline filling stations close down their pumps between 9 p.m. Saturday night and midnight Sunday every weekend, beginning December 1. We are requesting that this step be taken voluntarily now.

Upon passage of the emergency energy legislation before the Congress, gas stations will be required to close during these hours. This step should not result in any serious hardship for any American family. It will, however, discourage long-distance driving during weekends. It will mean perhaps spending a little more time at home.

This savings alone is only a small part of what we have to conserve to meet the total gasoline shortage. We can achieve substantial additional savings by altering our driving habits. While the voluntary response to my request for reduced driving speeds has been excellent, it is now essential that we have mandatory and full compliance with this important step on a nationwide basis.

And therefore, the third step will be the establishment of a maximum speed limit for automobiles of 50 miles per hour nationwide as soon as our emergency energy legislation passes the Congress. We expect that this measure will produce a savings of 200,000 barrels of gasoline per day. Intercity buses and heavy duty trucks which operate more efficiently at higher speeds, and therefore, do not use more gasoline, will be permitted to observe a 55-mile-per-hour speed limit.

The fourth step we are taking involves our jet airliners. There will be a phased reduction of an additional 15 percent in the consumption of jet fuel for passenger flights bringing the total reduction to approximately 25 percent.

These savings will be achieved by a careful reduction in schedules, combined with an increase in passenger loads. We will not have to stop air travel, but we will have to plan for it more carefully.

The fifth step involves cutting back on outdoor lighting. As soon as the emergency energy legislation passes the Congress, I shall order the curtailment of ornamental outdoor lighting for homes and the elimination of all commercial lighting except that which identifies places of business.

In the meantime, we are already planning right here at the White House to curtail such lighting that we would normally have at Christmastime and I am asking that all of you act now on a voluntary basis to reduce or eliminate unnecessary lighting in your homes.

As just one example of the impact which such an initiative can have, the energy consumed by ornamental gaslights alone in this country is equivalent to 35,000 barrels per day of oil and that is enough fuel to heat 175,000 homes.

Finally, I want to report to you tonight that we have now developed final plans for allocating reduced quantities of heating oil this winter and all of you know how very important heating oil is, particularly in the wintertime.

These plans, to be published Tuesday, will call for an average reduction of 10 percent of heating oil for industrial use, 15 percent for home use, and 25 percent for commercial use.

The reductions for homeowners alone will result in a savings of some 315,000 barrels of heating oil a day, which is enough to heat over 1½ million homes every day. For the average American family, as I indicated 3 weeks ago, this cutback in heating oil doe snot mean severe discomfort for anyone, but it will mean that everyone should lower the thermostat—as it is right here in this office now, and throughout the White House, and throughout every Federal installation—you should lower the thermostat by 6 degrees below its normal setting so that we can achieve a national daytime average of 68 degrees.

Those who fail to adopt such a cutback risk running out of fuel before the winter is over. While additional actions will be necessary to further offset the anticipated shortage of 17 percent, the steps which I have outlined tonight will relieve about 10 percent of that shortage.

They will make a very substantial contribution to our immediate goal of insuring that we have enough fuel to be adequately warm in our homes this winter, that we are able to get to work, and that we experience no serious disruptions in the normal conduct of our lives.

Above all, every step will be taken to insure that any disruptions to our economy which could cost jobs, will be as brief as possible and that they do not cause serious damage.

Nothing we do can succeed, however, without the full cooperation of the Congress in providing the legislation we must have, without the full cooperation of State and local governments in providing the broad leadership that we must have, and without the full cooperation of each and every one of you, all the American people, in sacrificing a little so that no one must endure real hardship.

For my part, I pledge to do everything in my power to insure that the decisions I have announced will be carried out swiftly and effectively and fairly, and whatever additional action is necessary to achieve our objective will be taken.

I intend to participate personally and on a regular basis, as I have since I last addressed you 3 weeks ago, in the work of my energy advisers. I intend to

advise the congressional leadership regularly of problems and progress. And I intend to see that the persons and organizations having responsibilities and capabilities in this area are fully and regularly informed.

We need new rules if we are to meet this challenge; but most of all, we need sustained and serious action and cooperation by millions of men and women if we are to achieve our objective, and that means millions of Americans across this land listening to me tonight.

Let me conclude by restating our overall objective. It can be summed up in one word that best characterizes this Nation and its essential nature. That word is "independence." From its beginning 200 years ago, through its history, America has made great sacrifices of blood and also of treasure to achieve and maintain its independence. In the last third of this century, our independence will depend on maintaining and achieving self-sufficiency in energy.

What I have called Project Independence—1980 is a series of plans and goals set to insure that by the end of this decade Americans will not have to rely on any source of energy beyond our own.

As far as energy is concerned, this means we will hold our fate and our future in our hands alone. As we look to the future, we can do so confident that the energy crisis will be resolved not only for our time but for all times. We will once again have plentiful supplies of energy which helped to build the greatest industrial Nation and one of the highest standards of living in the world.

The capacity for self-sufficiency in energy is a great goal. It is also an essential goal, and we are going to achieve it.

Tonight I ask all of you to join together in moving toward that goal, with the spirit of discipline, self-restraint, and unity which is the cornerstone of our great and good country.

Thank you and good evening.

STATEMENT OF HON. JOHN A. LOVE, DIRECTOR OF THE ENERGY POLICY OFFICE

Mr. Chairman and Members of the Subcommittee, I appreciate the opportunity to appear before this Subcommittee to testify on the most critical issue of fiscal policy as it relates to energy. You have asked me to direct my remarks to the following questions:

1. Should fiscal policy be employed to mitigate the current energy shortage and to assist in the transition to alternative energy sources? If so, how?
2. Are fiscal incentives needed to stimulate exploration and development of domestic sources of energy?
3. If so, which would be the most efficient—a tax credit, tax deduction, depletion, etc.?
4. What would be the effects on supply and demand of allowing the price of all fuels to reach their natural level through marketing forces?
5. What would be the income distributional, environmental and consumer effects of a tax incentive approach vs. a free market approach?
6. Given the enormous capital needs to develop fossil fuels and their alternatives, is there a need for both tax incentives and price deregulation?
7. Is there a need for an "Energy Trust Fund," the monies from which would be used to develop various alternative forms of energy—coal gasification and liquefaction, tar sands, oil shale, geothermal, solar, wind, nuclear, etc.?
8. If so, how should the fund be financed—consumption taxes on gasoline or automobiles, or production tax on energy at source or some combination?
9. Who should administer such a fund?

First, there is a definite need for employment of a fiscal policy to mitigate the current shortage. To me, the question is one of degree and timing.

We need to look at the alternatives and balance the costs of the specific policies and the costs of the specific shortages being experienced as well as those which are projected. This is no simple task. The "ripple effect" of experiencing a specific shortage or of the use of specific fiscal tool requires detailed examination.

Insofar as the alternative energy sources are concerned, we also must consider the extent of the alternative energy supply needed from each.

Moving away from specific situations and degrees of hardships faced and speaking in general terms, I believe that the free enterprise system which is the touchstone of traditional American perseverance and independence has the fundamental role to play. Relaxation of fiscal constraints and encouragements of the operation of competition among business for the energy market should

be a primary factor considered as I see it. Some fiscal devices are "band aid" solutions with no long term benefits.

In response to your second question, we do need to make additional domestic sources of energy available. The Senate recently agreed that this was the case in the provisions it made for development of domestic energy sources in the "National Emergency Energy Act of 1973", S. 2589, passed on the 19th.

Financial incentives are, of course, the American way of encouraging a person, or company, to enter into a field or to step up his activities. As I said earlier, this can come from a relaxation of existing inhibitions which leads to greater fiscal rewards for the stepped up activities. This is true with respect to intensified exploration and to intensified development of available resources.

Speaking to your third question, I believe permitting fiscal rewards in the market place is one of the most efficient methods and I would favor it over increased depletion allowances and tax deductions which must be shared by all other taxpayers regardless of their use of the specific energy source involved. Increasing competitiveness and price freedom is something which should be approached carefully so that it is accomplished gradually with concomitant comprehensive overview and monitoring in order to assure an ability to ease off if the results are other than those expected.

I would expect that the law of supply and demand would produce, in a natural way, a balancing effect with price as the fulcrum. Price may go up, as it is doing in any event but the artificiality of controlled prices can bring about unnatural results such as a hording of supply and stimulation of unreal demand. In the long run, I think we will see a leveling off of the price factor and equalization of supply and demand sooner with fewer controls that affect the supply and demand equation.

As your question suggests, the relaxation of controls and permitting of a more free operation of supply and demand should encourage shifting of energy source utilization to those which have the greatest promise of long term availability.

I believe we will see capital flow to the long term investments as well as to the short term sources. With respect to your second question, the low cost petroleum has already been found. Future reserves will require a greater investment for discovery and for development. We also find that the future reserves are located at greater distances. Approximately $1 trillion will be required for cumulative capital expenditures. This is the estimated requirement of the non-Communist world for the next ten years. $250 billion of this will be required for exploration and development. Another $350 billion will be needed for the process of transforming the crude oil into the end products and for their delivery. As demand increases, the industry will continue to grow and additional working capital will be required. Recent increased capital borrowings must, of course, be repaid in the future.

If these funds are not made available by world economic conditions, or if our access to necessary supplies are limited, or a combination of both, there will be a shortfall which alternate sources must provide or economic growth will be limited by the energy shortage. Availability of supply, therefore, is but one part of a two part interdependent economic dimension and both dimensions must be considered.

Of course, funds come from internal as well as external sources and can be combined in a variety of ways to meet capital requirements.

It has been projected that internal financing could provide 60% of the $1 trillion capital estimated to be needed in the next ten years. Resulting debt-equity ratios would probably not be acceptable to sustain borrowing so that internally generated funds will have to be increased.

As we see it, this objective will not be achieved if the present practices of restrictive governmental controls on industry income continues. If we do continue it, then some other device for increasing available capital will be required. The alternatives are less attractive.

I have used the phrase "relaxation of controls" because I do not advocate removal of controls. If we were to relax these controls to permit a one or two cent per gallon profit margin on all petroleum products, for example, it could be sufficient to provide the necessary capital. We in the United States must now recognize that, fiscally speaking, the buyers market for oil has come to an end. The United States, as a buyer, is no longer a price leader but is a price follower.

It is no longer possible to attract capital under conditions of fictitious pricing which distorts the true supply and demand equation. Although the general tenor

of discussions today concerning the state of our energy industry have been directed toward methods of expanding it, it is important, I believe, for it to be recognized that we also could face a situation where there is actually a flight of capital away from the energy industry into more secure forms of investment. In part, the shortage we are experiencing is the result of a long term shortage of capital for which some respected economists blame past governmental interference with normal economic forces.

There are four factors which influence capital investment and experience indicates that if any one of them become unfavorable, capital takes flight often to other countries. These factors are (1) "Geological prospects" (2) "Proximity to markets" (3) "Cost of operations" and (4) What has been termed "Political risk factors."

While some may only think of "political risk" as the dangers which exist in political confiscation of assets within the jurisdiction of foreign nations, there are other political risks. It has been suggested that there is a much more subtle form of risk in the United States, presently as a result of the regulation of natural gas. The effect is to indirectly control the price of other petroleum products as well as forms of alternative energy so as to prevent the adequate formation of capital. It is contended that this fourth factor may have reached the point, in relation to the changing world scene, that energy capital may be now encouraged to take flight. This is a matter deserving careful attention when addressing the subject of fiscal policy and the energy crisis.

You have asked for an opinion on the relative merits of a free market approach and a tax incentive approach from the standpoint of income distribution, the environment, and consumer effects.

My answer to this is the same for each of the three perspectives. I believe relaxation of governmental regulations as I forsee it, which is the direction of a more free market interplay, will be more beneficial than will be the case by providing tax advantages such as greater depletion allowances.

Either approach would be intended to stimulate the fossil fuel industry and I judge the environmental effects, if any, to be equal, assuming the intended results are achieved.

Insofar as distribution across the income spectrum and consumer effects are concerned, I judge the tax advantage approach to be less fair to the consumer and to the income of taxpayers. "Freeing up" the market puts the burden on the user and also gives the user a choice. If the users cut back the demand, the supply will increase and price will moderate. Non-users, or low users, will not bear the expense as in the case of a general reduction of overall tax receipts for the country.

With respect to the question concerning an energy trust fund to assist in the development of alternative forms of energy, I recognize the arguments in favor of this approach. Namely, that it would constitute a permanent long range national commitment including assurance that the program would be adequately and consistently funded. However, at this time it is my hope and belief that the measures recommended by the Administration to promote research and development will achieve the intended result without invoking the disadvantages of trust funds such as the "locking up" of another portion of tax revenues for one specific purpose only. In the case of an energy trust fund, of course, is the added complication of identification of the persons or objects to be taxed to create and maintain the fund. Ordinarily, those who are taxed are the ones who will receive the benefits but it appears to me that this would be a difficult, if not impossible, task in this instance if there is going to be any hope for an equitable system.

Another problem as I see it will be trying to establish a trust now which will adequately respond to future energy situations.

I don't believe we can project those needs with actuarial accuracy and that it would be better to develop a national policy, including the flexibility which the energy trust fund could preclude.

In conclusion, Mr. Chairman and Members of the Subcommittee, it is my hope that in the days ahead we will see American labor, commerce, industry and all of our people uniting in a mutual effort to preserve our independence by returning to a position of self-sufficiency.

Thank you.

Senator GRAVEL. Our next witness will be Mr. David Freeman, the director of energy policy of the Ford Foundation.

STATEMENT OF S. DAVID FREEMAN, DIRECTOR OF ENERGY POLICY PROJECT, FORD FOUNDATION

Senator GRAVEL. Mr. Freeman, we sort of lost our audience. It does not denote in any way our lack of resolve. This record, I can assure you, will become a record that will be finely scrutinized and will be the basis for debate in the Congress and forthcoming legislation. So we are happy to have you come before us. If convenient, I would like to hear your presentation and then we will break for lunch and come back for questioning and then we will hear Mr. Mitchell in the afternoon with yourself.

Mr. FREEMAN. Fine.

I have a prepared statement which I submit for the record. I should like to proceed with a summary of the statement, if I may.

Let me state at the outset that my views this morning are strictly personal and not presented on behalf of the energy policy project which I am directing. That study will be completed in the coming year.

In recent decades, new tax laws have not been enacted as an energy policymaking tool. The depletion allowance and related tax incentives have been a controversial part of our energy policy for decades but by and large, the conventional wisdom, that the tax laws should be used only to raise revenue, has dominated energy policy. The tax laws and fiscal policy have not been used to help solve problems such as pollution control, to provide incentives for research and development of new sources, or to encourage greater efficiency in the consumption of energy. Government policy has dealt with these problems through regulations, inadequate appropriations, or not at all.

There are, of course, considerations of overall tax policy that suggest caution in using the taxing system for purposes other than raising revenue. And yet, tax policy can be a powerful tool for helping to solve basic national problems. And nothing is more basic to our economy in the months and years ahead than balancing our energy budget. Tax measures, such as the investment credit in the early 1960's, were successful in getting the economy moving ahead and I believe that new tax measures, combined with other action programs by Government, can play an essential role in solving our energy crisis which might otherwise make our problems of a decade ago seem like child's play.

As we examine the problems the country now faces from its overconsumption and underproduction of energy there is no end to the number of ways in which the tax laws could be used to help. The suggestions that have been made range all the way from income tax exemption for the cost of installing storm windows in one's home to doubling the depletion allowance. In my view, we should resist the temptation to flood the Tax Code with a large number of ad hoc measures. New taxes or tax exemptions should pass the test of being important and providing the Nation with more for its money and greater feasibility than available alternatives.

As the energy crisis begins to take its toll in the weeks ahead there is likely to be a hue and cry for rushing through all sorts of legislation. I think it is imperative that we distinguish between emergency meas-

ures and basic policies that will shape this Nation's future. We face a shortage in the coming months that cannot be eliminated by steep taxes on energy without really hurting the millions of working poor in this country. And enacting large new tax incentives for the oil industry might constitute a raid on the Treasury without helping us through the winter and summer of 1974 or the years to follow either.

In my view, there is no alternative to rationing and price controls to balance our energy budget in a public interest manner in the months ahead. But new taxes and tax incentives can be very effective in helping us in the years ahead. There is every reason to pinpoint areas where taxes could be added to the price of energy to provide incentives to use less or switch to sources that are available as well as areas where new tax incentives might be especially effective in enlarging the supply of clean energy to fuel America's future.

This morning I should like to direct the committee's attention to a few specific areas where I believe fiscal policy could provide an effective tool to balance our energy budget in the years ahead.

A key problem that America must now face is to find a quick replacement for a large quantity of the oil that we are planning to import, primarily from Saudi Arabia. It may be premature to conclude that these imports will not be forthcoming, but it is certainly late in the day to be developing a program which will give us an alternative. we should be importing oil as a matter of choice rather than desperation.

In my view the strippable coal resources in the Illinois Basin are the most promising large-scale source of secure energy supply available for quick exploitation to fill that gap over the next 10 years. In the future perhaps we can open new deep coal mines in the East and hopefully learn to mine coal more safely underground. And perhaps the coal and oil shale in the West can be mined some day without creating a dust bowl. But we should take the time to find out. And in my view, we should also learn more about the Atlantic and Pacific offshore rather than risking prime recreation areas for what may prove to be a thimbleful of oil in the big picture.

We know for sure there are billions of tons of coal in southern Illinois, which includes western Kentucky and Ohio and surrounding areas and that production could be enlarged by many millions of tons over a period of just a few years. And we know it is possible to reclaim these fairly level lands in an area of good rainfall if there are laws with sufficient teeth in them to require it. We also know that this coal is reasonably close to industrial centers and is now lower in cost than imported oil.

This expanded coal production would be used to convert to coal most electric powerplants and large industrial establishments that now burn natural gas and oil simply as sources of heat. The Nation currently uses upwards of 20 percent, perhaps closer to 30 percent, of its total energy in the form of natural gas and oil as sources of industrial heat which coal could replace. If such a replacement program were implemented over the next 10 years there would be large quantities of oil and gas available to supply transportation and small residential and commercial needs as an alternative to oil imported from the Middle East.

The coal in the Illinois Basin is high in sulfur content and, therefore, an integral part of this program must be the installation of equipment to prevent the ash and sulfur in the coal from escaping into the air. Such equipment has been developed (except for containing the very small particles which are of major concern but also exist in oil). It needs to be put into commercial use.

I believe that a well-designed tax package might be the most effective policy tool for making such a program happen. One part of the package would be to place a substantial tax on natural gas and oil when used as industrial boiler fuel. Such a tax would begin to make it economically attractive for industry to switch to coal. It could also provide the funds for making the switch even more attractive because the second part of the package would be to use the funds from this tax on oil and gas to help finance the investment for the switch to coal. The idea would be to enact a speical investment credit (or accelerated depreciation) which would apply to the new plant and equipment which industry would need to build to switch to coal including the equipment needed to bring the level of pollutants emitted from such coal burning down to meet environmental standards. The credit should apply only if both the coal-burning and pollution control equipment were purchased as a package. It would also be limited to such equipment purchased and put in use within the next 10 years. If special incentives are required to assure that the necessary coal mining and railroad cars are forthcoming they could be added but the package should be made self-financing by making the tax on the oil and gas sufficiently high.

It is, of course, obvious that the revenue from such a tax package would be high initially but would soon disappear as the tax achieved its purpose of causing the shift to coal. But such a conversion would require a 10-year period to be completely implemented. The revenue to be collected could be designed to cover the bulk of revenue losses from the credits which would also be limited to investments during the 10-year period. In any event, if the program could achieve its objective it is likely to be a bargain for the nation because of the benefits it would bring in terms of meeting energy requirements in keeping with concerns about foreign policy, environmental protection, and lower priced energy to the consumer.

The details of such a proposal obviously need much more study but I believe a package along these lines could be a most important feature of a governmental program to balance our energy budget in the decade ahead.

I might add, Mr. Chairman, that it is my considered judgment that the research and development efforts we have underway cannot possibly bear fruit by 1980 under the most favorable circumstances. We are just kidding ourselves if we feel we can balance our energy budget with technology that is still on paper being drafted in the Bureau of the Budget or the agencies of the Government. It is difficult in this country to build a powerplant that we think we know how to build in 6 years and get it working. Simple arithmetic will tell us there just is not enough time between now and 1980 to perfect new technology and then build the commercial plant and expect to have quantities of oil and gas energy in commercial use by 1980. We must learn to burn coal as coal and burn it more cleanly and mine it more safely and reclaim

the land if we are to do anything realistic about balancing our energy budget in the next few years.

The other half, of course, is on the demand side which, Mr. Chairman, you and I have talked about for year. The conservation of energy now becomes a necessity and has to be built into our lifestyles.

I think there is a need to reexamine the subject of tax incentives to increase supply of clean energy from secure sources.

This morning I would like to point to three specific measures to increase secure sources of fuel which I believe are worthy of immediate consideration. The first is a tax incentive designed specifically to encourage a maximum effort for secondary and tertiary recovery of oil from existing and future reservoirs.

It is a fact that currently only about one-third of the oil in the existing reservoirs is actually brought to the Earth's surface and consumed. The rest is just left in place because it is more expensive to produce. The economics have dictated a cream-skimming operation, yet sizable quantities of the two-thirds left in the ground could be recovered if there were sufficient economic incentives to employ and further perfect recovery techniques.

The opportunities here are for the recovery over the next decade of 20 to 40 billion barrels of oil that would otherwise be left in the ground. This, Mr. Chairman, is roughly the equivalent of what we found in the Northern Slope of Alaska. It is not a small amount of money. It is equivalent to the Nation's total current inventory of proven reserves. It is oil that has already been discovered and is connected to pipeline transportation systems already built. It is by far the most environmentally superior source of new petroleum that is available and, of course, it would be from wells in the United States, which means that it is also superior from a foreign policy and security of supply point of view. One could say that higher prices of oil would handle the incentive problem.

The problem with simply raising prices is that a price high enough to make higher recovery economically feasible would be much higher than the fair price for the oil that is easier to extract. It therefore seems to me that this is one area where a tax incentive might be uniquely attractive. The tax incentive could be a depletion allowance or some other form of incentive, designed to increase as the percentage of recovery increased and should be calculated in an amount to cover the additional costs and a reasonable profit. The public would be paying only the extra cost which would be justified by environmental and security of supply advantages which make this oil worth more to the public than market prices which do not reflect these values.

To offset the tax revenue that might be required for this new incentive I believe we should eliminate the current tax incentives which encourage production of oil in the Middle East.

Senator Ribicoff referred to this point earlier this morning, and it seems to me ludicrous to continue the depletion allowance and related tax incentives to encourage U.S. companies to produce oil in the Arab nations that are now embargoing the supply of oil to us. Surely if we are to continue with tax incentives to encourage exploration and development for more oil they should be pinpointed to domestic sources or areas of the world which are considered secure.

I refer not only to the depletion allowance but to the practice of counting the vast sums paid to Middle Eastern governments as a tax on profits which are then allowed as a dollar-for-dollar writeoff on U.S. taxes. Mr. Chairman, I believe that most Americans would not find it amusing if they knew that every time the Arab nations increased the royalty payment which the oil companies must pay to them for each barrel of oil produced that these dollars indirectly have their origin in the U.S. Treasury. There is a dollar-for-dollar offset against the taxes to the U.S. Government that the international oil companies would otherwise pay.

A small portion of these huge payments to the producing nations could be considered as a tax on profits and the oil industry should be treated the same as other industries that can offset taxes paid to foreign governments against U.S. taxes. But the bulk of the sums are obviously royalty payments, no different than the cash bonuses and royalty paid to the U.S. Government for offshore leases. They should be treated as a cost of doing business, not as a tax.

The fundamental point I make is that the depletion allowance and this technique of offsetting taxes are all encouragements to the petroleum industry to drill in the wrong place. Certainly, the Nation has only a limited amount of money to invest in incentives for oil production. Tax incentives to drill and produce in the Middle East not only waste the taxpayers' money but the effort is positively counterproductive, since in the absence of these overseas incentives there would be an even greater incentive to drill in secure areas.

It is important that we give the oil industry some new drilling signals through the tax laws, signals that are more in keeping with an energy policy designed to provide us supply from sources that are more secure. In keeping with this same general objective, it would seem important also to revise the tax incentives for geothermal and solar energy, for oil shale and synthetic oil and gas from coal, to place them on the same footing as natural gas and oil. The Congress may choose to abolish all such tax incentives. But if they are to remain it seems to me of fundamental importance to the development of an adequate supply of clean and secure energy, that the Sun and heat beneath the Earth and oil shale and synthetics be all placed on the same tax basis as petroleum. These new sources should not be delayed because of tax handicaps which are a vestige of a bygone age.

The tax laws can also be used to cut out the awful waste in the consumption of energy. Higher prices would create an incentive to use energy more efficiently and, rather than permitting the energy companies to become superrich, it is far preferable to add taxes designed to have maximum effect in eliminating waste. The money could then be used for public transportation and, as the chairman suggested, developing new sources of energy. The taxes should also be designed in a manner so as not to create hardships on lower income groups either by adding them to luxury items or providing tax exemptions or rebates.

The area where the tax laws could pay the biggest dividends would be to encourage the automobile industry to build cars with better mileage in a hurry. A tax program keyed to the mileage of the auto promises to be much more effective than a tax which tries to discourage citizens from using cars in which they already invested their money.

The time to stop cars from consuming too much gas is when they are built, not after a consumer is stuck with a gas guzzler and has no other way to get to work.

It may be that performance standards are preferable to taxation in this area but if we are to try to save gasoline through the tax laws we should enact a tax keyed to the mileage per gallon. Taxing miles per gallon rather than horsepower or other measures would give the automobile manufacturers every leeway to achieve better mileage through better engineering. The opportunities for doing so are by no means small. For example, the diesel engine provides mileage roughly double the engines now in most of our cars.

One idea could be to set a tax based upon 20 miles per gallon as a standard and provide consumers with a credit for every mile per gallon which a car could perform in excess of 20 miles per gallon while adding a tax that would increase for each mile per gallon below 20 which a car could perform. There are, of course, a number of variations on this theme but such a tax on an automobile could be a very powerful tool that would encourage the construction and purchase of cars that might even reduce the volume of gasoline required by Americans a decade from now.

Another area to be considered by the committee, I should hope would be taxes to control pollution. Thus far, we have relied exclusively on regulations to implement the Nation's goal for clean air and water. We have made some progress but it has required a running battle with industry which has had little incentive to perfect and use control technology. One reason is that the Nation's air and water has been available to industry as a free garbage can. These basic resources belong to the people and the Government should start charging for their use. Pollution taxes should be related to the damage which pollution inflicts on society and would thus bring these costs into the accounting systems of industry.

I do not suggest that regulations to protect peoples' health be in any way abandoned or watered down. On the contrary, charging polluters for every pound of contaminate they release would provide a powerful incentive to assist Environmental Protection Agency and make their job of enforcement considerably easier.

The adoption of pollution taxes is very much related to balancing our energy budget in the years ahead because it would assure that the price of energy reflected the full cost to the society. Prices that included the full cost to society would discourage wasteful consumption which society subsidizes at present. These same taxes would give industry a monetary incentive to perfect and use technology that would enable them to burn coal and other sources of energy in compliance with our environmental goals. It is a way of helping to balance our energy budget by controlling pollution rather than abandoning controls.

Mr. Chairman, I hope these thoughts are some help to the committee in deciding on whether the crucial areas when tax and fiscal policy can help provide clean energy for America's future.

Senator GRAVEL. Well, Mr. Freeman, I think your statement is excellent. There are a lot of areas to probe in it that I do not entirely agree with but I just cannot underscore how excellent I think your statement is.

We will return at 2 o'clock, and then we will launch into questioning with you and, Mr. Mitchell, we will hear you after that.

Thank you.

[Whereupon, at 12:10 p.m., the hearing was recessed, to reconvene at 2 p.m., this same day.]

AFTERNOON SESSION

Senator GRAVEL. We will call the hearings to order.

Mr. Freeman, I was very impressed with your statement. Let me first just ask a general question. This morning we tried to develop the existence or nonexistence of the game plan from the administration. You were here and heard the testimonies.

What comments could you make of a general nature relative to what you heard was the administration's position this morning?

Mr. FREEMAN. What I heard did not exactly encourage me. I heard Governor Love's testimony. I thought it was very forthright and very candid. He testified that he really did not have any sort of long-range plan. You can define long range as extending beyond the next 2 weeks.

I can only express the hope as an American citizen that the decisionmaking process will be accelerated at a geometric rate, because it is my judgment that we do not have any spare time. We have used up all of our spare time and decisions are needed and are needed yesterday.

All I can say is, I was not encouraged by what I heard this morning.

Senator GRAVEL. I share your view in that regard.

Going to your statement, starting—first off, let me say I could not agree more about the totality of cost to energy or to any facet of life. We have got to fix the total cost of it. That is not just the cost of manufacturing or profit. It involves the various prices we pay and what is involved with the total ecology. If we could affix that and apportion it, we could get our system working a good deal better, and I think we could have our cake and eat it, too.

I agree very strongly.

In your statement you say that there is no alternative to rationing and price controls to balance our energy budget in a public interest manner in the months ahead. You stated as a citizen, and I as a citizen and a Senator, looking at the administration's nonexistence game plan, it is apparent we are moving into something that we are unqualified or not predisposed to do properly.

I notice that this theme is woven through your entire statement.

Let me go back to the point that I made with Governor Love at the beginning. That was the thesis that incentives do two things. They increase supply and they lower prices. We get that money, or rather, we do not get the money. The incentives can be accomplished through various tax activities, so the money in point of fact stays within the private sector. We can tax and when we tax we raise the price, which could be an asset because that will dampen consumption. Then we have to hire the guys to collect the tax, then we give the money to somebody else to go to the job. So, in total efficiency in society, you create a bureaucracy to do the job.

Then there is the third. That is, of course, if you deregulate, price will rise, so you accomplish the same thing that you wanted to in the second case of taxes. You dampen consumption, which is a benefit.

Second, the rise in prices, the money goes to industry and therefore you do not need the bureaucractic infrastructure to reapportion this money in an imperfect way.

The only danger that I see in that situation is of course excess profits. That is why I coupled that equation with, or the bottom line of it, in order to have a free society and get some guarantee that you will not get a rip-off, we could get an excess profits tax. In this way, we get the marketplace and the economy doing the apportioning rather than the sad experience that we have had by having Government do it, where they were causing chickens to be priced, where the price of the chicken was less than the cost of the feed. There is no point in stuffing it into the poor animal because you are not going to get the profit at the other end. What they did was drown a lot of small chickens so we did not have chickens on our table. The same thing happened with meat and what have you.

So for the last 2 or 3 years we've had a horrendous track record.

Woven into your statement is a theme which is strongly accepted in the Congress, that is—and I for one have been guilty of the same thing—we see a problem and think Government can go and solve it. Maybe it cannot. Right now I have a big question mark whether it can or it cannot within certain contraints.

What I throw out to you is, one, your comments on this thesis and the viability of incentives, taxes, and deregulation, and totally a free market, with the caveat of a floor of excess profits for your consideration. Let's handle that subject for a moment.

Mr. FREEMAN. I see, Mr. Chairman, you saved the easy questions for this afternoon.

Senator GRAVEL. I shot that one this morning but there was no reponse to it. I think you probably can make a contribution.

Mr. FREEMAN. I would be glad to try to respond the best way I can. You have really asked a question that goes to the heart of the matter. It is hard, in view of what has happened in the last decade, for anyone to be cocksure of what the answers are.

I am troubled by the prospect of turning this problem over to the marketplace because in a very real way the marketplace has failed us in the last decade. We can exclude natural gas on the grounds that it was regulated by the Federal Power Commission but certainly, the price of oil, if anything, was propped up, not pushed down by governmental action over the last decade. We had quotas that kept out lower priced foreign oil. We prorationed. We have given the industry, I think, a rather generous tax incentive.

Mr. Chairman, that system just has not worked, either because the resources were not there or as some would argue the incentives were not great enough. Certainly we have continuously fallen short of having productive capacity in this country to meet our needs. Each year that we kept oil out, or thought we were keeping oil out, we kept importing more and more.

I am troubled by the notion that after a decade of experience where the gap between domestic production and domestic consumption of

petroleum kept getting larger and larger, that somehow we can solve it by throwing our hands up and saying the market place will handle it.

I am in favor of giving sufficient incentives to accelerate the exploration and development of our domestic resources, but there are many geologists, and there is a rather respectable school of thought that suggests in the lower 48 States, except for the Outer Continental Shelf, that this is an old petroleum area. We've drilled over 2 million holes in the ground and brought to earth 100 billion barrels of oil in the last 100 years. There is a lot left. The question is, at what rate can we find it and bring it to earth compared to the rate of consumption that we now have, which is enormous.

So, it might very well be that given the number of people in the oil and gas business today, and the rate at which their efforts can be expanded, that we have to face a few cold, hard facts here.

The constraint in the Outer Continental Shelf in the Federal lands where most of the oil and gas remain, in my judgment, has not been price, Mr. Chairman.

Senator GRAVEL. What?

Mr. FREEMAN. Has not been price. Every time the Government has offered lease sales in the Outer Continental Shelf in the recent years, the oil industry has been willing to put up billions of dollars just for the privilege of going out and drilling. I cannot get excited about those that say exploration and development out there has been inhibited by price controls as long as that situation has persisted. The bottleneck has been the inability of the Federal Government as a proprietor to learn what it owns, to find out enough about what is out there, what the environmental problems are, to develop a leasing program commensurate with the needs. It is not a problem of the price because if the price were too low, why would the oil companies be bidding millions of dollars just for the privilege of drilling?

Senator GRAVEL. Would it not make more sense, then, to appropriate the moneys, drill the public domain, do the seismic work, and find out what is there rather than put it on a bonus bid, which has been Government practice?

I see no sense, like in Alaska, causing the oil industry to put up with all front money, then to speculate on whether or not there is oil there or there is not.

Would it not make more sense to do it that way?

Mr. FREEMAN. Precisely. The statute that controls this, the Outer Continental Shelf Act, expressly provides for royalty bidding as an alternative to the cash bonus system. The Department of Interior has never even experimented with royalty bidding.

There are opportunities for concessions. If new legislation is needed, I am sure the Congress would be receptive to consider it. We are the only country on Earth that I know of that persists with this cash bonus system. We do not have a system that has a performance requirement. The Government which owns the resource is doing virtually nothing about finding out what is out there and what the environmental problems are. I come back to the point that the bottlenecks are governmental bottlenecks. We own as a proprietor most of the resources that are economically attractive to exploit over the next 10 or 15 years. We do not have our own storehouse of wealth inventoried. We do not know

enough about the environmental problems out there to able to satisfy concerned citizens who are really worried about the impacts.

We should take a few million dollars of all that bonus money and find out what we own. I do not think the price controls are the bottleneck.

Senator GRAVEL. Why not just get it away entirely from bonus moneys and just appropriate the funds to find the resources of this country?

Mr. FREEMAN. That would be a more direct approach than the approach that we are following.

Senator GRAVEL. Unless it is capricious both by Government and within the marketplace; right?

Mr. FREEMAN. Well, when it comes to the question of taxes versus letting prices go up, it seems to me our basic goal is to enlarge the supply of clean energy—and we have to look at this problem not just in terms of tomorrow and next month or next year. It is time we start thinking in terms of decades because that is what is required to develop these new resources. We have to learn to harness the Sun and develop the heat of the Earth and develop some fusion power and other totally new sources of energy.

Now, I really do not believe that on a discounted cash flow basis, that you can expect private enterprise to put the kind of funding, year in and year out on those long-term ventures that the country needs.

Therefore, I would rather see money collected through the tax route, perhaps through your Btu tax idea, which I think is a splendid idea and put that money to work in enlarging the supply of clean energy. This in the long run is the only way that we are going to get sufficient interfuel competition and sufficient action in the marketplace to balance supply and demand. It seems to me that we have got to take the long look and do the fundamental things beginning now if we are ever going to get out of this crisis.

I am a bit reluctant, quite a bit reluctant, to assume that letting the money flow to the petroleum energy industry and the other energy industries is ever going to develop a technology for adequacy, a technolgy for abundance.

For one thing, Mr. Chairman, there is a real economic interest on the part of companies in the oil business to maintain a certain scarcity. I am not suggesting that they have an incentive for the kind of shortage that we have now, nor are they responsible for the fact that the Arabs have cut off the oil. But there is no incentive for people that now have a very happy seller's market to do the kind of fundamental work that would undercut their own bargaining position.

So I think having the Government at least manage the direction of a major research and development program is a governmental function. That does not mean the work should not be done in large part by private enterprise. It does not mean that we should not perhaps use the contracting approach of creating a market for synthetic oil rather than the Government simply funding all this research and doing it themselves.

I am very attracted by the idea of trying to pull new technology out of the marketplace rather than the Government trying to push it through, if it is close enough at hand. But when you get these funda-

mental things like solar energy and geothermal, we are not far enough along and the Government needs to push there.

My answer to your question is, the bottleneck in terms of oil and gas is the Federal Government propriety role. We need to straighten that out. For a long term we need a research and development program which at least is game planned by the people because it is the people's money. I just do not believe that there is sufficient incentive for the companies in the business of hydrocarbons to do the kind of work that is going to provide very large new sources of energy to get us out of this mess that we are in.

Senator GRAVEL. There is no question that you cannot expect the oil industry to attack these other areas, particularly in respect to solar energy, and I am sure you are aware of my position on that, and I agree. However, they need not be incompatible if we have a public effort which would involve a trust fund or a tax effort that goes out and does the necessary contracting to get a solar prototype plant built, to build some experimental houses and buildings to heat with solar, to accelerate the fusion effort comparable to the fissional effort that we are making. That in itself will take a chunk of money, and we have got to inventory that cost. So that is one facet of the problem. That still does not negate what can be done under our free enterprise system with the private sector.

What I am suggesting—and I will go back. I do not necessarily quarrel with your statement about some of the excesses of industry in this regard. As I stated this morning, I criticized the quota system, but what would happen today had we not had that quota system to prop up what oil industry we have left in this country? We probably would have had a total flight of oil activity in this country, all going to the Middle East because that is where it was cheapest to operate. We would probably not have any infrastructure to speak of to handle the fuel crisis we have now rather than the dependency of let's say, from anywhere from 10 to 20 percent. Maybe that dependency right now would be a great deal more than that.

Mr. FREEMAN. It is difficult to speculate on what might have happened. We might very well have been smart enough to use some of that imported oil to build up some stockpiles and have some reserves, ready reserves in this country, if we had had the insight to do so. We might have been bright enough to develop some of our oil fields and shut them in and have them as a ready reserve.

I think it is kind of idle speculation to suggest, to review——

Senator GRAVEL. That is policy, though, which does not attach itself to the profit area. They are elements that can be handled properly by Government. That is where I think the Government should come in.

But the other elements where you don't necessarily need the Government to do it other than protect the public from unfair profits. Let's take an example of gas, talking about regulation. I find it a total anomaly as total policy in a society that we regulate the price to the consumer so it is cheap. It is the best fuel we have, natural gas. We have made it the cheapest fuel, cheaper than oil. So we have encouraged people to be wasteful in the best that we have. Rather it should be the reverse. We should have made that the dearest so we would be more provident in how we handled that particular resource.

Now, the Government could have done it. There is no question. But Government was in command. We have the power, Federal Power Commission to regulate gas. They want the opposite. It is a very attractive liberal thesis that we have got to keep gas cheap to the people. So what happens? We keep it cheap to the people and they do not drill for any gas, so we do not see any gas. You look at the intrastate gas where there is no control. Price has gone up, not exhorbitantly, 50 cents as opposed to say 20-some-odd cents, 28 cents for the other. You can satisfy those markets.

Why should we depress through artificial Government action to get people cheap fuel when it is not cheap?

Mr. FREEMAN. Mr. Chairman, we could probably spend a lot of time talking about that subject. It is one that I devoted a number of years of my life to when I was at the Federal Power Commission.

I think I understand the issues well enough to have some respect for all points of view. I think that we had a policy of low cost and promotion that applied across the board to energy. It was not just natural gas. The electric power industry under the Federal Power Commission when I was there, you know, was encouraged to promote the use of electricity. I was just as much a part of it as anyone.

I think the philosophy of the whole country in the early 1960's when President Kennedy was elected was to get the country moving again. It is a bit unfair to criticize ourselves. Even in hindsight those policies made a lot of sense. I grew up in the Tennessee Valley and damming the rivers and cheap electricity was probably second only to the Bible in terms of public acclaim in the region. In those days no one was against it. We can look back with hindsight and question the wisdom of persisting with these policies after we used up the hydropower and began the strip mining in eastern Kentucky. I have been very critical of the fact that we just drifted ahead into the 1960's and 1970's with these same policies.

But natural gas was a byproduct of the search for oil. It sold for 3, 4, 5 cents a million cubic foot before the Federal Power Commission ever got into the picture. Many of the contracts for the lowest price gas were entered into in the marketplace. Most of the lowest price gas was sold to industries that were not subject to FPC regulation at the pipeline sale.

I think it is still an open question as to whether or not we served the people well by saving consumers many hundreds of millions of dollars that would otherwise have been charged for natural gas. Because it was a byproduct, its cost was lower than the market price. There is no need to go back over ancient history in a sense. We have a situation——

Senator GRAVEL. I do not want to be misunderstood here, Mr. Freeman. The purpose of going over this is not to remonstrate over the past, as you point out. We can all be a Monday morning quarterback. We are about to try to define a policy for the future. If we have not learned from our mistakes in the past, then we are going to fall into the same pitfall. That is the danger I fear, that you have woven in here.

Let's tax more. Fine, if we are trying to get money into industry we can do it by letting the consumer pay the same thing. We just

don't put our tax on, run the money through the Treasury and back out again, unless we want to turn around and offer general guidance to the system. If you take that extension we can nationalize all the energy industries and let the Government run it as they do in the Soviet Union.

We believe that we can design a marketplace and through necessary Government adjust it for the public benefit. You are right. At one point, probably, the nature of the gas industry was such—at least in its distribution—was monopolistic. But today there are 3,700 independent gas producers in this country. That is not monopolistic. There is not one gas producer that is more than 10 percent of the total market. We do not even have close to that in the auto industry and nobody talks about nationalizing or regulating the sale of automobiles. Yet we do it for gas for some unknown reason, and gas is price sensitive.

I can recall a year and a half ago that our energy shortfall in the 1980's the amount that we were going to import in this country was predicted to be about 40 percent. A year later it was 55, 60 percent. Now it is even accelerated. What happened? Someone forgot to compute in the gas shortage curve that was coming down which then put a great demand on oil. That is one of the things that has exacerbated the energy crisis now. If you have a flight of capital from gas and you have a flight of capital from energy generally. If we had such good incentives to the oil industry, why is it that there was a flight of capital from the search for hydrocarbons, the way this country needs them? Why did the capital go to real estate? Look at Gulf Oil Co. It is becoming a conglomerate. If the oil business was hot, they would be taking over and putting it right there in the oil business rather than going out and building motels and buying real estate and competing with real estate dealers in this country.

Mr. FREEMAN. I think it is important that we review this history because it is just possible to draw the wrong lessons as well as the right lessons. If my analysis suggests that the problem has been the Federal leasing program rather than price controls, then the country could very well eliminate price controls and sit back waiting for a flood of oil and gas and find a trickle. I think it is quite important that we eliminate the real bottleneck, identify the real bottleneck and eliminate it.

For example, one is hard pressed to say that the Federal Power Commission price controls on natural gas in the Outer Continental Shelf has impeded the exploration and development for gas out there in the last decade. What has happened, after Santa Barbara, Secretary Hickle put a freeze on leasing for almost 2 years. I do not care whether the price of gas is $2 an Mcf, you are not going to get any gas out there if the Government doesn't offer any leases.

Senator GRAVEL. Was that freeze on the whole country?

Mr. FREEMAN. There was a freeze on the whole country. There were no lease sales after Santa Barbara for almost 2 years. There was one in southern Louisiana, 18 months or 2 years later. We have had a very much subdued and slowed down Federal leasing program.

I think that that has been more the bottleneck than price controls.

I testified before the Commerce Committee in favor of decontrolling new gas on dry land where I think there is directionality and I

think absence of price controls on non-Federal lands would encourage and accelerate the drilling. I think the bottleneck on the Federal domain is the Federal Government. I would respectfully suggest that one direct one's attention to unlocking that bottleneck because if one does not the absence of price control in my judgment is not going to make that much difference.

Senator GRAVEL. I do not disagree with that. I agree that there is a bottleneck. The area that I get concerned about is can we relieve that bottleneck? Can we also at the same time reestablish the balance of the situation so we can work better?

Mr. FREEMAN. Your suggestion earlier that we eliminate all the front end money comes a whole lot closer to the point, perhaps, than eliminating price controls because apparently the price controls have not inhibited the industry for putting up a lot of money to get the leases. If one goes to a bidding system that relieves them of putting up all that cash, there will be more funds available for the exploration and development, I would think.

I am also a little nervous about suggesting that we have to have rates of return on an essential commodity like petroleum equivalent to real estate speculators. I don't think——

Senator GRAVEL. Would you agree they should get the same return as an average manufacturing return, which has not been the case?

Mr. FREEMAN. I do not think the petroleum industry has had extraordinary profits over the 1960's. My own reading of the data is their profits over the 1969's have not been anything that one should be concerned about as a public citizen, but I am concerned sitting here today, Mr. Chairman, when monopoly power in the Middle East is setting the price of energy for the whole world on a noncompetitive basis, and American companies rightfully are following the leader, and there is really very little of what I would call price competition to protect the consumer taking place in the chaotic marketplace you have today. That is the reason I say that until we do something to get some better balance between supply and demand, that the idea of taking off price controls seems to me to be a very cruel idea for the American consumer, and it is not likely to increase the supply, just as Governor Love says. It is not going to influence the kind of Saudi Arabia that we give more money to the international oil companies.

Senator GRAVEL. They are going to get it anyway because they are pricing it that way. The point that I made with Governor Love, and I am sure that you agree, that we ought to have somebody represent this Nation and go ahead into negotiating the price.

Mr. FREEMAN. I think that this country needs to improve its bargaining position.

Senator GRAVEL. How would we do that though?

Mr. FREEMAN. I think some of the ideas you have suggested and others, to begin on an all-out effort to develop these alternative sources so that there really will be help coming in a very short period of time; going ahead with secondary and tertiary recovery incentives along the line that I suggested; in having a concerted effort to develop the coal that we know—that we can mine—all of these things.

In other words, my own analysis is, that perhaps more fundamental than changing the negotiator, is changing the negotiating power of this country by going—as you suggested earlier—to a balanced energy budget, even if it means inconveniences and show that after they cut to zero, they cannot hurt us anymore. Then moving ahead with enlarging domestic sources and cutting back on our consumption through true conservation ways—I think a combination of these things can improve our situation so our bargaining power will be greater.

I am not at all certain that simply changing the negotiator would make all that much difference. Maybe if he was a negotiator, he would have greater reasons to put together a program, but I think the incentives are there right now, if one looks at the stock market.

Senator GRAVEL. If you are Gulf and you are negotiating with Libya and someone jacks the price up in Kuwait and Libya responds and Saudi Arabia retaliates, you will have one company played off against the other.

The person who gets hurt is Mr. Consumer and the world, not just the United States. So, if we had one negotiator, one who negotiated the price of oil for the United States as one major market, it would make a substantial difference in what would be arrived at. The only person that could be played off against at that point would be other countries.

We have one oil company with three oil companies within one company dealing with one government. They do not quite negotiate; they call on another one. Then when Libya gets a price, it just fluctuates. You have just seen it happen before your very eyes. They will sit there and jack it up one afternoon 70 percent.

Mr. FREEMAN. I understand the problem. The basic problem, I think, is in the difference of the bargaining position.

Senator GRAVEL. How do you increase that? That is the point that I am making.

Mr. FREEMAN. There is no way—real way—short of moving to an energy conservation growth pattern and enlarging our supplies. In other words, the only way to change our bargaining position is through changing the degree to which we need the oil, to put ourselves in the position where we buy it if the price is right, but not because we have got to have it.

Senator GRAVEL. That would be the ultimate. Of course, if we are not in that position for 10 years, what do we do between now and 10 years?

Mr. FREEMAN. I think that we have got to start getting into that position much sooner than 10 years. I am not very sanguine about having the Federal Government becoming my negotiating agent over there. I say that in all candor, I am just not certain that it would be that much of an improvement.

Senator GRAVEL. You are prepared to say that if we turn around and let Government set the price, negotiate the price for gas in this country, which is what the FPC does, that that is OK?

Mr. FREEMAN. The Federal Power Commission is tring to set prices on the basis of a standard that has been enunciated by the Congress and interpreted by the court. It is a very different situation than try-

ing to bargain with something that you have got to have and have no alternative in the final analysis.

I think we are going to have to pay very close to what the seller wants because he does not have to sell. There is a fundamental strength in the bargaining position of Saudi Arabia, a country with just a few million people, that really does not need the money and does not necessarily have any incentive for producing more oil at the rate that we want it.

The news is really harder and the problems more severe than has been expressed by referring it to the present Arab-Israeli conflict. There is a fundamental economic incentive for a country like Saudi Arabia to go very slow in expanding production because it can get all the money it needs with roughly the current level of production.

Senator GRAVEL. More. In fact, they are presently producing less and getting more money.

Mr. FREEMAN. Right. After learning how to make more by producing less, I am not sure they are going to forget the lesson.

Senator GRAVEL. I am sure they are not, they would react the way we would react in that situation. That does not solve our problem in the short run, where if we can find areas that are price sensitive—you see, the problem that we are hung up with right now in our discussion, is exactly the problem that the Congress is also going to be hung up on, which way do we go to try and solve the problem?

Do we need more government? I think many areas of the Congress will say, "Yes; we need more regulation, we need more of this, more of that"—will that do the job? I think the only recourse we have is to go back again to this one case of gas that has been regulated since 1955 and see what has happened and the graphs are very graphic. There was a short spurt for a year and a half of increase, then it was all downhill. Why is it that under Government management, which is the FPC—and certainly it is no reflection on yourself or the Federal Power Commission—what we are dealing with is countervailing forces?

Why is it that with this total Government management, which is what the FPC has been, that there is not enough gas to go around today?

Mr. FREEMAN. Why is it the same thing happened with oil? The same thing has happened in the intrastate market for gas; there is a shortage of natural gas in Louisiana and Texas. There is a shortage of oil. It is quite possible that these are trends that occur, essentially independent of the Federal Power Commission. There has been a decline in drilling for oil and gas in this country since 1956 until the last few months.

I think it equally plausible to analyze that history and say that the problem has been that the more attractive hydrocarbon fields have been in the Middle East and that the petroleum industry shifted their investment out of the United States because there was such promising oil profits as other parts of the world.

Senator GRAVEL. Sticking with gas, why would the Federal Power Commission then grant the license to import gas from Algeria, at a total cost of $1.35 an Mcf when they were not prepared to go any more than $0.25 an Mcf for domestic sources?

Mr. FREEMAN. You have got me into an area, now, that I have problems with myself. I do not take responsibility for.

Senator GRAVEL. This is Government action. This is no different than the beef situation we experienced last year, or the chicken situation we experienced last year. One of the recommendations, I agree with was your thesis, I could not agree more, but there is woven into a good portion of your recommendations that we should do more of this. That is the part that frightens me, because we do not have a very good track record in that area.

Mr. FREEMAN. Perhaps my testimony is not as precise as I should have made it. I am saying that while we have a 20- to 25-percent shortage, like we have this winter, and while we have this kind of imbalance, I do not see any alternative to price controls and some sort of rationing.

I testified before the Joint Economic Committee and I am in favor of a market rationing system where we would try to use the marketplace to the extent that we can, to give everybody a basic ration. I do not know that we are in fundamental disagreement about the future. I think we both agree that there needs to be a federally led research and development program. I am in favor of giving the petroleum industry all the incentives they need. I am not certain, Mr. Chairman——

Senator GRAVEL. Price is incentive—we can tax or we can give them other kinds of incentives, price itself is an incentive. The people, the consumer, gives the oil company or the gas company incentive, if he is willing to pay more for their product.

Mr. FREEMAN. We have a system today where the price of crude oil for new sources of crude is a free market price and the price has not been controlled for over a decade. Some would say the price of crude oil has been supported by the quota system and prorationing. I do not understand what more we could do in terms of permitting the price of crude oil, new crude oil, to reflect market conditions. I am in favor of letting the price of natural gas, new gas on the non-Federal domain, be controlled. I believe the bottleneck in the Federal domain is the Federal Government.

Senator GRAVEL. Would it not be fairer if we said, OK, we will deregulate prospective natural gas, which I am happy to say from your background that you are thinking that way, but we have a lot of existing contracts that are sort of working themselves out. I think most of the contracts have a proviso that if the lid is taken off, they can go right up to whatever the market is.

Suppose we cracked it and said all these contracts have to expire, not make it just prospective—I think there is a basic unfairness to the person who knows most about the gas, who is already in the gas business, already has reserves, that tomorrow he has no tax, but he has already got a tax on it.

Mr. FREEMAN. Mr. Chairman, I see it entirely the other way. This gas is dedicated to interstate commerce under rules and price controls. People have bought gas furnaces and made investment in equipment, on the basis of those prices.

To decontrol the flowing gas simply gives windfall profits to people. It does not guarantee you that that money will go back in the ground, it could very well go back into the real estate business.

Senator GRAVEL. That is right, but we can stop that another way, but you are going to turn it around and give them an incentive another way, but why not let the market provide the incentive? The infrastructural cost is not going to change as I understand it, that would be less than 8 percent, deregulating at the wellheads, that would have less than an 8-percent impact on the consumer at the other end.

Mr. FREEMAN. There are 23 trillion cubic feet of gas, and every 5 cents is a billion dollars. That is a lot of money out of people's pockets. I don't know where it is going to go, perhaps in the North Sea or real estate, or somewhere else. I do not see where it brings you a single million cubic feet of gas. I am in favor of giving incentives to new gas that has yet to be discovered, but not the existing contracts that were dedicated under price controls. People knew when they sold the gas that the price was going to be controlled, people bought the gas under those circumstances.

To now turn around and say you can go to the ceiling, especially when that ceiling is being fixed by the people in the Middle East who have a monopoly because the price of oil and gas is competitive, that seems to me to be an unfair decision vis-a-vis the consumer. It seems to me we ought to make these incentives sharp enough to give us more energy, to go after new sources.

Senator GRAVEL. Could we not limit it? Could we not say "Fine, we will deregulate gas, we will decontrol oil, let the market work, but if you make it an unconscionable profit, we will tax it"?

Mr. FREEMAN. I have two problems with that answer. One is my hazy recollection of the history of the efficacy and enforcement of excess profit taxes suggests that they have not always been highly successful.

Secondly, if they are successful, and if they really are effective, you have left the producer in the same financial position that he would have been if he were regulated. I do not see that you are giving him any additional incentive.

Senator GRAVEL. I do not think that that is the case.

Mr. FREEMAN. If he is really looking for a higher return and greater incentives, if you say I am going to give you a dollar in the price, but I am going to have a tax collector come along and take it back, if it is really effective, I am not sure you are really going to enhance the incentives any.

Senator GRAVEL. It would if you turned around and said, say 20 percent, is that considered an unconscionable profit?

Mr. FREEMAN. I am in favor of giving the petroleum industry as high a profit as reasonable people could determine. But when they are exploiting oil and gas that is owned by the people of the United States of America, I am not sure that we have to go beyond a very high reasonable rate of return to get the energy produced.

It seems to me that there were 15 years of very good production of the natural gas under regulation. If the pricing was so low, why was it from 1954 until the late 1960s, there were ample gas supplies available. Apparently it was not all that bad for all those years, and I think the analysis of the history leaves you with a question mark as to whether or not our present predicament is not a function of a decline in resource base, a galloping consumption pattern, and a Federal Government with a leasing program that is just not up to the job.

Senator GRAVEL. Mr. Freeman, I unfortunately have to go vote. I will be right back and I would just like to hold you for maybe another 7 or 8 minutes myself. I think you are in the mother lode as they say in the mining industry.

[Recess.]

Senator GRAVEL. The hearing will be in order.

Mr. Freeman, I thank you for your patience. I think the phrase I enjoy the most in your statement was a "free garbage pail." I think that is an excellent description about the way we have treated the air, the water. In reviewing your statement, there is really not that much I wish to pursue in other areas. I agree very strongly with many of the concepts that you put forth.

Has your organization done any pricing of these concepts? If we set up an energy trust fund we would have to know what the tab would be, at least in the public sector.

Mr. FREEMAN. These particular ideas are my own personal suggestions. In the work that we have underway to be completed in the coming months, we are trying to price out many of the policy options and we hope to be able to present it to the Congress and the people of the country, some optional game plans. So we can evaluate what our policy options are in the context of how you get from here to there in the next 30 years. Our purpose is to try and put all the pieces of this energy puzzle together, not to suggest what our energy policy should be, but to lay them out in a coherent way so policymakers, committees of Congress, could evaluate what the options are and have them priced out to the extent that they can.

There are some things that we are finding very difficult to put a price on. For example, how much more is domestic oil worth to us than imported oil? At the moment, I guess the differential is close to infinity, but for long-term policy purposes, what sort of a fee, for example, would you put on imported oil to reflect the value that we, as a nation, would place on a more secure source.

Those are difficult questions to answer. One idea would be that you ought to have enough of a fee to try to fund strategic reserves and build up storage: but perhaps that is not correct. But we are going to try to be as helpful as we can and we will be publishing reports starting in the spring throughout the coming year.

Senator GRAVEL. Did you notice Victor Zorza's article in this morning's Post about the Russian attitude of international properties? I would suggest to you thinking that unless we have a world federal system, that we are struck by the boundaries of nationalism and that a nation like ourselves has no choice but to be independent, self-sufficient for whatever price that is. We have to be able to pay it or we can turn over to it all, title or deed to our society, to somebody else.

Mr. FREEMAN. Mr. Chairman, I have tried to express my own view that we certainly cannot be buying out of desperation. But I do hope we distinguish between Canada and Libya, and understand Iran as a friend though Iraq may be boycotting oil. And distinguish between countries like Indonesia and Nigeria from countries that are boycotting us. I am not at all certain that an isolation policy for the United States is 100 percent correct.

Maybe for other reasons, because the world has such a great need for energy, this country really cannot expect to draw very heavily on the rest of the world.

Yet, I am troubled by this blanket description that somehow puts our friends and the people that are boycotting us in the same boat. After all, Venezuela has been a dependable source of oil supply to the United States through all sorts of emergencies. They are behaving like a free market country should in getting the price they can, but there has been no hint of interruptions. Certainly Canada is a friendly neighbor.

I would think that we temper the self-sufficiency with an understanding that we should try to develop the capability for self-sufficiency, and buy because it is a bargain, rather than desperation.

Senator GRAVEL. Certainly, you consider me no hawk. By the same token, I think our friends today may not always be our friends tomorrow. That is one of the immaturities of our society. That the Shah has been a very good friend, supposing he were taken from our midst and someone else were in, then probably they would not be our friends tomorrow.

Mr. FREEMAN. There is a school of thought that suggests that once a nation like Iran embarks on raising the standard of living of its people, and embarks on a development program, that it has about as much need for the money as we have for the oil. I think that there is a friendly respectable school of thought that would suggest that no matter who rules Iran in the future, that that nation is embarked on a development program, that its people are now moving up the ladder to the point where they are hooked on the income.

The same is true of Venezuela. I do not think there would be a democratic government in Venezuela if we were to stop buying oil from them.

Senator GRAVEL. The unfortunate problem is that Venezuela and Iran cannot satisfy our needs, nor can Canada. The only nation that can presently offer any security to us would be Saudi Arabia and maybe some of the other states.

Mr. FREEMAN. I am not disagreeing with the basic thesis that we cannot become dependent on insecure sources. I just think that perhaps some of the rhetoric coming from some sources, heralding Project Independence, is overblown and overstated. It would be useful, until we have this capability firmer in hand, that we distinguish between the people that we are relying on today, Canada, Venezuela, and others, from those that have cut us off.

Senator GRAVEL. I would only like to close the questioning with you, sir, and thank you for coming, and I hope we will be able to get you again when we have a definite bill for your analysis. We would then appreciate it if you could give some thought to this dilemma of whether it is worthwhile to recycle through a bureaucracy as opposed to going directly to society in apportioning benefits in the effected discipline with constraints—constraints and movement of capital constraints on excess profits and all of that.

Mr. FREEMAN. Fine. . .

Senator GRAVEL. Thank you, very much.

[Mr. Freeman's prepared statement follows:]

PREPARED STATEMENT OF S. DAVID FREEMAN

Mr. Chairman and members of the committee, I was glad to accept your invitation to be a part of the hearings on fiscal policy and the energy crisis. There is no subject more timely and important. The nation needs to use every policy making tool it can muster to help balance our energy budget. And certainly the tax laws and other elements of fiscal policy are among the most effective tools that government can wield.

Mr. Chairman, the views I express this morning are strictly personal and are not presented on behalf of the Ford Foundation's Energy Policy Project which I am directing. That particular study of national energy policy is one we hope to complete in the coming year. My views today reflect my own involvement with energy policy over the last decade, first with the Federal Power Commission, later as an energy policy official in the Executive Office of the President, and more recently, as an interested citizen. I hope they will be of some value to the Committee.

In recent decades new tax laws have not been enacted as an energy policy making tool. True, the depletion allowance and related tax incentives have been a controversial part of our energy policy for decades. But by and large the conventional wisdom that the tax laws should be used only to raise revenue has dominated energy policy. The tax laws and fiscal policy have not been used to help solve problems such as pollution control, to provide incentives for research and development of new sources or to encourage greater efficiency in the consumption of energy. Government policy has dealt with these problems through regulations, inadequate appropriations, or not at all.

There are, of course, considerations of overall tax policy that suggest caution in using the taxing system for purposes other than raising revenue. And yet tax policy can be a powerful tool for helping to solve basic national problems. And nothing is more basic to our economy in the months and years ahead than balancing our energy budget. Tax measures, such as the investment credit in the early 1960's, were successful in getting the economy moving ahead and I believe that new tax measures, combined with other action programs by government, can play an essential role in solving our energy crisis which might otherwise make our problems of a decade ago seem like child's play.

As we examine the problems the country now faces from its over-consumption and under-production of energy there is no end to the number of ways in which the tax laws could be used to help. The suggestions range all the way from income tax exemption for the cost of installing storm windows in one's home to doubling the depletion allowance. We should resist the temptation to flood the tax code with a large number of *ad hoc* measures. New taxes or tax exemptions should pass the test of being important and providing the nation with more for its money and greater feasibility than available alternatives.

As the energy crisis begins to take its toll in the weeks ahead there is likely to be a hue and cry for rushing through all sorts of legislation. But it is imperative that we distinguish between emergency measures and basic policies that will shape this nation's future. We face a shortage in the coming months that cannot be eliminated by steep taxes on energy without really hurting the millions of working poor in this country. And enacting large new tax incentives for the oil industry might constitute a raid on the Treasury without helping us through the winter and summer of 1974 or the years to follow either.

In my view there is no alternative to rationing and price controls to balance our energy budget in a public interest manner in the months ahead. But new taxes and tax incentives can be very effective in helping us in the years ahead. There is every reason to pinpoint areas where taxes could be added to the price of energy to provide incentives to use less or switch to sources that are available, as well as areas where new tax incentives might be especially effective in enlarging the supply of clean energy to fuel America's future.

I should like to direct the Committee's attention to a few specific areas where I believe fiscal policy could provide an effective tool to balance our energy budget in the years ahead.

A key problem that America must now face is to find a quick replacement for a large quantity of the oil that we were planning to import, primarily from Saudi Arabia. It may be premature to conclude that these imports will not be forthcoming but it is certainly late in the day to be developing a program which will give us an alternative. We should be importing oil as a matter of choice rather than desperation.

In my view the strippable coal resources in the Illinois Basin are the most promising large scale source of secure energy supply available for quick exploitation to fill that gap over the next 10 years. In the future we can open new deep coal mines in the East and hopefully learn to mine coal more safely. And perhaps the coal and oil shale in the West can be mined someday without creating a dust bowl. But we should take the time to find out. And we should also learn more about the Atlantic and Pacific off-shore rather than risking prime recreation areas for what may prove to be a thimbleful of oil in the big picture.

We know there are billions of tons of coal in Southern Illinois, Western Kentucky and surrounding areas and that production could be enlarged by many millions of tons over a period of several years. And we know that it is possible to reclaim these fairly level lands in an area of good rainfall if there are laws with sufficient teeth in them to require it. We also know that this coal is reasonably close to industrial centers and is now lower in cost than imported oil.

This expanded coal production would be used to convert to coal most electric power plants and large industrial establishments that now burn natural gas and oil simply as sources of heat. The nation currently uses upwards of 20 percent of its total energy in the form of natural gas and oil as sources of industrial heat which coal could replace. If such a replacement program were implemented over the next 10 years there would be large quantities of oil and gas available to supply transportation and small residential and commercial needs as an alternative to oil imported from the Middles East.

The coal in the Illinois Basin is high in sulphur content and therefore an integral part of this program would be the installation of equipment to prevent the ash and sulphur in the coal from escaping into the air. Such equipment has been developed (except for containing the very small particles which are of major concern but also exist in oil). It needs to be put into commercial use.

I believe that a well designed tax package might be the most effective policy tool for making such a program happen. One part of the package would be to place a substantial tax on natural gas and oil when used as industrial boiler fuel. Such a tax would begin to make it economically attractive for industry to switch to coal. It could also provide the funds for making the switch even more attractive because the second part of the package would be to use the funds from this tax on oil and gas to help finance the investment for the switch to coal. The idea would be to enact a special investment credit (or accelerated and depreciation) which would apply to the new plant and equipment which industry would need to switch to coal including the equipment needed to bring the level of pollutants emitted from such coal burning within environmental standards. The credit should apply only if both the coal burning and pollution control equipment were purchased as a package. It would also be limited to such equipment purchased and in use within the next 10 years. If special incentives are required to assure that the necessary coal mining and railroad cars are forthcoming they could be added but the package should be made self-financing by making the tax on the oil and gas sufficiently high.

It is, of course, obvious that the revenue from such a tax package would be high initially but would soon disappear as the taxes achieved its purpose of causing the shift to coal. But such a conversion would require a 10 year period to be completely implemented and the revenue to be collected could be designed to cover the bulk of revenue losses from the credits which would also be limited to investments during the 10 year period. In any event, if the program could achieve its objective it is likely to be a bargain for the nation because of the benefits it would bring in terms of meeting energy requirements in keeping with concerns about foreign policy, environmental protection and power priced energy to the consumer.

The details of such a proposal obviously need much more study but I believe a package along these lines could be the most important feature of a governmental program to balance our energy budget in the decade ahead.

There is also need for re-examining the subject of tax incentives to increase supply of clean energy from secure sources. I do not intend to discuss the basic issue of whether the country is getting its money's worth from the depletion allowance and other related tax incentives now on the books. It is sufficient to say that whether you believe they are essential incentives or a giveaway to the oil industry, they have not succeeded in providing America with sufficient productive capacity of oil and gas. Some may say that is a good reason for abolishing them, others would argue we should increase them. We have studies underway which when completed may shed light on this basic question.

This morning I would like to point to three specific measures to increase secure sources of fuel which I believe are worthy of immediate consideration. The first is a tax incentive designed specifically to encourage a maximum effort for secondary and tertiary recovery of oil from existing and future reservoirs.

It is a fact that currently only about one-third of the oil in the existing reservoirs is actually brought to the earth's suface and consumed. The rest is just left in place because it is more expensive to produce. The economics have dictated a cream-skimming operation yet sizeable quantities of the two-third left in the ground could be recovered if there were sufficient economic incentives to employ and further perfect recovery techniques.

The opportunities here are for the recovery over the next decade of 30 to 40 billion barrels of oil that would otherwise be left in the ground. This is a quantity equivalent to the nation's total current inventory of proven reserves. It is oil that has already been discovered and is connected to pipeline transportation systems already built. It is by far the most environmentally superior source of new petroleum that is available and, of course, it would be from wells in the United States, which means that it is also superior from a foreign policy and security of supply viewpoint.

Of course higher prices for oil would mean that some additional recovery would become economical. But the problem with simply raising prices is that a price high enough to make higher recovery economically feasible would be much higher than the fair price for the oil that is easier to extract. Such prices would provide a tremendous windfall to the oil companies. It therefore seems that this is one area where a tax incentive might be uniquely attractive. The tax incentive could be a depletion allowance designed to increase as the percentage of recovery increased in an amount calculated to cover the additional costs. The public would be paying only the extra cost which would be justified by environmental and security of supply advantages which make this oil worth more to the public than market prices which do not reflect these values.

To offset the tax revenue that might be required for this new incentive for getting more oil out of existing reservoirs I believe we should eliminate the current tax incentives which encourage production of oil in the Middle East. In light of current events it seems somewhat ludicrous to continue the depletion allowance and related tax incentives to encourage U.S. oil companies to produce oil in the Middle East. Surely if we are to continue with tax incentives to encourage exploration and development for more oil they should be pinpointed to domestic sources or areas of the world which are considered secure.

I refer not only to the depletion allowance but to the practice of counting the vast sums paid to Middle Eastern governments as a tax on profits which are then allowed as to dollar-for-dollar writeoff on U.S. taxes. I believe that most Americans would not find it amusing if they knew that every time the Arab nations increased the royalty payment which the oil companies must make for each barrel of oil produced that these dollars indirectly have their origin in the U.S. Treasury. There is a dollar-for-dollar offset against the taxes to the U.S. government that the international oil companies would otherwise pay.

A small portion of these huge payments to the producing nations could be considered as a tax on profits and the oil industry should be treated the same as other industries that can offset taxes paid to foreign governments against U.S. taxes. But the bulk of the sums are obviously royalty payments, no different than the cash bonuses and royalty paid to the U.S. government for offshore leases. They should be treated as a cost of doing business, not as a tax.

The fundamental point I make is that the depletion allowance and this technique of offsetting taxes are all encouragements to the petroleum industry to drill in the wrong place. Certainly the nation has a limited amount of money to invest in incentives for oil production. Tax incentives to drill and produce in the Middle East not only wastes the taxpayers' money but the effort is positively counter-productive, since in the absence of these overseas incentives there would be an even greater incentive to drill in secure areas.

It is important that we give the oil industry some new drilling signals through the tax laws, signals that are more in keeping with an energy policy designed to provide us supply from sources that are more secure. In keeping with this same general objective it would seem important also to revise the tax incentives for geothermal and solar energy, for oil shale and synthetic oil and gas from coal, to place them on the same footing as natural gas and oil. The Congress may choose to abolish all such tax incentives. But if they are to remain it seems

to me of fundamental importance to the development of an adequate supply of clean and secure energy, that the sun and heat beneath the earth and oil shale and synthetics be on the same tax basis as petroleum. These new sources should not be delayed because of tax handicaps which are a vestige of a bygone age.

The tax laws can also be used to cut out the awful waste in the consumption of energy. Higher prices would create an incentive to use energy more efficiently rather than permitting the energy companies to become super-rich it is far preferable to add taxes designed to have maximum effect in eliminating waste. The money could then be used for public tran portati n and developing new sources of energy. The taxes should also be designed in a manner so as not to create hardships on lower income groups either by hitting luxury items or providing exemptions or rebates.

The area where the tax laws could pay the biggest dividends would be to encourage the automobile industry to build cars with better mileage in a hurry. A tax program keyed to the mileage of the auto promises to be much more effective than a tax which tries to discourage citizens from using cars in which they already invested their money. The time to stop cars from consuming too much gas is when they are built, not after a customer is stuck with a gas-guzzler and has no other way to get to work.

It may be that performance standards are preferable to taxation in this area but if we are to try to save gasoline through the tax laws we should enact a tax keyed to the mileage per gallon. Taxing miles per gallon rather than horsepower or other measures would give the automobile manufacturers every leeway to achieve better mileage through better engineering. The opportunities for doing so are by no means small. For example, the diesel engine provides mileage roughly double the engines now in most of our cars.

The tax could set 20 miles per gallon as a standard and provide consumers with a credit for every mile per gallon which a car could perform in excess of 20 miles per gallon while adding a tax that would increase for each mile per gallon below 20 which a car could perform. There are a number of variations on this theme but such a tax on an automobile could be a very powerful tool that would encourage the construction and purchase of cars that might even reduce the volume of gasoline required by Americans a decade from now.

Taxes to control pollution are another major opportunity for using tax policy to benefit the public. Thus far we have relied exclusively on regulations to implement the nation's goal for clean air and water. We have made some progress but it has required a running battle with industry which has had little incentive to perfect and use control technology. One reason is that the nation's air and water has been available to industry as a free garbage can. These basic resources belong to the people and the government should start charging for their use. Pollution taxes should be related to the damage which pollution inflicts on society and would thus bring these costs into the accounting systems of industry.

I do not suggest that regulations to protect peoples health be in any way abandoned or watered down. On the contrary charging polluters for every pound of contaminate they release would provide a powerful incentive to assist EPA and make their job of enforcement considerably easier.

The adoption of pollution taxes is very much related to balancing our energy budget in the years ahead because it would assure that the price of energy reflected the full cost to the society. Prices that included the full cost to society would discourage wasteful consumption which society subsidizes at present. These same taxes would give industry a monetary incentive to perfect and use technology that would enable them to burn coal and other sources of energy in compliance with our environmental goals. It is a way of helping to balance our energy budget by controlling pollution rather than abandoning controls.

I hope these views are some help to the Committee on deciding on the crucial areas where tax and fiscal policy could be an important element of a clean energy policy for our nation's future.

Senator GRAVEL. Our next witness is Mr. George Mitchell, chairman of the board, Mitchell Energy & Development Corp., Houston, Tex., Mr. Mitchell, it is a pleasure having you here.

The floor is yours, you can direct your presentation as you wish, with or without lights, and however.

STATEMENT OF GEORGE P. MITCHELL, CHAIRMAN OF THE BOARD, MITCHELL ENERGY & DEVELOPMENT CORP., HOUSTON, TEX.

Mr. MITCHELL. Thank you, Mr. Chairman. What I will do is start off with a few comments and then to give you an overview of whatever expertise I have in the field of exploration of gas and oil.

I have been involved in drilling and I do have expertise in that field. To give you an overview, I perhaps can focus on the potential of this Nation and how we may come to grips with what I call the short term, to try to help solve the energy dilemma.

I would like to begin by saying that I am also president of the Producers' Royalty Association, an association of 3,000 independent producers. And because I am an independent operator, I have a feel for what response these types of independents have in the marketplace and what can be done and what this committee can do to help create the incentives that are necessary to do this job.

I would like to start now with some slides, then a summary that I will go over, and then I will be glad to answer questions.*

Basically, I go back to the National Petroleum Council's study, this is an overview, even the latest study coming out would show—and others are very close to this type of thinking, the emergency that is now on would distort some of these numbers, but this does give you a chance to understand the problem and to think clearly with a few simplistic slides. A growth rate up to 1973, 3.67 on energy demand, the curve indicates or growth rate could be as low as 3.4 or 4.4.

The studies pick an area they thought to be the best, that 4.2 in 1985. There are a lot of the analyses that come out on these studies and show the price sensitivity which I will respond to in more detail and my concept of it is based on this particular growth pattern.

The emergency at this time due to the shortage of Mideast oil will distort this. I think it will probably distort it for the next several years because we must face conservation measures that will distort this growth curve through the year, probably until 1975.

To bring you into quick focus, the energy consumption of the Nation was divided by 11 million barrels in 1970, oil imports only, 3.4 billion barrels a day, it is now 6½ billion barrels a day.

Natural gas, at 21 trillion cubic feet a year, gas imports, and coal, where we have our largest reserve of 519 million tons. We will skip 1975.

The energy study indicates—and most other energy studies correspond to this quite closely—that the domestic oil at our present rate of exploration, would only be 11 million barrels a day in 1985, virtually the same. Oil imports, 14.8 million barrels a day, if we can get it, at a balance of payments deficit of up to $60 billion a year. Natural gas is hit very hard because of the lack of discoveries in the last 10 years, 14 trillion cubic feet a year, gas import is very expensive.

Coal, the most abundant source must come on, and nuclear power comes on quite strong, as long as we solve the environmental issues and get moving with them as soon as possible. To show you what is happening in oil, we have 10 million barrels a day or thereabouts, and

*The slides referred to are reproduced immediately following Mr. Mitchell's oral testimony.

the North Slope—it is way behind schedule, but coming on in 1977 and 1978.

The studies indicate that we are likely to have our 10 to 11 billion barrels a day by 1985 at our present rate of exploration. I will talk to that in a little bit.

Oil producing capacity by large States is declining, falling fast, because of the lack of exploration incentives. I think this is the type of curve that we can do something about in the next 10 years.

OK, gas is even much more serious. It peaked out in 1971. The demand at 21 trillion cubic feet a year, in 1972 the demand could be 43 trillion cubic feet a year by 1985. Our production is projected to 14 trillion cubic feet a year in 1985, possibly the production that will come from 48 States and offshore LGN in Alaska could come on to help make it up, and all the other possibilities, to help this premium fuel reach its peak.

I am not sure how we are going to do it, it is a very difficult thing to do, but there are ways we can alleviate it.

Here is a completed chart, I will not say too much about it but it shows the price sensitivity in cases 1, 2, 3, and 4, that if we had a price the case 1 is so much and the price of case four, we could be less dependent on imported oil. We would be as dependent in 1985, 11 percent of imported oil or it would be 38 percent by 1985.

The key that the studies show, and our indications show, that if the price of oil went from $3.18 a barrel to $6.69 that that case 1 would only depend on imports of about—that lower level, 11 percentage points.

The key to this is, this price of oil brings on coal, brings on oil shale, brings on tar from Canada, brings on many, many things that does not altogether relate, and the nuclear problem in the Southwest that has been heavily oriented to oil and gas would come on at this price. Natural gas would have to go up 40 percent or 75 cents per million Btu's and these prices are now in operation, are now in effect, to new oil and to new gas that goes into intrastate commerce, unfortunately it does not go to interstate commerce. This has been a lack of deregulation of gas, it really has been a very serious impediment to the gas, in spite of some of the other testimony you may have heard, it has been a serious impediment and we will answer that in a little bit.

But most people do not realize, and I talk to them in the halls of Congress and in the administration, that there remain in the United States 385 billion barrels of oil remaining to be discovered or worked out on secondary and tertiary treatment, yet our present resources are only 39 billions of barrels.

There are 1,100 trillion feet of gas remaining. Our present reserves are 260 trillion feet of gas. It is a matter of where is it and how are we going to get it and at what price and what incentives are going to take to get it.

Simply showing it by a graph, if your case one, where you have a better price, in 1985, it would be no more dependent on imported oil than we are in 1970, we are already up to 6 million barrels a day, or 6½. If we do not do something, our price sensitivity, we are going to be dependent on the equivalent of 18 billion barrels of oil a day.

This is the key that most people do not understand, the geology of the Nation. The geology of the Nation and Alaska is up here, you have it on your insert sheet on another map, I did not purposely leave it off, it is one of the best potentials we have. The geology of the Nation is such that we must and can triple the exploration and development of the Nation. This area, from Brownsville to New Orleans is the dotted line that you see of the geological basin in Texas and Louisiana. It provides 65 percent of the Nation's gas reserves.

There is a mirror image of those sediments offshore, all the way from Brownsville to Florida. There will probably be $60 or $70 million spent in this area and a half a trillion dollars worth of oil and gas discovered. In fact, 600 miles below Galveston, the deep sea drilling ship, an experimental ship, found oil and gas, 600 miles out in the gulf in 12,000 feet of water. So that whole geological region has potential.

Of course, other areas, the deep areas of west Texas——

Senator GRAVEL. How deep was the water?

Mr. MITCHELL. 12,000 feet of water. They drilled at the top of this dome. They found oil and gas shelves within 500 feet of the domes. It shows the sediments of the gulf coast go way offshore into deep water. The main area of 150 miles off Galveston, all the way to Florida, has great potential and we are just beginning to scratch the surface. There is a new technology that most people do not know about, they call it the bright spot seismic technology. It is the first tool that we have been able to discover—the American oil industry discovery, that positively identifies directly the gas that is under the surface before you drill for it, not just structure. Most geology and seismology defines a structure, you may have gas or oil, or you may not.

Therefore, one out of nine wells are dry.

This new technology, this is so special, it is 70 or so percent. It is going to revolutionalize offshore drilling and the Pleistocene sediments of Louisiana and Texas gulf coast. There are new discoveries just recently in the last 2 weeks of Texas, 110 miles offshore, we had barely scratched the surface here. This basin, I would say, would have $60 billion spent in the next 25 or 30 years and has tremendous promise.

This is most promising and the Alaskan basins are the second most promising, I feel, to help uncover the resources within a Nation to do the job.

I will mention some of the basins that are very important. West Texas Deep Basin, where you are drilling 21,000 feet wells, it is cheaper than LNG or anything else. The San Juan Basin has 8,000 wells at this time, delivering 1½ billion feet of gas to the coastal regions of California. That, by a redrilling program, could double the reserve and could double the deliverability to the west coast. You cannot do it at 18- or 20-cent gas. That is being hamstrung by the Gas Act, as it now exists.

Senator GRAVEL. What would be the price

Mr. MITCHELL. You would have to have 50 cents to do that program.

Senator GRAVEL. That is the same price as intrastate right now?

Mr. MITCHELL. Same price as intrastate. I will have to tell you something about intrastate price structure in another slide. What is going on now in Texas? Now the east coast is all up tight about

drilling, as we all know. These basins have tremendous potential. In fact, they have three discoveries of Sable Island in this direction—now from this area, all the way to Florida—separate basins have potential that ought to be explored. It can be done within environmental constraints. I will show you some slides of how we did it off the Texas coast, right in a very concentrated area. Then you go to the west coast, it has poential, of course. They will have to get back to consider Santa Barbara area, there is a tremendous reserve of oil and gas potential.

All the basins area of Ohio, I will talk about that in a little bit. As to the potential of these areas, we have to get our wells, in 1955 we were drilling 55,000 wells a year, now we are drilling 26,000 wells a year.

Senator GRAVEL. Would you care to respond now or later to some of the points Mr. Freeman brought up?

Mr. MITCHELL. Yes; I will because I disagree.

Senator GRAVEL. Would you rather do it now or later?

Mr. MITCHELL. Probably in the question and answer I could do it better, Mr. Chairman.

This is the Ohio basin, a highly industrial area of the Nation. Each year we have been drilling wells under the most highly industrialized area in the Nation and in this region that is 250 miles long, this is all one gasfield, 4,000 feet.

Unfortunately you cannot make any money at 30-cent gas. That is what it was for 15 years under these tight regulations. At 65 cents, the breakover point, the alternative of oil was $1.50 a million Btu or LNG. We can drill 25,000 wells in this region.

Senator GRAVEL. Let us underscore that. In this industrialized area, they are now paying for energy of comparable nature of oil; what are they paying?

Mr. MITCHELL. A dollar and a half per million British thermal units. Propane, they cannot get that, desperate for propane; natural gas, and synthetic natural gas would be a dollar and a quarter.

Senator GRAVEL. They could have natural gas?

Mr. MITCHELL. At 65 to 85 cents. At 85 cents, a dollar per million British thermal units can be delivered to them, you would have 25,000 wells drilled in this region in the next 25 years. This has a tremendous potential all the way across Lake Erie. We are working on the State of Ohio to try to get the lake put up. You can build these wells with proper environmental constraints.

This is an area, offshore Texas, that we as independents have tackled. We have had a number of offshore blocks, and have drilled 11 wildcats, several discoveries—1 off of Galveston, 1 off 122, 1 off 126. Independents can do these programs, too. If you work it with a consortium of independents and work with the gas companies and help with funding, we can also go into this. We are drilling oil at this point, now. We drilled oil at this point about 2 months ago; the discovery I mentioned to you, this was only 10 miles offshore. This area between the State line and the State of Texas, that is the State land, this is the Federal lands.

The latest discovery is 110 miles offshore, down here. All that area in between has hardly been scratched at this time, all the way from Brownsville to Florida.

Senator GRAVEL. How deep is the water in that area?

Mr. MITCHELL. The water out there at 110 miles out is only about 250 feet deep. Our technology is available now to drill in 500 feet of water, 700 feet of water in Santa Barbara, they are doing seismic work in 2,000 feet of water off Texas and they should have bids. The structures out there are much larger than they are closer in. The potential is enormous. We have hardly scratched the surface.

This is an interesting slide I want to show you. This shows you how we can trade off the environment and still receive the energy. This is the geological structure, the town of Galveston—studies that covers that yellow line—61st Street, that is 25th Street, we identified the geological structure, we had to run a seismic crew down Broadway, believe it or not, and we were able to identify this geological structure right in the middle of the city limits. I was born right here and we made a gasfield of a full circle where I was born and we made a discovery well back by an old warehouse. We kept it tight. We got 9,000 leases in a year and a half.

Then we did seismic work offshore. We saw two-thirds of the structure offshore. This is a big structure that is 7 miles long. There is a thousand foot vault where we call the Big Daddy vault.

Then, we had a very serious problem because this region is highly developed. This is the beach for 2 million people in the whole metro Houston area and we wanted to drill a well a mile and a half offshore; you should have seen what happened. Because where we were able to convince the city council and the others after six elaborate hearings and with a thousand environmentalists and concerned people—which they should be, they should be sure that I do it right—we worked out a program that I will go through in how we traded off the safety and the threat of oil spills for the need of energy.

Now Galveston is self-sufficient in their energy for all their needs coming out of this field. This is the area that we drilled the wells offshore. I have some slides to show you that. This shows you when we are drilling the well, we have devised a program that it would only be a low silhouette Christmas tree—three of them—a mile and a half offshore, a half a mile apart, that you could hardly see more than a buoy system. When we finished, this was drilling—when we finished the wells—here is a gas well completed that is all you will see offshore. A mile and a half, you can hardly see it from the beach front. The beach front, of course, services 2 million people. This is the second well that we are drilling at this time in the offshore program. We made a documentary on this and tried—Secretary Morton came down about 2 weeks ago and you were there, Mike, and he made the trip and, of course, he came to see this program as to how we did this program with all the environmental problems that we had to go through and the hearings we went through and the elaborate hearings, how it was done, and how did we do it, and where the panic of oil spills on the beaches were mitigated because people did not understand that you can do it and do it well.

This shows you another scene of the populated beaches as we were drilling the well, but right here we have a completed well that you do not even see a mile and a half from the shoreline. This is the type of

area that services 2 million people that we were able to do this project. The whole east coast ought to see how it was done. Secretary Morton said to send them to see that we can do it right. Everybody has a concept of pumping gooey wells along the surface. That is not what we—we can pump these wells and do it properly, you people on the committee need to understand.

This is an area on an island that we made a discovery well. We bought a warehouse and ripped off the middle third of the warehouse, ripped off the roof and drilled six slanted holes, one under the high school. Now, we have cotton stored on each side of the warehouse. We rent it out for cotton storage. It has worked out very well. You can do these things in a very highly developed area, all the way to the beach front.

Here is some pricing we made, discovery we made in Polk County, Tex. The price for this gas, we made a new contract the other day and got 93 cents a thousand in the intrastate market. We could not give it to interstate market because all they would offer is 40 cents.

The Power Commission and the Congress must face up to the problem that unless we turn loose the gas price, new gas preferably, and old gas, too.

Senator GRAVEL. Excuse me, unfortunately I have another vote and I will be right back, it will give you a chance to catch your breath.

[Recess.]

Senator GRAVEL. The hearings will be in order.

Mr. MITCHELL. This is one of the newest discoveries.

The fascinating thing about this discovery, the deep well, 13,000 feet deep. This field was abandoned by two major companies about 6 years because they had found gas, but they could only get 15 cents. So, we went back into the area and discovered the field of a better quality of gas. Fifteen cents was not commercial. Thirty-five, 45, now up to 93 cents for the very commercial areas, and about five rigs in this area at this time.

This shows you the cross section of the geology of this field at 13,000. It is a stratographic trap that is very much like the east Texas field.

This is a very difficult type of trap to find. That is 60-, 70-, 90-cent gas. A lot of wells, many, many wells drill like this.

This is an area that we made a big discovery back in 1967. We now have 1,100 wells in this field. It is in north Texas near Fort Worth and Dallas, called the Fort Worth Basin. This gas goes to Chicago. A company like ours furnishes the city of Chicago about 10 percent of their gas supply. This region, what we call the basin, is all underlaid by possible gas and oil. At 15 cents, $3 oil you could not afford to do it.

A year ago there was one rig running in this area, our rig. They made a deal on two blocks on each side of this area. We were getting 30 cents. It is subject to a lot of litigation through the Commission at this time. They got 78 cents for the gas on each side. There are 30 rigs running in his area at this time. This whole region of this county will have another 30,000 wells drilled in the next 30 years for gas and oil.

We are now able to furnish, with these two fields and developing each side of this field, most of the gas needs of the local power com-

panies and municipalities in this region that were deficient about a year ago. This is what price incentive has done and will do. The people do not understand.

This is an interesting project we are doing on secondary recovery. This is a field that we have been producing. We made a study of secondary recovery, knowing that oil will be $5, $6.50 per barrel. We are drilling a five-spot program in this field to increase the recovery of oil, to add another 2½ billion barrels of oil, knowing that we are going to get $5, $5.50 a barrel for the new oil.

This is something that really has the chemical companies all uptight. Dupont—we are one of the biggest suppliers of Dupont for raw products. They are upset about the problem because 15 percent feedstock cutback that they anticipate the chemical industry is saying will cost a million and a half jobs.

What this graph shows, that when we have ethane that we extract from the gas, from the stream going to Chicago and send it to Dupont, when natural gas is $1 a thousand, ethane would be 6 cents a gallon. Therefore, the Power Commission and Governor Love must get together, because it is one of the few sources of feedstocks that we are now being allowed to burn under the burner tip that is not—should be used this way.

Moving quickly to extract these liquids everywhere to help support the chemical industry that is in deep trouble at this time.

This shows you the same graph related to propane. Propane now running 25 to 35 cents in the future market. We are selling it for 13 cents. On a Btu basis, if your gas went for $1 a thousand you would have to get 8 cents a gallon to make it worth extracting. Since it is higher than that now, we extract propane in all these streams to help the chemical companies. However we must work with the Power Commission and Governor Love, because the Power Commission has archaic rules about Btu and recovery of ethane out of the gas streams.

This is an example of a field that laid fallow for 20 years. This field was drilled 20 years ago in this region here. Very tight gas sand, low deliverability, only 15 cents for the gas, and it laid fallow for all these years. We made a deal to get 65 cents for the gas. We drilled about 20 wells in these blocks. There have been about 300 wells drilled in the last 2 years. The gas cost was about 30 cents to just discover and produce. This is what can happen in many, many basins of the Nation that people do not understand how much can be done.

The Piceance Basin, where they just had the latest atomic shot, is a basin notorious for tight sands. We think this whole area, this junction of Colorado—we just made a discovery on a 500-acre block—all these red areas, and all this region here has tight gas sands and 65- to 80-cent gas. There are probably thousands of wells drilled in this basin also.

This is the one I was talking about earlier. This is one of the largest suppliers of natural gas to the west coast, what they call the San Juan Basin. We have some blocks in this area. We are drilling wells now. This region has 8,000 wells. They cannot get the gas out at the present deliverability in less than 8 years. If they redrilled that field at a decent price you could double the deliverability. A billion and a half feet now going to the west coast, because the Power Commission has certain rules that you cannot move with.

Senator GRAVEL. Why can you not?

Mr. MITCHELL. They will not allow you to get a high enough price on wells you drill on whole gas units. This is the trouble with the present gas regulation.

Senator GRAVEL. Can you give us an example of that?

Mr. MITCHELL. In the field I showed you earlier we convinced the city of Chicago that if they allowed us to build 125 wells within the old units, and let the price go from 19 to 30 cents, which is still lower than the 78 cents, that we proved to Chicago, that we pick up another 155 billion feet of gas for them. They approved it. We went to the Commission. The Commission, 2 to 1, approved it, then filed suit in the law courts. Now, we are trying to resolve it. Here, we are hamstrung. We cannot even get our 30 cents profits, and they are getting 78 cents for gas.

This region is so designated by Interstate Commerce at 22 cents. If they redrill those units, the units are in tight gas sands.

Senator GRAVEL. Let me understand. The Federal Power Commission defines what fields go to intrastate?

Mr. MITCHELL. No, when you once commit to interstate commerce you are restricted by the price that is set by the area price guidelines.

Senator GRAVEL. Can you take it out of interstate and put it into intra?

Mr. MITCHELL. No, they will not allow you to do it. The 20-year contract, when it expires, should allow you to get the price that you are entitled to, or if you do something new that would add more reserves, deliverability—one of the problems of the Nation is not only reserves, but deliverability. Old wells have low deliverability, but fresh new wells have high deliverability.

The Commission, if they would allow, say redrill this field, 8,000 wells, then we add another billion and a half daily deliverability to California and we would get reserves we would not get otherwise, many trillions of feet. They should allow that, for that money from the increased price to go into additional exploration. These are things that the Natural Gas Act must be faced with, because we must do something about the Natural Gas Act.

This is the type of example. California is starving for gas at this time. There are pollution problems along with the lack of energy. This would be a big asset to the California market if this type of program could go on.

Summarizing, what is happening in domestic exploration in the last couple or 3 years? We are spending $5 billion per year for exploration and development for the major companies and the independents. Overseas they are spending $5 billion a year.

Senator Ribicoff did have a point about tax credits. There were many arguments made. I told him they were clearly unfair to the independents. I have a summary here that shows that a foreign company, a company that has domestic income but drills overseas, that works with a small nation like Kuwait or Saudi Arabia that has tax credits in lieu of royalty, 50 to 55 percent in the matter of Kuwait and Saudi Arabia, has an advantage on a $1 million income. My analysis shows that their economic benefit would be $351,000 per year. My economic benefit on domestic would be $211,000 a year. They make 77

percent more economic benefit. The American oil industry is a great industry. Of 100 major companies, 10,000 independents, they have discovered the North Sea, the North Slope, the Andes, the Mideast. They have done a fantastic job.

One reason they do a lot of overseas drilling is because of the tax credits. I do think it ought to be reexamined in the light that we need that money, the $5 billion, to come back into the country again with incentives to spend it here on greater return, on the rate of return, to come back to this Nation to do the exploration needed.

Senator GRAVEL. If you took away that foreign benefit that they have, do you think that that money would come back?

Mr. MITCHELL. I would say that if we get price up the way it should, because if you raise the price from $3.18 a barrel to $6.60 a barrel you are talking about 12 cents a gallon—most people cannot convert barrels to gallons. We should always talk about per gallon on things, not barrels, because half the oil people cannot convert gallons to barrels.

So price should go up, that is No. 1. How do you take care, is there a windfall?

They need all the resources. The major companies and the independents who really do this job, you will need a half a billion dollars in the next 20 years or more. I think this. If you took it away you would make them become more interested in the return investment in this country, because of the political problems going on. On the other hand, there is something to be said for foreign exploration, that in Indonesia and Nigeria is helping us now.

Senator GRAVEL. May I ask a question?

The obvious question from colleagues of mine would be, What guarantees do we have if we permit all this money to flow into the industry, what guarantee do we have that they will spend it in energy?

Mr. MITCHELL. My suggestion in my summary, our No. 1 choice would be price. If that creates a windfall, maybe you may work a tax program that would give incentive to accelerate depreciation for plants, coal plants, or refineries, and an intangible drilling benefit, maybe double for exploration of oil and gas. That would pour a lot of money into oil and gas exploration and development. Or you may have an excess profits tax. That may be necessary.

I do think that one of these two or three alternatives should be considered and foreign tax structure should be examined along with domestic tax structure, so the incentive for domestic drilling, exploration, and development is at least as good as it is for foreign exploration and development for companies that have domestic income which could be offset against foreign tax credits.

To get 85 percent self-sufficiency by 1985, this is what I think—I do not know if we could make it 100 percent—but I say to get this, it means coal coming onstream, shale, oil, tar, everything. That esoteric research may help us. It is going to take $15 billion per year as rapidly as possible. Foreign exploration's $5 billion per year may be cut back and come in this country if we had enough incentive. We should.

We have 1,700 rigs in this country, 1,400 operating now. The 300 left are not that good, are being repaired, or so on. We need 3,000 rigs in this country immediately to do the job. The infrastructure for rig manufacturing is only 50 rigs per year, however between the years,

between 1946, after World War II, after no drilling, we built 100 rigs a year, and we actually got to 55,000 wells a year by 1955. We can do it now if we work at it.

We have infrastructure problems, pipe deficiencies, which we might, must answer.

Mr. Bentsen did some good work. We have to get with that. We have technical and manpower deficiencies, great manpower deficiencies. We have to crash program of 100 rigs a year. We have to get pipe. We have to get $15 billion and incentives—this committee can help on how it should be done—into the industry, and the geological basis that would enforce to do it at a reasonable price.

Senator GRAVEL. Do you have a background for that $15 billion per year?

Mr. MITCHELL. It is my best judgment. Here is the background I used. I talked to Governor Love about making a model where we could interrelate on interdependent loops the whole energy problem, and how one depends on the other—rigs, and so forth. And it ought to be with assistance done on it, program set up on a limited growth problem, other things. That is a 6-month project, though.

Senator GRAVEL. That could be operating in 6 months?

Mr. MITCHELL. Yes; and it is very important.

Senator GRAVEL. Is that what you call a computer model of the whole situation?

Mr. MITCHELL. Yes; all facets—coal, thermal power, geothermal, nuclear, how all these things relate against prices one against the other, foreign imports, and we should update it every 6 months. It ought to be done by the Department of the Interior, not an oil company, because they are suspect. If we did this, we could finally come to grips to know each year where we stand. Models are dynamic. They change as events change.

Senator GRAVEL. You are saying, Mr. Mitchell, this could be in operation in 6 months?

Mr. MITCHELL. MIT has done some of the best work I have seen done on what they call the systems dynamics where the loops are dependent on the relation of the other loops. In other words, you get more rigs, you drill more wells, and it affects the reserve. We can predict that 26,000 wells a year drilled, will yield so much oil and gas. We could predict on 50,000 wells a year within a 20 percent accuracy how much oil and gas you would find, and the deliverability that it would create, because deliverability early on is high. Deliverability on late and old wells like we have now is low. These things could be worked out.

Senator GRAVEL. Do you have any idea what cost would be involved in getting that kind of model?

Mr. MITCHELL. I talked to Rogers Morton. He was interested in this. What will be done, whether they are working on it, I do not know. I do think that the Government must do something like this to understand the whole energy situation.

Getting back to this, you see from my projection I have got to double the number of wells drilled at least from 26,000 a year to 50,000, 55,000 a year. That will have to go from $5 billion a year, and using just ratio, economic ratioing, to $15 billion a year. I do not have the infra-

structure to do this. It will probably take us 5 years to build up to this. But the geology of the Nation is waiting for us to do it.

Senator GRAVEL. Since we are talking about the time required for various options and priorities, whether solar, fusion, fission, the rest of it, if the Nation gave top priority to this, realizing that it could be the most responsive in the shortest duration, not necessarily alleviating our efforts on the other, but if we gave top priority, could that time element that you are talking about be shortened?

Mr. MITCHELL. Yes, it could be shortened. We did it after World War II. Between 1947 and 1955 we drowned ourselves in oil and gas. We were very short at the end of World War II. We have an experience we have gone through.

Senator GRAVEL. Suppose the administration at this point in time said that they would either go out and have this done or contract in the private sector, and build up the infrastructure to build up the rigs so we can be drilling full force by summer.

Mr. MITCHELL. You could not do it that fast, by summer. We must start gearing up. I would say, instead of 5 years we might crash it to two and a half years. You see, we could begin right now. I am scheduled to drill 100 wells next year. I only have pipe for 20. We are scrambling as hard as we know to try to figure it out.

Senator GRAVEL. What are you going to do?

You cannot drill those other wells?

Mr. MITCHELL. If I do not have the pipe I cannot start the well. That is serious.

Senator GRAVEL. Are you aware of what impact the steel import program that we presently have, if that affects pipe?

Mr. MITCHELL. Yes. I think the fact that the Japs and others had cut off pipe import to this country. We are exporting rigs and pipe, which is disturbing me.

Senator GRAVEL. Exporting?

Mr. MITCHELL. We are exporting. That disturbs me. If imports are cut off, we are exporting pipe to other nations around the world, other companies around the world, and rigs. That should be looked into quickly, because this Nation needs everything we can get our hands on.

Senator GRAVEL. How much are we exporting, do you think?

Mr. MITCHELL. I do not have the numbers. I know that we are. Right now, what is happening with pipe, we went to the Cost of Living. I think majors that now have allocation of pipe because they are big enough are also grabbing retail pipe. Independents are having a tough time.

Senator GRAVEL. The point Senator Bentsen was making, though, is that there is incentive for the steel manufacturing to make flat steel because it gets a better price under the Cost of Living Council's regulations.

Mr. MITCHELL. He is right. This is what we hear, too, to some extent. The mills will have to answer this. I do not know the answer.

We are trying now and working with people to see, with the Railroad Commission of Texas, to see if we cannot finance it.

We have 3,000 independents in Texas, that may only drill 50 or 60 percent of the wells they would drill otherwise. We only raised the

number of wells last year by 3 or 4 percent from the year before. We need a dramatic increase in the number of wells drilled—say 50 percent next year, 35,000 or 40,000, then up to the 50,000 as quick as we can. Because if the incentives are there pricewise, and we think they are there—we have doubled our budget from $9 million to $18 million last year, just to give you an example just what a company's doing, and many other independents like us are doing the same thing. And the majors should move back into the country.

Senator GRAVEL. You say that you have raised your budget level from $5 million to $18 million?

Mr. MITCHELL. My budget, drilling exploration budget went from $9 million last year, the year of 1973, to $18 million.

Senator GRAVEL. Let me take that situation. You have had a 100-percent increase in your projected activity?

Mr. MITCHELL. That is right.

Senator GRAVEL. What caused you to do that?

Mr. MITCHELL. I anticipated the oil prices, the gas prices would go up pure and simple. I did it a year and a half ago when we did our budget work. We worked with the bank, I talked with the Chase Bank, the Bank of Chicago.

Senator GRAVEL. That is primarily for oil or gas?

Mr. MITCHELL. Oil and gas.

Senator GRAVEL. Both?

Mr. MITCHELL. Both. Gas is very important.

Senator GRAVEL. Do you sell most of your gas intrastate or interstate?

Mr. MITCHELL. Interstate. It is very difficult, for 15 years it has been very difficult to work with.

Senator GRAVEL. The gas that you are drilling now, as you discover gas, is it sold interstate?

Mr. MITCHELL. Intrastate as much as possible, new gas. We have an old field in Chicago that is a large part of our gas sales. Two-thirds of it, though, is going to Chicago, so I still have a majority going to interstate market. All the new reserves, I found I get 85 cents or $1 a thousand intrastate. The Power Commission now is 45 cents, and you have to argue all over the place for about 6 months.

Senator GRAVEL. You are getting 85 cents?

Mr. MITCHELL. New gas intrastate today.

Senator GRAVEL. That is the price. That is higher than the figures I had seen of 50.

Mr. MITCHELL. Polk County, that is going to be 82 or 93 cents, depending on the heat content of the gas. That is a rich gas.

Senator GRAVEL. Comparing that to oil?

Mr. MITCHELL. The oil equivalent for fuel oil would be, at the present price $10 fuel oil coming from the wells it is about $1.50 per million British thermal units in my guess, which reaches Houston at probably $1.20.

Senator GRAVEL. You are still talking about 25 cents cheaper to the consumer on a British thermal unit basis?

Mr. MITCHELL. Yes, there is an S. & G. plant planned at Corpus Christi that is $1.30, from Trinidad, then the gas will go to Chicago. My gas sells in Corpus Christi at 25 cents. It is unbelievable, really.

Senator GRAVEL. This is all done through the licensing of the Federal Power Commission?

Mr. MITCHELL. Yes.

I said, why are you not bold and just raise the price a dollar. Would it not be unfortunate if we got too much gas? I cannot get a response out of him.

Senator GRAVEL. What would happen?

Price would be depressed; would it not?

Mr. MITCHELL. I would say it would if we got too much gas well, we would have to sell it for the best price we could get. Sometimes then the interstate boys hammered it down to a good price because we had too much 10 years ago.

Senator GRAVEL. With a crash program the worst that could happen to the consumer is that there would be a glut on the market.

Mr. MITCHELL. It would be the best thing that could happen to the country. I cannot seem to get that over.

Senator GRAVEL. Are you prepared to respond to Mr. Freeman? I did not know he was a member of the Power Commission.

Do you want to touch on some of those points?

Mr. MITCHELL. This is the last slide.

Yes, I listened to Mr. Freeman's testimony.

Senator GRAVEL. Let me pose a question. Essentially, what he was saying was that there was a free market that existed in oil and that with all the money that they were getting they did not produce. We still had scarcity.

Do you have any comments?

Mr. MITCHELL. The point he brought out, that they were spending billions for leases, and therefore apparently they thought it was a good deal to spend that billion for leases. They would have spent more billions if there had been higher price for the gas. They would have drilled many more wells if there had been a higher price for gas, because as I mentioned, showing you the geology of the gulf coast in itself, you could probably triple the program.

I agree with Mr. Freeman on how do we not spend all that money in lease acquisition and put it in exploration and development, because it will wind up to be $2 or $3 billion a year in the next year or two that the Department will take in lease bonuses.

Senator GRAVEL. Do you know how much they took last year in lease bonuses?

Mr. MITCHELL. A couple of billion.

Senator GRAVEL. That was revenue to the general fund.

Mr. MITCHELL. That is true.

Senator GRAVEL. From bonus sales?

Mr. MITCHELL. Yes, that is true.

Senator GRAVEL. Without producing one British thermal unit of energy at that point.

Mr. MITCHELL. Therefore, I think there ought to be some system of recycling that, or a plan that enables you to give these without spending all that money to go to the general fund, recycling that.

Senator GRAVEL. So we get the figures, do you happen to know how much the oil industry gets in the way of depletion allowance domestically?

Mr. MITCHELL. My average depletion is 18 percent.

Senator GRAVEL. Total volume of dollars?

Mr. MITCHELL. No, I do not have total volume.

He mentioned the voume of overseas depletion, $1.6 billion, Mr. Freeman did or someone did earlier, $1.6 billion. I do not know what the total depletion allowance is.

If we had price, depletion is not that important.

Senator GRAVEL. Perhaps we could develop a chart that would cover both the last 5 years, what the Government has received and what it has put out in depletion.

You want to make additional comments on what moneys are available to industry and what they are doing?

Mr. MITCHELL. I was answering Mr. Freeman's question. He did not believe price made any difference in the exploration and development of oil and gas reserves. What he does not understand, when the expertise of this 100 large oil companies and 10,000 independents in the world cover the world in oil with great talent—they have great talent, even though they are much maligned and they deserve a lot of criticism they get, including independents, too.

In the period of surplus if they had not had some input of control they would have decimated the independent industry. In fact, I would say 50 percent of the independents were not in existence today that were in existence in 1955. All of them now are seeing stars in their eyes again. They are coming out of the woodwork, all of them.

I have 200 prospects that we are waiting on now that I would drill in the next year or two. Every independent has 10 or 20 back in his head, or 100 of them. They have been working on them for years. But you could not make money at 15 cents gas, you could not make money at $2.50 oil.

So I disagree with him. The lack of regulation on gas has had tremendous impact on the money that has been spent for gas exploration. We are feeling the domino effect that you brought up earlier, because gas has caused a domino effect or propane, ethane products, a domino effect on oil products to cause their consumption to go up as we ran out of gas.

I feel the Federal policy has been one of the biggest problems we have had in the gas exploration business. I think because of the import program the industry survived. There are 100 large companies and 10,000 independents with tremendous infrastructures, tremendous talent. If you try to create a national oil company—if you look at Mexico, Brazil, Argentina, or the Russian oil companies, they are disasters compared with the American oil industry, except for one British company and one Dutch company. They have fairly covered the world with energy. Therefore, they are suffering from a very bad image. When you consider what they have done for cheap energy of the world, they deserve some credit.

What he does not understand is, to replace the competitive structure—the reason they are so competitive is when you have 100 major companies chased by 10,000 independents for 70 years, they better be efficient. We better be efficient, or we are out of business. It is that simple. It is one of the best examples of the free enterprise systems I know of worldwide.

I think he underestimates the ability of this industry to gear up for this job, whether it is coal, oil, uranium that many are involved in, geothermal, that we should use this infrastructure to gear up for this job. How do we get the $15 billion and how are we to get the infrastructure available for the $15 billion in exploration and development in the field?

That I am familiar with, exploration and development, it needs that much to really start attacking the resources of the Nation that is available to this job.

Senator GRAVEL. What if the lands that the Federal Government owns, if we went into a contracting program where we paid, if we do not go the bonus route?

It would be provident for Government to assess what it has. First, take offshore.

Would it make any sense to turn around and appropriate money to contract with whatever oil companies on a bid basis, to go ahead and do this to find out what is there?

If we find out what is there, make a decision on the type and method we wish to exploit it.

How do you think that would affect the industry?

Mr. MITCHELL. I would say the system that they have, companies competing on a competitive basis, whether you do it in royalties or some other method than the bonus system, or recycle it back in, which may be a way to do it. I think to take a system we know is the most efficient in the world, to try to devise a national oil company or a semi-national oil company, I think is the wrong way to go about it.

We should back up the free enterprise system because we have a great infrastructure to do the job. Admittedly, that is going to be a difficult and long process. No national oil company has done it. You do not want to go that way. You just want to service contract-type arrangements, something of that kind.

Senator GRAVEL. Unfortunately, the energy industry has a credibility gap with one, the Congress and two, the people in this country. Deserved or not, it is there. Obviously, it must be deserved or it would not be there.

But to try and sell this to the Congress, you get the questions that we had between Mr. Freeman and myself. That was, that is great, but we do not believe they will use the money there, and what is going to stop them from taking the money and going elsewhere.

Mr. MITCHELL. I feel this. When oil companies, you know, the Commerce Department look at this, when their return or investment gets out of bounds you can do something about it 2 or 3 years from now. The return on investment now—and all of them will tell you now—has not been sufficient. The tremendous capital needs, I know this. They need every bit of capital they can get at this time to do this job, not only in oil and gas, but in nuclear and coal. Shell Oil, if they got price there may be some price increases, they recycle it in the exploration and development on some sort of basis that this committee can develop or someone else. They will need these resources to do the job that has to be done, not only in this Nation but worldwide. Because I feel sorry for the developing nations that do not have cheap energy like we had. These are things that are on people's minds.

Senator GRAVEL. If we turn around and provide a free market situation with a trust fund and all of that activity, could we restrict; one, with an excess profit tax and two, say if you have money that has been earned in energy, that it has to be ploughed back in energy, and if you move it to other areas, then, make subject to an excess profit tax?

Mr. MITCHELL. I think that I had some recommendations, Mr. Chairman, that may be answers to some of the questions.

Senator GRAVEL. Go through your recommendations.

Mr. MITCHELL. In other words, I mention that while price in some cases would be a most effective weapon in overcoming the fuel shortage, I understand the political problems of doing that. I say if additional taxes must be applied, they should be structured in such a way as to stimulate exploration, development, and research.

You see, oil now is up to roughly $8.50 barrel. If all oil was $6.50 a barrel, we could do some of the projects that we mentioned. Coal would come on-stream.

I think the first phase I would recommend is to work at the tax structure that would give the incentive to give $50 billion back into the problem. However, the Treasury Department will split this.

Senator GRAVEL. You can measure that with the model that you would have.

Mr. MITCHELL. Our tax program could be devised. How do we have double intangible drilling and accelerated depreciation for coal mines and shale oil plants on an accelerated basis, so people would get into. Then if you do recycle trust funds on the off-shore leases, or you recycle tax, I am afraid that is going to come in the industry, whether it is a Btu tax, or on the gasoline.

But if you do have a program that recycling would go on, that would be second choice. Maybe both of them could go compatibly. If you get it through Congress, I do not know if the public would accept it.

I think, No. 1, an incentive on price; No. 2, an incentive on taxes that would bring $15 billion into the industry; third, if you had to recycle by having a tax on energy——

Senator GRAVEL. You are saying $5 billion now?

Mr. MITCHELL. $10 billion more.

Senator GRAVEL. That is $5 billion in the private sector now. We need another $10 billion.

Mr. MITCHELL. Well, if the Government brought in a $3 or $4 billion to be available the private would come in on the other $7 or $8 billion; then if you had to do trust fund or an energy tax, and recycle a trust fund. I would say $5 billion to go into exploration and development of the loans, would be a great impact getting up to the $15 billion a year needed for exploration and development.

Senator GRAVEL. When you say loans, would that be loans from the Government to operators like yourself?

Mr. MITCHELL. The way I would structure it, a dry hole contribution like a lot of major gas companies give us or major oil companies. They match your money. If it is a successful well, they get it out of production; if it is not successful, you should take out a loan; so we put 50 percent and the Government put up 50 percent.

You could triple your exploration program if they said they wanted to run a tax. If they run a tax on either British thermal units——

Senator GRAVEL. Would price do it? Do you think we would need this other aid also?

Mr. MITCHELL. I think price would do it.

Senator GRAVEL. You think price would do it alone, so we would not have to get involved with these other incentives.

Mr. MITCHELL. If you could get the people, Mr. Freeman and others to worry about the windfall to the companies, the price would do it right now. The competitive price would be even under the world price. The world price is an anomaly at this time, because it is up $10 or $12 a barrel.

Senator GRAVEL. If we eliminate depletion and doubled intangibles, and had a free market with an excess profit.

Mr. MITCHELL. Sign the bill tomorrow.

Senator GRAVEL. How would we do that with solar though?

Mr. MITCHELL. Solar energy, the esoteric role, I think we would have 10 years before you would begin to see what may work. I think we ought to do all the possible funding that has to be done on the Federal level, the way David Freeman said.

I think most major companies will not do that. They will do some of it, shale oil developments, coal liquefication, which is important, should be backed as much as possible through the Government to private industry with what is necessary to do the job. That is one phase as to how we have to go after this $10 billion or $20 billion program.

Senator GRAVEL. Maybe this is an unfair question, but if we threw in $10 billion more into energy, what would this mean in the way of unemployment in the country—because we are headed for a recession.

Mr. MITCHELL. I do not have numbers on that. I would say it would be a great help because the infrastructure needed in the drilling and the other industries to triple the program would be considerable. The lack of energy, the lack in plastics, we are at a 20-percent shortfall predicted by the plastics industry costing a million and a half jobs, would be deflected by the $15 billion program. I expect that economic loss alone to be $20 billion—a $15 billion or $10 billion additional will not make that up.

Senator GRAVEL. Do you have any cost figures as to what the various programs would cost? Let us say what it would cost in oil, gas, what it would cost in coal, to sort of hit some target areas and time frames?

Mr. MITCHELL. What does it cost to get a billion dollar equivalent?

Senator GRAVEL. Yes.

Mr. MITCHELL. There was some work just came out of Conoco—in coal it would take $50 billion to get up to 2 million barrels a day equivalent.

Senator GRAVEL. $50 billion?

Mr. MITCHELL. $50 billion. Conoco just announced what they thought it would take. They are in the coal business very heavily. Naturally you have geothermally. The key is that coal looks attractive now at 66½—$3 oil, shale oil and coal, forget it, it costs $5 a barrel to do it. It is looking attractive, now new oil and so on, these numbers I have are not all for oil and gas exploration and development.

The $6.50 barrels and all others, we put nuclear—we put fossil fuel plants all over the Southwest at a dollar MCF gas and 6 percent oil, they would have been after nuclear power by now.

This causes the interaction that we need to work on that model. I think if it is available for coal geothermal heat, it is hard to get. I have just given you my analysis with a rough economic analysis. By needing a double amount of the wells, the basins are available—we can predict how much oil and gas by drilling those numbers of wells. We have talked—we talked to Winger and Gonzales in Houston, they are the top two, so I feel that they could work these programs, what would happen. But I feel the price alone would do it if you are willing to say we can allay the fears of the consuming public, windfalls starting to get too large.

Second, tax incentives like I spoke about—do not talk about it like it is a nasty word. We could suffer depletion cutback so we may have a little tradeoff. It might be worthwhile to allay the fears of the people.

Third, if they do tax gasoline or tax British thermal unit, they should recycle it in a trust fund like you suggested. I feel that that is manageable without adopting a tremendous bureacracy, to some extent, that is as manageable as the other two.

Senator GRAVEL. Mr. Mitchell, I wonder if you might investigate with us right now, intangible drilling as a benefit or a call to industry as opposed to depletion. Take us by the hand through it.

Mr. MITCHELL. My average depletion is about 18 percent of gross income for these little strip of wells they are talking about 50 percent and not coming back in. Say, if I drill $100,000 well and $50,000 intangible drilling cost—say if I double that, I would get $100,000. The other $50,000 would be in equipment and intangible equipment that I would depreciate 10 or 15 years. By depletion of that well, usually it is 5 percent—and it is rather minor, too—what I am getting to, this incentive, to quickly get this tax writeoff the people would pour in money from all over the Nation to do this, providing Shultz does not change the net operating loss on unrelated businesses like he was threatening to do at the beginning of the year and about a billion dollars worth of funds dried up.

Senator GRAVEL. A billion dollars dried up?

Mr. MITCHELL. A half a billion to a billion would have dried up for the year had that gone through. Just the talk of it for 2 of 3 months he said not this year, it is not retroactive. They offered a 7-percent investment credit that would have been $60 million a year to industry, they were going to take away about a half a billion a year out of the joint funds that now are coming in to the independent industry, particularly in all directions. If you had double IDC and took 5 percent depletion as a tradeoff, the independents would welcome it. Some major companies may oppose it because they do not write off IDC in the tax year, I do not know, you would have to analyze that from the Treasury to see what effect it would have.

Senator GRAVEL. Would that not be a lockin and meet the objections that other colleagues had that if we gave you an incentive you may take the money and go build a hotel?

Mr. MITCHELL. If my incentives on intangible drilling, I do not get it unless I drill.

Senator GRAVEL. Depletion?

Mr. MITCHELL. Depletion would take my money.

Senator GRAVEL. The intangible drilling factors are——

Mr. MITCHELL. Drilling wells, you must get moving and the country must get moving to back us investmentwise to drill twice the wells we are drilling now.

Senator GRAVEL. I wonder if it would be an imposition upon you to maybe chart us some examples—we will make it part of the record. Obviously you cannot do it now. But please show us what doubling the intangibles for you and what more taxes—obviously the income you would be getting, and you would be paying more taxes as a result of this income—what that would mean?

Mr. MITCHELL. You mean paying more taxes by income of oil and gas rising in price and to see the oil and gas rising in price—say if all oil were released at $6½ barrel, what effect it would have, oil and gas released to 75 cents a thousand cubic feet, what effect it would have then if you double intangibles and you had a very large program, it would not affect our tax structure probably, at all because we would wheel it all up to get these 55,000 wells we need, you see.

Senator GRAVEL. One of the things that we need is a model or some tables to show the point you were making earlier which I think was a valid one, translating things into what it costs the consumer on his heating oil gallon or on his gasoline gallon, rather than barrels which is within the industry. The consumers and we in the political area have a tough time understanding that when we are talking about doubling the price of oil a barrel, it does not double prices at the gas tank. That is one of the things we want, is a chart translating all of this into the gasoline prices at the gas pump. Also maybe you could supply us some of this, Mr. Mitchell, both for heating oil and for gasoline and also a comparative chart related to the prices in other countries—throughout the United States and in other countries—to show what we consumers are paying and what other consumers are paying.

Mr. MITCHELL. Prices around the world?

Senator GRAVEL. Say, France, if you are paying over $1.30 a gallon for gasoline, and we are paying a good deal less than that, and I think that that is because of our preeminence of the oil industry in the world which preeminence is changing daily.

Mr. MITCHELL. Yes, we will do that.*

As I mentioned earlier, to try to show that $3.18 a barrel, that we are now at $4.20 a barrel, if we went to $6.50 a barrel to make this program work, all the studies we have done, to be 85 percent self-sufficient—100 percent is possible, would only add about 10 cents a gallon for oil.

Senator GRAVEL. What you are saying, if we permit the price to rise by $10—I mean 10 cents—at the gas station to the consumer in this country, that we could have enough incentive?

Mr. MITCHELL. We would be getting 10 cents a gallon—say 8 cents a gallon, that is the refinery throughput, 8 cents times 42 gallons to the barrel, is $3.20 added to the $4 oil which would be roughly $7 oil. At $6.50 to $7 oil, shale oil comes on. I am not so sure liquification of coal

*At presstime the material requested had not been received by the Committee.

does not come on. All these interdependent things now begin to work toward the energy sources, and geothermal comes on stronger and nuclear comes on stronger in areas where they have not been competitive up to now.

Senator GRAVEL. The question my colleagues would ask, if we take the lid off prices, what stops them from adding on another 50 cents—say a dollar a gallon?

Mr. MITCHELL. With the Mideast disturbance, it would probably go another 50—how long that will last I do not know. I would say oil, now the last batch of oil the day before yesterday, Shell did $11.80 a barrel and Nigerian lost—that was in Nigeria. That oil would have cost us $15 a barrel. I call this an anomaly, we just have to see.

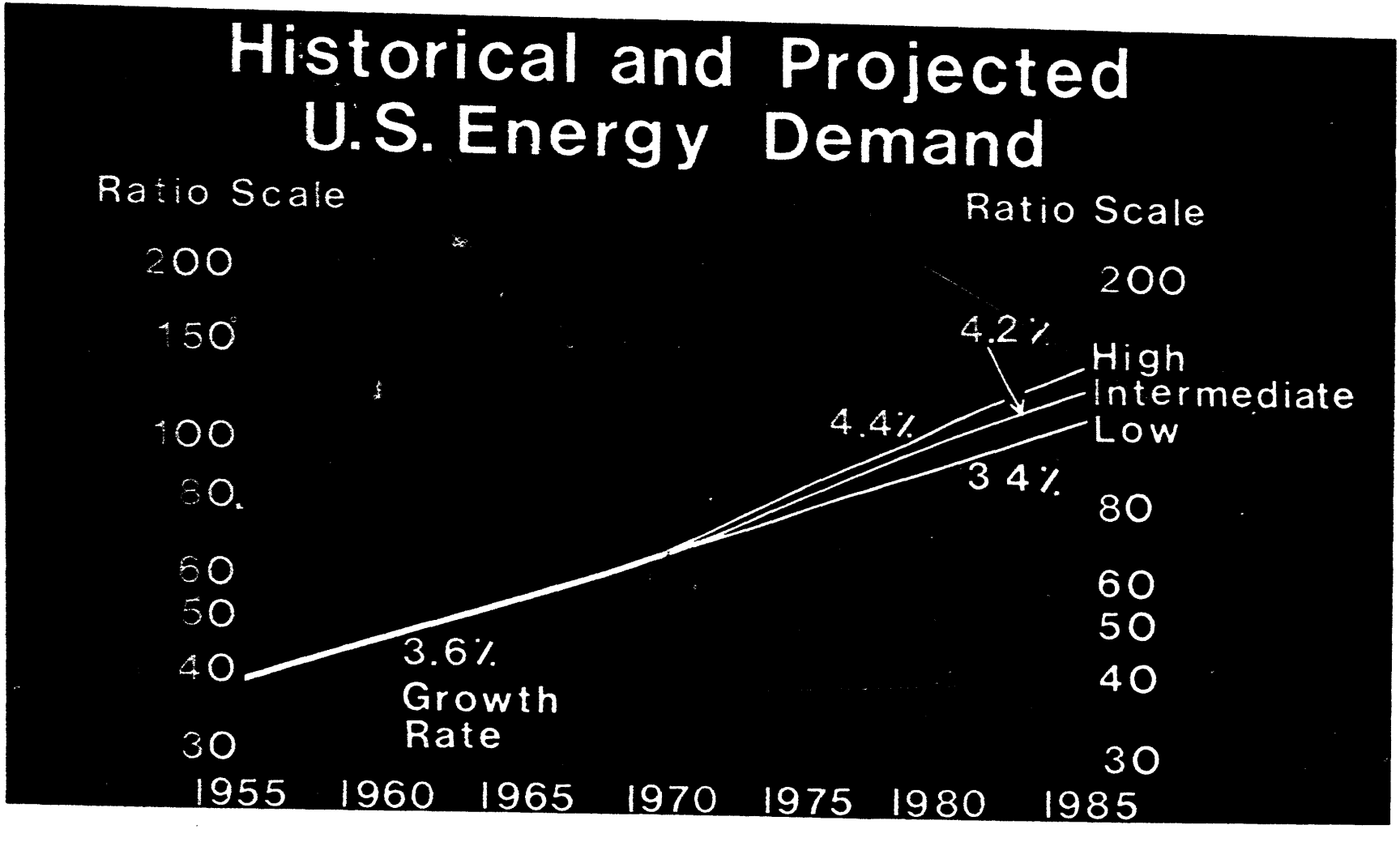
Senator GRAVEL. How can we handle this anomaly? We are right at the crux. If we come out legislatively and say OK we are going to release the lid on gas and oil, pricewise in this country, if it goes up, if it skyrockets, then everybody will say—that is right, we told you so, we need control, we need price control.

Mr. MITCHELL. Right now, they are controlling price of oil at 4.25 a barrel average. On that, we cannot compete or cause to bring on other streams like shale oil and coal gasification and so on. Meanwhile, right now we are going $2 a barrel, then old oil, they have a pretty effective program, you find a new barrel of oil I believe it releases one old barrel, the Cost of Living Council has put that into effect. I asked them in a letter last week, to change that to say if we release one barrel of old oil anywhere you might have it for any new barrel you go out and discover, which could give you new incentive to go find new oil, to release that old oil at whatever price you can get. I would say for a temporary time we would have to restrict old oil to something—$6.50 to $7 until we see what happens and we have this thing settled out in 6 to 8 months or 1 year. At $6.50 or $7, that is a good additional gas or oil incentive for companies and the independent to go back and do exploration and development on a large program.

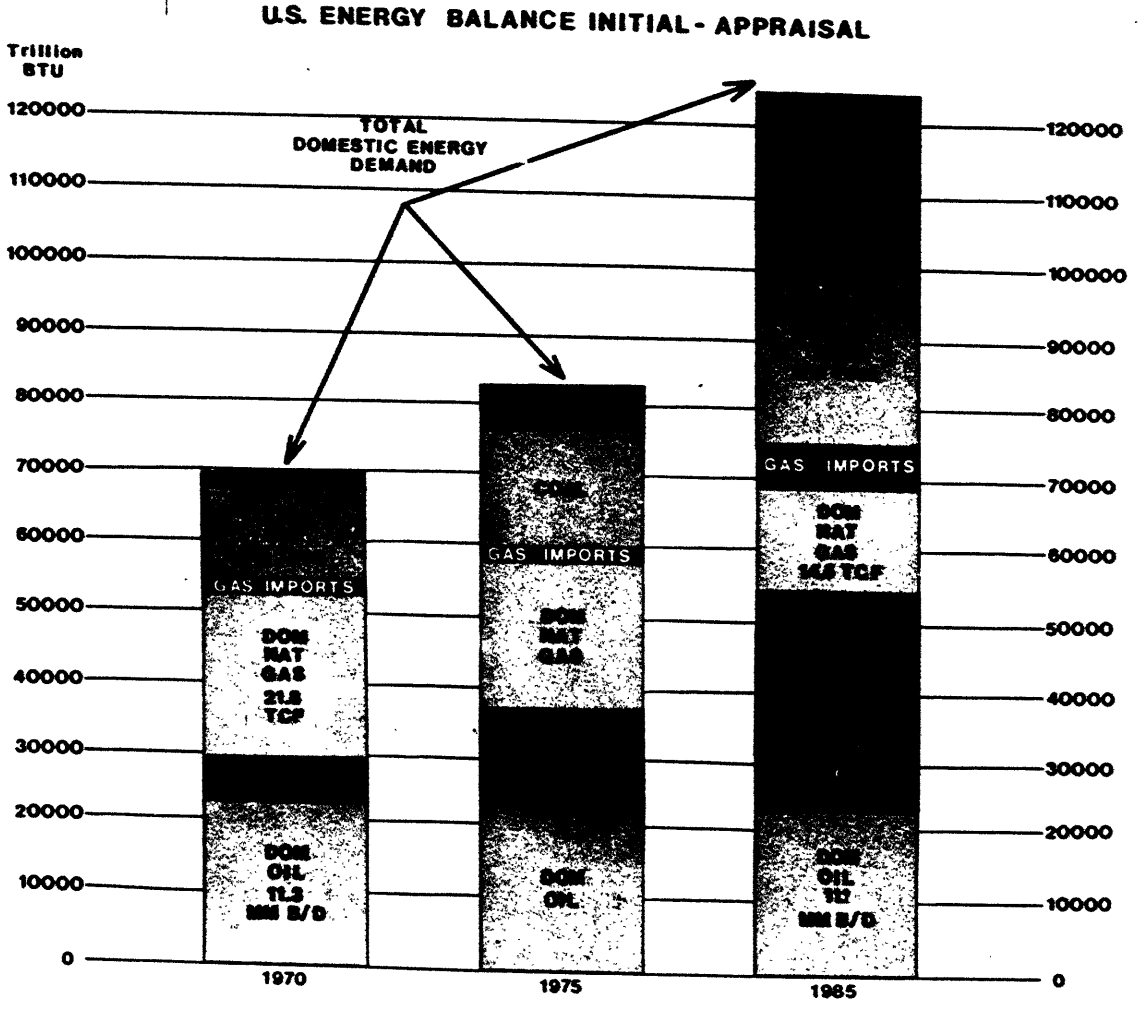
Senator GRAVEL. Mr. Mitchell, there is a vote on the confirmation of Mr. Ford for Vice President. I think we have explored this as best we can. I would like to extend you an invitation, when we do have a bill and open up hearings again, to have you come back and give testimony based upon the analysis of the bill which we would provide you. Your testimony has been excellent.

I think the meat was here this afternoon rather than this morning.

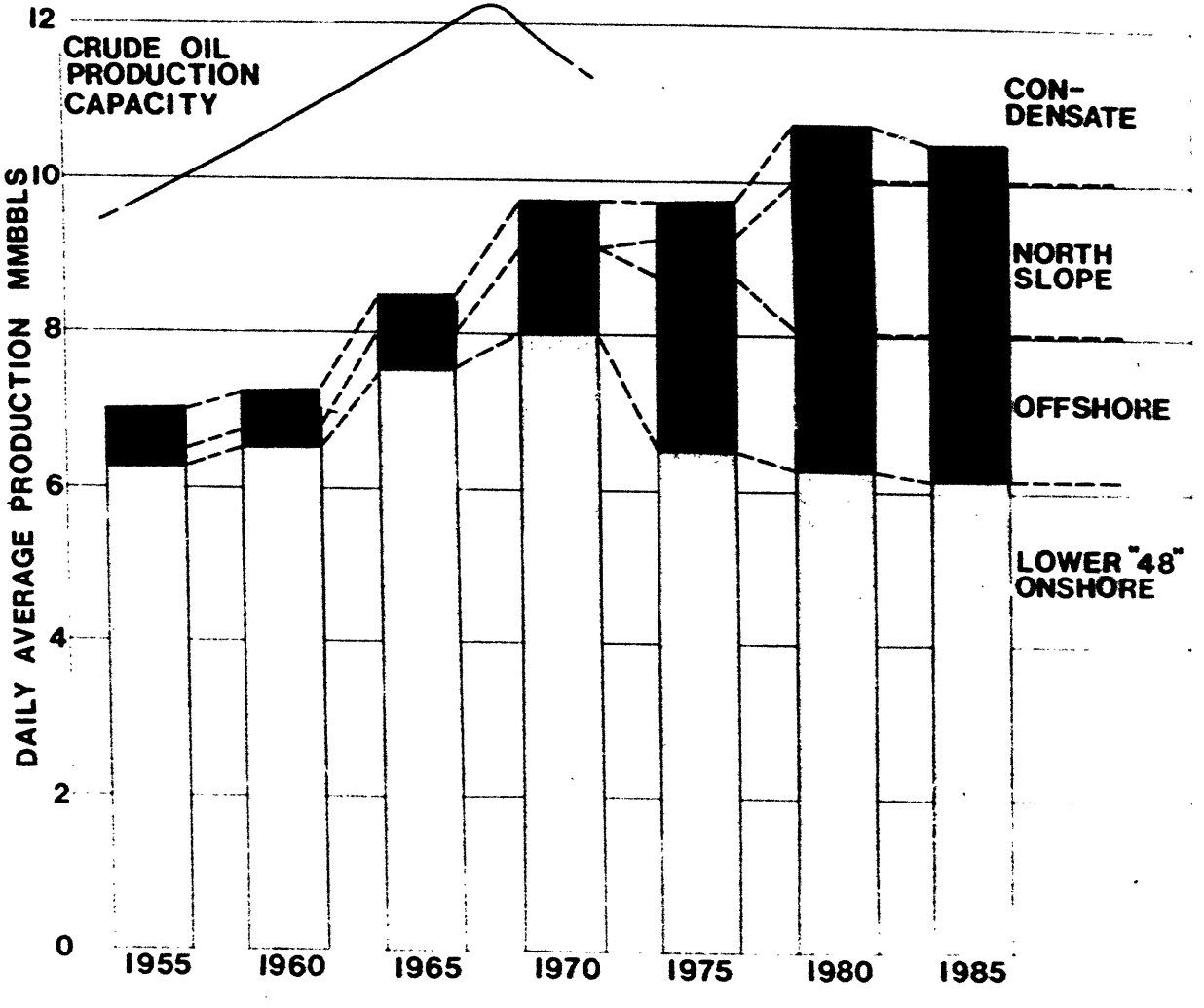
[Attachments to Mr. Mitchell's statement, referred to during his testimony, follows:]



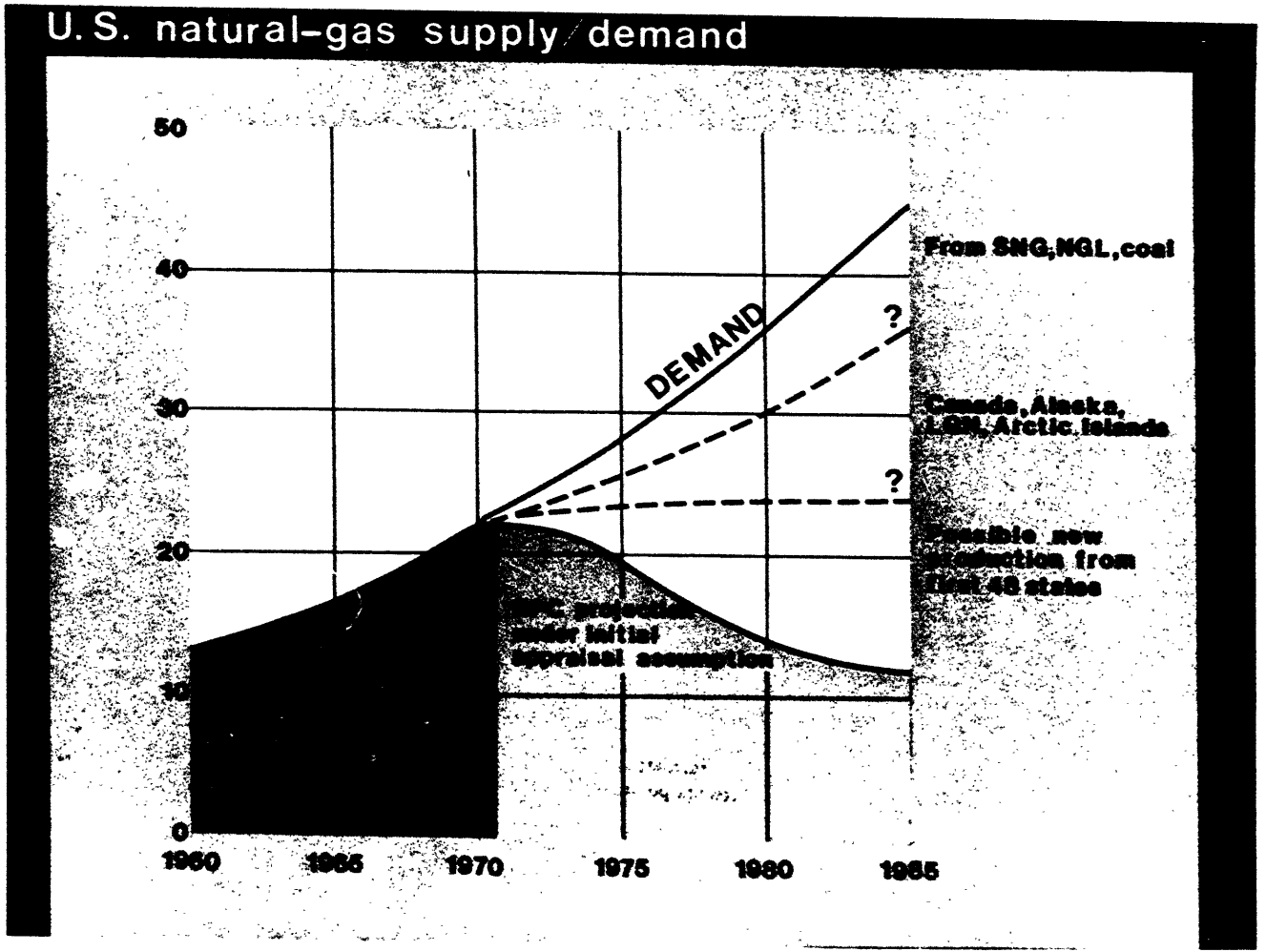
National Petroleum Council Studies



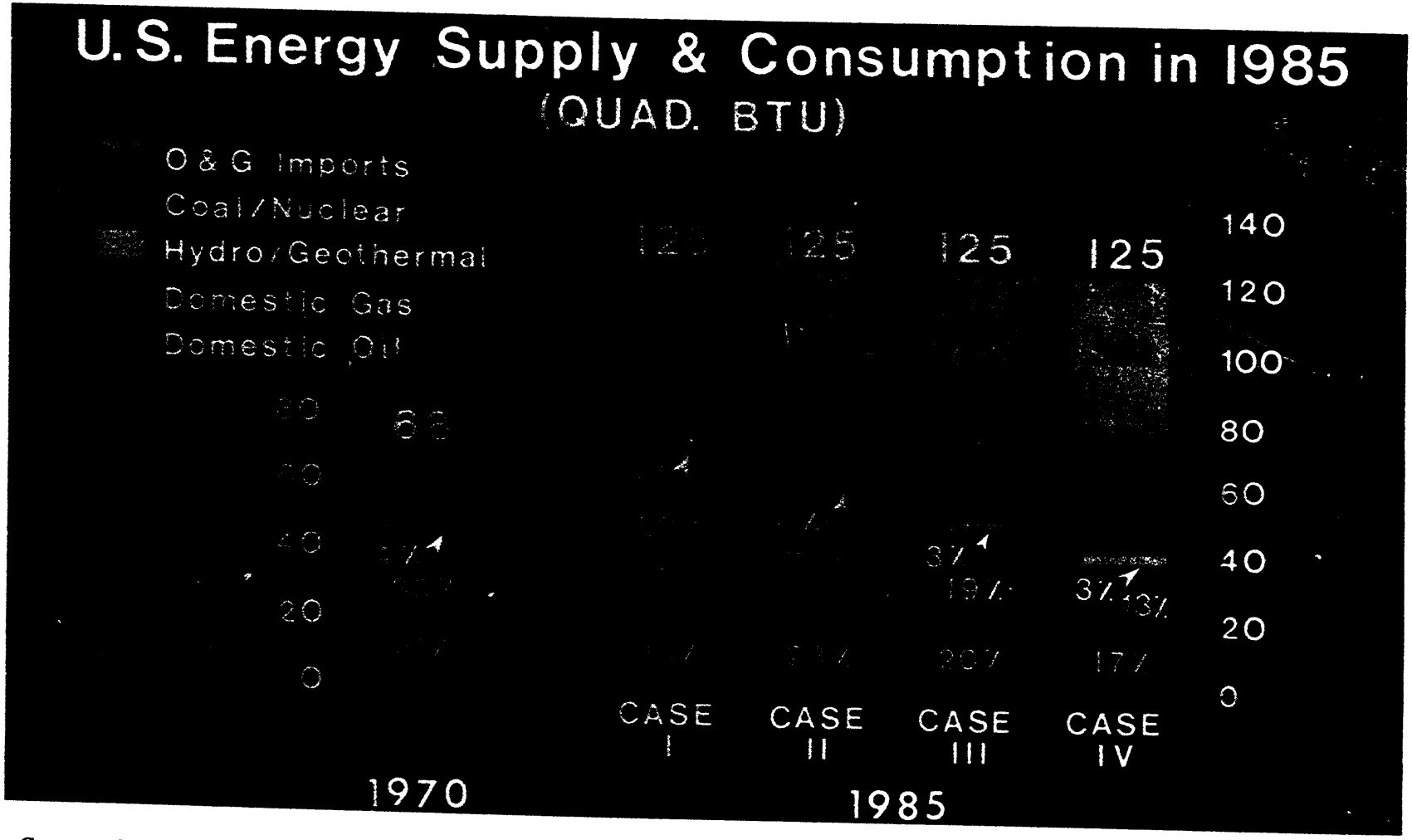
National Petroleum Council Studies



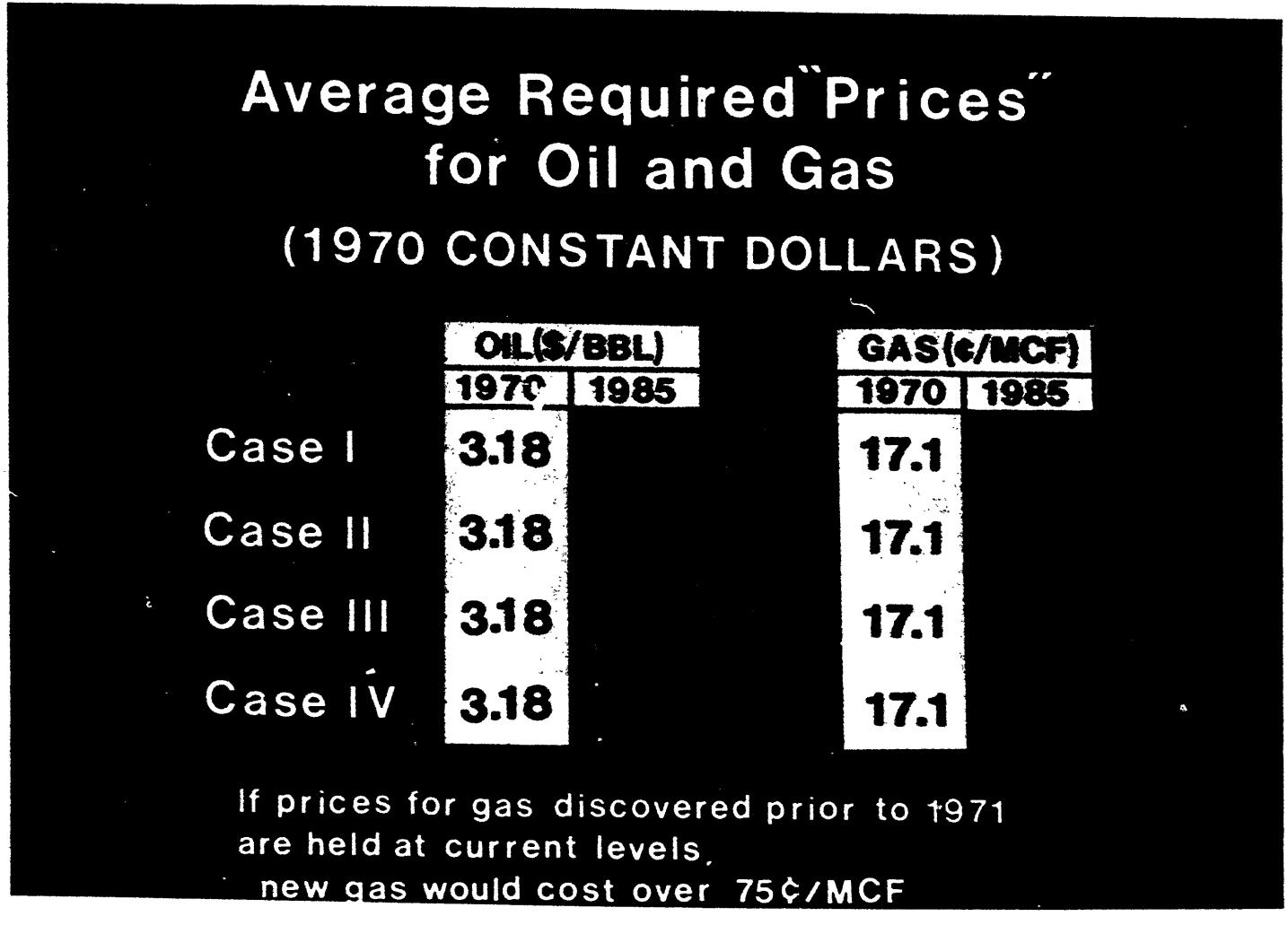
Under present exploration trends, there will be a flattening of oil and gas production through 1985



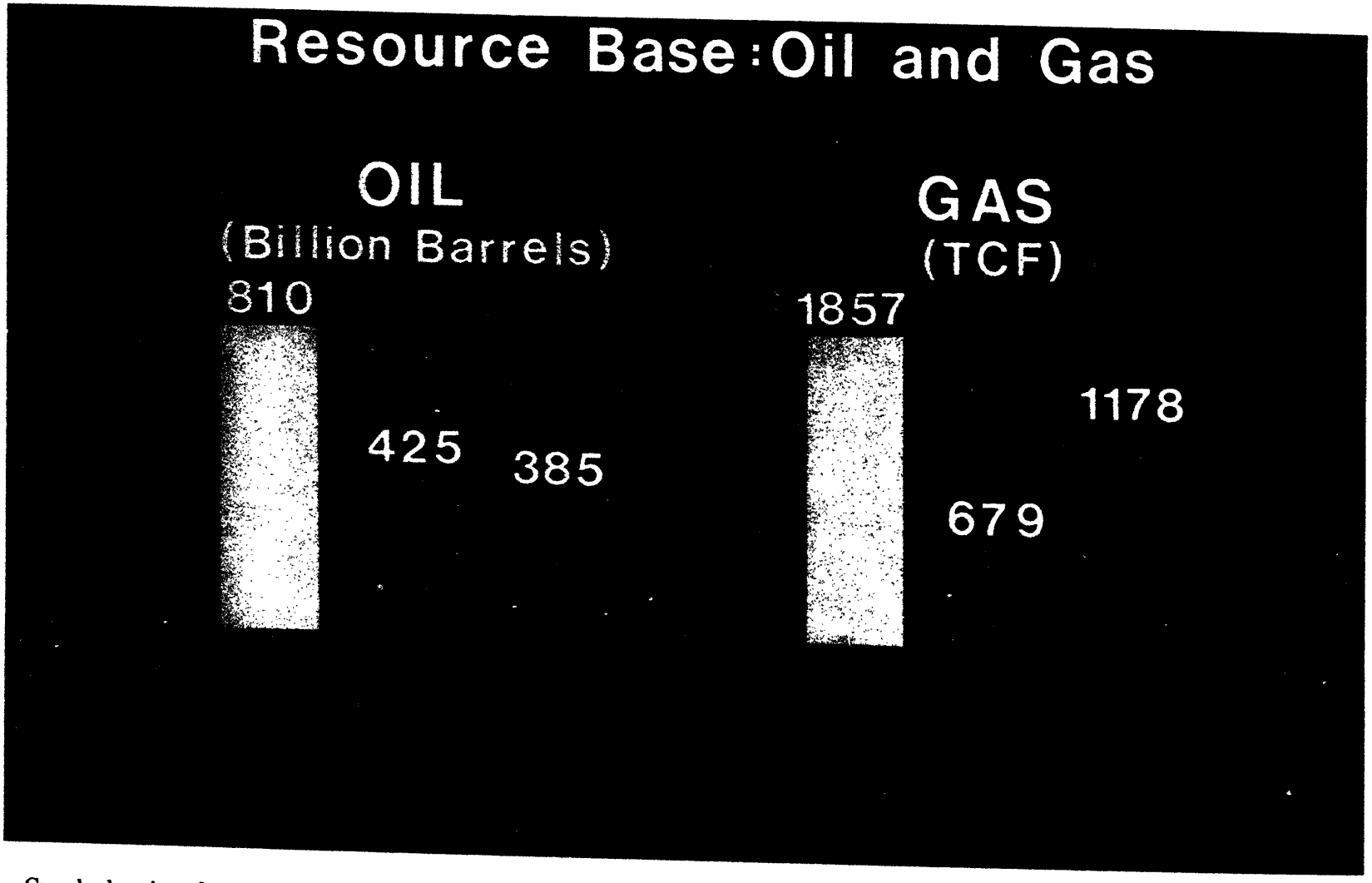
Natural gas supply and demand showing enormous deficiencies by 1985 under present exploration trends



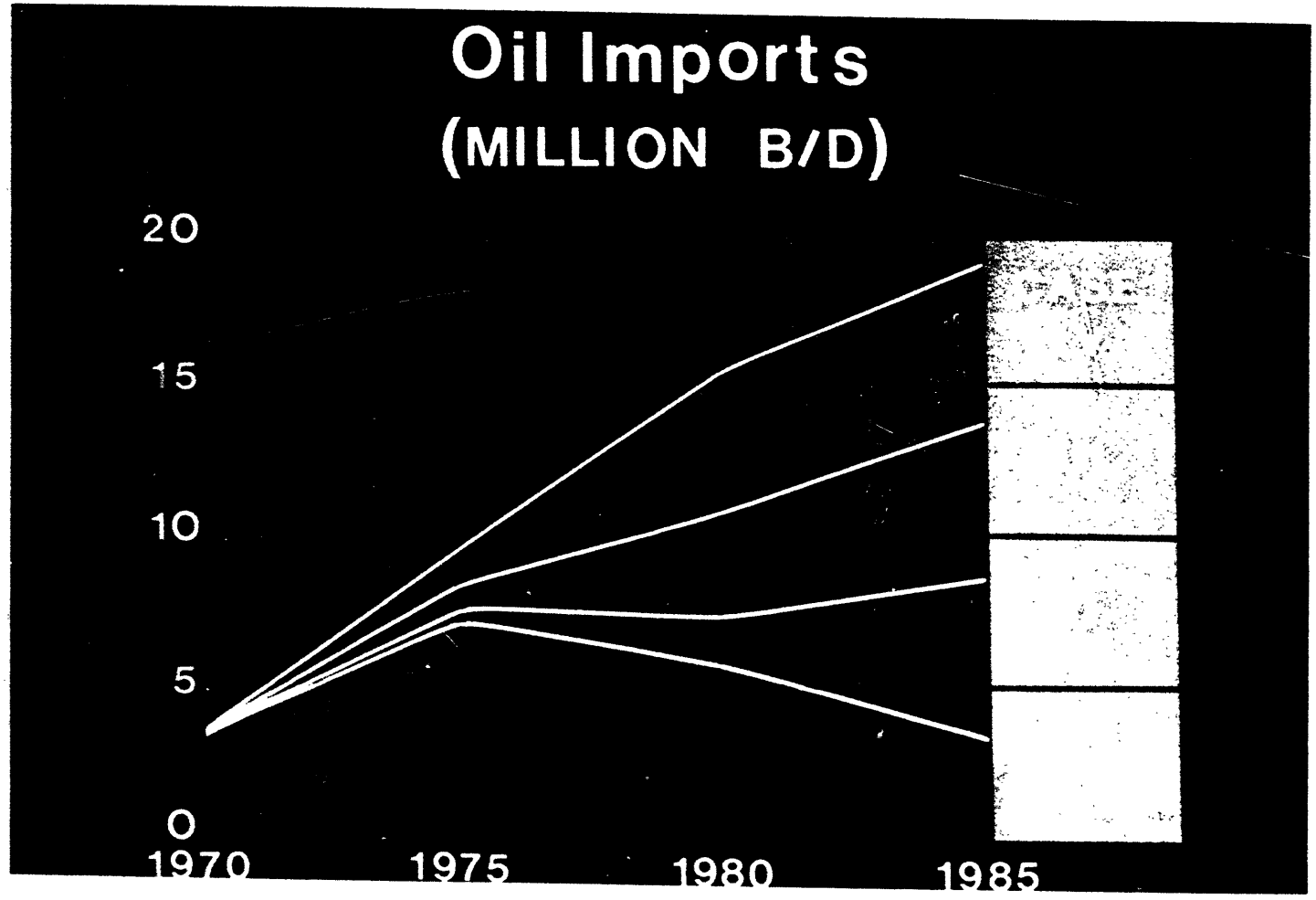
Case studies of energy supply and consumption in 1985. Case I shows the optimum outlook with success met in all energy-producing endeavors; Case IV shows results of the most limited success



National Petroleum Council data regarding price sensitivity effect on oil and gas



Graph showing the potential oil and gas available in the Nation's sedimentary basins. This is many times our present reserves

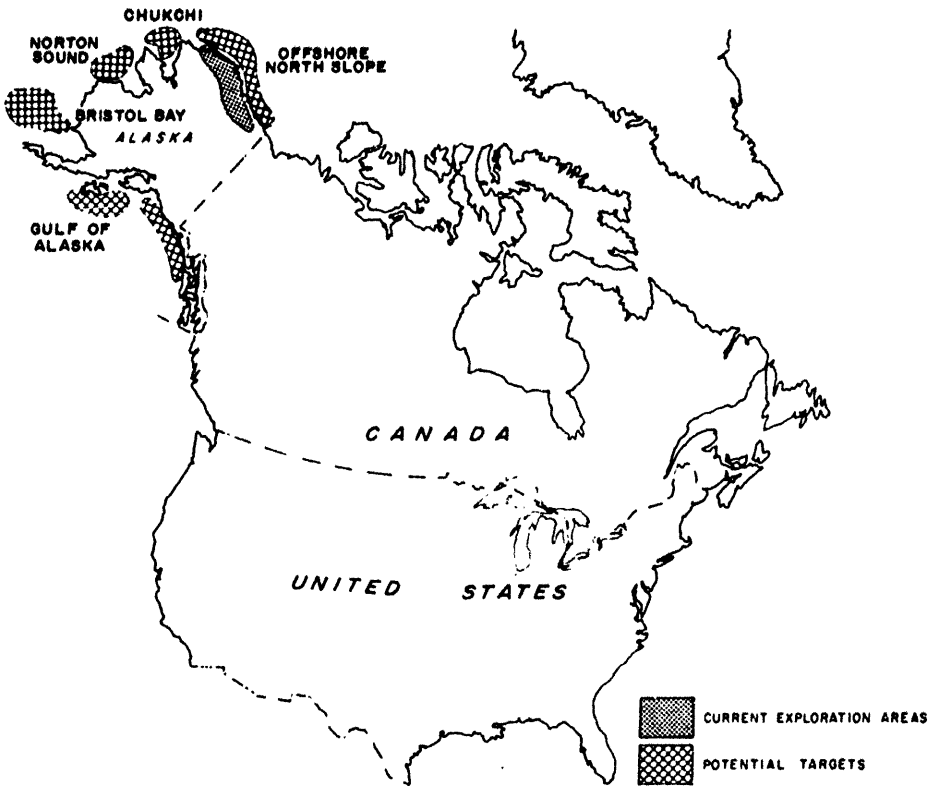


If exploration and development and other energy forms do not come on stream because of pricing by 1985, imports may exceed 18 million barrels daily at a balance of payments deficit in excess of $60 billion per year



LEGEND

1 Williston Basin
2 Uinta Piceance Basin
3 San Juan Basin
4 Anadarko Basin
5 Ft Worth Basin
6 Eastern Shelf
7 Arkoma Basin
8 Permian Basin
9 Gulf Coast Tertiary
10 Jurassic Trend
11 Appalachian Area
12 Pacific Tertiary
13 Sacramento
14 Atlantic Coast Basins
15 San Joaquin Basin
16 Imperial Valley Basin
17 So. Calif. Offshore Basin
18 No. Calif. Offshore Basin
19 Michigan Basin


CHUKCHI
NORTON SOUND
OFFSHORE NORTH SLOPE
BRISTOL BAY
ALASKA
GULF OF ALASKA
CANADA
UNITED STATES
CURRENT EXPLORATION AREAS
POTENTIAL TARGETS



Ohio-Lake Erie area could be drilled for gas in this basin if an increase in price is forthcoming; 25,000 wells could be drilled within the next 25 years in this highly industrialized area

Typical offshore play in offshore Texas area, showing discoveries in Galveston

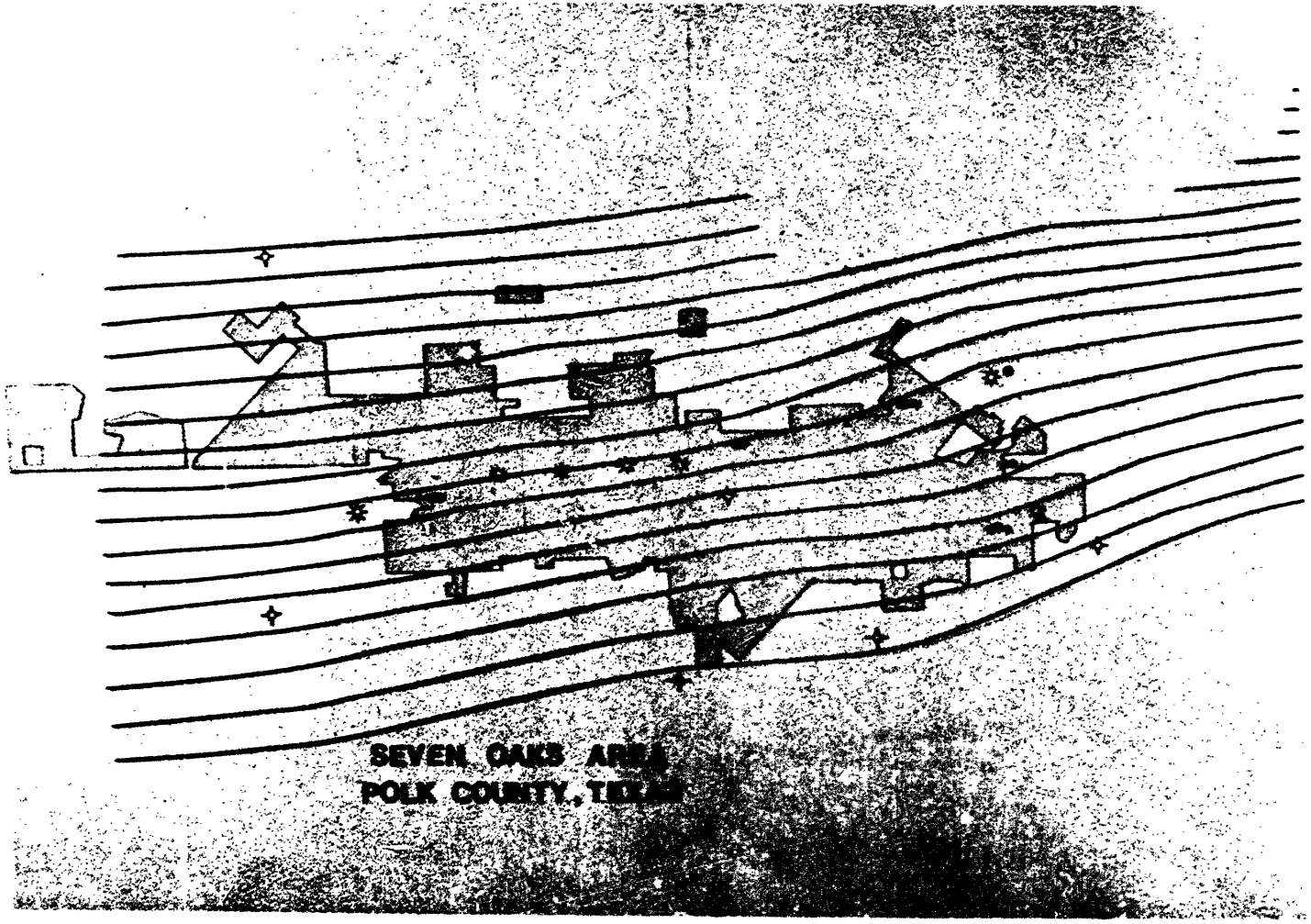
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The offshore drilling program of Galveston shows that the environment can be protected

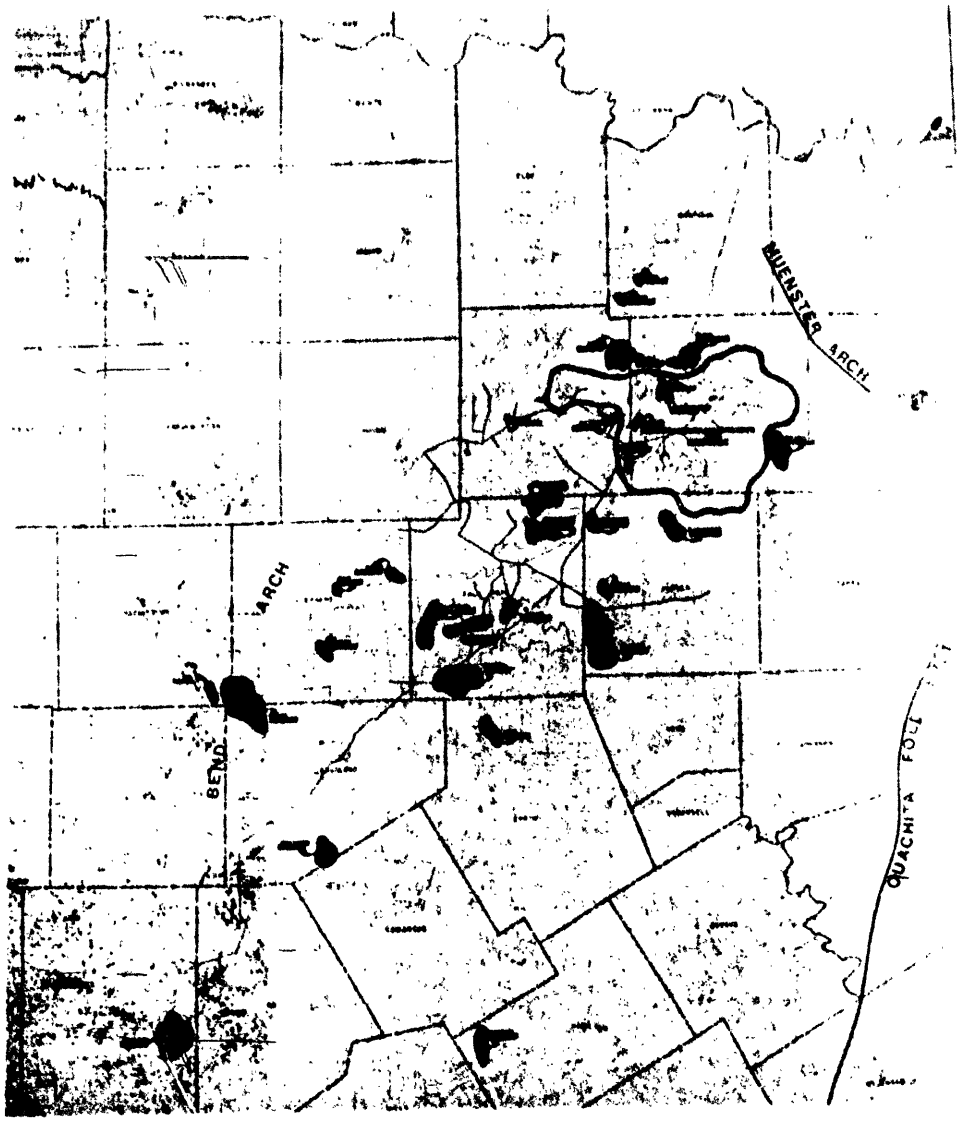


Drilling program within the center of a cotton warehouse with cotton stored on either side

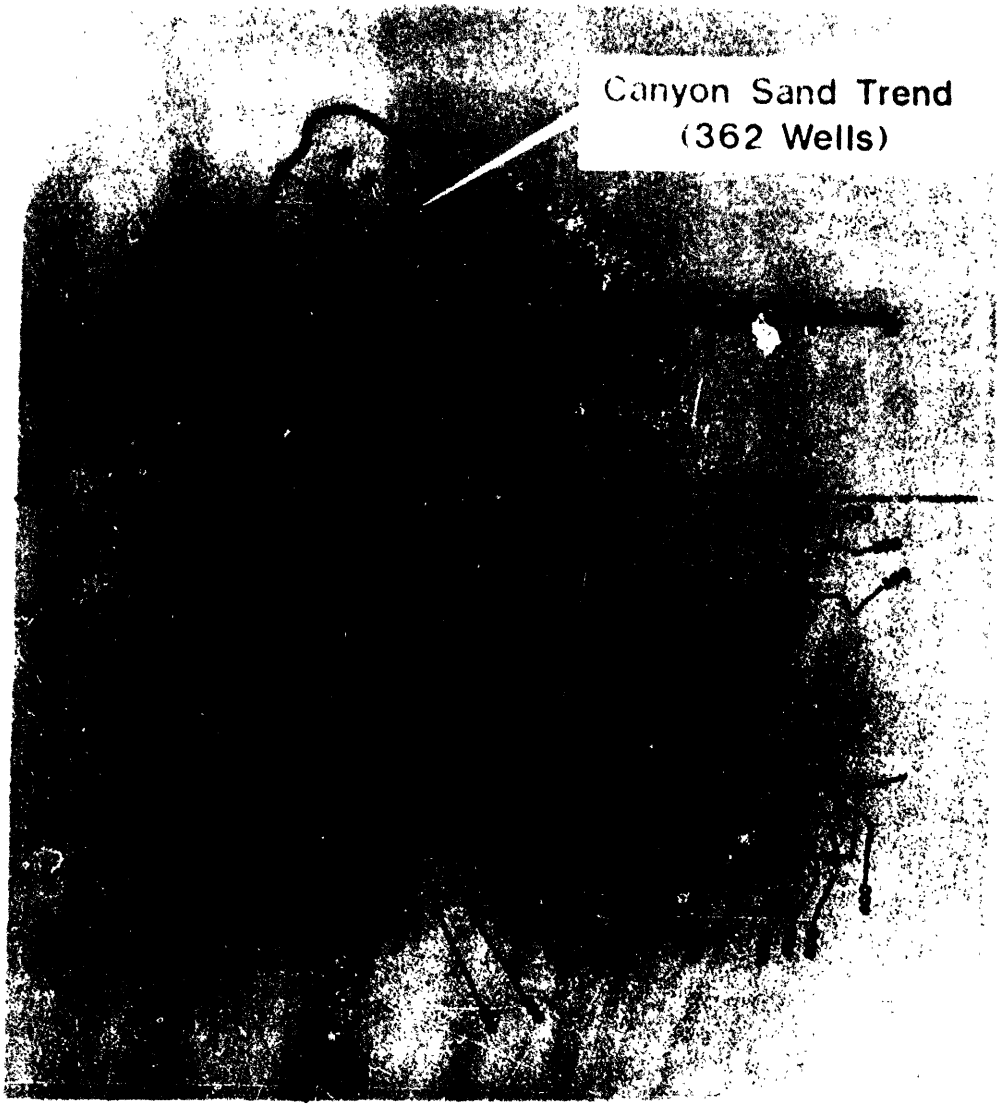
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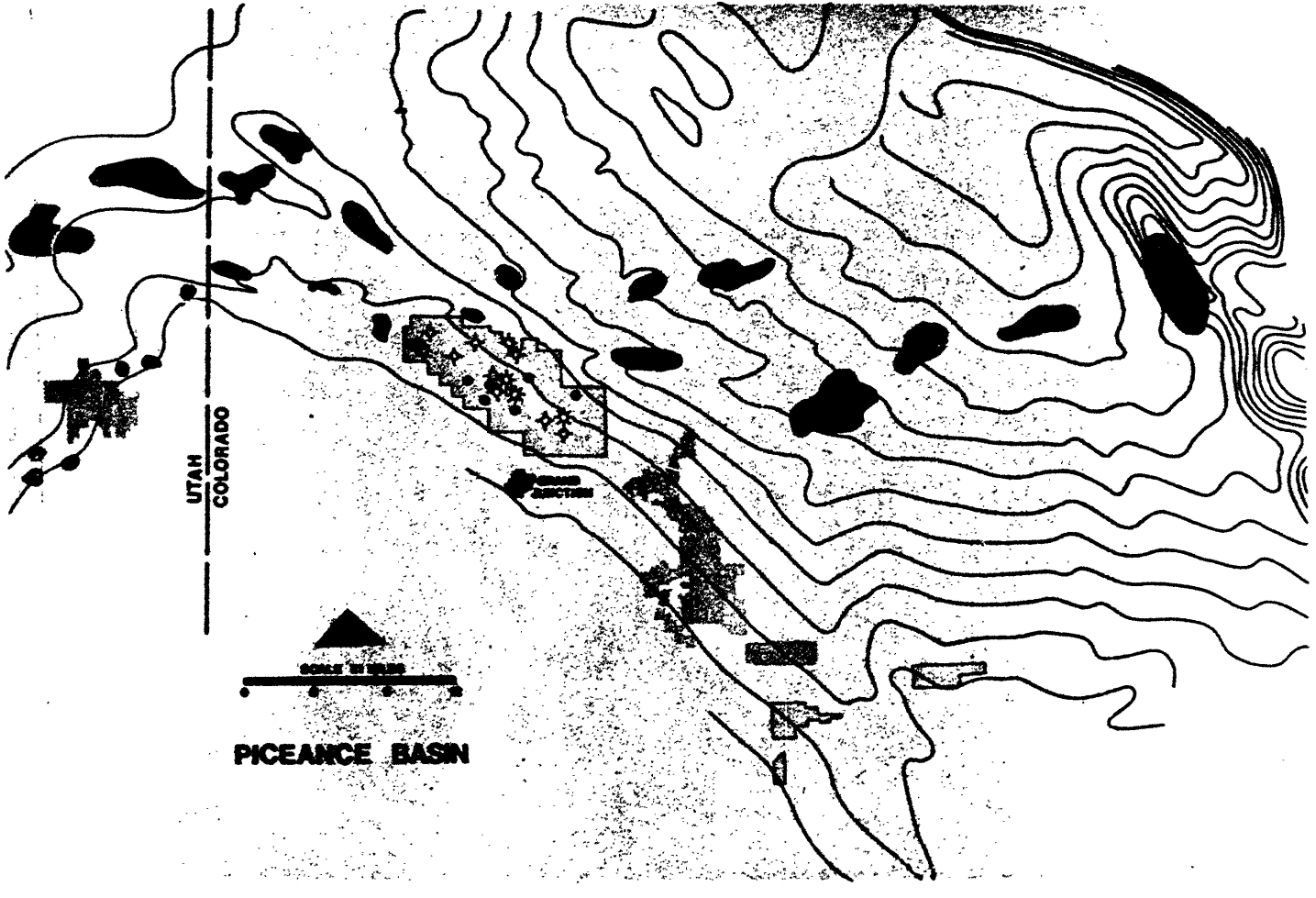
Polk County—new activity because of high gas prices



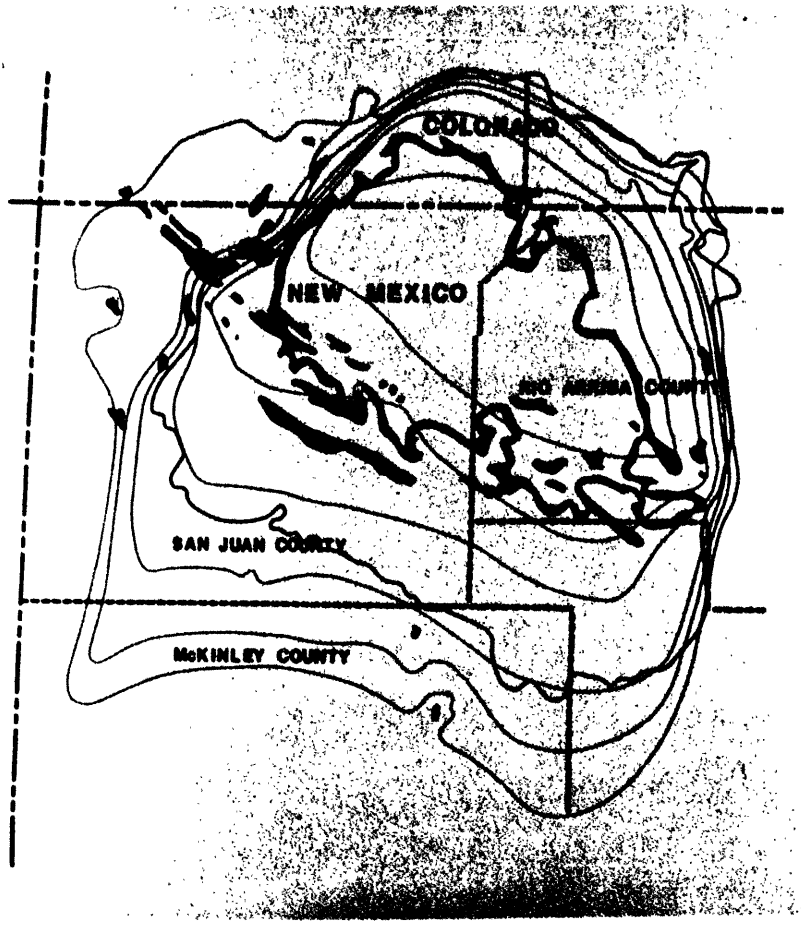
Ft. Worth Basin. Thirty thousand wells will be drilled in the next 25 years for gas and oil if price increase is realized



Canyon Sand Trend Area—Tight natural gas sands available at a reasonable price



Piceance Basin Area—area of large potential of tight gas sands



San Juan—8,000 wells now producing a daily billion and a half cubic feet of natural gas to California could be doubled in a redrilling program to help relieve the energy crunch in California if Congress would give FPC needed guidelines in a revised Natural Gas Act

Domestic Exploration & Dev.	Foreign Exploration & Dev.
1973 · 5 billions per yr.	1973 · 5 billions per yr.

FOR 85% SELF SUFFICIENCY BY 1985

Domestic Exploration & Dev.	Foreign Exploration & Dev.
15 billions per yr. as rapidly as possible	5 billions per yr.
1973 -- 1700 Rigs 1400 Operating	Needed as cap. is available -- 3000 Rigs Manufacturing capacity -- 50 Rigs per yr. Crash program -- 100 Rigs per yr.

Infrastructure Deficiencies

- Pipe deficiencies
- Technical manpower deficiencies
- Rig manpower deficiencies

Summary showing present exploration and development expenditures, both domestic and overseas, and future exploration and development expenditures that must be channeled to create the impact toward self sufficiency

[Whereupon, at 4:30 p.m., the subcommittee adjourned, subject to the call of the chair.]

FISCAL POLICY AND THE ENERGY CRISIS

WEDNESDAY, NOVEMBER 28, 1973

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

The subcommittee met, pursuant to notice, at 10:05 a.m., in room 2221, Dirksen Senate Office Building, Senator Mike Gravel (chairman of the subcommittee) presiding.

Present: Senators Long (chairman of the full committee), Ribicoff, Gravel, Hansen, and Dole.

Senator GRAVEL. The hearings will come to order.

This is the second day in the hearings trying to probe the areas where the Finance Committee through tax and market incentives, trade measures, can help to solve a very serious energy problem, that has beset our country.

We expect to meet this morning and this afternoon in order to receive the testimony of the Honorable Frederic Hickman, Dr. Richard Gonzalez, and Professor Erickson.

We have kept the list very short so that we can go into some depth with the witnesses who are expert in this field.

So our first witness this morning will be Dr. Hickman. Please come forward, Mr. Hickman, and take a seat. Bring whatever staff or assistants you have with you. Would you introduce your colleague for the record and proceed with your statement.

STATEMENT OF FREDERIC W. HICKMAN, ASSISTANT SECRETARY OF THE TREASURY FOR TAX POLICY, ACCOMPANIED BY WILLIAM JOHNSON, ENERGY ADVISER TO THE DEPUTY SECRETARY OF THE TREASURY

Mr. HICKMAN. Good morning, Mr. Chairman.

I have with me this morning Mr. William Johnson, who is the Energy Adviser to the Deputy Secretary of the Treasury.

We are pleased to be here with you this morning to discuss on behalf of the Treasury Department the question of Fiscal Policy and the Energy Crisis.

I do not appear before you as an expert on the intricacies of the energy problem, and I will try to confine my remarks to the role of taxes and to the aspects of Government revenues and expenditures as they relate to the energy problem.

It is most important at the outset to distinguish between short term problems and long term problems. The immediate problem is how to allocate the current reduced supply, and the longer term problem is how to make the U.S. demands for energy compatible with the rest of this world's demands for energy, and with the world's supply of energy commodities.

I would like first to take a look at the short term picture. We are at the present time and at current price levels faced with a shortage of petroleum products. The fundamental economics of a shortage are often lost in public discussion. A shortage exists where there is not enough of a product to satisfy those who would like to buy it at the existing price—and that latter phrase is most important.

In the free market, shortages do not exist, as the price simply rises; the number of people who wish to purchase the products decreases as the price rises; and the ultimate supply and demand balance out. The price at which that occurs is often referred to as the price which "clears the market."

At the present time, we have two special factors which must be taken into account, each of which accentuates the other. First, we have a system of price controls which for better than a year has held down the price of petroleum products in the United States while the prices of those products have risen elsewhere in the free world market. Second, we have had an abrupt and substantial decrease in the supply of petroleum products available because of the embargo by the Arab nations.

Thus, in order for the pricing system to perform its classic role of eliminating petroleum shortages by bringing supply and demand into balance, there would need to be a major increase in existing prices—first, in order to overcome the cumulative effects of the controls which have kept the United States' prices below free world market prices; and second, to reflect the major reduction in total supply caused by the embargo.

Our energy experts estimate that the supply of petroleum products will in the near term drop between 15 to 20 percent below the amount which would otherwise be consumed at existing prices. There seems to be general agreement that a great deal of the current consumption of petroleum products is not really necessary and that our citizens could, without major inconvenience, reduce their consumption significantly.

The problem is how best to wring that nonessential consumption out of the economy.

One option which moves in the direction of eliminating nonessential consumption is to make it inconvenient and difficult for people to obtain petroleum products, or simply to make some of them partially unavailable. Thus, the recommendation to close service stations on Sundays. Similarly, an allocation directive under which refineries would produce less gasoline and more fuel oil would inevitably reduce the consumption of gasoline, as we cannot consume that which does not exist. But it would also cause shortages of gasoline unless, through other measures, the present demand for gasoline is lessened.

A second option to deal with the shortage is rationing. Rationing does not really reduce the shortage, as there will still be more people

who wish to buy more gasoline than the supply permits. It will simply make the shortage compulsory—individuals will not be permitted to buy as much as they would like.

The appeal of rationing to its advocates appears to lie in the conviction that it would make everyone share equally and equitably in the shortage. If that were a fact, it would be an easy option. But in the real world, the requirements of individuals for petroleum products vary enormously and continuously, and no system of human decision-making can cope with all of the variations, even if there were agreement on the criteria, which there is not. What seems fair to one man often seems unfair to another.

In addition to that, rationing brings into play, of course, the problems of black markets and of outright criminality. You have always a profit which goes somewhere and which consumers will have to pay for it.

A third approach is to eliminate the shortage by permitting prices to rise until demand is reduced sufficiently to meet the supply. Such a price increase might or might not be accompanied by a tax, which I shall discuss in a moment.

Proponents of a price increase argue that even Congress cannot repeal the laws of supply and demand, and that the market is the fairest way to eliminate the shortage because it allows people individually to decide what is most important to them, rather than leaving that decision to some Government agency.

One family might decide, for example, that it preferred to have less gasoline and more beefsteak; and another family might decide that it was willing to trade the extra beefsteak for a somewhat more expensive vacation. Each family could make its own choice and would not be bound by the decision of a rationing board that no one would be permitted enough gasoline for an extended vacation.

A further argument for price increases is that they will tend to increase the supply of products. In the case of petroleum, a price increase will cause more wells to be drilled and will cause hitherto uneconomic wells and processes to become profitable and to go into production.

Those who oppose permitting the market to eliminate the shortage argue that the price increase which would be required to bring supply and demand into balance would be so large that it would be a hardship on many people, and, further, that market forces may not operate repidly enough to prevent critical shortages. For example, they suggest that the market might not operate rapidly enough to insure that households would have enough fuel this winter, or that certain businesses would not close down. A further complication arises from the impact of a major rise in petroleum prices on our price control system and the battle against inflation.

Before I turn to the subject of a price increase accompanied by an excise tax, let me call your attention to some data concerning the magnitude of price increases which might be required to bring us up to a free market price.

Table 1, which follows my statement, is an estimate of the price increases which would seem likely to occur if prices of petroleum products were freed. The assumptions on which the estimates are made

appear on the notes which follow the table. Different economists will make somewhat different assumptions, and will, of course, get different answers. I cannot say they would be wrong. There is no way to predict numbers such as this with any precision, and I do not present the numbers to you as firm convictions, but only as an indication of the orders of magnitude in which we are talking, based upon what seem to be reasonable assumptions.

You will note that table 1 indicates somewhat lesser price increases in the longer term than in the shorter term. This is because many of the adaptations to increased prices will be made by people only over a longer period of time. For example, we could expect higher prices to cause people to purchase smaller automobiles, but everyone will not convert immediately.

In any event, you will note that the range of price increases of gasolines and fuel oils on the gallon basis is from 8 cents to 15 cents a gallon in the short term, depending upon the assumptions that are made with respect to the reduction in supply.

Table 2 shows the recent prices of gasoline in other countries compared to the U.S. price. Those were prices as of last summer. I think they have risen in all countries since that time.

In evaluating those numbers, you should keep in mind that those prices must be paid by foreign workers out of real incomes which are in most cases substantially less than the incomes of workers in the United States. On the table you will notice that the U.S. price is roughly half of the lowest price in any of the other countries. It is a substantially lesser percentage than the prices in the remaining countries.

Table 3 indicates how these numbers relate to the expenditures of a low income and an average income family. You will note that the expenses of gasoline are only a minor part of the total expense of owning an automobile and other transportation expenses. For example, in the table you will see that expenditures for transportation other than gasoline in the intermediate level family is $734, compared to gasoline, which is $230. Now those are averages and they include people who do not have automobiles, but they also include the capital costs of the automobiles for those who do. So the table does give you some indication of what I think we all know to be the fact, that the cost of owning an automobile is much greater than the price of the gasoline to run it.

You will note further that retail prices for gasoline, excluding taxes, have in recent years diminished in relation to other prices, so that in a period of increasing prices, gasoline has become, in a sense, a bargain item.

Table 4 illustrates how a 25 cent increase in the price of gasoline might affect the budget of an average family. We picked 25 cents not because it is a number for any price increase predicted in table 1, but because it is a large number—larger than what we think would occur if prices were decontrolled—and we are trying to give you some feel for whether or not that kind of an increase would be a major deprivation for ordinary families. You will see that there is an increase in expenses in the illustration. There would be a lesser increase if the individual were driving the lesser amount of miles which he would be permitted to drive if there were rationing. The assumption here is that he is one

of the people who elects at increased prices to drive the same number of miles that he previously drove.

There is some comparison, also, in the table of the dollars-per-week number for increased gasoline costs with other things that he might do with these same amounts of money. For example, the indicated increased expense for gasoline is a little bit less than a price of a carton of cigarettes. It is a little bit more than the price of a six-pack of beer. It is in the same neighborhood as the extra cost of substituting sirloin for hamburger.

Table 5 contains some illustrative prices and price changes of some common food items to provide some perspective as to what the price indicated in table 1 compares to in terms of recent food price increases. You will see that while you would be talking about an increase in gasoline prices if the maket were freed, but we have lived through other price increases in the recent past that are perhaps no less serious.

Table 6 gives us some insight into the extent to which the cost of gasoline is an expense of getting to work. If gasoline should become more expensive, there would, of course, be many people who would minimize that expense by carpooling or by using public transportation. But you will note from that table that there is a great deal less commuting in the lower income brackets than there is in the higher income brackets, and indeed, in the lower income brackets a great preponderance of people get to work in some other way. So that if we are talking about increases in the price of gasoline in terms of impinging on the ability of people to get to work, it does not seem, on the average, to be a major problem.

Well, let me talk now about the use of an excise tax. One option which has been the subject of recent public discussion is the imposition of an excise tax on crude petroleum or other petroleum products.

It is important to understand that an excise tax, such as excise tax on crude oil or on gasoline, is in this kind of a situation only a variation of the price increase option. The essence of the proposal is that prices to consumers be permitted to rise to the point where the shortage is eliminated by decreased demand. Some who argue that this would create a "windfall" for oil producers then argue for an excise tax to absorb that "windfall." That argument obviously leads to other arguments about what is and what is not a "windfall."

However, from the consumer's point of view, the result of the tax is simply a price increase. The price increase represents a greater percentage of income in the lower income classes than it does in the higher income classes, as do almost all increases in the prices of basic commodities.

So the price increase might be termed "regressive," although that term is not usually associated with a price increase. However, the effect of the excise tax is to take away the benefits of the price increase from those who own and produce the oil. Since those persons are, generally speaking, in higher income categories, the incidence of the tax is highly progressive.

The imposition of an excise tax under these circumstances is to be distinguished from normal excise taxes which are imposed on top of a free market price. In the latter case, the incidence of the tax is apt to fall on the consumer rather than the producer and is apt to be regressive in some degree. But that is not the situation we have here.

In judging the desirability of enacting or not enacting an excise tax, the following arguments are often made.

In favor of imposing an excise tax:

It permits some substitution of political judgments where it is believed that a free market will not respond quickly enough or in a satisfactory manner. But we have to note that that result could also be achieved through other mechanisms other than a tax, such as allocation. If we are concerned about the availability of fuel oil in New England, for example, we might deal with that problem by an allocation mechanism rather than by an excise tax, so there are alternatives even there, if one feels that some political judgment must be added to the ordinary operation of the market in order to make it respond more adequately or more quickly.

A second argument is that an excise tax would eliminate the alleged "windfall" profits. This, too, might be achieved by devices other than an excise tax, which I will mention later.

The arguments against imposing an excise tax are several and I think, perhaps, the first is the most critical:

History suggests to us that it is almost impossible to make such a tax a temporary one. The "temporary" excise taxes which were put into place during World War II did not come off until 1965 and some of them are still on hand. This fact, combined with the next point, are the really fundamental objections to an excise tax.

The second point is that a tax takes away the incentive for increased supplies which is provided by increased profits. Thus forcing more of the adjustment to be made in demand. If you are going to tax away from the producer the increase in price which has occurred, he will not have the money nor the incentive to create additional sources of supply.

A third point is that a tax creates large additional revenues, with twin dangers that withdrawal of large amounts from the economy may be deflationary and that those revenues may not be sensibly used.

As I indicated, it is possible to impose an excise tax on only a single product, say gasoline, and not on other petroleum products. If it were large enough, such a gasoline tax could bring supply and demand for all petroleum products into balance, with perhaps some minor increase in the price of other petroleum products as a result of the change in product mix.

In connection with proposals for imposing an excise tax on gasoline alone, the following arguments are often made:

Against the imposition of such a tax, it is argued:

That the tax on gasoline alone would put the entire adjustment burden on a single commodity, producing more severe dislocations than if the tax were distributed more widely. I think that can be illustrated if you would look back at table 1 again where you saw price increases ranging from 8 to 15 cents in the short term. If you were to put it on gasoline alone you would get much higher numbers—which might range upward toward $1.

Second, a gasoline tax has more impact at low income levels than a tax on crude. This is in part because more people at low income levels have cars that burn gasoline than have furnaces which burn oil. But, even there, it should be noted that perhaps 40 percent of all families

having after tax expenditures of $6,000 per year or less do not have cars and thus pay no gasoline taxes directly, although they may bear a burden from such taxes in the public transportation that they use and in the prices of other products.

A third argument against imposing a tax on gasoline alone is that it would provide no incentive to decrease consumption in other areas—no incentive to turndown the termostat, to insulate the house, to turn-off the lights when the cost of electricity generated by oil is increased, and so forth.

A fourth argument is that a gasoline tax is highly visible, highly resented, and highly emotional, all the way around.

In favor of imposing a tax on gasoline alone, it is argued:

First it would discourage the use of private automobiles. There are those who believe that to be a worthy aim, and they may be right and they may be wrong.

Second, it is argued that the public generally acknowledges that much driving is discretionary and therefore would not resent the tax on gasoline. But the public also recognizes the discretionary nature of other expenditure items.

Third, a tax on gasoline would require a very major price increase for gasoline and should therefore have a major psychological effect. One might, perhaps, reasonably expect a greater response on the part of individuals to a large change in one commodity than to a small change in many commodities, although I have to say as to such an expectation that is is not based on any solid evidence.

The case for a gasoline tax rests on the assumption that expenditures for gasoline are less essential than expenditures for other petroleum products and that a heavy gasoline tax would have less impact on jobs and production than lesser taxes spread over more products.

But, again, we have to note that some industries would be very hard hit by major cutbacks in gasoline. For example, motels and resorts, and the companies which build them and sell them furniture, and food and so forth, would be severely damaged. Another example might be the case of private aviation, the companies which lease planes and own airports, would be similarly affected. Many existing airstrips might be converted to real estate subdivisions, with a permanent loss of airstrips to the communities.

Thus, a very basic issue in making a decision about an excise tax in this area would be whether indeed we believe the jobs and production would be adversely affected more by large cutbacks in gasoline, or by more modest cuts in the broader range of products.

In making judgments as to the desirability of any tax, the additional questions which would have to be considered would include, to touch at least the top of the iceberg, the following:

If the purpose of the tax were to absorb the "windfall" to producers, then how would that "windfall" be measured?

How would a tax be designed so that it would disappear when the "windfall" disappeared?

How could the tax be designed so that it did not inhibit or render uneconomical activities which would enlarge the supply of petroleum products?

How would the Government deal with the very large excise tax revenues which would flow from a tax that would be large enough to "clear

the market"? That revenue might well be as much as $20 to $30 billion, annually. Taking that much money out of the economy could be severely deflationary depending upon how you put it back in. Even if the money were expended by the Government for desirable projects, there could be a substantial lag between the time of tax collection and the time of revenue expenditure, which would have major fiscal impact.

Should some portion of tax revenues be rebated to consumers? And if so, what kind of system would be required to dispense relatively small amounts to millions of families? Would that system have to make the same kind of decisions as a rationing system as to what families were entitled to what benefits?

Would some other form of tax, say an excess profits tax, be better suited to absorbing the "windfall" if it should be determined that a "windfall" exists? Would it be possible to devise an excess profits tax which would operate more satisfactorily than previous excess profit taxes, which were notorious for their complexity, inequity and inefficiency?

Well, it should be apparent from the simple recital of these many considerations that the use of a tax or taxes to eliminate or ameliorate the present shortages is an extraordinarily complex matter with major long run implications.

Let us turn, then to the long term situation. In the long term, we must learn to accommodate to the laws of supply and demand. If energy resources grow scarcer, increased prices should provide an incentive to develop other sources of supply, and should render economic operations which are not presently profitable. Already, we are told, the prospect of higher prices has occasioned much greater exploration and development activity in the oil industry. Even in the relatively near term, the experts foresee an increase in production from properties which have hitherto been uneconomic and from processes such as secondary recovery. At some point, processes such as production of petroleum from oil shale may become profitable and come on stream.

Our tax law presently provides incentives to the discovery and production of petroleum through the provisions for percentage depletion and for the immediate writeoff of intangible drilling costs. In April of this year, the Treasury Department presented to the Ways and Means Committee of the House, proposals for tax change which would rechannel some of the incentive now provided by the percentage depletion provisions into a new tax credit for exploratory drilling. While the proposals in question were in part a response to "tax reform" goals, they were also intended to provide a more efficient incentive for the discovery of new reserves.

Also included in the April proposals was a proposal which would lessen what seemed to the Treasury to be an undue tax benefit permitted under existing law with respect to foreign drilling. That proposal, if enacted, would tend to lessen the incentive to drill abroad. Those proposals are now pending before the Ways and Means Committee in the House and will be taken up, we hope, after the first of the year.

We believe that those several proposals are timely and will be helpful in the search for new energy sources. However, the greatest incen-

tive to energy development will continue in the future, as in the past, to be the prospect for profits provided by a free and efficient market. The opportunity for a taxpayer to save 5, 10, or 15 percent of his profit through tax benefits is of small moment if there are no profits in the first place.

While I have talked today almost exclusively about petroleum products, we are all aware that they are only a part of the total picture. In the search for other energy sources, as in the case of petroleum, however, the basic problems are not tax problems and are not susceptible of tax solutions.

But we must remain alert to see that our tax laws do not inhibit solutions and to insure that those laws are adapted, where appropriate, within the context of the total tax system, to facilitate solutions. We shall be pleased to work with your committee to that end. Thank you.

[The tables attached to Mr. Hickman's prepared statement follow:]

TABLE 1.—ESTIMATED IMPACT OF EMERGENCY SUPPLY RESTRICTIONS ON RETAIL PRICES OF GASOLINE AND FUEL OIL

Emergency condition	Increase in retail gasoline and fuel oil prices (cents per gallon)	
	Short term	Long term
Supply reduced by—		
10 percent	+8	+5
15 percent	+12	+7
20 percent	+15	+10

Basic assumptions:

Current (Nov., 1973) consumption of crude and refinery products (billion bbls/yr)	6.4
Crude prices on which current refinery product prices are based:	
Foreign crude (bbl)	$6.50
Domestic crude (bbl)	$4.15
Average (bbl)	$4.60
Retail prices (cents per gal):	
Gasoline	43
Fuel oil	22.4
Elasticity of supply relative increase in flow of oil in response to increase in price, is zero.	
Elasticity of demand, relative decline in consumption of oil products in response to increase in price is:	
Short-term (1 yr.)	—.143
Long-term (2 yrs. +)	—.229

TABLE 2.—AVERAGE RETAIL PRICES OF GASOLINE IN SELECTED EUROPEAN CITIES, JULY 1973

(In U.S. cents per gallon)

Country	Service station price excluding tax	Tax	Service station price including tax
Hamburg, Germany	32.2	79.7	111.9
Rome, Italy	22.9	76.3	99.2
Le Havre, France	26.7	76.2	102.9
Rotterdam, Netherlands	37.4	74.9	112.3
London, United Kingdom	27.8	48.2	76.0
United States	26.8	11.9	38.7

Note: Gasoline prices were increased on Sept. 30, making prices roughly $1.13 per gallon for regular grade and $1.19 per gallon for premium.

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TABLE 3.—ILLUSTRATIVE EXPENDITURES FOR A FAMILY OF 4

[The tables below show annual budgets for 4-person families,[1] one at an intermediate level of living, the other at a lower level of living, in 1971. These budgets were derived from Department of Labor publications.]

	Amount	Percent of after-tax income
Intermediate level:		
Total budget	$10,971	
Consumption	8,626	89.8
Food	2,532	26.4
Housing	2,638	27.4
Transportation (excluding gasoline)	734	7.6
Gasoline	230	[2] 2.4
Clothing	1,196	12.5
Medical care	612	6.4
Other	684	7.1
Other costs	560	5.8
Social security and disability payments	419	4.4
Personal income taxes	1,366	
Lower level:		
Total budget	7,214	
Consumption	5,841	88.7
Food	1,964	29.8
Housing	1,516	23.0
Transportation (excluding gasoline)	408	6.2
Gasoline	128	[2] 2.0
Clothing	848	12.9
Medical care	609	9.2
Other	368	5.6
Other costs	357	5.4
Social security and disability payments	387	5.9
Personal income taxes	629	

[1] Weighted average for both owners and nonowners of automobiles.
[2] In the 10 years since 1963, the general price level has increased by about 47 percent while the price of gasoline (excluding taxes) has only increased about 33 percent.

TABLE 4

ILLUSTRATION

Mr. T lives 10 miles from work and commutes each day by car. During each week, Mrs. T drives to and from the shopping center 2.5 miles from their home three times and makes 5 other trips of 5 miles each taking the children to piano lessons etc. Mr. and Mrs. T go to the movies 2.5 miles from their home once, to and from the bowling alley 2.5 miles from their home once each week, and to and from church 2.5 miles from their home once each week. Mr. and Mrs. T also drive 1,500 miles on their vacation and 850 miles on other trips each year. Under these circumstances, if Mr. and Mrs. T's car gets 15 miles per gallon, the following additional amounts would be spent for gasoline if the prices were increased by $.25 per gallon.

Increased commuting cost per week	$1.64
Increased personal driving cost per week	.84
Total per week	2.48
Increased cost of vacations and trips per year	30.75

If Mr. and Mrs. T were to reduce their consumption by 25–30 percent, they might do so without severe problems as follows:

Carpool for commuting (sharing costs with one person)	$0.82
10 percent reduction in personal driving	.08
10 percent reduction in vacations and trips	3.08
Reduction in cost per week (excluding vacation and trips)	.90

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Note No. 1.—Only about 25 percent of the average car owner's expenses of operating his car are attributable to gasoline. Accordingly, a 100-percent increase in gasoline costs will only increase *total* car ownership expenses on the average by 20 percent.

Note No. 2.—Mr. and Mrs. T may choose to spend the additional amounts on gasoline rather than reduce consumption. It is likely that Mr. and Mrs. T will choose to give up some gasoline for some things and will choose to give up some other things in exchange for gasoline (for example, a carton of cigarettes a week at $3.04 per carton, a six-pack of beer a week at $1.43 per six pack, or substitute 3 pounds of hamburger for 3 pounds of sirloin at a reduction of $3.00). With mandatory fuel rationing, Mr. and Mrs. T would not be able to make the substitutions which are the most satisfactory to them, the choice would be made for them by the government.

Note No. 3.—Illustration is based on driving 10,000 miles per year, which is slightly above the national average based on Department of Transportation statistics for 1970. Lower income groups drive considerably fewer miles on an average.

TABLE 5.—INCREASE IN AVERAGE RETAIL PRICES OF SELECTED FOOD COMMODITIES FROM AUGUST 1972, TO AUGUST 1973

Item	Retail price		Percentage increase
	1972	1973	
Steak	1.58	1.86	17.7
Chicken	.41	.92	124.4
Milk	.59	.65	10.2
Eggs	.51	.96	88.2
Bread	.25	.27	8.0
Pork chops	1.26	1.99	57.9
Shrimp	1.18	1.38	16.9

WHO COMMUTES TO WORK BY CAR

The table below indicates that few lower income workers commute to work by car. Given that lower income people reside in cities and other forms of transportation are available in cities, the percentages are not surprising. For families with incomes over $15,000, 81 percent commute to work by car while less than 20 percent of those families with incomes less than $3,000 commute by car.

TABLE 6.—MILES DRIVEN COMMUTING BY MONEY INCOME CLASS

[In thousands of dollars]

Commuting miles per day	—0.5	0.5–1	1–2	2–3	3–4	4–5	5–7	5–10	10–15	+15	Average
0 [1]	99.5	87	89	87	76	66	49	36	22	19	41.9
Less than 10	0	2	6	6	12	16	21	23	25	23	20.0
10 to 20	0	3	2	2	7	8	12	17	21	21	15.2
20 to 40	0	5	2	3	4	6	11	15	19	24	14.4
40 or more	.5	4	1	1	2	4	7	9	12	13	8.5

[1] Includes those who do not work.

Source: Survey Research Center, University of Michigan.

Senator GRAVEL. Mr. Hickman, this is an excellent analysis of the problem and we are certainly grateful, in particular for the revealing tables that you have provided. They can be very useful in the dialog as it develops in the Congress.

But, as you appreciate, it is an analysis of the pros and cons of various alternative causes of action. What we are searching for, of course, is to chart a course to a solution of the problem. I personally am impressed with the proposal of letting a free market allocate goods and services. I think the difficulty of trying to sell that to the Congress, is going to be great because of certain attitudes that we have.

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Yesterday, in our hearing, a statement was made that the oil companies have received intensive benefits, depletion, writing off intangibles and all of that. This morning, I was looking over some data which suggested that the profits enjoyed by oil companies, are slightly below the average of the manufacturing sector in this country.

Would you have any comment as to why the conventional wisdom is that the oil companies are ripping it off, when in point of fact that is not the case?

Mr. HICKMAN. Well I think it is true that the tax system does provide some reduction in the cost of capital to the oil industries, but capital tends also to move in the free market and over a period of time those things all tend to adjust themselves so that in the long-run, the after-tax rate of return tends to settle down at about the same level that comparable investments create elsewhere.

Senator GRAVEL. Well, then are you telling me that despite these tax incentives that we have in the extractive industry area—there has been a flight of capital from energy and that apparently these incentives have not worked, since capital was not retained in that activity?

Mr. JOHNSON. May I comment on this?

Senator GRAVEL. Please.

Mr. JOHNSON. I think that while there have been incentives in the tax system, there have also been very substantial disincentives to investment in the oil industry. One disincentive certainly has been price controls.

Senator GRAVEL. Price controls on oil have been in existence since 1971 while those on gas have been there since 1955. Now I can understand, of course, that the flight of capital from gas has been unbelievable when you look at the figures now. But why the flight of capital with respect to oil—a trend which was evident for a number of years prior to 1971.

Mr. JOHNSON. There have been a number of reasons but one of the reasons that has exacerbated this flight over the last several years, has been the low profitability of the industry brought about, in part, by some controls over the prices of products produced, by that industry.

The result has been a relatively higher profit abroad than in the United States with the obvious consequence that many oil companies have found it more profitable to invest in Europe or drilling in the North Sea rather than in the United States. There have been other factors, too.

Senator GRAVEL. Well the North Sea has not produced anything of substance yet.

Mr. JOHNSON. There is an awful lot of capital going into it.

Senator GRAVEL. I know that. I pointed that out in my question. Is there a free market there with respect to the price at which oil from the North Sea will be coming into European markets? Is there going to be a totally free price for gasoline and crude oil?

Mr. JOHNSON. It varies from country to country in Europe, but generally, yes there has been a freer market in Europe for products, gasoline, than there has been for crude oil.

Senator GRAVEL. But by your table, though, it shows that the price in Europe is about the same. The difference is in the tax which the Europeans have to pay. Having lived in Europe I know that they

have a problem collecting income taxes. Their system is not as successful as ours on a voluntary basis, and maybe one of the conclusions one could draw is that it is easier to get the money right off of the top. That is why they tax gasoline very heavily.

But, be that as it may, you are not talking about very much difference between the United States price—say 26, and the German price of 32 cents. So actually what happens is that by putting this much excise tax on, they dampen the market forces. With a free market there without high excise taxes, there would probably be an increase in volume. They would sell larger cars for example. So they have interrupted the free market situation just by the excise taxes they have put on.

Mr. JOHNSON. Well again the European countries vary. Italy, for example, has done other things that have interrupted the operation of the free market mechanism in that country and that, I would say, is an exceptional case. But the countries of Europe vary, also the costs vary. European countries have historically relied more heavily on Middle Eastern crude oil which until recently was considerably cheaper than crude oil produced in the United States. This, of course, has changed completely in the last year or so. The European countries have also had some crude at least, that supplied by north Africa, coming into their refineries at smaller transport costs.

I think the introvertible fact, however, which has been demonstrated in a study by Chase Manhattan Bank, is that the profitability on foreign operations has been higher than profitability on U.S. operations. This has contributed to the flight of capital.

Senator GRAVEL. You devote a significant portion of your statement to excise tax. Though the money comes to Government under such a tax, no money is given to increase supply. So if you add an excise tax, you still have not changed the factors affecting supply.

Mr. HICKMAN. That is right. The great disadvantage of an excise tax is that it suppresses the effect that a price increase has on supply. The proponents of a tax argue that it is intended only to absorb up a windfall. The windfall is then defined as that amount which would not have a supply effect.

Senator GRAVEL. Well in actual point of fact, though, if oil companies received money and the money stayed in productive channels, then is it really a windfall? It is the government policy to increase the supplies—so that consumers have it. Therefore is not this a misnomer? Should we only talk in terms of windfall profits when individuals take it for themselves only to enhance their personal living standards and not with respect to corporate profits which are plowed back in the business.

Mr. HICKMAN. That is an area that I leave to the economists to some extent and to their technical definitions of "windfall." But I think that the point that you make is a very persuasive one, yes, that the money may in fact be used to increase the supply. That is an important part of the overall picture.

Senator GRAVEL. With respect to rationing, once you impose rationing, obviously there is a black market that is going to take place. Because as you point out, in the real world the people that have the money can increase their supply of gasoline. They will, in one way or

another, pay in order to get more gasoline and coupons, so that money would go, essentially, into a black market. This extra money is equivalent to paying for an increase in price. People are now paying more for a price of gasoline.

Now the other proposal that has been bandied around is, of course, having a white market. This would entail having an exchange at which people can go sell their tickets. Let the poor sell their tickets so they can let the rich buy more gasoline to run their bigger cars. Here again, it is redistributing money according to income levels. It is a way of subsidizing the poor, if you wish. But do you not agree that this does get money back to the productive source where we want it to go in order to increase supply?

In other words, that gas rationing actually has the effect of an excise tax?

Mr. HICKMAN. It has some of the same effects, that is right. It holds profits down and distributes them elsewhere, the profits that otherwise would increase supply.

Senator GRAVEL. Well, if you come to the conclusion that you want to increase supply—excise taxes or rationing will not contribute to that. And we also have concern about windfall profits, defined to mean profits that are not plowed back into the search for new oil and gas. Then what would be your analysis of a free market situation, coupled with an excess profits tax on dividend income beyond a certain point?

Mr. HICKMAN. Well, the concept of an excess profits tax, if one can look simply at the abstract concept, is really a better approach to what people are proposing for the excise tax area, than an excise tax. In either case, you are attempting to absorb up some of the profits which for one reason or another somebody concludes ought not to go to the producers of oil. The difficulties of the excess profits tax in the real world is that such taxes have been extraordinarily difficult, cumbersome inequitable, highly litigated taxes, whenever we have had them. In a sense that may be a good thing because those difficulties insure that we do not keep these taxes very long.

Senator GRAVEL. But is that not just the way the income tax is? It is highly litigated, and it is horrendously complicated?

Mr. HICKMAN. The income tax is a picnic compared to the excess profits tax. I think a tax lawyer would put them in different worlds. The excise tax proposed would, in fact, be an excess profits tax. It is not only an excess profits tax, but to the extent that it absorbs the entire price increase, it is a profits tax—taking the whole thing away as the price goes up. It may be that some other device similar to an excess profits tax could be devised, but I think the classic idea of an excess profits tax in which you are measuring increased profits over some previous base, would be a cure worse than the disease.

Senator GRAVEL. Well, I do not really see the difference. I do think there is a substantial difference between an excise tax and an excess profits tax. Rather than call it excess profits tax, why do we not just call it a tax, a stronger tax on moneys that are not ploughed back into where they are supposed to be going, that is, getting more supply? And as you get more supply, it will dampen the price, and that in itself in a market situation will begin to depress the possibility of excessive profits.

Mr. HICKMAN. Well, I understand the concept, and I think that it has some allure. But to what companies would you apply it? Who would be the taxpayers subject to this tax? Would it just be oil companies? Would it be farmers with a well in their backyard? Would it be, say, large conglomerates that happen to have a small oil operation? Would it be companies who do not have any oil?

How would you decide?

Senator GRAVEL. Well first, let us just take oil. You could expand it beyond oil, that would not be terribly difficult. But a guy has an oil well in his backyard, and he is pumping it out and selling it and the price has gone up, he makes a ton of money. And then he takes off to Florida and does not do another lick for the rest of his life. I would consider that an excess profit.

Mr. HICKMAN. Well, his case is easy, but suppose——

Senator GRAVEL. Let's take a conglomerate. They own 10 wells. They own a piece of property that has got 10 wells on it. OK, the price goes up. You must have auditing ways where you can find out how much extra income was due to price increases. Then you establish a mechanism encouraging the plowback of the increased earnings.

Mr. HICKMAN. But you are talking about the gross income, not the net income. You have got to separate out net income for a profits tax. That is what is left after your expenses. That requires that you segregate the activity that you are talking about.

Senator GRAVEL. But, Mr. Hickman, you have been doing that ever since you have had the depletion allowance. You make that assessment all the time. So why is it so difficult to now make an assessment with respect to excess profits?

Mr. HICKMAN. One of the possible alternatives which you put your finger on is that you could design a tax around net income from the producing property. Our present tax system requires you to keep records which segregate the profits, the net income, if you will, from particular properties, for purposes of claiming the allowable percentage depletion. You could perhaps design a tax around that.

Senator GRAVEL. But they are already doing that. They are already reporting that to you. You would not have to hire one extra person.

Mr. HICKMAN. Oh, yes.

Senator GRAVEL. Well, really, would you? You have got all the data. They are filing for depletion. They are filing for these other taxes. You have got it right before your very eyes as to what their costs are and what is involved. So I do not see the horrendous task.

Mr. HICKMAN. There is no question but that an excess profits tax of that sort would be much easier and really a horse of a different color from the kinds of excess profits taxes that we have had in the past. While we have talked about that in a general way, we have not really focused on all the technical problems that are always there as you get into these things.

Senator GRAVEL. Well, I think it is very important because this may be the only way we can sell a free market, and that is what you are recommending. So you say it is great to have a free market. And you show us in the table that the prices are not going to be disastrous as they climb up. Then the only way we are going to sell it to the people of this country—because they have no confidence in the oil companies

right now, and they think that there are going to be windfall profits—and so the only chance we have to develop a new policy is to say, here is a safety valve, that is, an excess profits tax, and it is really not all that difficult to administer.

Mr. HICKMAN. You understand, I am not recommending any definitive course of action. As you correctly pointed out, I was trying to analyze it. I do feel that the case for reliance on the market is a persuasive case.

Senator GRAVEL. But do you not think, Mr. Hickman—and I am sure that in the Treasury and in the administration somebody must feel this way—that the situation is so grave in this country that somebody should be coming up with a recommendation from the administration so that we can do something?

Mr. HICKMAN. And we are doing that, Senator. It is just that we are not ready this morning with those recommendations.

Senator GRAVEL. Well, how bad are things going to have to get in this country before somebody does come up with a plan or suggestion?

I have put forward one, and you thought it was too complicated until I showed you that it is not so complicated.

Now, when are we going to get something of substance to give some guidance and some hope to the people in this country? We, as persons, are being deluged with telephone calls of emergencies in our States of unbelievable natures, and we have had 2 days of testimony from the administration telling us that, well, we are working on a plan.

If you are not going to tell us, who are you going to tell?

We are going to pass the laws. You are going to have to come to us some day.

Mr. HICKMAN. Well, you will be the first to be told I am sure, once we have sorted the ideas out and have arrived at what seems to be the best answers given the complexity of the problem. I agree, and everyone agrees, I think, in the administration, that it is a most important problem, and I can assure you that it has the very highest priority throughout the administration.

Senator GRAVEL. Good. I think I have used up my 10 minutes, and I would go on to Senator Ribicoff. Do you have a time problem?

Senator RIBICOFF. I have a few questions.

Could you tell us how much Federal income taxes were paid by the top five international oil companies to the U.S. Government in the past 5 years?

Mr. HICKMAN. I cannot tell you that offhand, Senator, and as you know, there is a statutory prohibition against disclosing returns. When you ask for information about small groups you get into questions as to whether or not you are disclosing return information which is illegal to disclose. I would have to go back and look at the numbers and see whether it is the kind of a grouping that would permit me to tell you the numbers without revealing to the public from individual returns. I will see what I can do and supply it for the record.

Senator RIBICOFF. Can you supply the committee with figures showing on a nation-by-nation basis the revenue loss to the Treasury from foreign tax credits, depletion allowances, and intangible drilling expenses claimed by U.S. oil companies operating overseas?

Senator GRAVEL. Would the Senator yield and add to that also a comparison of the competitive position with the company doing that to a domestic oil company?

Senator RIBICOFF. I would say to the Chairman that that was the next figure I was going to give Mr. Hickman. I have a chart here which I will turn over to you indicating that a $1 million investment in a domestic oil operation as against a $1 million investment in foreign oil property would bring an economic benefit to the domestic operation of $211,146, as against $351,000 for the foreign one.

[The table referred to by Senator Ribicoff follows:]

COMPARISON OF TAX RESULTS FROM DOMESTIC VERSUS FOREIGN OPERATION OF OIL AND GAS PROPERTIES

	Domestic property	Foreign property
Production sales	$1,000,000	$1,000,000
Less:		
Royalty, ⅛	125,000	125,000
Net profits override, 55 percent	371,250	0
Gross income	503,750	875,000
Operating expenses	200,000	200,000
Net income before taxes	303,750	675,000
Foreign tax, 55 percent	0	371,250
	303,750	303,750
U.S. tax, 48 percent	[1] 92,604	[2] 0
Net income (cash flow) after taxes	211,146	303,750
Potential value of excess tax credit	0	[3] 47,250
Economic benefit of domestic versus foreign operation	211,146	351,000
Tax computation:		
Net income before taxes	303,750	675,000
Less: Allowable depletion:		
22 percent times 503,750	110,825	
22 percent times 875,000		192,500
Taxable income	192,925	482,500
U.S. tax at 48 percent (before foreign tax credit on foreign income)	[1] 92,604	231,600
Foreign tax credit:		
Taxes paid	371,250	
Less: Sec. 901(e) reduction (48 percent times 192,500 allowable depletion)	92,400	
	278,850	
Limited to U.S. tax on foreign income	231,600	231,600
U.S. tax at 48 percent after foreign tax credit		[2] 0
Potential value of excess tax credit	[3] 47,250	

[1] Domestic property and foreign property are identical as to production sales and operating expenses.
[2] Domestic property is subject to a ⅛ royalty plus a 55 percent net profits override.
[3] Foreign property is subject to a ⅛ royalty plus a 55 percent tax on net income

Mr. HICKMAN. Yes. We would be happy to.* We will see what we can supply in these areas. We never can say offhand what we do have, but we usually can get some kind of an estimate and give you a range of the magnitudes involved. I would say that in the case of the foreign tax credit it is a little difficult to say that we are losing money. The question is, if somebody is operating abroad and paying a tax there, are we losing money because we do not tax him on what he is doing abroad? The concept of a foreign tax credit is that we will let the foreign country do the taxing, and we will not tax up to that level.

*At presstime the material requested had not been received by the Committee.

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But we will not offset a foreign tax where the foreign country is taxing at a rate higher than the U.S. rate.

Senator RIBICOFF. Well, is that really the problem, Mr. Hickman?

American oil companies operating abroad are allowed under American tax laws three basic loopholes or incentives as some would describe them. They get foreign tax credits. They get oil depletion allowances. And they get intangible drilling expense deductions. Now, do you see any justification for the American taxpayers helping American companies to develop resources in a foreign nation that embargoes the oil to the United States?

Do you see any justification for such a policy?

Mr. HICKMAN. I think you have to go back a moment and look at what I tried to say about the foreign tax credit. We are talking there about whether the company should pay taxes twice. If it is paying taxes abroad, where it is in fact located and operating, we do not see the credit as the granting of a tax benefit. If you take the credit away, you are not penalizing anybody but the company. You are making American companies noncompetitive with other foreign companies, which are operating in the oil producing countries. They are just paying tax to one country. The different countries around the world have different tax systems, but most of them arrive at the same general goal, that an operation pays tax in one country, usually the country where it operates, and not in some other country, and not twice on the same incomes. It is our fundamental view that a foreign tax credit, except where it is abused around the edges—and it sometimes is because it is a complicated mechanism—is not a tax benefit. Really, it is only tax fairness that the company should not pay a tax twice on the same income. So if you take the credit away from those American-owned companies which are now operating in the embargoed nations, you would be simply subjecting the companies—not the embargoed nations, but the companies who are already up to their ears in trouble because of all this—to a double tax. And I do not see that that gets you any place.

Senator RIBICOFF. Well, I don't really follow you. In other words, do not American companies if they start exploring for new deposits of oil in Saudi Arabia, and they invest huge sums of American dollars to do that, and American technicians, get an intangible drilling allowance against their taxes that they pay in the United States?

Mr. HICKMAN. That is right.

Senator RIBICOFF. And they also get a depletion allowance for their investment in drilling in Saudi Arabi.

Is that not correct?

Mr. HICKMAN. Both of those——

Senator RIBICOFF. Well, also, this is American capital. I just want to take it one step further. Governor Love testified that you would have to invest $1 trillion to really get this country moving in alternate sources of energy, or the further exploration of gas and oil in the United States, whether it goes to oil shale or liquefaction or gasification of oil now. If you are able to produce a barrel of oil in Saudi Arabia or Kuwait for 6 cents a barrel as against $2.88 a barrel in the United States, you are going to invest your money in Saudi Arabia and Kuwait and not in the United States, in Alaska or Wyoming or

Texas or Louisiana or offshore. As a result we are encouraging American capital, American technology to explore for foreign oil. We are using American taxpayers' money. The oil we help find, however, is not made available to us.

Should we continue being that foolish to subsidize these countries with our tax dollars when they embargo their product in the United States?

Mr. HICKMAN. Well, I am afraid we are not meshing, but it comes back to the basic question of whether these things are properly regarded as a subsidy, and I think in the case of a foreign tax credit—and that is just one of the items that you named——

Senator RIBICOFF. In 1970, American oil companies earned over $1 billion abroad and did not pay a single cent of taxes to the United States. That has been consistent year in and year out. By the time they got through paying their taxes abroad and taking their tax credit on top of that on that billion dollars' worth of earnings, they did not pay a dime to the U.S. Treasury.

Mr. HICKMAN. Well, that sometimes is true.

Senator RIBICOFF. Sometimes? It is consistently true, is it not, Mr. Hickman?

By the way, how many people in the Treasury Department do you have whose time and efforts are involved with all of the tax problems relating to oil and gas?

Mr. HICKMAN. Well, we have two separate staffs of economists and we have two separate legal staffs, all of whom operate in these areas, all of whom spend a substantial part of their time worrying about problems of this sort. This is one of many problems that we worry about, but it is an important problem. I suppose the total number of professional economists is in the neighborhood of 50, and the total number of lawyers is perhaps 35, and I am pleased to say that I think that they are an extraordinarily capable group of people.

Senator RIBICOFF. Do I understand your position that you think it is perfectly all right for the United States to continue giving these three basic benefits to American companies operating in countries that embargo their products to us, the depletion allowance, intangible drilling expense and foreign tax credits?

Are you for the three of those?

Mr. HICKMAN. So far as the foreign tax credit is concerned, I think that is basically sound and should apply there as it applies in any other kind of enterprise, whether it is oil or not. It is relief from double taxation.

So far as the depletion allowance is concerned, whether we take it away or not, if you work through the arithmetic it simply makes no difference. The committee considered that in 1969 in connection with the Tax Reform Act. In view of the arithmetic——

Senator RIBICOFF. I know, but at that time we did not have those countries embargoing their product.

Mr. HICKMAN. All I am saying is that if we take percentage depletion away from the foreign oil operations, it would not increase the amount of tax that they pay. It just does not mean anything to them in this context. It is because their foreign tax credits at the moment, for the most of them, are in excess of the limitations. They have got

credits to burn because they pay taxes in those countries far in excess of what they would have to pay in the United States on their foreign income. Under those circumstances, because of the way the system works, the depletion allowance does not give them any tax savings on the foreign operations. You can take it away or not take it away. It does not make any difference, and that is why in 1969 your committee did make the change with respect to the computation of the foreign tax credit limitation and the carryover provisions as between countries. It is a separate computation that is based on the kinds of problems that you are worried about. It took away what your committee decided was the improper element. Indeed it was your committee's version that ultimately prevailed in 1969.

Now, so far as intangible drilling costs are concerned, we have a proposal in our April 30 package that deals with what we believe is an improper situation, which occurs when there is drilling abroad by a branch of a U.S. corporation as distinguished from a subsidiary. The losses in the early years are then carried home because they are a part of the U.S. corporation, and they are deducted against the income of the U.S. corporation.

Now, intangible drilling costs are an expense. Money has been spent, and at some point, under any tax system, the costs should be deductible. The preference, if you will, arises from that fact that they are immediately deductible whereas in most businesses, expenses which are incurred in order to create an income-producing activity are required to be capitalized and written off over some period of time.

So, you have to start with the proposition that those expenses are allowable to somebody at some time. They are an appropriate expense. But what is happening is that the expenses are deducted against the U.S. income in the early years. Then companies frequently incorporate, or even if they do not incorporate, they begin to make money abroad. The foreign tax credit operates as all our tax provisions do, pretty much on a year by year basis, with some carryovers. But the foreign tax systems frequently do not take the early losses into account, with the result that they charge a very high tax once income is earned, and the U.S. Treasury pays for that by giving a foreign tax credit.

So it is proposed to cut the credit back.

Senator RIBICOFF. How much does that amount to?

While you are getting that material, did you ever submit a bill on that proposal in April?

Mr. HICKMAN. At the request of the Ways and Means Committee, we made our proposals in broad form, so no bills have been introduced. The proposals were made in this rather thick book, both in a general sort of way and with a quite detailed technical explanation.

Senator RIBICOFF. Do you have a copy of your proposal?

Could I have a copy of that?

Mr. HICKMAN. Yes, of course.

Senator RIBICOFF. Could I have that information that I requested of you by Monday morning?

Mr. HICKMAN. I suspect that it will not be possible to have it by Monday morning.*

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*See footnote, p. 119.

Mr. Fiekowsky, who is our principal expert, says it depends on the year for which information is requested. We will be glad to see what we do have and check back with you this afternoon, if that will be helpful.

Senator RIBICOFF. In general, could you just give us the general figures that you have on it?

I understand that you would not have 1972 or 1971. I can understand that. It seems to me 1970, 1969, 1968 should be there.

Mr. HICKMAN. Well, we have some earlier years in different forms.

Senator RIBICOFF. Well, you could just pick the recent years. I am just curious to see what those figures looked like in 1970, 1969, 1968. I can understand and where you would not have 1972 and 1973.

Thank you very much.

Thank you, Mr. Chairman.

Senator DOLE. There has been some controversy on whether there should be a tax credit or a deduction, this would make a difference as far as the American companies who produce in foreign countries are concerned.

Mr. HICKMAN. Well, there has been a continuing controversy among students of foreign taxation for at least 10 years as to whether or not a deduction for foreign taxes would be preferable to a credit. The position of the administration is that the credit system is the better system. It puts American companies operating abroad on the same basis as foreign companies operating abroad. It is neutral in that respect and does not penalize the American company which wishes to compete with a foreign company in some foreign location.

If you give a deduction, you are not eliminating double taxation, so that you have, depending on the operations and the country, double taxation which would sometimes rise up to the level of 70 to 80 percent of the net profits, which seems to us not to be a sensible kind of a burden to put on American companies operating abroad. There are some people who think that American companies should not operate abroad at all. We do not take that position.

If you wish to advance the view that they should not operate abroad at all, then one of the things that you would do at the outset would be to change the credit to a deduction. But that is now our view.

Senator DOLE. You would not look upon that as an incentive to explore more at home?

Mr. HICKMAN. Well, it would be a very heavy penalty for straying from the United States at all, and of course, it would cause a terrific economic loss for American companies with respect to existing foreign properties on which they made very large investments.

Senator DOLE. Yesterday we had a witness from the Ford Foundation who proposed a depletion allowance which would increase as a percentage of recovery increased. In other words, he looked to secondary and tertiary recovery. I think he stated that we do a lot of cream skimming and get about one-third of the resource, and two-thirds are left in the ground.

Has the Treasury Department given any thought to additional tax incentives? I know you have given a lot of thought to disincentives, and I think Senator Hansen may want to review that record. I am not suggesting it has all been the Treasury Department's fault, but if we

looked at the incentives given the oil industry as a whole over the past several years we can see there certainly has been no encouragement for further exploration through reductions in intangible drilling deductions or the decrease in the depletion allowance. Of course, many of those now in the Congress who are concerned about the energy shortage, lead in the fight to lower depletion allowances and to otherwise make it more difficult for the independent oil producers and others in this country to explore for new sources.

Is there now any such study under consideration that would increase the tax incentive as the percentage of recovery increases?

Mr. HICKMAN. We have not studied in any detail that particular suggestion. We have, as I indicated, worried about the general problems of incentives, and we did in our April 30 package propose a new minimum tax. For some people it would result in a decrease of the amount of percentage depletion that they could claim.

The reason for that proposal is that some taxpayers offset so much of their income that they pay little or no tax. The thought is that we should put some kind of overall limitation on the amount of income which people can offset on the theory that there can be too much of a good thing. It is damaging to the tax system to have large numbers of people not paying income taxes because it erodes the confidence of the average taxpayer in the system.

At the same time, we recognize that so far as our energy needs are concerned, it is perhaps more important that we get additional exploration and that we get, if you will, more bang for the buck, from a credit.

We proposed a tax credit for exploratory drilling. It should more than offset the disincentive from the new minimum tax, and it should rechannel the same dollar amount of incentives into a form where they will provide greater impact.

A great many people believe that all social problems can be solved through the tax system, and we do not believe that. We think that in this kind of a case, the biggest incentive that could be provided, would be the opportunity to make a profit at free market prices, and until we get at least to that level, we should not worry about adding new tax benefits to those which now exist.

Senator DOLE. I speak with reference to the appearance and testimony of Mr. Freeman of the Ford Foundation. His argument appears to have some merit because of the immediate results that would be possible. Maybe after a thorough analysis the advantages would disappear. But if we are talking about how to find a quick source of energy, it does appear to have merit. We have discussed the Alaska pipeline and solar energy, and a number of other things that may produce results in 4 or 5 years, but it does seem that if we could encourage production from existing wells which have become uneconomical to pump, the results could be almost immediate. We cannot only look for the tax incentive to spur production or encourage exploration, but if there is some potential—and I am in the process of trying to determine that—the concept is worth investigation. If either increasing the depletion allowance or more tax credit might make it possible within 6 months or a year to tap resources estimated to be between 30 to 40 million barrels of oil, then that possibility seems to me to be worthy of consideration.

Dr. HICKMAN. Well, I agree, it is worthy of consideration, but I suggest to you that if we had a free market price, oil would be produced if we needed it, and the people wanted it, and it would not be produced if they did not.

Perhaps that is a much better test than for us to try to provide an artificial incentive to produce something which at free market prices people may not want.

That amounts to a subsidy that all of us help pay on the cost of production which flows just to the people who use it. After we get back to a free market situation, then perhaps we can take a second look to see what real problems we have. The free market is without any question of much greater moment than anything we could conceivably do in the tax area.

Senator DOLE. When these hearings were first under discussion we were still having an energy problem. During the course of arranging the hearings it changed from a problem to a crisis. I have read your statement, and must confess I am not in agreement with all of the points you raise.

As far as the Treasury Department is concerned do you see any one area of legislation for this Committee to consider, which would give us some immediate stimulus for production?

You have analyzed the different proposals and different ideas, but do you have any one recommendation that you could really bear down on?

Mr. HICKMAN. I do not at this time have a recommendation that I think lies within the joint province of the Treasury Department and your committee to solve the problem. I think the basic problem is a different problem than a tax problem. I realize that your committee jurisdiction extends much more widely than mine does at the Treasury.

Senator DOLE. That is all I have.

Senator GRAVEL. Senator Hansen?

Senator HANSEN. Let me compliment you for your very excellent presentation. Mr. Hickman, I think you have done an awfully good job in calling some facts to the attention of the American people. I hope that some of them will be interested enough to dig a little more deeply than they have been willing to in the past, and I would hope also that the press might be able to handle a very complicated and involved subject in a manner that will permit wider understanding of it than we have had so far. I think it is obvious from what we read today and from the questions that are raised—I regret that Senator Ribicoff is not here because it is not as simplistic as many of us seem to think it is.

First, I would say with reference to the statement that the distinguished Senator from Connecticut made in the questions and the questions he asked you, it would be simple. When we get into trouble one of the things that politicians do particularly is to look around and see whom they can point the finger of blame at, and I think that there is plenty of that going on today, too. We do not like to admit, any of us, that maybe we have made some bad judgments in the past and part of the fault may lie with us. In this instance I expect there is going to be plenty of blame to go around for everybody and a lot left over; and I say that not only directing my comments toward the Congress, but toward the administration as well.

It has been said that nobody warned us. I am going to call attention to the fact that then-Governor Dewey Bartlett, now U.S. Senator apprised the Southern Governors Conference about 5½ years ago that we were in real trouble, but no one was listening. And certainly that has been typical of all too many of us.

With respect, however, to the points that were made by Senator Ribicoff, I think that before we drop the ax and start saying what we are going to do to American investments in foreign countries we had better look at the full extent of our involvement worldwide, and to see how many resources we get from around the world. And then, after having been apprised of that rather painful bit of knowledge—and it may surprise a lot of people to see how dependent we are, not only upon foreign countries for oil, but for a lot of other things as well—to view in the context of that knowledge suggested changes in tax law. My guess is that there will be considerably less enthusiasm for saying that we need to cut off all of the benefits that go now to American investors because they have been going over there in the Middle East and drilling wells instead of drilling them here.

I think also we want to contemplate what would happen if American entrepreneurs were not interested in going abroad and not becoming involved, and how America's position under that sort of policy would have deteriorated. We are aware today that our Navy is being supplied with oil that comes largely from America. Why? Because the Arab nations have cut off the availability of Middle Eastern oil for the Mediterranean fleet and other fleets as well. So we are going to have to come back to this country. The military has ordered an allocation of our desperately short domestic supply now to supply the Armed Forces around the world.

These are some of the things that I think we need to contemplate and understand before we start writing tax laws.

I regret that Senator Ribicoff is not here, because I am certain he shares my firm and full conviction that each of us and the two of us together want to do the very best job we can for America. And as far as I am concerned, I think that this country has done enough in trying to make the whole world a place that resembles Utopia. I think we have got problems here at home that we had better start thinking about—to keep American homes warm, how to keep jobs going.

I listened to one of the TV shows this morning, and I guess this is the first dramatic evidence, just over the weekend, of what is ahead for us in the energy crisis. One of the major truck companies on the west coast had a whole fleet of trucks idle because they could not get diesel oil. One of the major airlines has laid off 1,000 employees because they could not get fuel.

My particular area is about 90 percent tourist and recreation oriented. And I can assure you that when Governor Love spoke a couple of weeks ago about the possibility of closing national parks to private automobile traffic this coming summer, it shook the hell out of a lot of people in Wyoming. I live in a little town that gets 90 cents out of every dollar from the tourist.

If tourists cannot drive in there, there are going to be a lot of people out of business; there are going to be a lot of people on relief. And I can assure you that as far as Wyoming is concerned there is no ques-

tion but what anyone with a job in that State, if given the option of deciding whether he would pay twice as much for his gasoline, and pay for that gas out of the check he receives because he has a job, or buying a lessened amount of gasoline of prevailing prices with a welfare check, you would find that we would develop overnight a lot of free enterprisers, a lot of people who would say they really had not understood how this free market economy works in this country. I make those observations because it is easy these days to demagog and say we are going to be for the poor people. We are all for the poor people.

It is a good platform to run on. Like Senator Russell Long said about his uncle, there is a place for ethics in politics, but you say any damn thing you can to get elected. However, there comes a moment of truth, too. I think we are near that point right now. When more homes get cold, more schools are closed, more factories are shut down, and more people are out of work, we are going to be reexamining a lot of the premises we have made, because we have not been totally honest with ourselves.

I make these observations, and I regret that Senator Ribicoff is not here, because as I say, I think he and I have no basic disagreement at all. I just suggest that we need to look below the tip of the iceberg. It has just started to emerge now, and it is going to get a lot bigger.

And having said that, let me say that the estimates that I have seen with respect to capital investment that may be necessary to meet our energy needs between now and 1985 have been at least $500 billion—maybe more, but at least $500 billion. As an economist and as a representative of the Treasury Department, would you think that to take action against companies that have foreign investments, that would further reduce their revenues, the amount of the income that they can keep now which could go to supplying this $500 billion at a minimum—some people say it will take $1 trillion between now and 1985 to meet our energy needs—would that serve the long-term interests of this Nation best in your judgment?

Mr. HICKMAN. Well, it seems to me it never serves our long-term interests to penalize people for things that they did in reliance on past laws. That does not necessarily mean that there might not appropriately be some adjustments in the system as we know it, because the tax system must change and adapt as circumstances change.

But in terms of a wholesale abandonment of the present system, I think our policy is that it would be more unfortunate.

Senator HANSEN. Mr. Chairman, if I may I would like to ask unanimous consent that there may be included in the record at this point a story cut from the Wall Street Journal of November 26, "Coupon Book Economics." It is an article written by Dr. Paul McCracken, who is well-known to this committee.

I would like to read just a couple of paragraphs from it. Dr. McCracken says, "During the last decade the real retail price of gasoline excluding taxes"—and by the real price he means this price adjusted to allow for changes in the value of the dollar generally—he says that the real retail price of gasoline during the last decade excluding taxes declined 8 percent. And during the last 2 years the real price of gasoline has declined almost 8 percent.

He goes on and concludes his article, after discussing among other things a black market and all of the other things that he anticipates will come into being, by saying that, "After the system operated for a while we would begin to perceive that what we had was a free market for gasoline, plus a slightly disguised income redistribution program. It might then occur to us that we should have a straightforward income distribution program" if that is where we are going—other than the straightforward superiority of the price system and free and open markets to handle the economy's allocation function.

What I think he is saying in summation is that we seize upon this opportunity now presented thinking that we are going to get out of a bad situation. Actually, all we are going to do is spread the misery around. I have deplored on numerous occasions the fact that all the emergency bills we have considered in the Interior Committee this year, with the exception of the passage of the Alaskan pipeline. We are mostly concerned with spreading the misery around. When people's homes get cold and schools are shut down and jobs disappear, that is not going to be a satisfactory answer.

Senator GRAVEL. It will be included in the record.

[The article from the Wall Street Journal follows:]

[From the Wall Street Journal, Nov. 26, 1973]

COUPON BOOK ECONOMICS

(By Paul W. McCracken)

During the weeks immediately ahead decisions will be made about energy that will in quite fundamental ways shape not only our economy but also the future course of American life. And there is an uncomfortably high probability that we shall set ourselves on a course of action that will be difficult to reverse and bitterly regretted.

That we confront a difficult energy problem is clear enough. We are consuming oil at the rate of just over 17 million barrels per day. Domestic production is about 11 million and not rising. Directly and indirectly roughly one-third of the six million that must be imported has been coming from the embargo area. The annual growth in demand could be expected to add roughly another million barrels per day to our requirements, and this also would in the normal course of things have come from the Persian Gulf because that is where the oil is.

This confronts us with a tough problem, one whose gravity is not to be minimized. Looking toward the year ahead we have a shortfall in probable petroleum supply of 15% to 20% relative to normal demand, and oil and gas in turn supply roughly half of our energy requirements. When we remember that a spot shortage at one point can have domino effects in other directions, the large potential that this shortage has for disorganizing our economic life becomes apparent. But for a nail . . . some kingdoms can be lost.

What should our energy programs do for us? What are the guidelines for determining what we should do and should not do? Precisely because the problem is so urgent we need to take time enough to perceive the longer run consequences of our short run actions. We have this problem of energy today in part because we did not take time a few years ago to think through the longer range results of some immediate actions. In a seizure of evangelical fervor, for example, we charged mindlessly ahead on some environmental standards that were clearly building up requirements for oil and gas which could not be met even before the Mideast war. The result of this theologization of environmental programs, which tended to treat questions about consequences almost with contempt or as sin, is that as these painful consequences now become more apparent the perfectly good cause of having regard for our environment is threatened with being discredited. If so it will have hard going to recover support from a public understandably suspicious because of having been burned once.

There will in this urgent energy problem again be a tendency to act as if the problem is so urgent that we must mount our steed and ride instantly off at top speed without even taking time to make sure that we are headed in the right direction.

SOME SOCIAL VALUES

Efforts at voluntary conservation are, of course, commendable. There are even social values to be derived at these joint efforts for the common good. And there can be no doubt that habits about energy use, reflecting quite rational responses to cheap energy prices (and not, as some comments seem to suggest, a new variant of original sin), have led to some uses that can readily be curtailed. Indeed, it is possible that something approaching half of our shortfall could be taken up by such careful using of energy more sparingly.

Rationing commends itself to many as the way to handle the remainder of the job. It seems fair because "everybody would be treated alike."

If we do go into rationing, certain predictions can confidently be made. One is that what starts out as "treating everybody alike" will be a program that each citizen is sure is discriminating against him. For one thing there is infinite variation in people's situations. Giving everybody X gallons per week, or even everybody in Z category X gallons, will be just fine for the inactive family whose car spends most of its time getting dusty in the garage; and it might be lethal for the active family using the car for all manner of things. There is a way to use this enormous variation in individual situations, but more of that later.

The result is that a rationing program in practice would waste gasoline and oil because simplistic and across-the-board rules, inevitable in such a broadside program, would put substantial amounts of these scarce products into the hands of those for whom the need would be of secondary urgency.

A more unfortunate aspect of rationing would be its adverse effect on public morality. If there is one lesson to be drawn from experience with these programs it is that black markets would flourish. Thus those with "flexible" standards of morality, or who have political pull, or who can work some other angle will do relatively well, while the ordinary decent citizen will wind up with the dry gasoline or oil tank. Economies that are managed by license and edict and coupon books are also economies with pervasive corruption and graft. This is no accident. Those possessing the authority to grant favorable decisions possess something of great value, and there will be growing numbers who are willing to pay the price. All they will need to do is look around them to conclude that almost "everybody does it."

The major weakness of the rationing approach is that it slows down the process of curing the problem. Businesses inevitably will be reluctant to commit capital for products that are to be sold in a rationed market. It is one thing to bet one's ability to match wits with market forces and quite another to bet against the vagaries of government decisionmaking.

Rationing, which starts out as a holding action during a shortage, will ineluctably prolong the shortage.

Another approach for dealing with the shortage is the imposition of a stiff tax on gasoline and fuel oil. This would be vastly superior to rationing. It encourages every user to examine his own unique and peculiar combination of circumstances for ways to use scarce, high-priced products more sparingly. There is the usual skepticism about whether a higher price would have much effect, but the limited factual evidence available suggests that with something like a 20-cent-per-gallon tax on gasoline the shrinkage in use would bring demand into balance with limited supplies even with the absence of Mideast oil. And this would "treat everybody alike" in the meaningful sense that the intensity of pain for the last gallon given up in each case would be more nearly equal for all people than with rationing. It would use these scarce resources more efficiently.

This tax approach has two drawbacks. One is that an increase in price would hit lower income groups harder than those with high incomes. This is less certain than seemingly obvious. A lower income family (e.g., a retired couple) may find it easy to avoid the problem by curtailing use while a family with a larger income and less ability to cut usage will feel the bite. Moreover, there are far more effective ways directly to take care of society's quite legitimate concern about income distribution than to paralyze the pricing system. In this specific

case for example, we could have a rising deduction from income taxes going down the income scale with the credit payable in cash if it exceeded the income tax liability. The better approach, of course, would be to have a full-scale income maintenance program.

The more serious though less obvious drawback of the tax approach is that it does nothing to cure the fundamental need for enlarging our supply capability. It uses the pricing system to ferret out usages of secondary importance, but it does not use the pricing system to make a commitment of capital into energy production more profitable. Thus it would be a policy to allocate scarcity but not to eliminate it.

This leads to the third approach. Ever since the pricing system was invented, there has been a way to handle the shortage while fundamental forces are being set to work to correct it. What Americans most need now is enough clear-headedness at both ends of Pennsylvania Avenue so that higher prices for energy can start to get us more oil and gas. This will mean higher profits for the energy companies, but the U.S. Treasury will be a majority participant in the increased profits.

Here we do need to keep some specific facts in perspective. During the last decade the real retail price of gasoline excluding taxes (i.e., this price adjusted to allow for changes in the value of the dollar generally) declined 8% and during the last two years the real price of gasoline has declined almost 8%. A change in the ever more bargain basement character of these prices was about due in any case.

Of the three ways to regain balances between demand and more limited supplies, an outright higher price would be most effective, and rationing at the outset would be most attractive (and, in the end, most disappointing). We have, therefore, a good chance that within the next few months rationing of gasoline and fuel oil will be adopted. Is there anything that can be done to minimize its perverse effects? Not much. Rationing, particularly peacetime rationing, almost inherently works badly and encourages black-marketeering, corruption, and waste.

AVOIDING A BLACK MARKET

One modification of the rationing system would, however, be helpful if the political process insists on going down that road. That would be to allow gasoline coupons to be freely bought and sold. In this way gasoline would be utilized for the most urgently felt needs. There would more nearly be equal sacrifice "at the margin." There would be no black market. And demand for gasoline would still be held in the aggregate to supplies available if the right total amount of coupons had been issued.

After this system operated for awhile, we would begin to perceive that what we had was a free market for gasoline plus a slightly disguised income redistribution program. It might then occur to us that we should have a straightforward income distribution program plus the straightforward superiority of the price system in free and open markets to handle the economy's allocations function.

If we could be sure of that result, a bout with rationing would almost be tempting.

Senator HANSEN. One of the problems that I think is posed by the dilemma in which we find ourselves is, how do we encourage and how do we deal fairly with those energy producing companies that are now being asked to convert from oil or from natural gas to coal. One of the situations that has been contemplated is, if the Arabs choose to they could at a given point in time open up their wells again and withdraw the embargoes on the shipment of oil to this country, and despite the fact that we are deficient in refining capacity in this country maybe they could see that most of our energy needs were pretty well supplied. And yet, if we are going to do the best we can by burning less clean fuels, in your judgment is there some need to be able to give assurance to power companies who have been using oil and/or natural gas and now face conversion to coal that there will not be a disruption in the use of the coal that would come into being by virtue of this changeover?

Or do you anticipate any reluctance on the part of companies to make the conversion to coal and to supply the cleanup equipment in stacks and so forth, if there is a possibility that within a year or two there may be a renewed flood of foreign oil into this country?

Do you think that the quotas on foreign oil would then be established?

Mr. HICKMAN. I think that is more nearly in Mr. Johnson's area.

Mr. JOHNSON. Well, I think that there are many things that come to mind in answer to your question. First of all, the price of foreign oil is high now, much higher now in fact than the price of domestic oil. U.S. oil prices will be rising, but at the same time this is making the use of coal far more profitable, and it has made it possible, in fact, created incentives for the utilization of coal, even with the expensive stack and gas cleaning and other types of desulfurization techniques. So that those companies that do convert back to coal may find that it is an economically optimal source of energy anyway.

I do not think the price of foreign oil is going to fall. We are seeing high oil prices, both in the United States and foreign countries. We are going to be seeing these for many years. And we, I think, simply have to adjust to this fact and find cheaper, more economic sources of energy, such as the burning of coal.

The second point is that the thing that does concern me is that we will impose such restrictions on the mining of coal, particularly low-sulphur coal, that we will put out of business a large number of mines, particularly in the western part of the United States. I refer particularly to strip mining legislation and the Mansfield amendment that some people feel—to quote one person on my staff who has looked at this—could have the effect of causing a disruption in supplies.

Senator HANSEN. Mr. Johnson, let me say that I share your convictions about the price of foreign oil. I really do not anticipate that it will go down either. I ask the question because people have asked me about this, and I wanted to get your reactions on record. I think the Arabs have found out they are equally as sharp as any of the rest of us, and maybe a little sharper. And I guess they found out how, if they did not already know, how for a long time the laws of supply and demand work, that if you are in the tight supply situation we are in now you can get just as many dollars by selling half as much at twice the price. I do not expect that they are going to be under any compunction at all to raise their production over there to the point where it will adversely affect price.

Mr. JOHNSON. Let me add if I may a third point that I forget to mention, and that is, in the likely event that we are faced with a flood of imported oil and it is cheap oil, that is going to displace U.S. domestic oil, then the new oil import program will come into play, the license fee system that was established last April. It is the intention of the administration that the fees shall be adjusted if necessary to assure that there is a continuing and substantial incentive for domestic production in the United States.

Senator HANSEN. I must say that the points that Mr. Hickman made and the statements I have heard you make from time to time, Mr. Johnson, have great appeal to me. I believe that the only real solution to our many problems is to repeal the Economic Stabilization Act.

I think that the time is long past due when price controls are serving any purpose. And in order to underscore the concern I have in that regard, I would like to call attention to a letter written by John K. Evans in, I think it was in the Washington Post. He points that prices of Tunisia oil POB that country now are $12.64 a barrel. I am conscious of the fact that many of the drilling contractors in this country are unable right today to get materials that are absolutely critical to drilling oil wells. They cannot buy casing. The reason they cannot, of course, is that the steel companies because of the price control mechanism, find it unprofitable to produce oil well casing. And as a consequence they have gone into other products that yield a higher return.

I have had friends call me from Wyoming saying that they could get more if they had it for old casing that has been pulled from a well than the price of new casing. With this kind of a mess, I am completely weary of those who say, well, we will make other adjustments. We are so far behind, and we are getting farther behind every day, that the only way to make an adjustment is to say, this is a very bad system, and to stop it right now.

I would like to ask you if you think you can appropriately answer and if you choose not to I can understand—do you think that as you contemplate the problems that are underscored by the whole energy crisis in this country it is feasible or practical now to continue a system of wage and price controls?

Mr. HICKMAN. I think I would have to say that that lies beyond the scope of my authority to answer this morning, one way or another.

Senator HANSEN. If I were to observe that I suspect you might have some personal opinions you would permit me to do that, would you not?

Mr. HICKMAN. Yes.

Senator HANSEN. Thank you.

The CHAIRMAN. Could I just ask one question, please?

Do your people agree at this time with the attitude that has been expressed to me by the people in the Chase Manhattan Bank to the effect that we should decide in this country whether or not we are going to have an industry that can produce our requirements of energy, and that if we do, we should take whatever steps are necessary to assure that that industry can operate at a profit? This means that you might have to protect it at a higher price than the world market in times when there are not shortages. And that if you do not want to do that, then you ought to make plans to rely upon the world market for your oil and your energy, and have your plans for drastic cutbacks in the consumption of it far below what we are having right now. Because if that is the way you want to do business you could not expect to maintain any 80 percent capacity, but say, have a 50 percent cutback in fuel as other nations are having or even greater when the world market is no longer available to you.

Do you agree with that?

Mr. JOHNSON. Well, I think that there is no question that I personally and many people in the administration concerned with the energy policy concur fully that we ought to develop our own industry. We should begin immediately to do everything possible to develop

our own industry so that we can become less dependent on foreign oil and in this way less likely to have interruptions of foreign supplies of oil, cause difficulties both for our foreign policy and also for our domestic economy. We concur, yes.

The CHAIRMAN. Well, I am not sure that I understand whether you have answered the essential point that I was driving at.

For the future, would you recommend a program where we do or do not protect the domestic energy industry, and I am not just talking about oil? I am talking about oil, coal, shale oil.

If we can give it whatever protection it requires in order that it have the capability of producing our requirements in times of emergencies such as we have right now, do you think we ought to do that or not?

I am talking about providing adequate protection in order to have an industry adequate to meet our needs in an emergency.

Mr. JOHNSON. Yes. There may be some disagreements as to how best to do this, but certainly as a general objective, yes, we concur.

The CHAIRMAN. Because that is what I thought I had been fighting for down here for the last 20 years. And I thought we had a law that would do that. We just could not get anybody to administer it, notwithstanding all the pleadings, beggings, and cajoling of every President that has occupied the White House during that period of time. The people just did not want to pay the difference between the world market price and the domestic costs.

Now, is there any real way that our energy industry can effectively compete if the Arabs just decide they want to invade this market below our costs and this Nation puts no impediment in their way, when they have got a lifting cost of 13 cents a barrel and we have got a lifting cost of maybe $3 or more on the average?

Is there any way we can compete with that?

Mr. JOHNSON. Well, as I said before, the policy of the administration has been, with the change in the oil import program, to utilize license fees as a way of providing incentives for the development of U.S. resources.

Should we come to the event that the Arab countries begin to flood the United States with cheap low-priced oil, then it was certainly the intent of the administration last April when the program was announced, and it is the intent now, to raise those fees to such a point that the Middle Eastern oil does not result in disincentives or discouragement to the development of U.S. resources. The development of U.S. resources must take priority as a matter of, both of national security and economic well-being of our country.

Let me say that it is my understanding, particularly having come back from a recent trip to Saudi Arabia and other places in the Middle East, that the Arabs themselves do not want to, and most of the countries—all of them in fact, the major producers, Arab or non-Arab—do not want to have the United States and the rest of the world become so dependent on their oil resources that they are going to be depleted within 20 or 30 years. There is a great deal of concern in Saudi Arabia, for example, that the basis for the Saudi economy, oil, will be depleted at present levels of anticipated development in the West in 20 years, well before the Saudis have the ability to develop a diversified economic base.

Now, the attitude of the Saudis' leaders that we talked to was, we want you to develop your own resources in America. We do not want you to anticipate such a large withdrawal of our oil, which could leave us very literally high and dry in future generations. And that attitude is shared by the Kuwaitis. It is shared by the Venezuelans, the Canadians, who are imposing certain restrictions on exports.

So I do not anticipate on returning to the position that we were in in the 1950's and 1960's, where there are substantial temptations for excessive production on the world market that will have the effect of dragging prices down to the point where the U.S. oil cannot compete. I just do not think that is going to happen.

The CHAIRMAN. Well, what I am talking about is a fairly simple proposition. In order to maintain the capacity of the American industry to provide the needs of this Nation in emergencies, it would have been necessary to maintain a higher price on energy than this Nation has been paying. Now, the defense amendment was on the statute books to bring about that higher price and thereby to expand domestic supplies. But it was not politically expedient for this administration, or for that matter even the previous one, to accept that answer, with the result that the amendment was actually used as much to hold the price down as it was to hold the price up. And you cannot blame an act of Congress for failing to work, if the people who are supposed to administer it use it to achieve just the opposite effect or fail to administer it the way it was intended.

Now, I have had the privilege of taking some courses in economics. I majored in that in college. I did not have the opportunity to go ahead and take a Ph. D., but it is my impression that the average economist, or the overwhelming majority of them who have a Ph. D. degree in that subject, feel that free trade is the end, that it is the zenith and the ultimate of all good, and that anything that conflicts with free trade is bad by definition. In other words, they feel that if you had free trade there would be no wars, there would be no air pollution, there would be nothing bad, there would even be no cigarette smoking. Just anything that is wrong would not be here if you had complete free trade, and all problems would be solved.

Now, I have heard that point of view because very few of them depart from it. But it would seem to me that some of us who did not have the privilege of becoming a Ph. D. in economics find it necessary to understand that it does not work out exactly that way, that there come these times when the Arabs do not abide by the principle of free trade, or the Israelis refuse to abide by it, or the Europeans do not abide by it, or the Canadians do not abide by it. And if nobody else is going to abide by the principle of complete ultimate free trade, then I do not see how we can afford to.

Do you?

Mr. JOHNSON. Well Senator, at the risk of exposing my credentials, I am an economist and I do have a Ph. D. degree. But I agree with you. I feel that, generally, free trade is a desirable policy, but not for a commodity that is absolutely critical to the U.S. economy and to the U.S. national security and that is subject to political interruptions. In that case, I cease being a free trader and become a protector.

The CHAIRMAN. Well, let me confess I come from an oil-producing State. I have income from oil. I am as prejudiced as the lawyer who pleads the lawsuit.

All I ask you to do is just consider my argument, which I think any jury has a duty to do. And it is not a matter of who is right, or why he is right. The question is What is right? That is what we ought to be trying to do for the good of this country, the industry, to see that this Nation can meet its needs in emergencies. I do not think prior to this time that we could have brought this about. People just did not realize how important energy is to us.

Is that not fair enough to say at this point?

Mr. JOHNSON. I think that the American public is being educated, yes.

The CHAIRMAN. I think it is good for us. I can recall one of my good friends, as Chief of the Corps of Engineers, who confidentially told this friend that if a flood should occur in one part of the country, that might be a good thing. Let these people get good and wet down there. They did not understand the need of having dams. They would not cooperate with anybody; and maybe after those floods were over with, maybe they would have learned what a flood is all about.

So it could be that this thing might be a blessing in disguise, for if the Arabs had waited awhile longer, until we were 50 percent dependent upon foreign fuel, rather than only 25 percent dependent upon it, we would have really been in desperate straits.

I want to assure you that I am anxious to cooperate with you; and I also hope that your people are going to have some plans here to stimulate this economy in the event that this fuel crisis theatens a recession. Are you going to have something like that available to recommend to us, if it becomes imminent?

Mr. HICKMAN. That is a matter of grave concern, and one that the administration is worried about, yes, sir.

The CHAIRMAN. Well the Washington Post has a report on the social pages that I was at one of the social events a few nights ago. And the question was asked about the danger of recession. I asked Governor Burns of the Federal Reserve Board, hoping I would get some reassurance out of him. He just did not say anything. He did not say yes, he did not say no. It must have seemed like I was talking about an unpleasant subject, or maybe he just does not want to talk about business when he goes to a social event. He can take that attitude if he wants to, but it would seem to me that we would need to have the Chairman of the Federal Reserve Board and a majority of his Board as well as those who occupy the White House and those on this end, to be ready to act if need be—if each is to do his part.

If this energy crisis threatens a recession, as well as some chilly days for the people in this country, are your people ready to do their part?

Mr. HICKMAN. Well. I think that the subject is under constant study as to whether it will or it will not have that effect. That really falls in a department different from mine, but I am sure if the occasion and the need arise, they will be ready, yes.

The CHAIRMAN. Well I hope you will have some contingency plans because if those things start going from bad to worse, they tend to move rapidly. And I think you ought to have some answers to recommend to us in a hurry if you think that that is the case. We will demonstrate that we can act on this committee to meet emergencies. Sometimes we act long before the emergencies arise and get criticized for it, but we can act if we have to and we hope that your people will be

ready to recommend something on your end. I want to thank Senator Hansen for yielding to me. He is a great Senator and makes a tremendous contribution to this committee and to our Nation.

Senator HANSEN. You are very kind, Mr. Chairman.

Let me say that I am extremely grateful for your observations and I would just like to say before you leave here, I said earlier how pleased I was with the creation of this subcommittee. I am pleased because I think we are looking at the supply side of the picture and it is just a sad, sorry fact that most of the legislation we have talked about and what little we have passed this year with the exception of the Alaska pipeline and the stripper well amendment, did not have very much to do with supply.

The chairman of the subcommittee and others, I know, have been very much interested in this stripper well amendment. I think one of the members of the Cost of Living Council said that we cannot have that, it might blow up the whole pricing system for petroleum. I said well that is the best news for this country I have heard yet. I believe it.

Mr. Chairman, you speak about the security of this country and I cannot think of anything that has been more maligned than the mandatory oil import program—People can sure find all kinds of fault with it. But they are finding fault for different reasons today than a few years ago. A few years ago they were saying: "Shut down all the stripper wells, forget domestic oil production here because we can buy it abroad so much cheaper." We are unduly taxing the American citizen, he is paying an exorbitant price. I do not hear many people complaining today because the price of domestic oil is about half now on the gulf coast of what imported oil is.

I had nothing to do with the adoption of that program, but I would ask you, was it not your understanding that when it was agreed that we would permit the importation of 12½ percent of the amount of oil we consumed, that we would also allow the price to rise for the incentives to the domestic industry that would encourage the kind of activity which would assure that we had adequate supplies? Then did we not go right ahead through administration of the program and figure out all kinds of loopholes to permit about 30 percent of our needs to come into this country?

The CHAIRMAN. That is correct. And in order to get the Defense amendment and to persuade the Executive to administer it, we had to agree to the loopholes. To begin with, we had to agree to certain exceptions. We had to agree to the Canadian exemption and some people will say that the time will come when we cannot rely on the Canadian oil. Well I guess you are seeing that the time comes in a hurry. When they have a greater need for it than we do, you cannot rely upon it, it is just that simple.

We had to stand still for a lot of things that we did not like about it, but that was better than nothing because we hoped to preserve the domestic fuel industry. But, obviously if you had not had it, and I would hope that we can find some experts who can get us the actual figures, you would have had less capacity to produce oil and gas than you do now. Because even the way it was in Louisiana, you could not get anybody to pay you just for an ordinary lease.

Historically, if somebody wanted to lease your land—no special knowledge, just on the chance that they might have a chance to find some oil—they would pay about $5 an acre to lease. That is how it has been for several years in Louisiana. Some people do not pay anything for leasing. They are doing you a favor to drill it off. In fact, they would be delighted to go into partnership with you if they could drill on your land. And about half of them have had to go out of business because they simply could not make enough money to justify staying in business. Now those of us who of course are representing oil producing States felt that was unwise.

We plead our case without too much result, I regret to say. In due course, the pressures from other parts of the country caused the program to be abandoned. But I believe that the record will show—and a study by any independent group I think that is not connected with one side or the other would tend to demonstrate—that we would have a lot less producing capacity today to provide our requirements had we not had that amendment.

Senator HANSEN. Just one final question, Mr. Chairman. You have spoken many times on the importance of increasing supply, and I find myself in almost constant agreement with you. There are those today who would throw up their hands in horror when we talk about letting the supply and demand situation control the market until supply and demand come into balance. You have made an observation about supply and demand that I think is most appropriate this time.

Would you explain very simply in terms a farmer can understand how the law of supply and demand works?

The CHAIRMAN. Well, it has to do with the housewife that went into Mr. Schultz' store and asked, "How much are those tomatoes?" And Mr. Schultz said, "They are 30 cents a pound." She said, "Well, that is an outrage, Mr. Hickman sells tomatoes for 20 cents a pound." Schultz said, "Well why do you not buy your tomatoes from Hickman," and she said, "He does not have any." So Schultz said, "If I did not have any I would sell them for 10 cents a pound." [Laughter.]

Now that is about the kind of a situation that we are in now.

Senator HANSEN. Well is that not about what we can look forward to, just with rationing alone?

The CHAIRMAN. That is the case, right. But one point has been made about that. One reason that the other fellow had no tomatoes was probably because he had been selling them too cheap to begin with.

Senator GRAVEL. Thank you. I would like to ask Mr. Hickman if he would provide us with the following background statistical information?

An estimate of the revenue effects of the various provisions of the Internal Revenue Code effecting energy resources and production, including the following ones: Cost depletion, percentage depletion, intangible drilling costs, expenses of exploration, and new development costs, foreign tax credits; and along with that, your views on what accommodation of tax policies would immediately encourage new drilling exploration, within the United States.

In other words, would intangible drilling provisions have a more direct effect on drilling than, say, depletion allowances? *

*At presstime, the material requested had not been received by the committee.

Also, if you could provide an estimate—if the Treasury has it at this point—of what the shortfall might be projecting the recessional effect that seems to be in motion right now as a result of the energy cutback.

Mr. HICKMAN. The shortfall in the budget?

Senator GRAVEL. What the revenue shortfall to the Treasury will be. You must be playing with some figures within your organization as to what that would be. And if you have any figures from other agencies as to what the increases might be for the social costs—unemployment and other expenses.*

And finally, we have talked primarily this morning about the private sector. I think there is one other sector which Congress is dealing with in a very strong fashion. That is, of course, the cost of R. & D. and where the moneys will come from to do all of this. Presently, the Federal Government's high-water estimate is $1 billion, listening to the various figures which have been suggested. At a minimum, we should probably be at a $2 billion figure right now.

What are your thoughts as to where this money will come from? Is there talk of new tax rates? Or are we in the Congress to try and apportion these moneys within the existing budget?

That is a question for now. Where do you expect that we are going to get the money to finance the R. & D.? We are spending $1 billion. We are probably going to need at least another $1 billion. Where are we going to get that?

Mr. HICKMAN. To the extent that they are proper governmental programs, they will be worked into the budget and you cannot identify, or should not try to identify, the source of the dollar which is spent for any particular purpose.

Senator GRAVEL. Well could I offer for your suggestion, then, the creation of a trust fund that would fall within the Treasury's bailiwick. Do you administer the highway trust fund presently?

Mr. HICKMAN. Well we hold the money of a lot of things, but we do not administer them.

Senator GRAVEL. Well, would you have any objection to holding the money for an energy trust fund?

Mr. HICKMAN. I think, in general from a governmental financing and fiscal point of view, the segregation of revenues in a trust fund is not a very good way to finance programs.

On the whole, one is better off to deal with these things as general appropriations and to assess particular projects on their merits and make the decision, up or down, as to whether the money should be spent. It is not a categorical position, but I think it would have to be shown why the use of the trust fund had some particular merit in this particular situation.

Senator GRAVEL. Is that your view toward the highway trust fund which has been in existence for quite a few years?

Mr. HICKMAN. Well there has been a political scrap for quite some time about the highway trust fund, and I do not take any position on the merits of the highway program and so forth at this point. But in general, we are opposed to new trust funds.

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*At presstime, the material requested had not been received by the committee.

Senator GRAVEL. Well, is that not somewhat of a business as usual attitude? Maybe the problem we face today with energy is not a business as usual problem. It will require a little bit of imagination to address ourselves to that problem, if we are going to get the serious sums that we are talking about?

Mr. HICKMAN. Well you were talking about spending the money.

Senator GRAVEL. I am talking about a vehicle—well, let us look historically at what happened to the highway trust fund. This Nation was choking at the end of World War II. A highway fund was developed. People were taxed. The tax went right back to the people in the way of a product which did the job—maybe it overdid the job, maybe we have overbuilt our highways—but it is one of the most successful programs that we have seen in 30 years. So maybe what we need now, if we are really going to solve the energy problem, is to set up an energy trust fund so that we can get enough money into that area.

Mr. HICKMAN. You are suggesting that it is easier for Congress to make the decision to spend the money if the money is sitting there on the shelf in a trust fund, and that may be true.

Senator GRAVEL. Well, but now I would submit that the money has got to come from somewhere. So if the administration wants to seriously go after solving the energy problem, then they ought to come in with a recommendation for a tax increase that will bring in a billion or more dollars, or whatever the cost is, for the R. & D. over a decade to do the job. If they are not prepared to come in with a tax increase, then I am making a suggestion to have a tax increase. I think we ought to have a Btu tax and create a trust fund and have the money go right to it.

Now what would be your reaction to increasing taxes on a Btu basis, which would be fair and nondiscriminatory, and putting it into a fund so that people are assured that if they are going to suffer the pain of a tax increase it will at least go to alleviate the problems they are suffering most?

Mr. HICKMAN. When you get into taxes on Btu's, you raise a whole range of new problems. You get into whether or not you are concerned about a tax that simply takes away profit that should be left with the producer. One can make the judgment that the money can go into a fund and it can be administered from Washington or elsewhere more wisely than the producers can use it.

Senator GRAVEL. I am sorry, Mr. Hickman, you are missing my point. We have spent all morning talking about the private sector. Now I am talking about the public sector. Unless you can have private oil companies come in and spend money for research on fusion, fission, and solar research, then we are not talking about the same thing.

Mr. HICKMAN. No, I understand that. There are certain areas in which Government funding may be required.

Senator GRAVEL. We are spending $1 billion right now.

Mr. HICKMAN. All I am saying is that it is our general view—and the opposition is not categorical in any sense—but it is our general view that Government programs are best carried out by looking at them on a periodic basis and appropriating the amount of money we think is required to do what needs to be done and to deal with the

programs within the budget generally, rather than to set up a trust fund.

Senator GRAVEL. Well, I can only suggest that we will look forward to a tax package coming in from the administration to fund the cost on an R. & D. program. I would say, as a citizen, not as a Senator, that if all the grandiose plans we are talking about doing are not accompanied by a tax package, then it is rhetoric. It is sham rhetoric because the simple citizen in this country knows that if you are going to do something, it costs money to do it. Where is the money going to come from?

You are tax people—tell us, where is the money going to come from?

Mr. HICKMAN. The money comes, ultimately, from taxes of one sort or another.

Senator GRAVEL. So if we want to increase our R. & D., and I do not mean to badger you, sir, but if we want to increase our R. & D. by another billion dollars and if we are facing a shortfall because of an impending recession, where is that money going to come from?

Mr. HICKMAN. If one is to increase the total expenditures by a billion dollars, and you do not wish to increase the deficit, then the revenue must come from increased taxes of some sort.

Senator GRAVEL. And if we chose to go the deficit route, we would suffer the pains of possible inflation, would we not?

Mr. HICKMAN. Well all that depends on how much the deficit is at the particular time. I am not trying to avoid the question. I am just trying to say that in terms of a particular situation, the Treasury and the Office of Management and Budget must look at the total revenues that we collect and the total outgo and then make decisions about the desirability of any resulting deficit. Then out of those total revenues, and out of that deficit, if you will, we finance the expenditures which the Government wishes to make. If one uses a trust fund, you are not really changing that basic process except that you are making an advance determination that out of those revenues, x dollars must go into this particular pocket, but the money still comes from the public generally. I just say that in general we think it is better to finance or to budget within terms of a general budget rather than through a separate segregated trust fund.

Senator GRAVEL. Well, if we are talking about the general budget, are you aware of any funds that are being impounded that the Congress has appropriated for energy R. & D.?

Mr. HICKMAN. I am sorry, I am not aware. You have taken me beyond the scope of my expertise.

Senator GRAVEL. You are not aware of that? Could I ask the Treasury to give me an evaluation of the concrete proposal for creation of an energy trust fund and the equity of establishing a tax on Btu on all forms of energy, fossil fuels, hydronuclear, et cetera. I would also like an evaluation of the difficulties in collecting that tax at the source rather than at the end of the line, the consumer. The reason for collecting at the source is so that you do carry it through and penalize the deficiencies.*

*At presstime the material requested had not been received by the Committee.

I have no further questions. I just want to thank you, again. I think that the statement and data you provided us was excellent. Thank you very much.

I think we will break until 2 p.m. and then have Dr. Gonzalez and Dr. Erickson come back.

[Whereupon, at 12:15 p.m., the subcommittee recessed to reconvene at 2 p.m. the same day.]

AFTERNOON SESSION

Senator GRAVEL. The hearings will come back to order.

Doctor, I am sorry for the delay, and I also apologize for the lack of attention from either colleagues or the press. For some reason the most serious problem that has afflicted this country cannot seem to draw flies. But, we will have a record, and when some people begin and desire to focus on the problem, we will have this record and we will have proposals prepared, so that we will have done our work.

I cannot think of a more momentous task at hand. I certainly appreciate your coming forward with your expertise, and look forward to your presentation, following which we will go into questions.

STATEMENT OF DR. RICHARD J. GONZALEZ, CONSULTING ECONOMIST

Mr. GONZALEZ. Thank you, Mr. Chairman.

I am Richard J. Gonzalez, an economist with extensive experience in energy economics. After several years of teaching at two universities, I was associated for 28 years with one of the largest integrated oil companies as economic adviser, director, and treasurer. I have also served as a consultant to the Federal Government several times and as a member of the Energy Advisory Committee to the Secretary of the Interior. I was chairman of the Economics Advisory Committee to the Interstate Oil Compact Commission in the years 1946 to 1949 when the rapid increase in demands required maximum efforts to expand domestic supplies in order to avoid shortages. I am a member of the National Petroleum Council and was chairman of the Drafting Subcommittee on Petroleum Policies for the United States in 1966 and of the Committee on Factors Affecting U.S. Petroleum Exploration and Development.

Your invitation for me to participate in these hearings on ways in which fiscal policies can help alleviate energy problems is appreciated. My statement will respond to your questions first and then provide some additional comments related to national energy problems.

First, the comments regarding specific questions. One, should fiscal policy be used to help solve national energy problems?

Fiscal policies can serve a useful purpose in coping with current energy problems, provided that the main reliance for good solutions is on competitively determined market prices to balance demand and supply for the various alternative domestic fuels.

Unless market forces are allowed to work effectively, the Nation may waste billions of dollars on expensive alternatives such as liquefied natural gas imports and synthetic gas from naphtha, a highly de-

sirable clean fuel that can be used directly without conversion. Undue sums may also be spent on the manufacture of synthetic oil and gas from coal beyond the minimum that may become necessary after steps are taken to carry the direct use of coal by utilities and industry as far as economically feasible and practical in order to release oil and gas for other uses in which they have the greatest advantage. There are large deposits of low-sulfur coal that can be mined and delivered to major markets at attractive costs and prices, much lower than for synthetic fuels made from coal.

There are a few sensible ways in which fiscal policies can supplement operation of market forces to expand energy supply and gradually slow down growth in demand with net public benefits. The following comments discuss sections that seem appropriate and inappropriate to me.

A. Congress should reaffirm the well-established basic principle of percentage depletion and other existing tax differentials for energy, such as current expensing of intangible development costs, as an effective means of attracting more capital to accelerate discovery and development of more energy resources. This complex issue deserves further discussion which will be presented in the next section of this statement.

B. Congress could levy a small tax on use of electricity to pay for Federal research on power generation, including that on nuclear power.

C. Careful study should be given to gradual introduction of increasing taxes on weight and horsepower of automobiles geared to the rate at which plants can be converted economically to make smaller cars which can realize about twice as many miles per gallon of gasoline as those now generally in use.

A change of this nature over a period of 15 years or more would reduce resource requirements and prove the cheapest way to reduce undesirable emissions. Concerns about higher risks involved in using small cars would be overcome as cars are built to provide greater safety and all become small in size.

D. Gasoline tax changes should be small and gradual to avoid disrupting operation of the economy in view of the essential role of automotive transportation.

Higher prices should serve public needs by covering higher costs for additional supplies as well as by encouraging conservation in use. Raising gasoline taxes sharply while maintaining price controls on crude oil and refined products would be absurd, since supply will respond more to price changes than demand. Punitive additional taxes of 5 cents, 10 cents, and even 30 cents per gallon of gasoline mentioned in the press would drastically disrupt consumer spending patterns and add insult to injury in a time of shortages. High gasoline taxes imposed in Europe reflect lack of indigenous oil and concern about foreign exchange payments for fuels. Such high taxes are not appropriate for the entirely different circumstances of the United States.

Senator GRAVEL. Could I interrupt you here for a moment, Doctor?

From my knowledge—and it has been more than 10 years since I was in Europe—they had difficulty collecting taxes. People just did not have the same attitude toward taxation as ourselves. You were here

this morning when we looked at that table that the Treasury put forward, and you have a different explanation as to why the tax is high. You do not think that it is an effort to also raise revenue, because they cannot get it otherwise?

Mr. GONZALEZ. Yes, it is an effort to raise revenues. But we have to keep in mind that they introduced these high taxes a long time ago before they ever used much gasoline because they were conscious of the fact that they had to rely on imported fuels, that this would cost them foreign exchange, and this was the problem. So the reason originally for the introduction was to cope with the foreign exchange problems.

Once you set the tax, as has been suggested earlier today in these hearings, the tendency is to keep the tax in effect. And of course the fact that it raises revenue in a stiuation where you have difficulty collecting income tax, this naturally lends to the reason why it would be continued at a high rate.

Senator GRAVEL. Good. Thank you.

Mr. GONZALEZ. We can be relatively self-sufficient in fuels. In addition, our living styles differ from those of Europe. We are more dependent on private transportation, and the major inadequacies of public transportation cannot be corrected except over a period of many years

Proposals to divert funds collected by taxes levied for interstate highways to finance mass transit are unfair to taxpayers and undesirable in terms of economic efficiency. Funds collected on the theory of providing specific benefits for those who pay the taxes cannot in good faith be diverted to an entirely different purpose. If less money is now needed for interstate highways, the logical step would be to reduce the Federal taxes imposed for that purpose.

Local transportation problems vary enough among cities and among States to make it desirable for each to work out its own solution and find a method of financing approved by taxpayers living in the area that will benefit from the mass transit system. Some cities have used sales taxes and others might vote for local gasoline taxes, especially if Federal gasoline taxes are reduced. Such procedures would make taxpayers aware of the direct costs involved and stimulate interest in economic efficiency which would not exist in case of massive Federal subsidies. The Federal treasury cannot pay such subsidies, except by collecting taxes from each locality and then sending part of the money back, a procedure which encourages extravagance and waste on the mistaken theory that someone else is paying for the unnecessary costs.

E. Consideration should also be given to new taxes on transportation to finance Federal actions to improve railroad movements of passengers and freight because of greater efficiency in terms of energy use by comparison with planes and motor vehicles.

For major cities that are not more than 250 miles apart, high speed trains such as those used in Japan and Europe could be cheaper than and as quick as plane travel in terms of elapsed time from point to origin to final destination. Such service would also reduce the amount of energy used in moving to and from airport terminals.

The basic requirement for improvement of rail service would be a rebuilding of road beds and tracks in many cases. That major outlay

could be financed by the Federal Government initially by tax revenues collected for that purpose and later by appropriate fees for each train operated over its facilities. Then planes could concentrate on long trips and trucks on short haul movements on which they have natural advantages over railroads. The savings in energy from such changes would mount rapidly after the initial steps to make rail transit better and more attractive are completed.

F. A Federal research and analysis agency should be created within the department of Government charged with primary responsibility in energy matters and should be financed from general revenues as part of general administrative expenses.

This agency should be staffed by a small but highly qualified corps of energy specialists, including scientists, engineers, economists and lawyers, capable of working together to analyze all aspects of energy problems with an open mind, rather than with preconceptions strongly in favor of one form of energy, such as nuclear power or oil from shale. Knowledge about each form of energy will be necessary, but the entire staff should be dedicated to an analysis of all aspects of each solution, good and bad, and to an impartial appraisal of the various alternatives to the best of their ability. The bias that has existed in Federal energy research in favor of nuclear power should be avoided in the proposed agency.

The six preceding points deal with some fiscal actions that could help cope with energy problems. A discussion of this subject would not be complete without comments on the dangers of hasty and inappropriate actions. My views on three such points are set forth below.

G. Expensive crash programs for energy research and development should be examined critically to avoid mistakes, waste, and creation of vested interests in projects that will prove to be unattractive.

Proposals to solve energy problems by efforts similar to the Manhattan project to create a nuclear bomb or the space program to land a man on the Moon overlook some key points. The major differences are that there is no single simple goal in the case of energy, but various competing alternatives, that energy affects the welfare and life of every person, and that economics, environmental considerations, and the preference of voters are involved in addition to technical feasibility. There will be little benefit and much waste from developing another form of energy, such as oil from shale, and then finding that there is overwhelming public resistance to its use on environmental grounds.

The Nation is already faced with inflation stimulated by Government spending in excess of what can be collected by high taxes. Initiation of expensive major energy research projects on a crash basis seems particularly inappropriate at this time. Limitations on the number of qualified specialists and on the sequential nature of intelligent research mean that massive new outlays on energy research cannot be spent wisely and will prove harmful.

H. Proposals to impose selective excess profits taxes on suppliers of energy are economically unsound and would handicap efforts to overcome shortages.

The development of domestic energy resources has lagged because prices have not been allowed to keep pace with costs, and profits have

become subnormal relative to alternative investment opportunities. Without higher prices and profits to stimulate development and production of new energy reserves, the best solution to present problems through increased supplies will prove unattainable.

The appearance of sharply higher profits from rapid liquidation of old reserves accumulated years ago at a time when the purchasing power of the dollar was much greater than now reflects reduction of capital values and the effects of inflation rather than true economic income. In order for development and production of energy to increase, prices must be adequate in relation to current and prospective costs. In these circumstances, higher profits on older investments are necessary to help attract capital for new ventures, and to compensate for inadequate profits during the long period of years that consumers enjoyed unduly low prices for all forms of energy as the result of unsound Federal price controls and excessive reliance on imports.

I. Proposals for a Federal oil and gas corporation created to develop potential resources on Federal lands on the theory that it would serve as a yardstick for private operations would delay and reduce development of important new supplies, and should not be approved.

Oil and gas exploration and development is a hazardous, specialized business with none of the characteristics of a public utility that would make it appropriate for a Government enterprise. Costs under one set of geological conditions provide no basis for judging operations under different circumstances because each province and field has separate characteristics and costs.

If a Federal petroleum corporation were created, there would surely be pressures to set aside for it the most promising prospects, thereby creating a bias in its favor relative to any competition allowed in the same area.

Senator GRAVEL. Doctor, unfortunately, I have a vote right now regarding the Attorney General. I will be right back. It will not take me but 5 minutes.

[A brief recess was taken.]

Senator GRAVEL. OK, Doctor, you may continue.

Mr. GONZALEZ. If a Federal petroleum corporation were created, there would surely be pressures to set aside for it the most promising prospects, thereby creating a bias in its favor relative to any competition allowed in the same area. A Government company would have to draw personnel and equipment from the limited available resources, with the result that there would be a diversion of effort but no net increase in activity. In addition, a Government company could not be expected to proceed as rapidly or to find as much oil and gas as a number of companies working the same area simultaneously.

1. Are fiscal incentives needed to stimulate exploration and development of domestic sources of energy?

Yes, such incentives are needed because of the unusual risks and losses in exploration, drilling, and mining, and are effective measures.

2. If so, which would be most efficient?

The long established tax differentials for petroleum and mining have proved effective and have that background of advantage over untried new measures such as investment tax credits. I agree with the recommendation in the recent report of the National Commission

on Materials Policy that Congress should "continue the percentage depletion provisions of our tax laws as a time-tested major incentive to discovery and development of mineral resources" and that "the total cost of mineral exploration be allowed as a tax deductible item, as intangible oil and gas well drilling costs are today."

For reasons that will be set forth in the next section dealing with the tax differentials for petroleum, I believe that it would be a mistake to limit the deductions for intangible development costs to operators already engaged in the business.

3. What would be the effects on supply and demand of allowing the prices of all fuels to reach their natural levels through market forces?

If prices of oil and gas had been allowed to find their competitive equilibrium with coal in the past, there would be a greater supply now and probably little change in demand, since energy consumption is highly unresponsive to price changes in the short run. Now that shortages exist, problems arise in achieving price levels required to balance supply and demand for the long run without overshooting that level in the near term.

No one knows what the response of supply to price changes will be because of the impossibility of predicting the size and number of new discoveries or the rate at which additional recovery can be maintained from known fields.

I would like to comment here that if we had tried to guess 10 years or 15 years ago about discoveries, I doubt if anyone would have predicted the discovery of Prudhoe Bay, which is the largest field that has ever been found in North America. Yet, of course, it was found.

Senator GRAVEL. Doctor, I can add that in 1965 when people were telling me about leases up in Prudhoe Bay I just scoffed at them and said, well, even if they found it how could they ever get it out.

Mr. GONZALEZ. And you would have been quite right if it had been a small discovery. But naturally, the conditions changed and it is a large discovery.

Thus far, the increase in wholesale and retail prices for refined products has been substantially larger than for crude oil. The starting point for improvement of supply is in production, however, which can be expanded only to the extent prices enable operators to incur and finance higher costs. If oil and gas prices are allowed to find their natural levels, I believe that the increased productive capacity will provide a large part of the best solution for U.S. energy shortages.

4. What would be the income distributional, environmental, and consumer effects of a tax incentive approach versus a free market approach?

There is no easy answer to this complex question. My preference for the past method of supplementing the free market approach with the long established appropriate fiscal measures has already been set forth. Adverse income distributional effects due to higher prices could be corrected by personal income tax credits on the basis of specific amounts according to the size of family if desired. As for environmental impact, the same results should be realized by either course so long as environmental standards call for measures to reduce emissions to the extent necessary for acceptable quality of air and water.

Economists would tend to favor a free market approach in so far as practical in the belief that it would be the most efficient and least costly method for the long run.

5. Given the enormous capital needs to develop fossil fuels and their alternatives, is there need for both tax incentives and price deregulation?

Because capital needs for expansion of U.S. energy supplies will be very large in relation to past expenditures, there is a need for both higher prices and appropriate tax measures that have proved effective in the past.

Since the term "deregulation" is applied primarily to natural gas, it should be noted that the issue for old gas concerns a return to contract provisions set aside by Federal regulations. The terms of such contracts would generally limit prices to less than the equilibrium price with other fuels at this time. The restrictions imposed by Federal controls were based on unsatisfactory allocation of costs between oil and gas and treatment of gas production as a public utility contrary to its basic nature.

6. Is there need for an energy trust fund?

7. If so, how should it be financed?

8. Who should administer such fund?

The term "trust fund" is inaccurate when revenue collected for specific purposes are committed as quickly as they become available, as is the case of the so-called highway trust fund. A single fund to finance a vast variety of energy projects would be a mistake that should be avoided to escape endless bickering about allocation among competing alternatives. A better arrangement would be the levy of specific taxes logically appropriate for specific purposes, such as the tax mentioned on electricity to finance related research efforts. A Department of Energy and Natural Resources would be the logical administrator of such special funds that are separate from the appropriations controlled by Congress through the regular Federal budget.

I should like next to comment regarding changes in petroleum tax differentials.

As stated in the answer to the first question, the subject of differential tax treatment for oil and gas deserves additional discussion. I have testified on this subject a number of times before congressional committees, most recently at hearings of the Committee on Ways and Means on February 26, 1973. I will submit that testimony for the record of these hearings if the committee wishes to see an extensive analysis of this complex subject, but limit my remarks here to a few key points concerning the reduction of percentage depletion for oil and gas in the Tax Reform Act of 1969 and some of the questions and proposals of current interest about these differentials.*

First, current oil and gas shortages have been aggravated by the effects of the cut in percentage depletion from 27½ percent to 22 percent, and of the imposition of minimum tax rates in the Tax Reform Act of 1969. That legislation had an effect on profits equivalent to a 9-percent cut in oil and gas prices at a time when costs were increasing and the value of the dollar was declining. It was an important factor

*Mr. Gonzalez' testimony before the House Ways and Means Committee appears at p. 164.

contributing to the 20-percent decline in drilling from 1969 to 1971. The cut in percentage depletion seemed a breach of faith to investors because it was a change in the rules of the game after they had been encouraged to risk billions of dollars under the promise of the long-established gross depletion rate of 27½ percent. If the cut had been applied only to new wells drilled after the change, investors could have made decisions on the basis of the new rules without fear that they must now take into account an additional risk that rates may be cut retroactively again at anytime. That unnecessary risk adds to costs and discourages investments.

Second, since the reduction in percentage depletion was a mistake in terms of its impact on development of needed energy resources and in terms of the way in which it was made, Congress should consider action to correct that mistake. The gross depletion rate could be restored to 27½ percent or raised even higher to reflect current conditions, but a simpler solution would be to abandon all varying gross depletion rates and to provide that the basic common limitation of percentage depletion to 50 percent of net margins before cost depletion shall be the single uniform standard for all minerals. Such change would avoid confusion about the reason for varying gross depletion rates and clarify the point that all energy and mineral production should receive the same differentials treatment appropriate for the depletion of basic resources.

Third, questions raised about whether oil and gas shortages mean that tax differentials have not served their purpose show a lack of understanding of the process of investment. Investments are expanded and contracted as profit opportunities become more or less attractive relative to many others. Profits margins depend on prices, costs, and taxes. The factors contributing to the decline in U.S. oil and gas drilling include the following major items: Federal controls on oil and gas prices; pressures from consuming areas to rely much more heavily on imports rather than domestic production; the Tax Reform Act of 1969; continuing attacks on tax differentials for oil and gas; various impediments to production of newly discovered fields in the Santa Barbara Channel and Alaska; and delays in leasing of Federal acreage on the Continental Shelf, one of the most prospective areas for new discoveries. With all these handicaps, oil and gas shortages would now be much worse but for the favorable effect of tax differentials.

Fourth, the criticism that differential tax treatment for petroleum is wrong in principle based on the premise that it contributes to lower costs and prices that stimulate demands and hasten exhaustion of resources is incorrect. These differentials are key factors in the discovery of unknown resources that are of no value until they are discovered but are essential to industrialization and economic progress at this stage of technological development. Before oil and gas are exhausted, new energy resources will be developed, as has been the case before for wood and coal as the principal sources of energy in previous centuries. Furthermore, economic analyses, which I and others have presented, show that percentage depletion for the high risk and capital intensive nature of the petroleum producing industry serves largely to avoid undue price increase for oil and gas relative to manufactured products when income taxes are imposed.

Fifth, if tax differentials can be demonstrated to stimulate demands to an undesirable extent, any necessary correction in price could be achieved better by severance taxes than by changes which reduce discovery and development of new resources. The difficulty in distinguishing between capital, capital gains, and ordinary income from mineral operations might be avoided for all minerals by Federal severance taxes in lieu of income taxes imposed by existing provisions. In that case, severance tax rates could be set to provide revenues comparable to those now realized over the life of typical ventures in each mining industry. To avoid premature abandonment of valuable resources, severance taxes should not be applied to older, high cost operations.

Sixth, proposals to limit percentage depletion to amounts reinvested in new oil and gas ventures would be inequitable and would not accomplish their intended purpose of encouraging expansion of investment in exploration and drilling. Percentage depletion recognizes the loss of capital values caused by production, as clearly evident in the case of royalty owners, rewards developers of resources for past success in providing reserves needed to support production, and also serves as an incentive to take risks in exploration and drilling that otherwise would not appear as attractive as safer investments. Requiring percentage depletion to be reinvested would mean that the promised rewards might never be realized, because each time the reward is earned the only way to collect would be to risk the funds again. The result of such changes would be comparable with a game of chance in which winnings can never be withdrawn, but must always be risked again, even if the odds become unattractive. Investment can be encouraged only by making it appear attractive in terms of profits on each venture.

Seventh, limitation of deductions for such items as intangible development costs to investors already engaged in the business would be the wrong move in terms of solving energy problems because it would handicap entry of new money at a time when it appears necessary to attract vast new sums from sources outside the petroleum industry. This proposal appears to be based on the idea that outside funds considered to be tax dollars may not be spent wisely, and may be of benefit primarily to entrepreneurs who organize drilling funds, rather than to consumers in terms of added supplies of oil and gas.

There is a much simpler and better solution for that concern than the proposed limitation of deductions to firms already in the business. Deductions could be allowed for ventures only in which the organizers risk funds at least equally with those who provide capital from outside sources. Such provision would concentrate efforts on the drilling of those prospects that appear economically attractive in terms of potential new resources without adding a new handicap to the attraction of outside funds on the scale that is likely to be necessary if oil and gas supplies are to be expanded as necessary to help solve energy shortages.

Finally, it should be noted that existing tax provisions influence favorably the ability to finance operations and to serve public needs effectively. Many petroleum producing firms, including most of the smaller ones, borrow as much as possible to develop their new reserves, and are forced to slow down development of new capacity when changes in taxes reduce their cash flow. The efforts of many different companies, ranging in size from small to large, are required to dis-

cover and develop oil and gas on the scale needed to meet demands. Since operators of all sizes take the same risks in exploration and drilling, many times in joint ventures between small and large firms, they should all be encouraged to add new reserves and supplies by the same tax differentials that have become a well established factor in the economics of this industry.

Existing tax provisions have a psychological influence as well as an economic value. It can easily be observed that investors derive satisfaction from the prospect of deferring or reducing income taxes by the various measures in the tax laws adopted by Congress to serve the public interest. Because investors are willing to pay for that psychological satisfaction, public needs for discovery and development of mineral resources can be met more effectively by a combination of tax provisions and attractive prices than by higher prices alone.

In conclusion, I would like to comment on the role of fiscal policies in long-term solutions of energy problems.

The Nation's energy problems have developed over the past 20 years because recommendations as to sound long-term policies were ignored in favor of short-run expediency. The long leadtime in providing major new supplies of energy means that current problems cannot be solved quickly, but can be overcome in time with complete commitment now to the right long-term policies.

A Cabinet Committee on Energy Supplies and Resources Policy, appointed in 1954, concluded that an increase in oil imports faster than domestic demand and production would endanger the Nation by resulting in inadequate incentives for discovery and development of U.S. oil, gas, and coal. The import controls adopted were not allowed to serve their intended purpose because imports appeared cheap. Under pressure for exceptions and exemptions sought by consuming areas, imports doubled their share in the U.S. market between 1959 and 1972, with the results on development of domestic energy resources predicted in 1955 by the Cabinet committee.

Another prophetic warning about the dangers of increasing reliance on oil imports was stated in the following words in the 1958 report of a special Cabinet committee:

> The low cost of imported oil is attractive, but excessive reliance upon it in the short run may put the Nation in a long-term vulnerable position. Imported supplies could be cut off in an emergency and might well be diminished by events beyond our control. This vulnerability could easily result in a much higher cost, or even in the unavailability of oil to consumers. It is therefore believed, that the best interests of consumers, as well as of national security, will be served if a reasonable balance is maintained between domestic and foreign supplies.

A 1970 report by a Cabinet task force also concluded that restrictions on imports were needed in the national interest, but recommended that the system of controls be changed from quotas to tariffs. Unfortunately, this analysis failed to appraise national energy problems as accurately as earlier reports. It underestimated demand, overestimated domestic supply, and assumed incorrectly that prices of foreign oil would decrease. Its recommendation that tariffs be set at levels designed to drive the price of U.S. crude oil down, together with the effect of the Tax Reform Act of 1969 equivalent to a substantial cut in price, worked to discourage drilling at a time when the need for expansion of discovery, development, and capacity was quite apparent.

Quotas have been abandoned and license fees imposed on oil imports in a manner designed to encourage construction of refining capacity in the United States. New refineries cannot be financed and built, however, unless they can be sure of crude oil supplies. The basic need is to encourage expansion of U.S. capacity to produce all forms of energy to the extent necessary for relative self-sufficiency and independence in fuels. Whether the fees established are adequate to accomplish this purpose should be examined by Congress. Careful thought should be given to the best combination of measures—including tax differentials, quotas, and license fees or tariff duties on imports—needed to accelerate development of U.S. energy resources and capacity efficiently.

Fiscal policies followed in the period 1926 to 1969 proved valuable in encouraging development of energy resources, and would have been even more effective if oil imports had been limited as recommended in 1955 and 1958. For the future, fiscal policies and other measure setting limits on imports will be essential in order to serve well the interests of consumers and of national security by restoring and maintaining relative self-sufficiency in energy.

Thank you, Mr. Chairman.

Senator GRAVEL. Thank you, Doctor, for an excellent statement. The exploratory activity we have had in this country from 1956 on has been generally decreasing. In your statement you attribute that to the disincentives that were built into the economy up till 1969. You focus primarily on 1969 forward.

In looking at the chart in the staff blue book it has gone down since that point in time, but the decline had already begun earlier. So to what do you attribute the decline prior to 1969?

Mr. GONZALEZ. That is a very good question. The nature of the discovery and development of mineral resources, especially oil and gas, is highly erratic, and is subject to cycles of expansion of exploration and drilling, which lead to a surplus; and then, lower profit margins discourage activity.

In my judgment what happened was that the price increases in the early period, 1946 to 1948, and then through 1951 resulted in stimulating long-range efforts, which ended in expanding capacity more rapidly than demand. We ended up then with the surplus of capacity that tended to operate to keep prices down, and to discourage the drilling of new wells in States such as Texas and Louisiana where there is proration of production according to market demand.

The better wells were restricted very substantially, so that finding more oil did not appear to be a very profitable operation at that time. However, from a long-range standpoint, we were not developing reserves as fast as we should have. We were simply learning how to produce our reserves more rapidly, deplete them at a faster rate.

From the long-run standpoint, we should have been encouraging the continuing discovery and development of long-run needs. The oil import program, if it had been implemented as it was designed originally, would have done that because it would have kept prices from declining.

I should point out that following 1957 and 1958, crude oil prices actually went down, and this was a major contributing cause to the decline in drilling in the period 1957 to 1965.

We have also, in a sense, had price controls affecting oil as well as gas, because gas competes directly with heating oil, and with fuel oil, which are an important part of the sales of the petroleum industry. So controlling the price of gas indirectly served to control the price of heating oils and fuel oils.

Senator GRAVEL. I raised this point earlier. Even with the incentives we had designed there was still a flight of capital from domestic exploratory activity. That capital went elsewhere after the Second World War. The Government was active in the marketplace. You went through a successive series of activities. And of course, American enterprise was preeminent in the world at the time. So it went to Venezuela and developed Venezuela, left Venezuela, came to Alaska, developed Alaska, left Alaska, went to the North Sea, and developed the North Sea. Concurrent with these activities, it started during the Second World War to move slowly into the Middle East.

And then after the Second World War, American companies moved heavily and consistently into the Middle East. One cannot help but think that there must be some attractiveness in the world market, since American business was preeminent and could go where it could be done the cheapest. We did have the smaller independents that could not move out into the world with the same ease that the majors had. They were stuck at home. And the others went out and ploughed the easier fields, so to speak.

And so we had a dichotomy of policies within the Government: One to develop domestic self-sufficiency for security reasons; and the other—including both conservative and liberal factions—which favored keeping the price low to the people, and U.S. development of foreign sources. This of course is the reason why American oil companies essentially controlled world oil, or did until they started being expropriated.

Is that not a valid statement to append your analysis?

Mr. GONZALEZ. Yes. I think this is an explanation of why there has been a more rapid expansion of reserves and capacity abroad than in the United States. I should add——

Senator GRAVEL. It was a lot easier to sit down with a sheik and cut a deal before he got his Ph. D. Of course that situation has changed, but it was a lot to cut a deal than to go fight the railroad authority in Texas, which they probably thought was regulating the oil company as much as the railroad.

Mr. GONZALEZ. Well, you certainly have an aspect there of the explanation. I should point out two other things. One, the foreign demand for oil was growing very rapidly, much more rapidly than the demand in the United States, and this was a natural expansion by American companies in order to participate in the growth of the markets abroad; just like other American businesses have gone abroad in every field, because there is a rapidly growing market, and they have expertise that they can use to make profits abroad.

The other thing we have to remember is that there were many people who thought that we could always count on that foreign oil,

that it would always be cheap. And therefore, instead of spending a lot more money developing U.S. resources, we ought to expend some money developing foreign resources, and then simply increase our imports.

Now the major companies, the internationals in the 1950's thought this was the answer. But by the 1960's, they began to see the problems that they were going to run into with the internationals, as the sheik and his advisers became better informed about economics. And then in 1969, when the Cabinet task force asked for submissions from everybody on what should be done, the internationals very strongly recommended that the Government limit imports, because they realized the risks that were being created for the United States by that policy.

Now, unfortunately, the Cabinet committee did not heed those recommendations. They guessed wrong, and they thought that if they guessed wrong, they would have time to correct their mistakes. But they were guessing wrong then, and the time to correct the mistakes was 1970, not 1973.

So unfortunately, it is a combination of circumstances, that once you have committed your capital abroad, you cannot very well bring it back. Now, there has been a period of the last 15 years in which we have had no expansion of capital import for exploration in the United States; at a period when our demand for oil and gas was increasing very significantly.

So inevitably, this put great pressure on our own resources to a point where we are now depleting them very rapidly, both oil and gas; and made us more highly dependent on imports.

Now, I think we have to work our way back out of the situation over a period of time. Prices will inevitably play a part now because, as we said this morning, it does not appear that the prices of foreign oil are going to go down dramatically. Therefore, it appears that there is every reason to encourage greater development of our U.S. resources, which are now being held by price controls to lower prices than the world markets.

Now, that does not make sense, because we are, in essence, saying that we are willing to pay more for foreign oil than for our own domestic resources, which are more secure, and contribute to the development of our own economy. Now we have to refocus our thinking in terms of how do we bring about this expansion of capital.

Now, the primary way to do it, of course, is through price. But we have to bear in mind that price alone is probably a more expensive way to do it than through a combination of price and the fiscal policies that we have used in the past, because these we know will work. Now, there are some situations in which I think tax credits might be appropriate, and I am going to mention one that was discussed this morning: the question of encouraging additional secondary recovery.

I think this is a case where a tax credit for secondary recovery profits might be very effective as a device for encouraging production. Now, I think the method that was suggested, of some kind of graduated depletion according to recovery, is totally misconceived, and would be an administrative nightmare because you do not know what the recovery is from a field until you finish producing it. And it simply

would not make any sense for the Government to get involved in trying to figure out, not only where the reserves are, but what the oil in place is, which would become another element of constant argument between the operators and the Government

This would be a very complex thing. You have a much simpler way to do it. So frequently people who do not understand this business come up with exotic solutions that are quite impractical, and that tell us what their objective is. We can devise methods that will accomplish that end much more simply and effectively

Senator GRAVEL. I wonder if we could impose upon you to give us some specific recommendations for a tax proposal concerning secondary recovery and other measures to increase supplies—recommendations of a specific nature?

Mr. GONZALEZ. I would say an investment tax credit would be the way to encourage secondary recovery profits.

Senator GRAVEL. You do not think deductions for intangible expenses would do it more?

Mr. GONZALEZ. The intangibles already are there, but many times the major expenditure for a secondary recovery profit is not in drilling more wells, but in putting in facilities to inject water or some other fluid or steam in order increase recovery.

Senator GRAVEL. Does not the present investment tax credit have an impact in that area?

Mr. GONZALEZ. The existing tax credit applies to all investments. It applies, let us say, to an automobile plant that uses, that creates equipment to use energy.

Senator GRAVEL. So you do not direct the capital back into energy supply.

Mr. GONZALEZ. As well as it does on the supply side. Now, we are trying to work on the supply side, and in order to work on the supply side, we have to have a differential that encourages it more than the demand side.

Senator GRAVEL. You do not have sufficient confidence in the free market by itself, that it will bring money rapidly enough to focus on the problem area?

Mr. GONZALEZ. I do not think the free market in itself—well, let me put it this way.

You could achieve the same results with the free market as with a combination of price and tax differentials.

Senator GRAVEL. Correct me if I am wrong. With a free market, the price would go up to a higher level, and everybody would rush to satisfy that demand?

Mr. GONZALEZ. Yes.

Senator GRAVEL. So that if you provide an incentive in addition to that, would you not be giving a gratuitous gift?

Mr. GONZALEZ. No. What happens is the price does not have to go as high to get the same rate of return.

Senator GRAVEL. But then you are disguising the subsidy or appropriation—the subsidy is an appropriation. It is money we do not get in our treasury to them turn around and appreciate. So we are appropriating money to the industry, very directly, in order that the consumer need not have to pay a price.

Would it not be better bookkeeping in society, as we have now learned with our environmental problems, to just lay the cost where the costs belong, so that we all know what it is, rather than try and disguise it through various devices; without knowing what we are doing in our bookkeeping?

Life is tough enough without throwing other barriers into it.

Mr. GONZALEZ. Very well. Let me comment on that.

There is certainly that argument, and I mention it in my testimony. I would say that we also have to keep in mind what is the most effective way of serving a public need, because we are concerned about this as well as getting it done.

For example, we are worried about inflation, and certainly higher prices are inflation. And this is an indication, so we have to keep in mind——

Senator GRAVEL. But we have already lost control of that, given the pricing of foreign oil.

Mr. GONZALEZ. We have lost it only in a sense, because we still now have within our hands the question of what your equilibrium price is that will restore a balance between demand and supply.

Now, the point I want to make is, the tax differentials may be the cheapest way to get a job done that needs to be done for the public. Now, you see, this is why I suggested that if we decided that tax differentials did keep the price lower than we thought we wanted it to be, I would be inclined to suggest that we levy severance taxes on the production of the fuels in order not to discourage the discovery of them.

You see, what I am concerned about is that this system of percentage depletion and intangibles operates very effectively to get people to discover new resources given freedom of price to respond to market conditions. Now, if you do not allow prices to respond to market conditions, then you have killed the whole thing.

Senator GRAVEL. But will not the severance tax also affect the market by raising the price?

Mr. GONZALEZ. The severance tax will surely affect the market to the consumer, but it does not discourage the development, the discovery and development of resources. This is the point that I am concerned about.

You see, the point that I am concerned about is that we certainly do not want to discourage the discovery and rapid development of our resources of energy right now. This is the time when we would like to speed it up, if we could. This is why we talk about these measures that would encourage secondary recovery. These are existing wells. This could be done most quickly, you see.

Now, in addition to that, we have the proposition that investors are accustomed to a certain system of doing this, that they know has worked. I have taken the position with respect to percentage depletion that the great mistake was to have cut it retroactively on all the wells that had already been drilled; that if you do it ahead of time, then the investor knows what he is doing, and he demands the price. He will only put it in if he knows that he can expect the price that will give him the profit he wants without percentage depletion.

So in that sense, I will agree that the job could be done even without percentage depletion. It might be done even without the option

to expend some intangible development costs. But I submit my judgment from my experience in this industry, that that would be a very expensive way to do it; so much more expensive that we would be better served to keep those provisions, and if we thought there was a subsidy, to put in a severance tax.

Now, the severance tax could be used to correct any element of subsidy, so the consumer is not getting too low a price, but the severance tax would not discourage the discovery and development of a resource; and that is what I am concerned about, because my concern right now in this situation of shortages is that we do everything we can to stimulate the discovery and development of all forms of energy. And I say all forms of energy; I am talking about coal and nuclear power and everything else that we can think of, because I think we are going to need our domestic energy.

A country with 6 percent of the world population, and an energy consumption that is much higher than the rest of the world cannot afford to look toward its import for its long-run supplies. We have half of the world's resources. We have large potential oil and gas resources.

We have uranium. We have the potential to satisfy our energy needs. We are not a have-not Nation in energy, by any means. We have got the potential to do this job for the Nation.

Senator GRAVEL. Excuse me. I have to run and vote again. Mr. Best has some questions here that he was giving me, and I have got enough things I want to pursue myself.

So while I am gone, I will ask him to pose the questions that he has. And I will come back and hit my questions, and do not go away, Dr. Erickson, because we are going to give you as much as we have given Dr. Gonzalez.

Mr. BEST. I think one of the things that we would be interested in exploring is the impact of the percentage depletion versus the intangible drilling expenses as an incentive for direct exploration. In other words, what would be the impact of new exploratory wells if we were to increase the incentives for domestic drilling and reduce the depletion allowances, which has become a symbol of tax loopholes, and so forth; assuming a free market price on the development of our own indigenous resources?

Mr. GONZALEZ. I believe that the intangible development costs is an extremely important tax differential, because it is effective immediately; whereas percentage depletion is something that you realize only over the life of the production. And now we have the added uncertainty that the rate may be cut after you make your investment.

So I would agree that there is a great deal to be said for the type of incentive that can be paid at the time the investment is made; and then, you would no longer have this question.

I believe we have to bear in mind a rather fundamental thing about minerals and oil and gas, in particular. That is that when you find and develop them, they are a capital asset, and you have two ways of realizing on the value of this capital asset. One is you can sell it outright to somebody else, such as a refinery, who is going to need the supply. And if you do sell it outright, under our laws, this sale is treated as a long-term capital gain. It is not taxed in the same way as ordinary income.

Now, the other way that you can realize on the discovery and development of mineral resources is to keep the property and produce it. Now, investors are naturally going to look at those two alternatives, and weigh "which one of these is most advantageous to me?"

Now as long as we have capital gains differentials, if you eliminate percentage depletion, I think what you would find would be that you would encourage a lot of people to sell their properties outright to somebody else, and maybe buy somebody else's property outright; pay their capital gain, but establish a cost depletion basis which is realistic in terms of the market.

And so you might end up then with another change, that people do not ordinarily think about when they just talk about changing percentage depletion. In other words, there are always these alternatives, and you have to bear in mind all of the alternatives when you talk about making a change.

But certainly, I will agree that there has been a lot of emotional feeling generated by percentage depletion, and the charge that the oil producers do not pay their fair share of income taxes. As I have pointed out in my testimony, it is very difficult to distingush, for a producer, what is income, what is capital, and what is capital gains.

And I am going to give you a very specific example. We are now in the United States, producing a great deal of oil from old fields, large fields that were found in the 1930's, when the value of the dollar was entirely different from what it is today. Yet our accounting methods allow us to deduct only the 1930 investments against a price level that is entirely different in 1973.

Now, the appearances that we are making on the liquidation of those reserves are very high profit. The investment is low. The current price is high. The rate of return appears fabulous, but this is not true economic income; because if we want to stay in business in producing oil and gas, we have to replace those old, low-cost reserves with our current new oil and gas.

Now, if we followed a last-in/first-out method for handling our reserves, as we do for handling inventories, then we would have an entirely different reported profit. And some of the stories that we hear about corporations earning large incomes and not paying income tax would be put into perspective. Part of this is the fault of our accounting system. Our accounting system is simply not geared to cope with the mineral industries. The result of that, of course, is that the corporations appear to be making a lot more than they are. And they realize what is going on.

But the accounting system just forces them into a situation where the public thinks they are making very high rates of return.

Mr. BEST. The question was not really raised to focus on the attacks on "excess profits" that have been made. But it was made in response to a suggestion by one of the most successful independents in the oil business who testified yesterday, Mr. George Mitchell. He told us that percentage depletion was worth 18 percent to him, but that the intangible drilling expense provisions had a much more immediate impact on his ability to go out and search for new oil and gas.

And again, assuming a free market, if you eliminate his 18 percent depletion allowance, and doubled up on his intangibles, it would be a

much greater incentive for this large independent and for his 10,000 colleagues to go out and really do a job.

And I think it is recognized by all members here, that to increase the supply, we have got to increase drilling, offshore and on-shore, and let the market make the determination, but we must also provide the direct incentives to go out and do that drilling and not rely on the 30-year-old wells to supply our current needs.

So this was the premise that was behind that question.

Mr. GONZALEZ. Well, I would agree that the intangible option is more important to, especially, independent producers than percentage depletion, because it affects their cash flow immediately.

However, I would question seriously the concept that any producers would be allowed to double up on their intangible deductions, because I can hear a tremendous hue and outcry about people being allowed to deduct twice what they spend in the year they spend it. And I just do not think that Congress is about to approve that kind of a change in the tax law.

Mr. BEST. You might be right. Let me ask you one question about foreign tax provisions.

At this point when we are subject to an embargo by countries who are sitting on the largest reserves in the world, and the lifting costs in Saudi Arabia are something like 13¢ or 15¢ a barrel; is it really necessary to provide a foreign depletion allowance to encourage these companies to go to Saudi Arabia to find oil, which we cannot receive for our own economic benefit?

It is the same question Senator Ribicoff raised.

Mr. GONZALEZ. Yes, and you heard the answer from Mr. Hickman this morning, that because of the high income tax rates abroad, the situation is that the American companies end up with excess foreign tax credits, and a change in percentage depletion, say in Arabia, would not make a difference.

However, we have to bear in mind this, that in order to avoid this great dependence on Arab oil, we should be looking to development of oil in other countries. Now, here it could make a difference whether you allow percentage depletion and intangibles.

Now, my own judgment on this is that one of the problems is that we appear to be granting the same incentives for foreign investments as for domestic investments; whereas we feel that our domestic resources are the more important ones, and the ones we want to encourage right now. And I think that there are ways that we can accomplish what we are talking about, without just behaving like bulls in a china shop.

My own feeling has been that if foreign countries allow percentage depletion and allow the intanglible development cost deductions, then that is appropriate for us to allow, because that has been taken into account in what is taxable income; and taxable income there would be measured the same way as here. But if those countries do not allow those deductions, then their measure of taxable income is different from ours, and there is no reason why we should give it.

But, for example, Canada does have percentage depletion that is different from ours, but they do have it. So if Canada has it, I think we should recognize that in our foreign income tax credit.

So again, we have to be very careful about generalizations because we are not only operating in the Middle East, we are operating in a lot of other countries—Indonesia, South America, Africa—where oil is a lot more expensive than it is in the Middle East and the North Sea.

Senator GRAVEL. He will continue on with his questioning.

Mr. BEST. One point that has been made by you and others, is that we ought to let oil and gas prices seek their natural levels. How would you define their natural levels? In other words, who is actually determining what the price of oil is in the United States now? Is it a free market in the United States? Is it the OPEC nations who, in fact are, by government fiat, raising prices because they have a seller's market? That pretty much puts an umbrella over our own market. What is the natural level that you are talking about, so that if we did remove price controls, we would have a fair idea of where the prices would go?

Mr. GONZALEZ. I have given a lot of thought to this question. Let me say, first of all, that right now looking at the world market, you do not have a free world market so you are forced back to forget that level and you are forced to seek an equilibrium level for the United States. Now, when you talk about the long-term equilibrium price for energy, you have to consider nuclear power and coal as well as oil and gas because a great deal of our oil—of our energy is used by electric utilities which can use all of these forms and by industries that can use several of these forms. Now, when I look at this problem I see that we have vast amounts of low sulfur coal in the Rocky Mountain States, Montana and Wyoming, for example, that can be strip mined, environmentally, satisfactorily restored lands, at pretty reasonable costs for energy and I am going to use the expression of a million British thermal units, which is a common measure of energy, and point out that the National Petroleum Council has estimated that low-sulfur coal can be mined for 15 cents per million British thermal units. They have also said that it can be transported at a cost of 2½ cents per 100 miles per million British thermal units and to take the 1,200 miles from say Montana or Wyoming to Chicago, means a 30 cent cost delivery into Chicago. Now the sum of these two numbers is 45 cents per million Btu for low sulfur fuel. If I add another 5 cents on to that for the fact that costs are going up, we may want additional environmental improvements, I come up with 50 cents per million British thermal units.

Large quantities of energy that might be supplied as quickly as we can get them mined, the strip-mining equipment, and the facilities to haul it. Now the hauling can be done either in unit trains—that is, trains that run continuously from one point to another and then just turn around and go back and pick up another load and resume—or by slurry pipelines, which is a process in which coal is processed and moved through a pipeline along with liquids, water in some cases.

Now there is a slurry pipeline in operation from New Mexico over to Nevada and it is effective. But the reason I mentioned this is it gives me one reference point about competition that could keep down the costs of oil and gas. Now nuclear power is another form of energy that can keep down the cost of oil and gas. Furthermore, the cost of our oil and gas depends on whether we are willing to go after our best resources, or whether we did not have access to our best resources and insist in going for the lower grade and more expensive resources.

Now, by that, let me be specific, our most prospective areas are the Continental Shelf off the shores of the United States because this is where we are still finding major fields of oil and gas. These major fields are our lowest cost resources so it is important whether we allow industry to go out and develop those low-cost resources or not because if we do not then we have to go back in the old areas and find new smaller fields and the deeper fields and the more expensive oil and gas.

Well, now, look at this equilibrium price. My own judgment is that we are now looking at a range of energy costs that carries us back to where we were in real terms about 20 years ago, roughly to what it was in say 1953, or in the early 1950's. This is certainly true for oil. Now for coal and gas, I think we are in perhaps a little different ballpark, but I believe very firmly that a real increase in price of 50 percent to—that was 50 percent—to say 75 or 80 percent would result in the dramatic effort to expand all of our domestic energy resources. Now what does that mean in terms of cents per gallon, well let us go back to the fact that last year the average price of crude oil was $3.40 a barrel. We divide that by 42 gallons, which means that we were talking about roughly 8 cents a gallon. Now, what I am saying is that an increase in energy costs and prices in the range of 4 to 8 cents a gallon at the raw material, point of raw material production, would result in the dramatic change in the supply.

Now, in the case of natural gas, it is already evident that the higher prices of natural gas, have brought about a significant increase in the drilling gas wells.

Similarly, I think we would see this take place in the case of crude oil if we allow crude oil prices to go up.

Mr. BEST. Assume we allowed crude oil prices to go up to what may be $6 or $7 a barrel. In real terms, it may be $2.20 or something relating to 1953 prices you referred to—and the Middle East crisis was resolved and the spigot was turned on again, would American corporations—the major corporations—invest in our own indigenous resources or would we go back to a situation of increasing dependency on foreign oil which could later be turned off again. In other words, how are you going to get people to invest in $6 and $7 oil if there is no guarantee that import spigot would not be open wide again?

Mr. GONZALEZ. This, of course, is where Government policy becomes very crucial. My own judgment is that there are two factors working in this direction. First of all, the experiences that we have gone through in the last 3 years has made all investors very conscious of the advantages of investing in what I call the secure areas of the world.

Now the United States is the most secure because it is here. The rest of the secure areas you might say, North America, Western Europe, Japan, and Australia, that is it.

Mr. BEST. I think you would get some argument from the chairman that not even Canada is totally secure and it is pretty obvious that each nation takes care of its own needs before considering those of its neighbors.

Mr. GONZALEZ. Well, you might, but what I am saying is egress of security as against some other parts of the world. I think Canada is

still more secure than some other parts of the world, but there are two things working here. I believe that there is going to be great interest in investing in the United States if you can do so profitably just as has been the case in the North Sea. The North Sea is proceding, although it is a much higher-cost area than the Middle East.

Second, I think that if the Government is going to commit itself to relative self-sufficiency in energy, then it has to be prepared to reimpose restrictions on imports.

Mr. BEST. Would the majors support that policy? In other words, with these——

Mr. GONZALEZ. The majors did support that policy in 1969.

Mr. BEST. But what was the degree of self-sufficiency that they supported? I recall projections that we should—that we would become dependent on imports for 50 percent of our needs—did they support a 12.2 percent ratio that President Kennedy proclaimed?

Mr. GONZALEZ. The projections that were made was not what they wanted, but what was going to happen—now what they supported was the idea of staying with the concept that started the oil import control program—that the United States should limit imports to the degree required to encourage the development of its own domestic energy resources.

Mr. BEST. But we never did, really. There has been a decline since 1955 and I do not think that the majors—I am not against the majors, obviously—but I do not really think they supported maintaining import quotas at 12.2 percent in 1969 when that was Senator Long's proposal.

Mr. GONZALEZ. By 1969 you were already far beyond the 12.2 percent and certainly I would agree with you that in 1954 the majors did not want import controls. In 1959 they did not want import controls because they did think that they could survive on cheap foreign oil. But the experience of what they have been subjected to abroad where prices are now set unilaterally by a government where the taxes are imposed whenever they want to, where they are nationalized, these experiences have really been a traumatic change in their concept of what can happen to their investments. And I think you will find them just as enthusiastic about investing in the United States as the independents.

Mr. BEST. This assumes the Middle East crisis is solved and everything is back to normal. Let us look at some of our other trade policies in connection with this energy problem. We have heard that there is a shortage of pipe, of casing, of drilling equipment, et cetera. We have a steel import program which discourages import of pipe and casing and we also have exports of pipe. When you talk about coal, we export a significant amount of coal to Japan which is used for steelmaking. The steel is restricted on its way back here. So do you feel that anybody has addressed themselves to the overall nature of the problem? For example, if the powerplants do convert back to coal, are they assured of an ongoing source of supply for that coal? If they are not how are we to expect they would reconvert their boilers once again? Has anybody, anybody in the industry or in the administration, addressed themselves to the interrelated nature of the issues, not just oil import policy but the other issues—price, export policy, tax policy—that affect this problem?

Mr. GONZALEZ. I think you have called attention to a very important and difficult aspect of our energy problems. They have so many facets that there has been no mechanism in Government to try to cope with all the ramifications. This is one reason why I suggested a Federal energy research and analysis agency, because I think we must analyze all of these alternatives and each one of these is very complex. On the question of what we call tubular goods for drilling wells, this apparently is due, in considerable measure, to our price controls. And if we took off price controls, as Senator Hansen suggested this morning, I think we would solve that problem.

With respect to coal, I think we have to recognize that coal mines are now developed for specific markets to provide a specific kind of coal. The kind of coal we export to be used in making steel is not necessarily the same coal that we would want in order to generate electric power. So, there are these differences that have to be kept in mind. I think it is important to say that if a utility is going to build a plant to use coal, make a contract with the coal mine to supply it, they want to be sure that this is going to be effective for the life of this operation and they should be sure of that.

Mr. BEST. They have been burned twice. They switched from coal to residual, to gas, and now they have to go back from gas to coal.

Mr. GONZALEZ. And then they switched to heavy fuel oil, low sulfur, and now they have to go back to high sulfur, and they have had problems and they want some kind of assurance about their future and if we do simply switch them to coal now and then later on say that now you have got to give up coal and go back to oil, I can see how they would be in a very difficult position.

Mr. BEST. Well, let me ask you the question that is on everybody's mind since the testimony yesterday: Are you confident that we as a Nation do have long-term policies regarding achieving energy self-sufficiency, or are we operating on an ad hoc day-to-day kind of a crisis?

Mr. GONZALEZ. I do not think we have satisfactory long-term policies. In my judgment, to do this right, you have got to work on the demand side of the equation as well as on the supply side of the equation. I have, for years, been saying that we should have been doing something about encouraging people to switch to smaller cars because this can make a profound effect over a period of time.

Now we have waited until we have really had a crisis before we do things. This program that has been presented, that you refer to in which the United States would be 50 percent dependent on imported oil, in my judgment, was always an absurd forecast, an intolerable situation and should only have been presented as an indication of what you must not allow to happen in the long run.

But that should have been accompanied by a very positive statement of what had to be done to keep that from happening in the long run.

Mr. BEST. But that is the element that I have not discovered. In other words, I have seen the horrifying projections and maybe I have been living in the closest, but I have not seen the policies coming out either from the industry or from the Government, which would say we can achieve self-sufficiency in 10 years, and here is the way we do it.

Mr. GONZALEZ. You are quite right, and I agree with you that you have not had either from industry or from Government a statement of how we are going to get from where we are to where we would like to be in terms of energy self-sufficiency.

Mr. BEST. Thank you, I think we might turn to Professor Erickson.

But first let me just ask one question on timing. If we did go to a free market situation, and we did some of the things that you suggested—assuming the optimun that we did everything right—which is an optimistic assumption—how long would it take to get over the current shortage problem?

Mr. GONZALEZ. Well, you have to add to that the question of how much will the Arabs be willing to go back up in terms of production. Let me say that I do not think Arabia will ever produce as much as it was being counted on to produce which was 20 million barrels a day.

Mr. BEST. But part of our policy now is to say we do not want to depend upon them to supply 50 percent, so we want to ratchet them down to something, maybe 5 or 10 percent.

Mr. GONZALEZ. But you are asking how quickly we can get over our problem and I am taking it in two stages. One, if the Arab countries would go back up to where they were, rather than 5 million less than what they were producing, as they are at present, why then of course the world energy picture would become a good deal less critical. This is important because it would take some of these pressures off to overshoot the equilibrium marks in a period of serious scarcity.

Now, with respect to getting back into a good balance where we can say to them we do not care whether you cut it off or do not cut it off as far as the United States is concerned, in my judgment this would take us 7 to 10 years, more likely 10, if we started now. The trouble is we do not have the policies to start now and it is going to take us a year or so to hammer out some kind of agreement on policies.

Now whenever we get started finally on a program, then I think it takes us 7 years to really make a major dent on the demand and the supply.

Mr. BEST. You are on the National Petroleum Council which is an official advisory body to the executive or the Interior Department?

Mr. GONZALEZ. To the Interior Department, yes.

Mr. BEST. To what extent do the decisionmaking authorities—Governor Love and those others who make the decisions regarding energy—have the input from experts like yourself before they make the decisions? In other words, are you in constant contact with the executive branch? Are they relying on you for advice?

Mr. GONZALEZ. No, unfortunately in a crisis situation, you always tend to pick up the telephone and call someone you know for advice. They have been in constant communication with the major companies, I know that, and I suspect they have been in frequent communication with the Independent Petroleum Association of America. The National Petroleum Council is prepared to tackle whatever assignments the Government gives it because it operates only on a basis of responding to Government requests. Now, to the extent that the council has put out a great deal of information, that is available to all.

Mr. BEST. I have seen the 300- to 400-page books, but I mean as far as shaping policy, the national energy policy that everybody is looking for?

Mr. GONZALEZ. Well, as far as shaping policy, I am afraid that very few people have given much thought to it.

Mr. BEST. Thank you.

[Mr. Gonzalez' testimony before the House Ways and Means Committee follows. Hearing continues on page 190.]

TESTIMONY OF RICHARD J. GONZALEZ

HEARINGS ON TAX REFORM, PANEL ON NATURAL RESOURCES, FEBRUARY 26, 1973, HOUSE COMMITTEE ON WAYS AND MEANS

I am Richard J. Gonzalez, a consulting economist with many years of experience in the petroleum industry during which my special interest has been in the basic role of raw materials in providing the foundation for economic and social progress. I appreciate the invitation of your Committee to participate in this panel discussion on the taxation of natural resources.

In the hearings on tax reform held by this Committee in 1959, I presented an extensive analysis of the economic case for percentage depletion for petroleum production. That analysis is still valid and I submit it again as an appendix to this testimony. In that statement I said that the paramount economic test of a system of taxation is that it should interfere as little as possible with the industrial progress that enables the entire population to enjoy the benefits of rising standards of living. Since capital and minerals are the basic requisites for economic progress, Congress must be particularly concerned about the appropriate taxation for these key factors in order to assure the increasing supplies of capital and minerals required to continue further progress toward full employment, reduction of poverty, better living standards, and a cleaner environment.

Savings and investments must be encouraged because additional capital is needed to provide more and better jobs. The fair tax treatment of capital matters to most families, not merely to rich investors, as they strive to improve their income and security now and for retirement by various forms of savings including life insurance, participation in pension trust funds, and the direct and indirect purchase of stocks and bonds of corporations. Labor income taxed in the same year as earned requires no adjustment for changing dollar values, but the true earnings on capital can be determined only by proper adjustments for the changing purchasing power of the dollar during and after periods of marked inflation.

Mineral fuels are as important as capital for better living standards. They are the source of power that makes us more productive and that makes life more comfortable and enjoyable. Each gallon of oil or its equivalent in other forms of energy provides the power for the activities that generate more than $2 of gross national product and thereby make a corresponding contribution to tax revenues.

Mineral operations differ from most other investments in several major respects. First, unusual risks in exploration and development are reflected by the large number and high cost of unsuccessful ventures. Second, they involve unusually long lead-time before initial operation and exceptionally long life for the very successful ventures that are the principal attraction and reward for engaging in this risky business. Third, revenues are realized by the depletion of nonrenewable resources rather than by the sale of products made by utilization of renewable capital assets. Forth, mineral producing operations are highly capital intensive. These differences are the economic basis for appropriate tax differentials essential to fair treatment of investors in this business. Different tax rates are, of course, accepted in the tax laws as appropriate for different circumstances—as evident from lower income tax rates for small business.

BASIS FOR PRESSURES FOR TAX REFORM

Pressures for tax reform develop from appearances that in some cases income taxes paid currently are small in relation to what is reported as income. Two key questions are important in judging such appearances: (1) Is the so-called "income" a correct measure of amounts that should be subject to ordinary income tax rates? and (2) If there is special treatment for some income, does that treatment provide public benefits that exceed their cost in terms of tax revenue?

ACCOUNTING DEFICIENCIES IN MEASUREMENT OF INCOME

To the extent that accounting practices provide incorrect impressions of real economic income, they can be highly misleading as to the proper base to which ordinary income tax rates should apply. Two examples illustrate this point.

In recent years some companies have adopted the practice of recording the cost of dry holes as a capital investment in financial reports. Logically and according to the tax laws, the costs of dry holes are losses deductible currently. A firm that realizes $100,000 of taxable income from its operations and spends that amount on a dry hole has no income and no tax liability even if it chooses to capitalize the dry hole and report that it had $100,000 of income. Write-off of the dry hole in financial reports in subsequent years will produce further discrepancies between income for accounting and tax purposes over a period of time.

Another and much more important cause of misleading appearances as to the relation of income taxes to so-called income is the fact that the sale of minerals involves depletion of reserves acquired many years earlier when the value of the dollar was much more than it is now. For example, the discovery value of crude oil in Texas in the 1930's was about 30¢ per barrel. Applying the change in value of the dollar to this discovery value gives a correct current equivalent of this figure of about 90¢ per barrel. Percentage depletion is the statutory substitute for the deduction of discovery value which was permitted from the time of the original income tax laws. Accordingly, current percentage depletion on production of oil discovered in the 1930's should now be about 90¢ per barrel—or 26% of the current average price of crude at the wellhead ($3.40 per barrel). The 60¢ appreciation is neither ordinary income nor capital gain; it is merely inflation. The economic validity of this computation is confirmed by the current discovery value of new crude oil, which is about $1.00 per barrel—or about 29% of its wellhead value. The relation of percentage depletion to market price in effect before 1969 served, therefore, to compensate for inflation in ascertaining the correct economic income from petroleum production properly subject to taxation as ordinary income.

The adjustment for changes in the value of the dollar should be taken into account for all investments in determining ordinary income. Such adjustment is essential for the mineral industries, however, for the following reasons: (1) Peculiar risks and large losses in exploration for minerals mean that wide variations between capital costs and value of major assets are customary in this activity rather than the exception as in many safer fields of investment; (2) Revenues from the large mineral deposits are generally realized slowly from operations over many years after the initial outlays, so that changes in the value of the dollar become more significant in calculating true rates of return; and (3) Mineral producing operations are highly capital intensive as well as risky, and therefore different from industries with much lower capital investment per dollar of sales or much lower risks of losses in making initial investments.

Taxes imposed on so-called "income" due to changes in the purchasing power of the dollar would be capital levies rather than income taxes. Capital would be economically harmful because they would encourage consumption at the expense of desirable savings and investments and would also be inconsistent with the basic concept of income taxation.

Our tax laws have also differentiated between ordinary income and capital gains realized by some investors over a period of time by appreciation. Differentiation of this nature is appropriate and necessary for equitable treatment of long-term capital gains. Taxation of such gains created by wise investment over a period of years as ordinary income in the year realized would be inequitable and economically harmful. It would be a destructive influence on the accumulation and expansion of capital for economic progress.

For royalty owners and many mineral operators who engage in only one or a few successful ventures, the element of capital gains over a period of years is very important. These investors will inevitably seek to realize as much as possible from their successes either by operation or by outright sale of all their reserves. Unless percentage depletion provides returns comparable with capital gain sales, which has been the case under past treatment, the original owners will be encouraged to sell to others whose cost depletion will generally be much higher than percentage depletion without any real gains to the Treasury in terms

of tax revenues. Small operators contribute to the diversity of exploratory efforts that increases discovery and production. Therefore, their efforts to make new discoveries deserve to be encouraged along with those of the larger companies that account for the major portion of expenditures for exploration and drilling.

ANALYSES OF COSTS AND BENEFITS OF TAX DIFFERENTIALS

If some differentials actually reduce the effective rates imposed on ordinary income, the decision as to whether they help or hurt taxpayers generally depends on the relation of costs to benefits in each case over a period of time.

The investment tax credit illustrates the point. It allows taxpayers to reduce their payments on ordinary income by a certain percent of the amount of new investments for specified capital facilities. In the judgment of Congress, the public benefits from stimulating economic activity by this method exceed the cost in terms of reduced tax revenues.

The point that must be kept in mind about all tax differentials is that they have been adopted for various reasons that considered all aspects of public benefits rather than the simple issue of tax revenues or apparent equity in terms of relative tax burdens. If and when changes are investigated, all aspects of public benefits must be considered for the long-run along with the matter of costs in terms of tax revenues.

Tax reform will not serve the public interest if the results in terms of short-term gains in tax revenues are bought at the expense of long-run costs in terms of employment, national income, social welfare, economic security for consumers, and the ability of the United States to exert its influence in international affairs in support of peace and freedom. The only reforms worth serious consideration will be those that will strengthen this nation by providing long-run public benefits basically sound in terms of economic realities and with a substantial excess of benefits over costs.

BASIC ECONOMIC CASE FOR PERCENTAGE DEPLETION

The economic case for depletion remains strong and deserves special attention now when the nation faces shortages of oil and gas. The supply problems encountered thus far provide ample warning of the serious difficulties ahead in case of larger shortages.

The risks of wildcat petroleum exploration and drilling remain high as indicated by the fact that about 90% of exploratory wells and 25% of development wells are dry holes. Dry hole costs are nearly $900 million a year which is equivalent to 60% the total cost of productive wells. Consequently, productive wells must return much more than their direct costs in order to cover the total outlays on exploration and drilling.

A large part of the new efforts to develop oil and gas reserves are on the Continental Shelf and in Alaska where the capital requirements are extremely high. The 884 offshore wells drilled in 1971 cost $522,617,000 for an average of $591,200 per well, compared with less than $77,000 per onshore well.

Production of oil and gas still represents the liquidation of nonrenewable resources over a period of many years. Revenues from production for both operators and royalty owners are principally long-term gains in character even though that important economic fact is not made clear in financial reports. The erroneous appearance of ordinary income not taxed at ordinary rates is the fault of unsatisfactory accounting assumptions inconsistent with economic realities.

Oil and gas are more important to the satisfactory operation of the economy than ever before because they now supply a much larger share of the Nation's total needs for energy (over 75% currently compared with 50% in 1948). They are also environmentally preferable to other fuels.

The attractiveness of petroleum producing investments in the United States relative to other opportunities decreased substantially in the 1960's even before passage of the Tax Reform Act of 1969. This change is evident from the relatively constant outlays of around $5 billion a year for domestic oil and gas exploration and drilling during a period in which total private domestic investment in industrial durable equipment doubled under the stimulus of investment tax credits and accelerated depreciation.

The Tax Reform Act of 1969 raised taxes on U.S. oil and gas production by more than 4% of gross revenue and had an effect on profits equivalent to a cut

of 9% in prices. This adverse action against petroleum operators was an important factor contributing to the 20% decline in drilling from 1969 to 1971. The slowdown in completions due to the 1969 tax changes for petroleum will be felt progressively with each year as a contributing factor to oil and gas shortages.

Shortages of domestic oil and gas mean that the Nation faces the prospect of sharply rising imports, adding still further to the strong upward pressures on foreign oil prices and to the adverse balance of trade. The cost of oil and gas imports by the United States under continuation of present policies is likely to increase by 1985 to an annual amount at least $20 billion greater than in 1970. Such a change would impair further the value of the dollar and almost surely force upon consumers much higher fosts for all imported goods than would be necessary if national policies were modified constructively to encourage greater development of domestic oil and gas.

Coordination of all Federal policies in the right direction will be required to achieve reasonably satisfactory solutions for energy supply problems. Tax policy is an important part of the total program of action which will determine how well the Nation copes with serious energy supply problems. The stimulus of higher prices will not be fully effective if at the same time additional adverse tax changes are made offsetting increases in profit margins.

This brief analysis indicates that both the basic case for percentage depletion and the broader public interest in greater supplies of oil and gas to promote economic progress and environmental improvements will weigh heavily in a careful evaluation of all aspects of the effects of imposing additional income taxes on the production of oil and gas.

ANSWERS TO MAJOR ISSUES ABOUT PERCENTAGE DEPLETION

The preceding analysis provides the basis for reply to several issues often raised about the taxation of mineral production.

1. Do mineral producers pay their proper share of income taxes? The answer is that most of the receipts from depletion of reserves by production are not ordinary income and should not be taxed at ordinary rates because they are due to changes in the value of the dollar and consequently represent neither income nor capital gains.

2. Should depletion be allowed only in case the assumed "tax savings" are spent on further search for the same minerals? Percentage depletion provides recognition for liquidation of capital assets and for risks already faced successfully in keeping with past promises made to encourage investors to venture capital in the search for new mineral deposits. To require successive exposure to the same risks in order to collect on past promises would be comparable to a gambling game in which winnings can never be withdrawn but must be risked repeatedly regardless of changing odds. Making the rewards offered in the past subject to new conditions now will surely raise questions about what additional conditions will be imposed in the future to allow the successful investor to collect on the latest promises.

It would be poor economics to insist that gains made in a business must always be risked in the same business again. Such discriminatory provision for petroleum or minerals could easily lead to some wasteful uses of capital that would harm rather than benefit tax revenues and taxpayers generally.

To meet future petroleum demands, large sums of money will have to be drawn from outside sources in addition to those generated by petroleum producers. The new investors, such as gas pipelines and gas distributors, will not have significant credits for percentage depletion. They would be placed at a disadvantage relative to established producers by the proposed requirement and would feel that the ventures would have to be unusually profitable to warrant their entry. In addition, new investors would be concerned about the implications of the change in rules now on the prospects for their ability to realize benefits from percentage depletion in the future if continued reinvestment in the business no longer seems desirable.

In summary, a change allowing percentage depletion only to the extent that money is spent on new ventures would represent a change in the rules which could actually work to discourage rather than to encourage attraction of new capital on the large scale required to meet our national needs.

3. Does percentage depletion run counter to conservation principles by encouraging excessive use of oil and gas through low prices? A resource must first be found and developed before there can be any meaningful conservation. Percentage

depletion encourages discovery and development of resources essential for economic welfare but need not distort relative prices. As I pointed out in my testimony in 1959, a uniform tax on so-called "income" for oil and gas production would raise prices of these fuels unduly relative to other commodities because of the high risks and capital intensive nature of petroleum producing operations. Once the supplies are available, other policies will determine whether the resources are used wisely or wastefully.

4. Does percentage depletion on foreign production divert efforts abroad? Since percentage depletion provides recognition for liquidation of reserves by production, it is an appropriate differential for production everywhere. Percentage depletion is only one of several factors affecting prospective rates of return and investment decisions. The high bids made for offshore leases offered by the United States indicate that funds will flow into attractive prospects when available either in the U.S. or abroad. When there seemed to be a surplus of oil and gas here and a rapidly growing market abroad, it was natural that relatively more attention should be paid to foreign operations. Even then, however, much more money was spent on exploration and drilling in the U.S. than abroad by American companies. Therefore, I do not believe that there is any evidence that percentage depletion on foreign production is undesirable or has interfered with development of U.S. resources.

EXPENSING OF INTANGIBLE DEVELOPMENT COSTS

The second major differential tax provision requiring review is the option to expense intangible development costs currently. The alternative would be to capitalize these costs for tax purposes, as some companies do for financial reporting, and to recover these costs through depreciation along with tangible development costs that are capitalized in both cases.

The origin of this provision can be traced back to what used to be the common accounting practice of treating intangible development costs as a current expense in financial reports. With the introduction of state conservation regulations which helped provide assurance that wells could be counted upon to produce for many years rather than only for a short period of time, many companies gradually changed their financial accounting to capitalization of intangible development costs and to depreciation of these costs in relation to production. Some operators still treat intangible development costs as a current expense in both their financing accounting records and in income tax reports.

The impact of the difference in accounting treatment can be illustrated for an operator with $100,000 of taxable income and $40,000 of capital who spends $140,000 on a producing well, including $100,000 for intangible development costs and $40,000 for tangible equipment. If the intangible costs are deducted currently for tax purposes, there will be no net taxable income in the first year even though the financial reports capitalize these costs and show a net income of $100,000. In future years the capitalized costs would be charged as an expense against production but there would be no deduction for tax purposes.

If intangible development costs in this case were capitalized and taken as depreciation for tax purposes, then the initial income tax liability would reduce funds available for investment and require other financing in order for the well to be drilled. In both cases the deductions over the productive life of the well would be the same but the timing of tax payments to the Treasury would differ. To the extent of the cost of money to the Treasury, the provision for current expensing of intangible development costs does have a net effect on the present value of tax receipts even though that effect is much less than indicated by looking at the first year alone.

One point should be noted as a factor offsetting the impact of the intangible development cost option on tax receipts. Capitalized exploration expenses that precede drilling, including leasehold costs, are not allowed as deductions until a lease is surrendered even though experience with the erratic nature of such losses leads many firms to amortize these costs in financial reports they can be deducted for tax purposes. If these costs were also treated for tax purposes in the same manner as for financial reports, as proposed for intangible development costs, the gains in tax revenues would be much smaller than estimated.

The intangible development cost option is important to all operators, especially small operators. Since small operators generally use debt to maximum extent, their activities would be drastically curtailed without this option by the inability to raise more capital to offset the change in timing of tax payments. Small operators provide diversity in exploration that finds substantial quantities

of oil and gas and also increase competition in the petroleum industry. These public benefits should not be ignored or underrated.

The costs of the option to expense intangible development outlays in terms of the timing of tax receipts must be viewed in relation to the public benefits resulting from this provision. This differential is important in bringing capital into necessary development of oil and gas resources at less cost than would otherwise be possible. The public realizes substantial benefits in terms of economic progress. Adverse changes would have serious impact on drilling, on new supplies, and on the extent of shortages that are undesirable in the general public interest. The adverse impact might be overcome in the long-run through much higher prices for oil and gas, but that also involves public costs in terms of greater inflation than need occur under continuation of existing tax differentials.

U.S. INCOME TAX TREATMENT OF FOREIGN OIL PRODUCTION

The U.S. credit for foreign taxes appears to be widely misunderstood. Critics often relate U.S. income tax payments to worldwide income of oil companies without any regard for the large income tax paid to foreign countries, a misleading comparison that inevitably creates public hostility against oil companies on an emotional basis. The payments in question are not royalties, as foreign countries impose taxes in addition to normal royalties. Analysis of these levies shows that the foreign taxes in question are truly income taxes that limit after-tax income of the operating companies and provide increasing income tax revenue for the oil exporting nations.

The foreign income tax credit applies to all U.S. corporations on their foreign operations for the purpose of avoiding double income taxation of the same income. The principle involved in this provision is that the U.S. will collect income taxes on a foreign operation only if and to the extent that the foreign income taxes are less than would be paid on the same operation in the United States. For oil production in major producing countries, income taxes are generally higher than would apply on the same operation if it were in the United States. Consequently, the reason that no U.S. income taxes are paid on such production is that even higher foreign income taxes have already been paid. Furthermore, the foreign tax credit cannot be used to reduce income taxes due on U.S. operations so that it cannot be said correctly that payment of high income taxes abroad deprives the U.S. Treasury of any income tax revenue properly due on U.S. operations.

U.S. citizens and interests benefit from the development and production of foreign oil by U.S. companies in many ways. These operations provide supplies for American military forces abroad and for importation to meet part of the needs of consumers in the United States, result in tax revenues to the U.S. Treasury on dividend payments, aid in balance of payment problems, and reduce the amount of foreign aid needed by developing countries. Discriminatory changes in U.S. tax laws designed to discourage foreign oil operations by U.S. companies would merely work to the advantage of firms based in other countries without any gains for the Treasury or for consumers in this country.

ADDITIONAL TAX CONSIDERATIONS

Decisions about income taxes should not be made without regard to other taxes on petroleum and the general impact of all taxes on consumers.

Mineral production is frequently subject to special severance taxes not applied to other forms of business. Most of the principal petroleum producing states impose severance taxes on oil and gas production that represent costs of business affecting investments and prices. One problem with severance taxes is that they may work to hasten abandonment of oil wells that could otherwise continue to provide additional production for some years and greater recovery of the known oil in place.

While gasoline taxes have historically been levied for construction of roads and justified on the principle that the funds are spent for the direct benefit of those who pay these taxes, such funds are being diverted increasingly to other purposes. For example, in Texas part of the gasoline tax is used for public schools. At the national level, Congress is considering diversion to mass transit of funds raised by taxes imposed specifically for highway construction. Diversions of this nature lessen the burden of taxes for general revenue purposes and must be taken into account as a lightening of the general tax load made possible by the

suppliers of oil and gas encouraged by the differential Federal tax provisions applicable to petroleum production.

Income taxes on business are costs that affect investment decisions, supply, and long-run prices. Therefore, consumers cannot escape paying the income taxes levied on business, including the development and production of oil and gas. The imposition of additional taxes on oil and gas producing operations now at a time when the national interest calls for increased outlays for additional supplies and for price changes as reasonable as possible in order to secure those supplies would involve public costs exceeding benefits.

Continuity of tax treatment without disturbing changes every few years has great merit as a matter of general public policy. Without such continuity it is difficult to plan investments intelligently as required to serve public needs. Uncertainty creates risks that must be paid for in terms of higher rates of return required to attract necessary investments. Therefore, the tax rules used to encourage investors to undertake activities necessary for the public interest should not be changed in any way that undermines confidence about the future. If the Tax Reform Act of 1969 had changed percentage depletion treatment only with respect to investments made after its effective date, investors would have felt safer in evaluating investments on the basis of the new rates. The manner in which the change was made affecting all investments attracted under the old rules inevitably raised questions about the risks that still further cuts would be made later applicable to production from all prior investments.

Although these hearings will deal primarily with Federal income taxation, wise tax policies must take into account all forms of taxation, the net public effect of different ways of imposing taxes on industries of different nature, and the total tax burdens borne ultimately by consumers of different products.

SUMMARY VIEWS ON PETROLEUM TAXATION

The preceding analyses of various economic considerations lead me to question whether significant changes in Federal tax laws now would provide any net public benefits. The changes in 1969 were in the wrong direction. Imposition of still greater taxes by further reduction of percentage depletion or by requiring that intangible development costs be capitalized for tax purposes and recovered through depreciation would work directly contrary to the total Federal action needed to stimulate domestic discovery, development, and production of oil and gas. If the tax laws cannot be used to help solve energy problems, then they should surely not be changed in any way that will contribute to greater shortages.

A final pertinent point is whether there may be any tax policy actions worth considering as constructive steps in the right direction for the long-run. I have only one observation on this point. The uniform percentage depletion treatment of all minerals could be clarified by discarding the varying gross depletion rates in favor of the other limitation to 50% of net revenue before depletion which generally operates to set the maximum deduction in most cases. This uniform rate should be recognized as the minimum differential required for each property to protect the values liquidated by mineral production against taxation as ordinary income and should be assured for the life of investments made in minerals.

In the inescapable world of economic reality, decisions about Federal income tax treatment of petroleum and of all minerals must take into account all the considerations bearing on the net public interest incident to continuation of present policies and to any proposed changes. The main error that must be avoided is that of looking only at short-run tax consequences without regard for all other public impacts and long-run consequences. The evaluation of all the economic considerations is complex and difficult, but the right answers must be sought by your Committee and by Congress in order to serve the public interest well with the supplies of energy and other minerals essential for achievement of many important national goals.

SUMMARY STATEMENTS ON "PERCENTAGE DEPLETION FOR PETROLEUM PRODUCTION" BY RICHARD J. GONZALEZ, HUMBLE OIL & REFINING COMPANY, HOUSTON; PRESENTED TO THE COMMITTEE ON WAYS AND MEANS, HOUSE OF REPRESENTATIVES, DECEMBER 1, 1959

As an economist who taught for five years before becoming associated with the oil industry, I can readily appreciate why percentage depletion is widely mis-

understood and sometimes severely criticized. Superficially, this tax provision appears to interfere with normal economic processes and to create a tax advantage for producers of minerals. If the facts about percentage depletion were as simple as they appear superficially, Congress would not have consistently maintained this principle in effect as a result of its periodic studies. Instead, the taxation of mineral production is a very complex subject that requires and deserves intensive study.

Any thorough analysis of percentage depletion must take into account many facts. Careful appraisal of all relevant facts over a period of many years has led me to the conclusion that this long-established tax provision continues to be in the public interest, despite superficial impressions to the contrary. Seven major points in my appraisal of the subject are set forth briefly in this summary prepared at the request of the Committee, but the full force of all the points made can be appreciated only by consideration of the complete paper submitted for these hearings.

1. PETROLEUM IS ESSENTIAL TO NATIONAL WELFARE

Increasing supplies of oil and gas are essential for economic progress and national security. These fuels have greatly improved our living standards and have been of incalculable value during wars and other emergencies. Each gallon of oil provides the energy base for a dollar of national income. Therefore, petroleum will continue to be of vital importance to our expanding economy.

2. THE RISKS OF EXPLORATION MAKE PETROLEUM PRODUCTION A UNIQUE BUSINESS

High risks and large losses on unsuccessful ventures are inevitable in petroleum exploration. Only about three per cent of the thousands of exploratory wells that must be drilled annually discover significant commercial deposits. Furthermore, the results of exploratory drilling are highly erratic and quite unpredictable. Finally, production results in depletion of a wasting asset that can be replaced only by new exploration and drilling, usually at increasing costs. These peculiarities seriously handicap attraction of funds into this business. Nevertheless, petroleum producers must risk about five billion dollars annually to develop enough new supplies of oil and gas to meet the needs of our economy. The necessary amounts of money could not be attracted into the search for petroleum without reasonable tax differentials relative to non-mining investments that are less risky.

3. DIFFERENTIAL TAX TREATMENT IS NECESSARY FOR MINERAL PRODUCTION

The unique nature of petroleum producing makes it different from other businesses except mining. Most of the receipts from mineral production that appear to be income really represent capital and capital gains. These capital values cannot be taken out of the business or taxed as ordinary income without impairing the reserves of oil and gas required for continuous operation and for economic progress. Therefore, differential tax treatment is necessary for petroleum production and for mining operations generally. *Differential* tax treatment should not be assumed to constitute *preferential* treatment because appropriate differentials are necessary for the unusual conditions in mining in order to avoid an inefficient allocation of capital when income taxes are imposed.

4. EXISTING PERCENTAGE DEPLETION RATES ARE APPROPRIATE DIFFERENTIALS

The rate of percentage depletion for petroleum set by Congress in 1926 after careful study was a conservative measure of the capital actually depleted by production. It continues to be a conservative measure at present. A reduction of percentage depletion would encourage operators to realize on their successful ventures through the capital gains route rather than by operation. Sales of reserves in the ground would adversely affect the funds available for development of new resources, the number of operators engaged in the business, and the estimated tax revenues to be realized from such reduction. The decision of the Federal Government to impose mandatory restrictions on imports this year because of concern that further increases in imports would endanger the level of domestic exploration and drilling considered desirable for national security also serves to make clear the fact that any action taken now to reduce the incentive for expenditures on new ventures would be ill advised. Profits on the amounts

actually invested in successful petroleum operations are in line with those of other industries. Therefore, any additional taxes on petroleum production would inevitably have to be passed on to consumers because they could not be absorbed without seriously reducing the development of necessary new resources. In deciding whether petroleum producers and consumers pay a fair share of the tax burden, consideration must also be given to the special taxes imposed on petroleum, particularly severance and gasoline taxes. The various facts pertinent to this point lead to the conclusion that the long-established rate of percentage depletion is no more than an appropriate tax differential for current conditions.

5. PROPOSALS FOR GRADUATED DEPLETION ARE UNSOUND

The concept of graduated percentage depletion is economically unsound because it assumes incorrectly that risks can be controlled by size. Actually, the real risk on each venture is the same whether it is undertaken by a small firm or a large one or jointly by two firms of vastly different size. The large firms producing more oil must risk proportionately more money than the small ones in order to offset the depletion of reserves caused by production. The erratic results realized on expenditures even by large firms mean that risks cannot be reduced to a matter of cost accounting or insurance.

6. A CUT IN DEPLETION WOULD HURT THE ECONOMY

If percentage depletion were reduced, the entire economy would suffer because economic progress would be retarded and tax revenues would decline. Drilling would be reduced sharply, with adverse effects on the use of steel and equipment for new wells, on employment of labor, and on development of new reserves of oil and gas. The minimum reduction in drilling to be expected if percentage depletion were cut to 15 percent of gross income would probably cause a loss in total tax revenues of a billion dollars annually. Less drilling would soon cause shortages of domestic supplies, thereby bringing about higher prices for our principal fuels and contributing to inflation. Even a small increase in gasoline prices caused by a reduction of percentage depletion could accelerate the trend toward economy cars and have far reaching consequences on tax collections from gasoline and from the automobile, steel and rubber industries.

7. PERCENTAGE DEPLETION AT EXISTING RATES PROMOTES THE NATIONAL WELFARE

Percentage depletion has become an integral part of the economic structure of the mineral industries as well as a key factor in economic progress. Existing rates cannot be reduced without serious consequences for all consumers, for millions of stockholders, for thousands of workers in many industries, and for national security. Therefore, percentage depletion should be continued at existing rates because such action best serves the public interest.

The major points summarized above should serve to correct some of the superficial misconceptions about percentage depletion. They throw new light on the critical view that this tax provision is unsound because it attracts too much capital into petroleum production and allows producers to pay less than a fair share of taxes. Percentage depletion does attract more money to this business than would otherwise be risked currently, but that does not prove that the relative flow of funds that would prevail in the absence of income taxes has been altered. For reasons set forth previously, a differential such as percentage depletion is required when income taxes are imposed in order to avoid placing the mining industries at a disadvantage in attracting capital because of their unusual risks. Percentage depletion also means that the effective income tax rate on what is reported to be "income" from depletion of mineral resources is lower than on the income of other industries, but it does not follow that mineral producers do not pay a fair share of the tax burden. The unusual element of capital gains in receipts from mineral production means that such receipts cannot be taxed as ordinary income without impairing the supply of minerals required for economic growth. Furthermore, heavy severance and excise taxes must also be taken into account in judging the true burden of taxation on petroleum and its products. These examples serve to illustrate some of the complexities that must be considered in an objective study of percentage depletion.

The paramount economic test of a system of taxation is that it should interfere as little as possible with the industrial progress that enables the entire

population to enjoy the benefits of rising standards of living. Congress must be particularly concerned, therefore, about the effect of taxation on the key factors for industrial progress; namely (1) capital to provide the machines that multiply our productive capacity, and (2) minerals as a source of materials and energy for an industrial society. Increasing quantities of capital and of minerals are the indispensable requisites for economic progress.

National policies designed to encourage the growth of capital and the development of mineral resources have been the foundation of the rapid economic development of the United States in the past. The future growth of real income will continue to depend on wise policies enabling us to reap the benefits of increasing quantities of capital and minerals per person. Unless such wise policies are continued in effect, the progress which we in the United States have come to believe is inevitable will not be realized and our nation will soon find itself surpassed by others in economic welfare and in military strength.

Percentage Depletion for Petroleum Production

(By Richard J. Gonzalez, Humble Oil & Refining Co., Houston, Tex.)

Percentage depletion deserves the objective study being undertaken by the Committee on Ways and Means. This tax provision should be evaluated rationally, not emotionally, to ascertain whether it continues to be reasonably suited to the special circumstances of the mineral industries and to make a net contribution to the general public welfare.

This paper is designed to present information that should be taken into account in an objective analysis of percentage depletion for minerals generally and for oil and gas in particular. In order to provide an adequate background for an understanding of the issues involved in this complex subject, the importance of petroleum supplies to our economy and the unique nature of oil and gas production will be considered first. These circumstances, together with the large capital requirements essential for adequate supplies, provide the basic reasons for differential tax treatment. The proper rate for percentage depletion is then considered in both theoretical and practical terms. Finally, the full economic consequences of a cut in depletion are analyzed to show that the economy as a whole would suffer from such a change and that even tax receipts of the Federal Treasury would be adversely affected.

IMPORTANCE OF OIL AND GAS TO ECONOMIC PROGRESS

Oil and gas are essential to the economic progress of industrial nations. They now supply 70 percent of the inanimate energy used in the United States, compared with 25 percent in 1926.[1] In 1958, crude oil, natural gas, and natural gas liquids produced in the United States had a value in excess of $9 billion, or approximately 57 percent of the total value of all domestic minerals produced that year.[2] More than 30 States now produce crude oil.

Liquid fuels have been particularly important in providing mobile power ideally suited for many purposes, from small engines of fractional horsepower to the huge motors of airplanes and diesel locomotives. These fuels are the basis of our public and private transportation. They have also contributed greatly to mechanization of agriculture and increased productivity in industry. The technological developments and economic progress of the past generation could not have been realized without rapidly increasing production of oil and gas. All of the net increase in energy consumption in the United States since 1926 has been supplied by oil and gas.

In moving mobile equipment and in running all sorts of machines, oil and gas multiply our productive capacity tremendously. Admiral Rickover has described the great contribution to our way of life of machines run by inanimate energy in the following vivid terms:

Man's muscle power is rated at 35 watts continuously, or one-twentieth horsepower. Machines, therefore, furnish every American industrial worker

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[1] U.S. Department of the Interior, Bureau of Mines, Monthly Petroleum Statement No. 437, "Crude Petroleum and Petroleum Products," November 1958, p. 24.

[2] U.S. Department of the Interior, Bureau of Mines, "Nation's 1958 Mineral Output Valued at $16.4 Billion," press release of Dec. 31, 1958, pp. 1–2.

with energy equivalent to that of 244 men, while at least 2,000 men push his automobile along the road, and his family is supplied with 33 faithful household helpers. Each locomotive engineer controls energy equivalent to that of 100,000 men; each jet pilot of 700,000 men. Truly, the humblest American enjoys the services of more slaves than were once owned by the richest nobles and lives better than most ancient kings.[3]

Chart 1 shows the close relationship that existed between real income and energy consumption per capita in the United States over the past 30 years. All forms of energy have been expressed in terms of gallons of crude oil for this purpose by conversion of other fuels on the basis of heat content measured in British thermal units as reported by the Bureau of Mines in its studies of energy production and consumption. The annual data show a decline in both income and energy consumption during the depression of 1930–33 and a subsequent upward trend for both factors. In recent years, a gallon of oil has provided the energy base for slightly more than a dollar of real income. The close correlation between the increase in income and the growth of energy consumption, particularly oil and gas, indicates that the United States must continue to encourage availability of greater supplies of oil and gas in order to achieve rising standards of living for an expanding population.

Chart 2 demonstrates the same close relation between energy consumption and income per capita in countries throughout the world. The data plotted were published by the Joint Committee on Atomic Energy in its report on "Peaceful Uses of Atomic Energy." The bars at the top of the chart show that India and Burma have low energy consumption and income per capita. Many other countries are similarly situated in this respect. About the middle of the scale, the bars for the Netherlands represent energy equivalent to 447 gallons of oil and income of $447 per capita. The United States has the highest energy consumption and income per capita. Analysis of the relationship by countries show that a gallon of oil or its equivalent in other forms of energy provides the basis for a dollar of income. Therefore, the development of a barrel of crude oil that contains 42 gallons provides the energy base for about $42 of income. Thus, crude-oil selling for about $3 a barrel, or 7 cents a gallon, at the well provides great stimulus to economic progress and real income per capita.

IMPORTANCE OF OIL AND GAS TO NATIONAL SECURITY

Oil and gas are also essential for national security. In World War II, more than one-half of all the tonnage shipped to our military forces consisted of petroleum products.[4] Adequate domestic petroleum supplies have been of incalculable value to the United States in other national emergencies as well. During the Korean incident, for example, domestic petroleum supplies were increased sharply to take care of military and civilian requirements, even though prices were frozen. During the Iranian crisis of 1951 and the Suez crisis of 1956, the availability of additional oil supplies in the United States and Venezuela proved of great value. In each of these emergencies, our favorable position with respect to petroleum supplies actually saved us tremendous sums of money, perhaps even averting major wars.

The United States has not had to undertake an expensive program of stockpiling petroleum for national emergencies because adequate reserves and productive capacity have been available as a result of private investments. In view of the great quantities of oil that would be needed for even a year of military and essential civilian operations, the cost of stockpiling petroleum would be high if domestic capacity were not adequate for emergency needs. The U.S. Government is reported to have spent $8.2 billion for stockpiling of strategic materials.[5] At 4 percent, the interest cost alone on this investment exceeds $320 million annually, or as much as the figure often cited as the amount of tax revenue the Treasury might realize by reducing percentage depletion on oil and gas.

Petroleum continues to be highly important to security even with the development of nuclear weapons and intercontinental missiles. The United States must

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[3] H. G. Rickover, rear admiral, U.S. Navy, "Energy Resources and Our Future," presented May 14, 1957, before the Annual Scientific Assembly of the Minnesota State Medical Association.

[4] "Petroleum in War and Peace," papers presented by the Petroleum Administration for War before the Senate Special Committee To Investigate Petroleum Resources, "Oil in Peace and War," Ralph K. Davies, p. 6.

[5] Representative Albert Thomas, quoted in the Houston Post, Aug. 6, 1959, sec. 6, p. 2.

be prepared to fight effectively by conventional means since it does not propose to start a nuclear war. Otherwise, important areas of the world will soon be lost to aggressors who will not hesitate to take advantage of any deterioration in our ability to conduct conventional military operations. The stockpile goals of the Office of Civilian and Defense Mobilization are still based on a 3-year war. Even in the dire event of a nuclear war, petroleum would be essential to our immediate retaliatory power, to our continued military strength, and to our ability to rebuild rapidly.

UNIQUE NATURE OF OIL AND GAS EXPLORATION AND PRODUCTION

Oil and gas are so important to all of us in the United States that a case can be made for differential tax treatment, even in the absence of any other unusual circumstances, on the basis of the benefits that flow from adequate supplies of these fuels at reasonable prices. Savings in the cost of wars and of defense as a result of adequate petroleum supplies may well have offset fully the theoretical cost of percentage depletion, leaving as a net gain the contribution of oil and gas to a higher rate of general economic progress. An increase of even 1 percent is the rate of economic growth attributable to the effects of adequate domestic supplies of oil and gas because of percentage depletion would more than compensate the Treasury for any assumed loss of revenue due to this tax provision. Such a gain has probably resulted from the far-reaching economic effects of reasonably priced petroleum products on the automobile industry and many other related industries.

If the importance of petroleum were the only basis for percentage depletion, the decision on continuance of present rates would rest on the judgment of Congress whether there is any cheaper or better way of accomplishing the beneficial results that flow from encouraging the development of adequate supplies of oil and gas. In that case, the problem to be weighed would be the same that Congress must deal with every time it decides that certain activities are sufficiently desirable to deserve encouragement by special treatment in the form of tax differentials, price supports, and other means.

Another basic reason exists, however, for differential tax treatment of petroleum production. This reason consists of the unique nature of the exploration and development process for oil and gas resources.

Petroleum production is a mining venture with many characteristics of mining ventures in general and with some peculiarities of its own. Production inevitably depletes a wasting asset that occurs in natural form and that cannot be reproduced by man. The search for most mineral deposits, particularly oil and gas, is characterized by great uncertainty and by a long time lag between outlay of funds and eventual recovery of capital and earnings. Mineral production is also subject to the principle of diminishing returns and increasing costs. All of these circumstances create the need for differential treatment when taxes are imposed on income in order to enable the mining industry to compete effectively with other industries in attracting capital.

Many minerals can be located by surface exploration. Some minerals, such as sand, gravel, and coal, are fairly common and the location of large deposits is well known. Some petroleum deposits have been discovered from surface evidence, but as the search has been extended deeper the industry has had to supplement surface geology with expensive tools designed to provide clues as to subsurface conditions. No direct method exists for ascertaining the location of underground petroleum deposits. Instead, operators must first locate what appear to be structural traps (formations that serve to hold any accumulations of hydrocarbons), and then drill exploratory wells to test whether such traps, if they exist, actually contain commercial deposits of oil and gas. After production is discovered, the size of the field must be determined by further drilling. Finally, oil and gas are produced over a period of years, frequently 20 or more. The revenue from this production must pay for (1) the expenses of lifting the oil and gas to the surface, (2) expenditures on exploration and drilling for both successful and unsuccessful ventures, and (3) a rate of return commensurate with the risks.

The risks in petroleum are illustrated by the experience on drilling. Reports of the Committee on Statistics of Exploratory Drilling of the American Association of Petroleum Geologists show that only about 11 percent of the 68,700 exploratory wells drilled in the search for new fields in the 10-year period 1949–58

were completed as producing wells.[6] In other words, only one exploratory well in nine finds a new field. Many of the new fields prove to be quite small with little commercial significance. Studies by the Committee on Exploratory Drilling show that less than 30 percent of the new discoveries develop into commercial fields with a million barrels or more of oil reserves or 6 billion cubic feet or more of gas reserves. In fact, out of 1,000 exploratory wells drilled in the search for new fields only about 3 percent discover significant commercial deposits of oil and gas.

The erratic results of exploratory drilling are indicated by the fluctuations in the estimates of new discoveries. The range in initial estimates of discoveries reported by the American Petroleum Institute and the American Gas Association during the past 10 years was from 890 million barrels of crude oil in 1949 to 315 million barrels in 1958 and from 2.9 trillion cubic feet of gas in 1950 to 9.0 trillion cubic feet in 1957. While the average results for the industry in terms of the percentage of exploratory wells completed as producers remains fairly constant because of the thousands of wells drilled, even a large company drilling a hundred or more such tests a year can have a wide deviation from the average. Furthermore, the true measure of success is the value of the discoveries relative to the funds spent rather than the proportion of exploratory wells completed initially as producers. By this measure, the results of exploratory expenditures are unpredictable even for the industry as a whole, since there is no way of forecasting the reserves of new fields to be discovered by future drilling.

After the discovery of a field, much exploratory work involving unusual risks remain to be done. During the 10-year period 1949–58, the industry drilled 37,000 exploratory wells designed to test extensions or deeper sands in producing fields. About 75 percent of these exploratory tests were dry. The evidence again indicates rather erratic results in the estimated changes in reserves due to exploratory drilling and development in known fields. The estimated extensions and revisions for crude oil were 2 billion barrels in 1950 and 4 billion barrels in 1951, although drilling did not change much. Even greater fluctuations have occurred in the reported extensions and revisions for natural gas, which ranged from 4.6 trillion cubic feet in 1954 to 19.2 trillion cubic feet in 1956, although only about 5 percent more gas wells were drilled in 1956 than in 1954.

In the face of unpredictable results, the petroleum industry must risk millions of dollars on individual ventures and billions of dollars annually for exploration and drilling. One offshore lease of 2,500 acres was recently purchased from the Government for $26 million, and many other leases have been bought for millions of dollars, including some that have later been surrendered as nonproductive after the drilling of expensive tests. Exploratory wells range in cost from fairly modest sums at shallow depths to several million dollars for deep tests, particularly offshore and in remote or difficult areas, such as Alaska. The Chief Petroleum Engineer of the U.S. Bureau of Mines estimates that the petroleum industry's explorations costs, including dry holes, were $2,268,390,000 in 1955. In addition, he estimates that development costs for producing wells and equipment amounted to $2,859,075,000, raising total expenditures for exploration and development to $5,127,465,000.[7] These expenditures represented about 65 percent of the gross revenue from the sale of domestic oil and gas production and exceeded the funds available after paying for current operating expenses and royalties. This evidence as to the relation of receipts and expenditures demonstrates that the industry must risk again in the search for and development of new reserves (1) all the capital recovered from past ventures, (2) most of the reported profits, and (3) substantial additional sums of outside funds. These vast sums must be risked without the ability to calculate in advance an anticipated rate of return because of the highly erratic relation between outlays and value of results. The inevitability of large losses on unsuccessful ventures means that there must be the opportunity in case of exceptional success for commensurate rewards in order to provide a reasonable incentive for funds to be risked in this business.

The inherent uncertainty in the search for oil means that there is no way of predicting what results will be realized on funds risked in this business. One operator may risk only a few hundred thousand dollars and end up with a prop-

[6] B. W. Blanpied, "Exploratory Drilling in 1958," Bulletin of the American Association of Petroleum Geologists, June 1959, p. 1124.

[7] C. C. Anderson, "Petroleum and Natural Gas in the United States—Relation of Economic and Technologic Trends," paper presented at the World Power Conference, Montreal, Canada, Sept. 7–11, 1958.

erty worth a million and another may spend millions on one venture and end up with a total loss. The right to deduct losses in computing taxable income helps to cushion their blow if the taxpayer has other income, but this does not provide any reward for risking money in the business. Unless there is a reasonable hope of retaining enough net income from successful ventures to compensate for all the risks taken, operators would be better off not to take such risks.

The peculiarities of exploration and drilling mean that cost and value usually differ by large amounts for individual ventures. This is in contrast with most nonmining investments for which cost and value at the beginning of operations for individual projects are rather close. This striking difference for petroleum led Congress early in the application of income taxes to decide that value was the proper basis for determining depletion due to production. This decision recognized that the capital depleted by production from different properties was usually measured best by the value of these properties after discovery.

The provision authorizing depletion on the basis of discovery value meant little to the high cost operators, but provided more incentive for new ventures by the most successful and efficient operators with low costs.

The timelag between initial exploration and final development of substantial production is generally about 5 years and is sometimes much longer, particularly in foreign operations. Because of the unusual risks and the long timelag, investments in petroleum involve much more uncertainty concerning prospective returns than most other businesses. For this reason, price alone is not an adequate incentive for the investment of funds. The President's Materials Policy Commission recognized this fact in its report, Resources for Freedom, June 1952, in the following words:

Because of the past erratic price behavior of minerals and the long interval between initial investment and yield from production, the Commission concludes that incentives provided through te price structure are unlikely to bring about enough exploration and development to meet national needs for domestic production of scarce minerals.[8]

When an operator finally succeeds in completing a successful well, he immediately begins to deplete a wasting asset by production. He is engaged in selling his capital assets on an installment basis. His receipts above current operating expenses represent a complex mixture of capital, capital gains, and ordinary operating income. The ordinary income is that part of the total which would be required by a purchaser of the property as compensation for his investment and his management of operations. The major part of the income to the successful developer of petroleum reserves ordinarily represents the capital values realized from depletion of his basic assets.

In order to continue in business, a producer of petroleum must seek to offset his production by constant search and drilling. Unlike his counterpart in manufacturing and trade, he cannot predict what it will cost him to replace his productive facilities. Unlike the farmer, he cannot manage his operations in such manner as to realize annual income without diminishing the productive capacity or value of his capital assets. Revenue from the sale of oil and gas represents to an unusual degree a realization from liquidation of the corpus itself, rather than ordinary income that can be expected to recur without much decline over a long period of years.

An operator seeking to replace production by spending money on new ventures finds himself up against the principle of diminishing returns and increasing unit costs. The shallower, the larger, and the richer resources are easiest to locate and develop. Therefore, replacement generally requires operators to turn to the development of deeper, poorer, and more expensive resources. Drilling costs increase rapidly with depth, and are much above past experience in new areas, such as offshore and in Alaska. Improved technology is utilized to the fullest degree to offset this tendency toward diminishing returns, but even so petroleum production is still in a less favorable position than many manufacturing industries and utilities which enjoy constant or decreasing costs as volume expands.

The unique problems of mining in general and petroleum production in particular constitute serious handicaps in attracting capital. Most investors do not like to risk large sums on ventures in which they may lose a substantial part of their capital. They prefer reasonable security for their capital investment, even though

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[8] The President's Materials Policy Commission, "Resources for Freedom, Foundations for Growth and Security," June 1952, vol. 1, p. 34.

they cannot escape the risk that the rate of return may vary from what is anticipated. Many retail stores discontinue operations because they are not sufficiently profitable, but their owners may still recover a large part of the capital invested in buildings, fixtures, and inventories. By contrast, unsuccessful dry holes represent a large and total loss of the funds risked. An average of 20,000 dry holes annually have been drilled during the past 5 years, and the losses on dry holes are now probably about a billion dollars annually. Under these circumstances, it is unlikely that the necessary amounts of money could be attracted into the search for oil and gas without reasonable tax differentials. Some funds are available for risky ventures from people who are interested in gambling on a long shot, but the amounts available from such sources are far from sufficient to provide the large sums required for exploration and drilling.

The President's Materials Policy Commission recognized that the preceding factors warrant and require special treatment for mining ventures. Its statement on this point was as follows:

The Commission believes further that special provision must be made in the Federal corporate income tax structure to meet the unusual problem which confronts many private companies in the minerals field. It is customary under U.S. tax laws to permit a business to recover tax free its investment in physical assets as they wear out or become obsolete. Ordinarily the recovered investment can be applied toward replacing physical assets. But for many minerals there is considerable uncertainty as to whether reserves can be replaced, and considerable risk is entailed in attempting to replace them. Moreover, for some major minerals the real cost of replacement keeps rising because of the progressive depletion of natural resources. Percentage depletion is an effective means of meeting this problem, apart from its efficacy as an incentive.

LARGE CAPITAL REQUIREMENTS

A final factor pertinent to the need for differential tax treatment for petroleum production is the great amount of capital that must be risked annually by the industry to meet the needs of our expanding economy. Annual production in the United States now approximates 3 billion barrels of petroleum liquids and 12 trillion cubic feet of natural gas. At current prices for proved, developed reserves, operators would probably have to pay about $5 billion to acquire from existing resources enough reserves to replace this production. Expenditures of comparable amount on exploration and drilling may be made in the hope of replacing production, but the results to be realized from such expenditures cannot be predicted in advance.

Since the energy requirements of an expanding economy show a steady upward trend of around 3 percent, petroleum producers are called upon not only to replace production but also to expand reserves in order to meet future needs. Even at 3 percent, requirements will double in less than 25 years. Past experience shows that wells in the United States have been called upon to produce in 10 years as much as the total estimate of known reserves at the beginning of the period. Consequently, an aggressive search for new supplies must be carried on constantly in order to keep the United States from beginning to feel a shortage of domestic supplies. The U.S. Geological Survey and other authorities are confident that sufficient domestic resources remain to be discovered and developed to keep pace with requirements for a long time to come. Development of these potential resources will require vast expenditures. These expenditures will not be made in the face of uncertainty and unusual risks unless there are strong incentives designed to attract capital into exploration and drilling.

Investors have been encouraged to make tremendous outlays in petroleum production under the tax differentials that have been in effect for many years. There are now about 650,000 producing oil and gas wells in the United States. Within the past 10 years alone, over 300,000 successful producing wells have been completed. The gross cost of all producing wells and facilities may conservatively be estimated at around $30 billion. Thousands of individuals and firms operate producing wells, millions of investors own stock in companies with oil and gas production, and many more millions have indirect holdings through mutual investment trusts and mutual insurance companies.

The amounts of investments involved on a cumulative and current basis and the number of individuals concerned as well as the importance of minerals

distinguish the extractive industries from other risky types of ventures which are not granted differential tax treatment. Some activities other than mining also involve high risks but they generally require less venture capital relative to gross income or can be considered less important to economic progress and national security. For research, a high risk activity considered essential to the Nation, Congress provides patent rights to reward significant contributions.

For reasons of national economic progress and security, petroleum producers must risk on new ventures nearly as much capital annually as all public utilities, which constitute a highly important activity but of an entirely different character. The attitude of investors toward providing funds for these two activities illustrates the dramatic difference in their appraisal of risks. Utilities can finance large initial projects by borrowing 50 to 75 percent of the total capital required. By contrast, funds cannot be borrowed for exploratory ventures in mining. Established producers can borrow some funds by mortgaging proved properties with values in excess of the amount borrowed, but even the largest integrated oil companies do not usually consider it prudent to rely on debt for more than about one-fourth of their total capital structure.

REASONS FOR DIFFERENTIAL TAX TREATMENT

Three reasons emerge from the preceding analysis as the basis for differential tax provisions for petroleum production: (1) the unique character of the business, which means that a large part of what appears to be ordinary income from successful ventures according to customary accounting represents capital gains that cannot be taken out of the business without impairing the reserves of oil and gas required for continuous operations; (2) the necessity of attracting large sums of capital into a continuing search for new supplies, particularly for an expanding economy; and (3) the incalculable benefits of petroleum to national progress and security. The force of these reasons leaves no doubt that Congress has had logical grounds for differential tax treatment of petroleum production and all other extractive industries engaged in depleting resources.

The critics who argue against any differential tax treatment claim as an ideal neutral taxation which would tax all income equally in order that market price alone would direct capital into what they claim would be its most efficient uses. According to this theoretical approach, the market is the best judge of the relative value of different goods and services to individuals and, therefore, to the general public welfare. As a practical matter, this theory leaves a good deal to be desired. The public and Congress definitely agree that certain activities should be discouraged by heavy taxation, while others should be encouraged by differential or even preferential treatment. For example, liquor and tobacco are heavily taxed because they are considered less essential or desirable than other products. On the other hand, various special devices, including lower tax rates, are used to encourage small business in general. Many other forms of legislation, including complete tax exemption for educational and charitable organizations, tend to refute the theory that Government wants to or should adopt a neutral attitude toward all economic activities.

The theory of neutral taxation, if accepted in principle and applied correctly, would require appropriate differentials for unusual conditions in order to avoid an inefficient allocation of capital. Economic theory holds that different risks call for commensurate returns. Two industries can be visualized, therefore, that are alike with respect to elasticities of demand and supply and that have annual sales equal to capital investment, but differ in risk to such an extent that the required rates of return are 8 percent for industry A and 24 percent for industry B. In the absence of taxes, the proper allocation of capital between A and B will be guided by price alone. Selling prices for the product from each dollar of investment will include 8 cents profit for A but 24 cents for B. If income taxes are then imposed at a 50 percent rate, prices will have to be adjusted so that both industries continue to make their former rate of return after taxes in order to attract the necessary capital input. The income tax would force B to charge its customers 24 cents more for the products from a dollar of investment, but A would need to charge only 8 cents more. These changes would alter the relative demand for products A and B and cause an inefficient diversion of capital from industry B to industry A. In this case, the exemption of 50 percent of B's net income before taxes would be the differential required for true neutral treatment when income taxes are imposed. Then B would bear the same burden of taxes as A despite a different effective rate. Such differential tax treatment would be essential for industry B to main-

tain the same attraction for capital relative to A as it had before the imposition of income taxes. A similar differential would be required to achieve neutral tax treatment if the rates of return were 12 percent for A and 18 percent for B if B needs twice as much capital per dollar of sales as A. This case would more nearly reflect the true relation because petroleum-producing operations have both higher risks and larger capital requirements relative to sales than manufacturing. The important point demonstrated by these illustrations is that differential tax treatment cannot be assumed to be preferential tax treatment that causes an undesirable allocation of capital resources. In other words, the theoretical assumption that all tax differentials cause a less efficient allocation of capital is not correct.

The preceding discussion shows that two different major premises support the system of percentage depletion that Congress has applied to minerals for many years as economically sound and in the public interest. First, the existing provisions may provide no more than the necessary differential in order to maintain the ability of the mineral industries to attract capital in competition with less risky businesses when income taxes at existing rates prevail. Second, the differential established may actually provide some degree of preferential incentive designed to attract capital into mining, compared with true neutrality, because such incentive is considered to be the best way of encouraging the development of sufficient supplies of minerals. The history of the development of percentage depletion and its extension to an increasing list of minerals at rates that were raised for some items as recently as 1954 suggests that Congress has had in mind clearly the desire to encourage exploration and development expenditures in mining because of the importance of minerals to the general welfare and the national security. Whether the means and the rates chosen result in the precise degree of differential required for absolute tax neutrality or in some degree of preferential treatment will always be subject to debate. The data do not exist and cannot be secured in our complex world to permit any accurate measurement of the difference between what has happened and what might have happened in the absence of all taxes. Such debate serves little useful purpose. Attention should be directed instead to the reasoning back of the selection of the present rate of depletion and the various approaches that provide evidence as to the proper rate necessary under current conditions to bring forth adequate supplies of essential minerals.

DEVELOPMENT OF PERCENTAGE DEPLETION

A brief review of the development of percentage depletion is essential for an understanding of the rates authorized. When income tax rates first reached a substantial level during World War I, Congress became fully aware of the need for differential tax treatment of mineral production. In 1918, it adopted discovery value as a basis for computing depletion for minerals. Under this system, the value of a new producing property was ascertained under conditions prevailing within a period of 30 days after its discovery. That discovery value became the basis of depletion. In other words, Congress decided to allow the developer the same depletion that would be granted without question to a cautious investor who avoided the risk of exploration by purchasing the property after it was proved to be productive.

Discovery value depletion required determination of market value for each new discovery. This provision involved a great deal of work and proved difficult to administer. Congress and the Treasury Department set about to find a simple equivalent that would be easy to administer. They found that the value of discovered oil in the ground was related to the current market price of the oil being produced. Some Congressmen concluded from the evidence that discovery value exceeded 30 percent of the market price, but others preferred 25 percent in order to be sure that any doubt would be settled in favor of the Government. A compromise was reached which provided that depletion could be calculated on the basis of 27½ percent of gross income but not more than 50 percent of net income before depletion. This provision was adopted by Congress in 1926 and has remained in effect for oil and gas production since that time. Subsequently, percentage depletion at varying rates was substituted for discovery value depletion for other minerals.

Percentage depletion now applies to about 100 minerals. The rates on gross income vary from 5 percent on sand, gravel, and oyster shell up to 10 percent for coal, 15 percent for many minerals, 23 percent for sulfur and uranium, and 27½ percent for oil and gas, but the same limitation to 50 percent of net income before depletion applies to all minerals. The varying rates on gross income appear to be

related to (1) relative scarcity, (2) costs and risks of exploration, (3) importance of adequate supplies to welfare and security, and (4) the relation of net income to gross revenue. In practice, the controlling limitation is often based on 50 percent of net income, and in this respect all minerals receive the same treatment. The exclusion of up to 50 percent of net income for depletion has the same effect as the exclusion of 50 percent of long-term capital gains.

The preceding review shows that the rate of percentage depletion for petroleum was fixed by Congress as a result of careful study. The rate has been reviewed numerous times, always with a decision not to make a change. Whether the rate continues to be right for current conditions deserves careful consideration.

THE PROPER RATE FOR PERCENTAGE DEPLETION

The major attack on percentage depletion is that the rate for oil and gas should be reduced. The critics who make this attack seem to accept the need for differential tax treatment but propose that the rate of percentage depletion on gross income be cut almost in half or graduated downward with the size of gross income. To support these proposed changes, the critics argue that income tax rates have changed and that risks are reduced by size. The inadequacy of these points can be shown in both theoretical and practical terms.

The chief theoretical argument for a reduction in depletion stems from the increase in tax rates. Some critics argue that percentage depletion should be cut sharply on the grounds that income tax rates are now about four times as high as in 1926. They look on depletion as a measurable subsidy that should have kept constant as tax rates changed, contrary to the position taken by Congress that depletion is a valid principle that should be applied consistently regardless of fluctuations in the basic tax rates. The fallacious reasoning of the critics overlooks many facts that must be taken into account in an objective analysis of the proper rate of percentage depletion. First, Congress has provided about the same recognition for capital depleted by oil and gas production since 1918, although tax rates have been changed up and down many times since then. Second, as income tax rates are increased, Congress must exercise great care not to tax capital and capital gains as ordinary income in order to avoid disruption of the capital growth that is essential to economic progress. Third, oil and gas are now much more important than in 1926, providing about 70 percent of our inanimate energy now compared with only one-fourth in 1926. Fourth, the risks in drilling have increased, as indicated by the fact that about 38 percent of all wells drilled currently are dry holes compared with only about 27 percent in the years preceding 1926. Fifth, the amount of capital that must be attracted into this business has multiplied many times as demand for oil and gas has quadrupled and as the search for new supplies has had to be extended deeper and to remote and inaccessible areas. In view of all these changes, the increase in income tax rates is not in itself a valid reason for reducing percentage depletion.

Two ways can be used to test existing depletion rates in theoretical terms. The first is to ascertain whether present rates still measure the discovery value of new properties, since that is the basis on which a purchaser would be allowed to compute depletion. Developed producing properties sold outright have commanded prices in recent years of about $1.25 to $1.50 per barrel of proved reserves in the ground. These prices include payment for development and for tangible equipment. The price paid for tangible equipment, which would generally be in the range of 15 to 25 cents a barrel, would be recovered through depreciation. The balance of the price paid would be for the reserves and, therefore, would be recoverable through depletion. On the average, therefore, the purchaser probably pays $1 or more per barrel for the oil reserves. His cost depletion represents at least one-third of the current average price for oil at the well of about $3. By comparison, the maximum depletion of 27½ percent of the gross selling price of crude oil cannot exceed 82.5 cents on $3 per barrel, and the average deduction is considerably less because of the limitation to 50 percent of net income. Therefore, the purchaser takes cost depletion rather than percentage depletion in determining taxable income. In this case, the price paid is not influenced by the existence of percentage depletion, so that it cannot be said that capitalized values created by percentage depletion are used to defend the rate. This approach shows that percentage depletion at existing rates is still a conservative measure of the capital value of oil in the ground. The rate cannot be reduced without subjecting to taxation as ordinary income part of the capital values depleted by oil and gas production.

A second theoretical approach to the reasonableness of existing rates takes into account the fact that developers of reserves can sell their properties outright and thereby realize on their success through the capital gains route by which only 50 percent of the gain is taxable and the maximum tax is 25 percent of the long-term gain. Unless continued operation of a property is about as attractive as its outright sale, many operators will be tempted to sell out and retire from the business in order to enjoy past success without the need of taking further risks. The increasing sales of producing properties in recent years indicate that present depletion rates are close to a break-even point with outright sales. Any reduction of percentage depletion would swing the balance more heavily in favor of sales of reserves in the ground. Such sales absorb capital that would otherwise be spent in the search for new supplies and also tend to reduce the number of operators engaged in exploration and drilling. Both of these developments are undesirable from the standpoint of attracting sufficient capital into the search for new supplies adequate to meet increasing demands.

As a practical matter, critics object to percentage depletion on the grounds that too much capital has been attracted into petroleum production, that the industry is too profitable, and that oil producers do not pay their fair share of taxes. They overlook the most significant practical consideration of all, however, which is that percentage depletion at existing rates has become an integral part of the economic structure of the industry. Therefore, a reduction would have serious repercussions for millions of consumers and stockholders as well as for thousands of operators and firms engaged in production and for hundreds of financial institutions.

The practical situation used to support the charge that percentage depletion attracts too much capital into petroleum production is the substantial restriction on the output of some domestic wells, particularly in Texas, that has been in effect in recent years. The domestic industry is estimated to have a total productive capacity of about 10 million barrels daily and a shut-in capacity of about 3 million at its recent average producing rate of about 7 million. Critics immediately jump to the conclusion that too much capital has been invested in the industry. The operating rate of 70 percent indicated by these figures is certainly less than desirable, but this is only one of the facts that needs to be considered in judging the adequacy of current investment and capacity.

Several important factors must be considered in deciding whether current spare petroleum capacity is greater than needed. First, a reserve domestic producing capacity of 1 million to 2 million barrels daily is desirable for emergencies. Second the current level of spare capacity reflects a lag in adjustment to the rapid increase which has occurred in imports and to the slowing down in the rate of growth of domestic demand. This lag is not surprising in view of the long period of time that elapses between a shift in exploration and the subsequent reflection of that shift in drilling and production. Exploration activity has been in a downward trend since 1954 and drilling is now well below the record level of 1956, but additional time will be required to reestablish a normal relation between current capacity and the desired level based on demand and the necessary strategic reserve for emergencies. Third, current productive capacity is only a short-term measure of the adequacy of capital input. The behavior of proved reserves is a better measure for the long term. For several years, proved domestic reserves have shown only a small increase even though demand continues to advance at a long-term rate of about 3 percent a year. This development reflects the decline in exploration and drilling that has occurred in recent years as an adjustment to the rise in imports, the increase in shut-in capacity, and the decrease in the growth of demand due to intensive competition from gas. The ratio of domestic reserves to demand is somewhat lower than has traditionally existed in the past, indicating that investment has not been excessive. In fact, the Director of the Office of Civilian and Defense Mobilization and a Special Cabinet Committee concluded that petroleum imports should be restricted because they constitute a threat to the level of exploration and drilling considered desirable for national security. In view of these considerations, percentage depletion cannot be said to have encouraged excessive development of domestic resources. On the contrary, one of the best reasons for maintaining percentage depletion at existing rates is that the system has worked to encourage development of new resources at about the rate required to meet the needs of our expanding economy.

The opinion of some critics that percentage depletion makes petroleum production unduly profitable is not borne out by the evidence. If production were unduly profitable relative to the risks involved, large oil companies would find it advantageous to become net sellers of crude oil and would show high rates of return. Instead, the large integrated companies are generally net buyers of crude oil with rates of earnings quite comparable with manufacturing. Statistics published by the First National City Bank of New York show an average return on net book investment in the period 1947–58 of 14.8 percent for petroleum and 14.1 percent for all manufacturing. (See chart 3.) Twelve industries exceeded petroleum in rate of return during this period. In 1958, petroleum realized an average return of only 10.2 percent. Tabulations published by Fortune on the 500 largest corporations show that in 1957 and 1958 no oil corporation was among the 10 most profitable firms, measured by the rate of return on investment, although 6 of the 10 largest firms according to assets and 4 of the 10 largest firms according to sales were oil companies.

Some successful firms engaged solely or principally in petroleum production show a return on book investment in the range of 20 percent, but this is not surprising for unusual success considering the risks taken and the funds lost. Book investment reflects practically all of the funds risked by manufacturing corporations but only the successful ventures of petroleum producing companies. A producing firm that reports a 20 percent rate of return on book investment may realize only 10 percent on the total funds risked if half of its total outlay has been lost on unsuccessful exploration. In order to be representative of industry results, statistics on earnings would have to take into account, along with the results of the most successful firms, all exploration ventures that have failed, operators that have not achieved sufficient success to be included among the publicly held corporations, and the producing operations of integrated companies.

The charge that percentage depletion allows petroleum producers to pay less than their fair share of taxes is a loaded argument based on the assumption that fairness consists of imposing the same tax rate on all income regardless of its character. This assumption is not valid theoretically or practically for reasons set forth previously. Selected statistics about income tax payments by individual oil producers or by large companies in the petroleum industry do not present the full story unless they take into account how much of the so-called income represents capital values, whether current drilling operations are unusually high relative to production, and the full tax consequences of the investments being made over their entire productive life. A company or individual currently spending unusually large sums for exploration and drilling may report small taxable income immediately, but these expenditures will provide the basis for generation of large tax revenues over a period of years in the future. Finally, the fairness of tax payments must be judged by looking at the tax structure as a whole rather than at individual components.

If percentage depletion provides any measure of preferential treatment, such advantage is more than offset by the burden of other taxes. A substantial special tax is levied by the principal producing States for the severance of oil and gas. In Texas and Louisiana, for example, the severance and property taxes amount to about 23 cents per barrel of production.[10] Excise taxes are imposed on gasoline at a much higher rate than on other essential products and even then on many luxury items. Gasoline taxes already average 6 cents a gallon for the States and were recently raised from 3 to 4 cents by the Federal Government. Total excise taxes inflate the cost of gasoline by about 50 percent above what it would be otherwise. Gasoline tax collections are reported to have exceeded $4,600 million in 1958.[11] Some of the gasoline taxes are justified on the benefit theory of taxation, but the States divert substantial amounts to nonhighway uses. In addition, highways provide benefits for the general public and the national security that should be financed by general taxation. Therefore, gasoline bears an undue load of taxes that should be collected from other sources if the tax system were designed to be truly neutral in its effect on economic activity.

An expression of the taxes generated by domestic petroleum production provides an indication of the large current tax load on the industry. In 1958, excise taxes alone amounted to about $1.44 per barrel of domestic consumption of

[10] Texas Research League, "National Resource Taxation," Rept. No. 7, p. 9.
[11] New York Times, Aug. 23, 1959, sec. 3, p. 1.

petroleum products. Income tax payments on oil and gas production by producers and royalty owners are calculated to amount to 42 cents per barrel of domestic production on a typical operation that merely offsets depletion by the development of a corresponding amount of new reserves. Severance and other local taxes on production are estimated to average 21 cents a barrel. The total of these levies provides a minimum estimate of $2.07 as the tax revenue generated by a barrel of domestic crude oil production, not counting the indirect revenue created by other related activities of drilling, refining, transportation, and marketing. This burden of taxation on petroleum is quite heavy, although the essential nature of oil products to our economy would suggest that they should not be taxed more heavily than the products of other industries.

As stated previously, percentage depletion at existing rates has become a part of the economic structure of the industry. Evidence indicates that any advantage in tax treatment due to this provision has been passed on to consumers in the form of lower prices, as a result of competition, and has been offset by other tax levies. A reduction in depletion would force the price of petroleum products higher and discourage their use. These developments could not help but have an adverse effect on the entire economy. Therefore, percentage depletion should not be changed in the absence of conclusive evidence that a better system can be substituted to provide the necessary stimulus to the development of petroleum resources. The chances of improving on the long-established system of percentage depletion seem quite small. This conclusion was expressed by the President's Materials Policy Commission in the following terms:

In short, the device of percentage depletion as an incentive to minerals exploration is not without its limitations. But no alternative method of taxation has come to the Commission's attention or could be devised by the Commission which, in its judgment, promises to overcome these limitations and still achieve the desired results, particularly not without seriously dislocating well established capital values and other arrangements in the industries concerned, with highly adverse effects on supply. Taking the practical situation as it finds it, the Commission believes that any radical alteration of the existing tax arrangements would be undesirable.[12]

The need for careful evaluation of all the repercussions of any changes in percentage depletion was also recognized by the Special Cabinet Committee on Energy Supplies and Resources Policy in its report issued in 1955. The recommendation of this Committee on the subject of tax incentives was as follows:

Present tax provisions on coal, oil, and gas production have been an important factor in encouraging development of energy sources at a pace about in keeping with demand. Further analysis and study by the appropriate branches of the Government should from time to time be made to review the amount and method of making such allowances to maintain proper relationships with continuing changes in other features of the tax law. Any changes which may be proposed in the future must be analyzed in terms of their probable effect on development of domestic resources needed for economic progress and national defense as well as the fiscal and tax policies of the Government.[13]

THE FALLACY OF GRADUATED DEPLETION

Some critics propose a graduated reduction of percentage depletion according to size of gross income, with a rate of 15 percent if gross income exceeds $5 million a year. The proponents of graduated depletion contend that the present rate is justified for small operators because of the risks they take but that lower rates are justified for large companies because their size protects them against unusual risks.

The Treasury has estimated that the effect of this proposal would be 95 percent as great as a complete reduction of the rate to 15 percent on all production. Therefore, the plan appears to be a clever means of reducing opposition to the change by making it appear that the additional taxes would affect only big business. Actually the impact of the reduction would fall on millions of shareholders in corporations and on all consumers of oil products and gas. This plan would penalize shareholders in oil companies and place them at a disadvantage in relation to individual operators.

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[12] The President's Materials Policy Commission, "Resources for Freedom, Foundations for Growth and Security," June 1952, vol. 1, p. 35.

[13] Office of Defense Mobilization, "Report on Energy Supplies and Resources Policy," release No. 10987, Feb. 26, 1955.

The graduated depletion plan is fallacious because it assumes incorrectly that the risks of petroleum exploration and development differ according to the size of the firm. This misconception arises because of confusion over the nature of risks. The risk of being ruined or forced out of business seems uppermost in the minds of critics who propose a lower rate of depletion for large companies. But the real risk on each venture undertaken is not altered by the size of the concern making the expenditure. The loss in case of failure will be the same for the small operator who may have staked his entire capital on the well as for a larger firm. The only difference is that the probability of total loss for the larger firm on a number of ventures should be less than for a firm risking everything on one well. By proper selection of the type of ventures undertaken, however, and by securing participation by others on exploratory wells, a small operator can minimize his chance of suffering losses that force him out of the business. Neither the small operator nor the large firm can alter the chance of loss on a particular venture. The unusually high probability of loss is the real risk that makes petroleum exploration unlike ordinary investments and that warrants differential tax treatment.

Both small and large operators usually relate the size of the sums risked on different ventures to their resources in the same manner that any intelligent person would if required to gamble on a game of chance. The large firms producing more oil must risk proportionately more money than small ones in order to offset the depletion of their reserves caused by production. The large firm that has assets of a billion dollars and risks $100 million on exploration ventures will not be out of business if its efforts do not develop properties with an equivalent value, but it may well be worse off than if it had abstained from risking its money. Large firms unquestionably suffer substantial losses on many unsuccessful ventures, some of them quite expensive. If their financial reports show net earnings despite these losses, the explanation lies in the results realized from depleting the reserves developed by prior successful ventures. The economic worth of the firm may decline even while it continues to report some net earnings if its basic reserves are not being maintained by adequate success on current exploration.

The probability of success or failure for each exploratory well remains the same whether the operator has staked all his funds on it or is also engaged in drilling a hundred wells. The risks in the search for oil are so great that both small and large operators often find it prudent to take only part interests in expensive ventures so that no single failure will prove catastrophic. In fact, many wildcats drilled by smaller firms are supported by dry hole money from large firms. Nothing can be gained by encouraging imprudent management of risks and discouraging successful operators from expansion by a system of graduated depletion.

Advocates of graduated depletion claim that this change would be in keeping with the role of small and large companies in the discovery of new reserves. The theory that small operators discover most of the domestic oil is based on an inaccurate interpretation of the statistics with respect to the drilling of exploratory wells. Small operators drill a high proportion of exploratory wells relative to their production, but large companies do the major part of the expensive geophysical and geological exploration. If a small operator promotes the discovery well in a prospective area defined by the exploratory work of large companies and largely under lease to them, he is usually credited with the entire discovery although his participation may represent a relatively minor part of the new field. As noted previously, many exploratory wells drilled by small operators are supported to a substantial extent by dry hole money or other payments from large companies. Statistics on the number of discoveries also fail to bring out the fact that one major deep discovery by a large company, as in the case of expensive offshore fields, may equal in reserves many shallow discoveries drilled by small operators as a result of comparable outlays on numerous wells. Therefore, the relative role of small and large operators in the discovery of new reserves cannot be measured by statistics on the number of discoveries. Small operators unquestionably make an essential contribution to discoveries, but the efforts of the large firms are equally necessary. Therefore, all operators should continue to be encouraged to develop new supplies by the same rate of depletion regardless of their size.

The thesis that risk can be reduced by large companies to a matter of cost accounting is not supported by the facts. Reference has already been made to the wide variation in the new reserves developed by the industry as a whole relative

to wells drilled. The results are even more erratic for any firm, even a very large one, since no firm drills more than 4 percent of the wells. As stated previously, the true measure of success is not the proportion of total wells completed as producers but the value of the new reserves developed relative to the funds risked. By this measure, the large company takes the same risks as the small company and faces the same uncertainties. No operator, large or small, can predict his degree of success or purchase insurance that assures protection against the possibility of substantial loss on exploration and drilling. The risks in the business are so great that even large companies often find it desirable to engage in joint ventures, as is frequently the case for offshore drilling. These facts show that the theoretical case for graduated depletion is not supported by the practical realities encountered by the industry.

ECONOMIC CONSEQUENCES OF A CUT IN DEPLETION

Critics say that large additional tax revenues could be realized by reducing percentage depletion, but they seldom talk about the adverse primary and secondary effects of such a change. The Treasury Department has recognized that such effects would follow a change in depletion. Analysis of these effects will show that the proposed change would operate to reduce total tax receipts and to retard economic progress.

The Treasury Department has estimated that a cut in percentage depletion to 15 percent for petroleum might initially be estimated to bring in $390 million of additional income tax receipts. On the assumption that the primary effect of such a change would be to reduce dividend payments, the Treasury calculated that this gain would be offset to the extent of $65 million. These figures would indicate a theoretical gain of $325 million if there were no other consequences, but the Treasury noted that there would be other secondary developments that would also affect tax receipts.[14]

A cut in depletion which would increase taxes on petroleum production by $390 million would reduce drilling sharply. Operators would have to curtail drilling by at least 8,000 wells annually, based on an average cost of $50,000 per well, to offset the additional tax burden. Furthermore, the lower rate of return and the fear of still further reductions in percentage depletion would impair incentive to invest and also the ability of operators to secure outside capital from investors and lenders. Therefore, drilling might decline much more. At the current rate of about 50,000 wells annually, drilling is already down by 15 percent from 1956 as a results of other economic factors. If the long-term outlook for profits from production were now permanently affected by a cut in depletion, a further drop in drilling of about 25 percent might take place, causing well completions to decline by 12,500 wells annually. A decline in drilling of this magnitude would have serious repercussions on the use of steel and equipment for new wells, on employment of labor in drilling, and on development of new reserves of oil and gas. All of these developments would affect tax revenues adversely.

An estimate can be made of the major effects on tax receipts of a decrease in drilling due to a cut in depletion by considering what would happen to the development of new reserves. About half of all the wells drilled currently are completed as oil wells. A minimum reduction of 8,000 completions would mean about 4,000 fewer oil wells annually. New oil wells develop an average of about 125,000 barrels according to experience since 1945. Therefore, the minimum reduction in drilling would cut back the development of new crude oil reserves by about 500 million barrels of crude oil annually. The potential loss of tax revenues resulting from this change would be about a billion dollars annually on the basis of the figures discussed previously of $2.07 taxes per barrel levied directly on crude oil and its products. The loss in tax revenue following a cut in depletion could be much greater if drilling decreased by more than 15 percent.

A reduction in drilling would soon bring about shortages in domestic petroleum supplies required for economic progress and security. In such case, the United States would necessarily become more dependent on foreign oil, with all the risks and hidden costs of such course, or prices of petroleum products would have to rise. Representative Ikard has estimated that prices might be forced upward by 5 cents a gallon for gasoline if this product alone had to compensate for the additional taxes imposed by a reduction in percentage depletion.[15]

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[14] Congressional Record—Senate, Aug. 11, 1958, p. 15536.
[15] Congressional Record—House, June 24, 1959, p. 10743.

An increase of only a few cents a gallon would accelerate the trend toward economy cars and cause a further loss of tax revenue as well as far-reaching repercussions on the automobile, steel, and rubber industries. Taxes have already forced the price of gasoline to levels that meet resistance from consumers, as shown quite clearly by the rapidly increasing popularity of economy cars that realize much higher mileage per gallon. The point of diminishing return on gasoline tax collections has probably been passed already, so that measures designed to raise additonal tax revenue from petroleum are likely to be self-defeating.

A cut in depletion would present a serious threat to the rate of economic progress of the United States. Evidence has been cited previously to show that a gallon of oil provides the energy base for a dollar of income. Therefore, any action slowing down the annual development of crude oil by 500 million barrels, or about 20 billion gallons, would necessarily operate to reduce real income for the entire economy by a substantial amount. Part of the impact of such adverse development might be offset by larger imports or by substitution of other fuels at higher costs, but the net effect would still be serious.

The preceding review leaves little room for doubt that the full economic consequences of a cut in percentage depletion would be to reduce tax receipts and to retard economic progress. The United States cannot afford to embark on such a course, particularly at this time. Indeed, such action could lead to disaster in view of Russia's intensive drive to develop oil and gas resources and accelerate industrial growth in an effort to surpass the United States in economic and military strength.

CONCLUSION

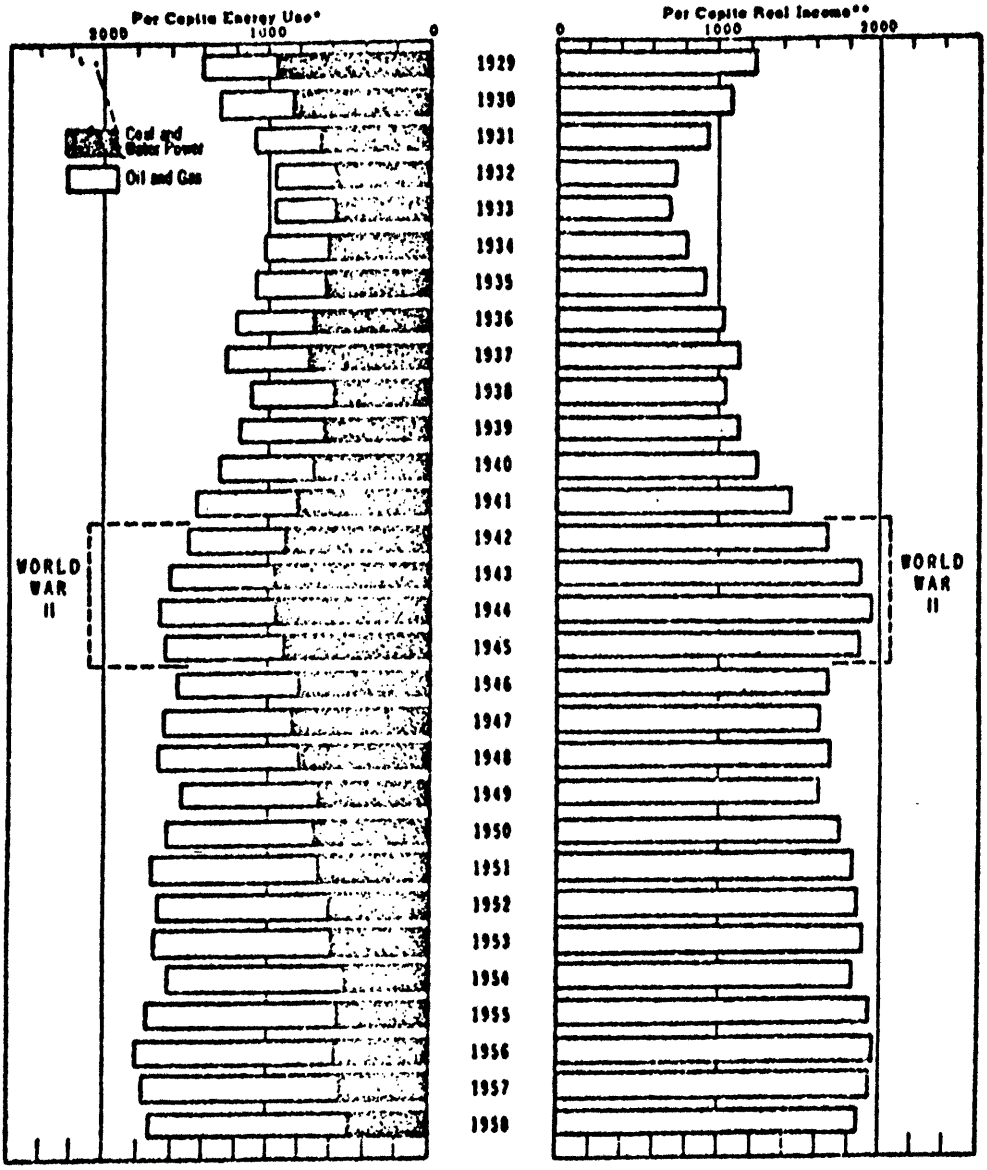
Taxation of mineral production is an extremely complex matter. Much of the popular discussion in favor of a reduction in percentage depletion overlooks many important points and is quite superficial. This paper has sought to call attention to points that should not be ignored in an objective evaluation of percentage depletion. The basic conclusion of this analysis is that differential taxation of petroleum production, such as that provided by percentage depletion, is required because of special circumstances of vital significance.

The issue of the proper rate for percentage depletion has been reviewed in both theoretical and practical terms. The evidence supports existing rates for oil and gas as an appropriate differential required to attract the amount of capital that needs to be risked in the search for new supplies in the interest of economic progress and national security. The encouragement to development of petroleum resources supplied by percentage depletion has been of incalculable benefit to the Nation and to every citizen in war and peace.

Vast sums of equity capital and borrowed money have been ventured in exploration and drilling for oil and gas on the basis that the existing rates of percentage depletion will be maintained, regardless of the changes up or down in basic tax rates. These rules have become a part of the economic structure of the industry, and have been a major factor in the availability of adequate supplies of petroleum at reasonable prices. Any change in the system will necessarily create adverse consequences for millions of investors, for all consumers of oil and gas, and for the Nation as a whole.

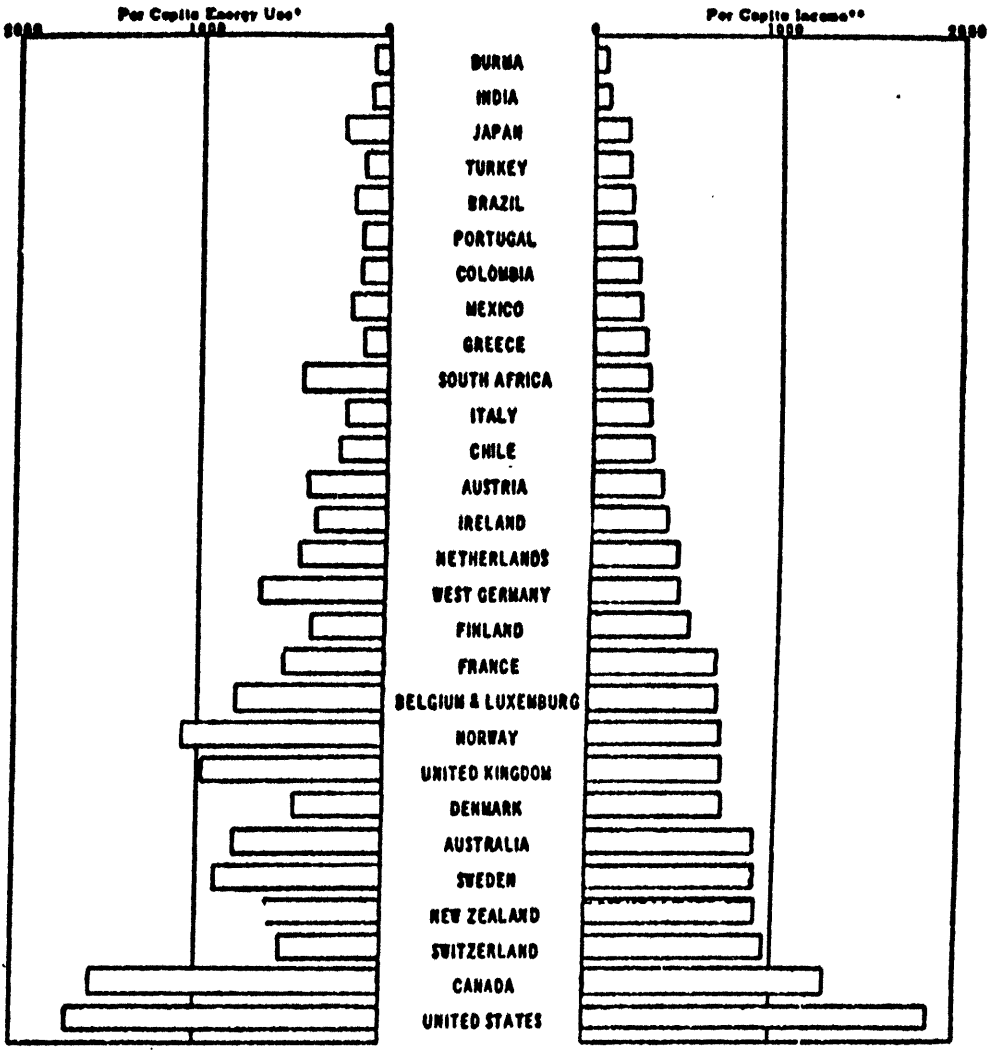
Impartial analysis of this problem by congressional committees in the past and by special governmental agencies, such as the President's Materials Policy Commission and the Special Cabinet Committee on Energy Resources and Supplies, has led to the conclusion that percentage depletion should be continued at existing rates because such action best serves the general public interest. The present analysis leads to the same conclusion. In fact, the conclusion can be carried further to say that a reduction in percentage depletion would not only hurt the entire economy but also adversely affect tax revenues. Therefore, the long-established system of percentage depletion should be continued in effect without change.

REAL NATIONAL INCOME AND ENERGY CONSUMPTION PER CAPITA HAVE BEEN CLOSELY RELATED IN THE UNITED STATES

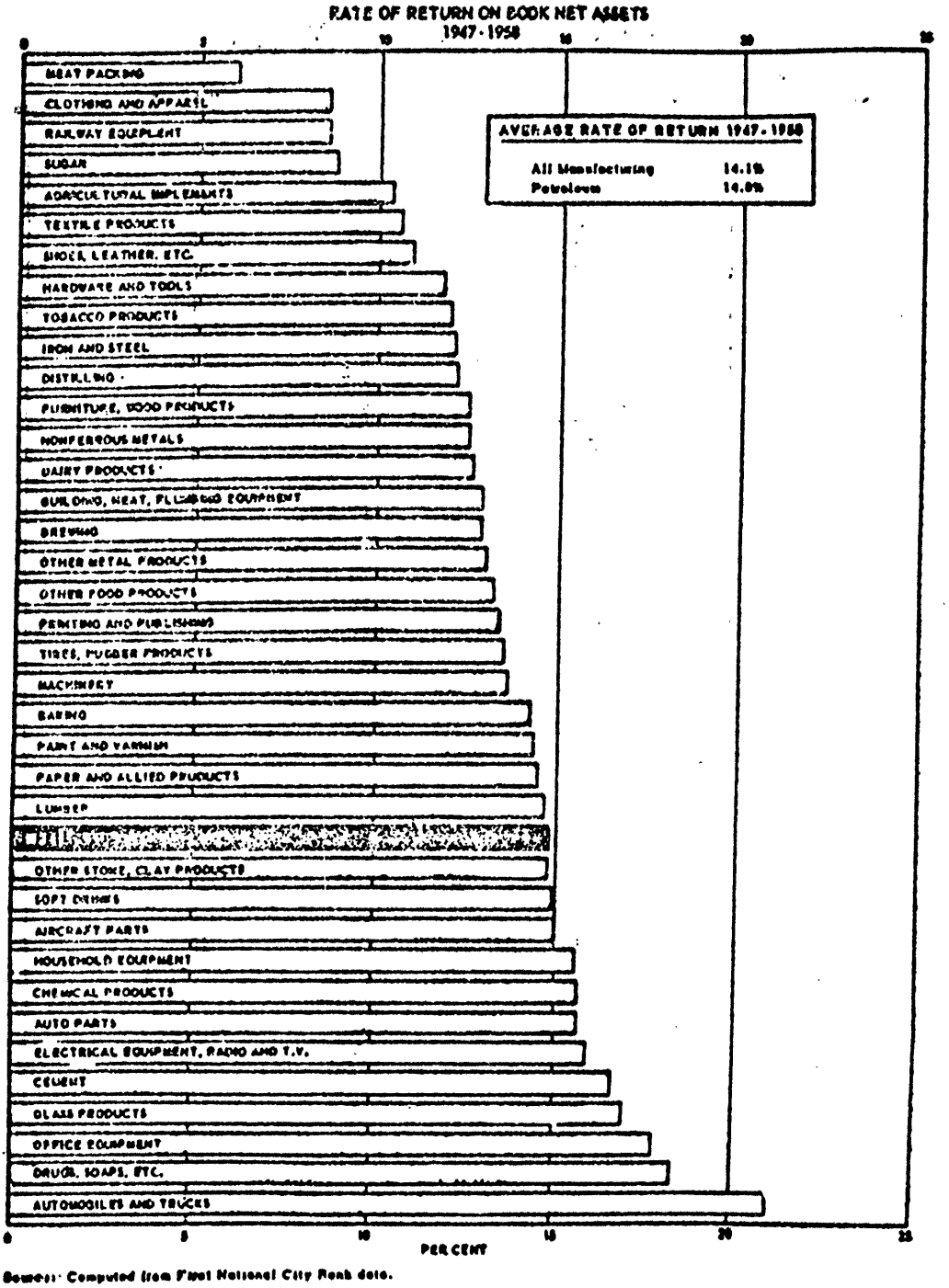


*Consumption of oil, gas, coal, and water power expressed in gallons of crude oil.
**National income in 1954 dollars.
Source: Bureau of Mines and Department of Commerce.

ENERGY CONSUMPTION AND INCOME
ARE CLOSELY RELATED THROUGHOUT THE WORLD



*Consumption of all forms of energy expressed in gallons of crude oil.
**National income measured in U.S. 1952 dollars.
Source: Joint Committee on Atomic Energy (1952 Data).



Source: Computed from First National City Bank data.

Mr. BEST. I think we will go to Professor Erickson—and I have to apologize to you professor, for the lateness of the hour. There are some important votes in the Senate this afternoon which are keeping the Senator occupied—I can tell you that your statement will be seen by all the Senators. I will make sure they see it.

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STATEMENT OF EDWARD W. ERICKSON, ASSOCIATE PROFESSOR OF ECONOMICS, NORTH CAROLINA STATE UNIVERSITY

Mr. BEST. Do you have other people that are going to accompany you?

Mr. ERICKSON. No. These are just other people who contributed additional input material in this statement, and I thought that it was appropriate to include them on it.

What I would like to do, rather than read the statement all the way through, is to talk about it a little bit, and then I think really the most productive part of the proceedings is the exchange of questions and answers afterward. And I look forward to getting to that stage of it.

Mr. BEST. However you want to summarize it would be fine.

Mr. ERICKSON. The one approach to energy policy that an awful lot of people unfortunately seem to take is to view it as a grade B Western movie in which the only question is to identify the good guys from the bads guys, and you can always tell the bad guys because they always have on black hats, and that is the oil industry. Now, I do not think that is appropriate, and that is particularly inappropriate in an issue which crops up very frequently, and that is the issue of competition in the energy markets.

The Federal Trade Commission now has a complaint. With regard to natural gas markets, one of the frequent arguments that you hear of why we cannot deregulate the wellhead price of natural gas is that they are not competitive.

I think it is important to distinguish between the tail and the dog, and not to let extraneous issues wag the energy policy dog. On some of those extraneous issues—well, they are not extraneous, because people really believe them—unfortunate I guess, would be a better term—are competition, the income distribution effects of raising the price of gasoline, our balance-of-payments problem, environmental considerations, tax problems, and as a part of the issue on competition, concern about what is frequently called the "independent" sector, and that policy ought to be tailored especially to preserve that sector more than it necessarily would exist under perhaps some alternative situations.

Now, if you think about competition one of the principle factors which determine the competitive market is the number of firms. The FTC complaint names eight major oil companies. In a different kind of accounting you might want to talk about 20 to 30 major companies, and that in itself is a very telling point.

Now, how many other major industries in the United States can you think of in which you think about the 20 major firms?

What about the 20 major automobile firms, the 20 major computer companies, the 20 major copying machine companies?

You just do not find very many industries where you have as many firms as you do in the petroleum industry, particularly as many firms which are surrounded by a large number of very vigorous, active, smaller firms, independents. So that on that score it seems to me that the industry at large and particularly the producing section of the industry is essentially a very competitive industry.

Now, this is on the basis of its structure. Now, this is borne out, if you look at the profitability in the industry and say, gee, if an in-

dustry is noncompetitive that means it has a monopoly power. The result of monopoly power is the earnings that the companies are able to capture, and ultimately those earnings show up as returns on stockholders' equity. If you look at my prepared statement I have a table there which compares the profitability for the 8 major petroleum companies against 10 large firms which are generally conceded to have some market power. And the average rate of return on stockholders' equity for those companies is 20.2 percent. The average for the eight major petroleum companies was, for the last year which there is data in the FTC report, 11.1 percent. That is a very striking difference.

If you make another comparison and go to my prepared statement looking at the comparison of the eight largest petroleum companies Moody's 125 industrials, you will see that in nearly all years the petroleum companies do worse than Moody's 125 industrials in terms of rate of return. The only years where they are consistently better were the first 3 years of that data series, 1951, 1952, and 1953.

And one way you could characterize that data series is that the long-range trend of the earnings of the petroleum industry as relative to Moody's 125 industrials has been down over that span of years.

Mr. BEST. One point on this. Is it not true that while the Federal income tax burden on the petroleum industry may be less than it is, say for a general manufacturer, that State and local taxes other than excise taxes, are significantly higher than they are in the manufacturing sector? So that the overall tax burden of the industry, considering the State, local, and severance taxes and so forth is probably on a par?

Mr. ERICKSON. Well, that is the finding of Mr. Lichtblau.

Mr. BEST. You are referring to his study.

Mr. ERICKSON. Yes, but you have a problem, though. The problem is essentially what do you do. If you define tax burden in that way that you are saying, then other Federal taxpayers are in effect subsidizing the oil-producing States which charge and collect severance taxes in lieu of the corporate income tax. So that it is true that the companies do pay taxes other than income taxes, however those taxes are specific.

Mr. BEST. But those States in turn are also supplying the energy resources for the rest of the Nation.

Mr. ERICKSON. Yes, they get compensated for that, though.

But Lichtblau does indeed have a point there.

Now, there is one other problem that you have looking at these rates of return and a couple of other camparisons that are useful. You might want to compare them to all manufacturing, or to Moody's 24 public utilities. When you do that the comparison works out essentially the way table 2 here shows.

The more interesting comparison, though, is to compare the rate of return that the major petroleum companies are able to earn on their stockholders equity to their cost of equity capital, because as you noted in table 1, in this Moody's 125 industrials there are some firms that do have market power, so that this comparison is a little bit—does not do exactly what you want it to do.

Now, if you look at the rate of return on stockholders equity as compared to the cost of stockholders equity, to the degree of accuracy that

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those numbers can be calculated they come out approximately equal, about 11.5 percent. Now, the power of monopoly, as we are observing with the Saudis right now, is the power to withhold. So that if you withhold output if you restrict output to increase your earnings, then you would expect to see a divergence between earnings on stockholders equity and the cost of stockholder equity, and we do not see that in the petroleum industry.

I have no hesitation in stating very strongly that in my opinion, looking at the structural and the behavioral and the performance data that are available to me, and there is a good deal of data available about this industry, is that the industry is effectively a very competitive industry. And you do not have to know very—a little commonsense observation is worthwhile here—you do not have to know very many people in the industry before you get a pretty high regard for the competence and caliber of the people that staff those companies. And if they were going to collude or conspire, they would certainly do better than 11.5 percent on stockholders equity. I have no doubt about that.

Now, it has been charged in various places that the joint bidding ventures in offshore exploration are a means by which the companies circumvent the antitrust laws, and this is a vehicle for them to engage in collusive activities. My associate Bob Spann and I reviewed all of the Federal lease sales from 1954 through 1973, and did some very detailed tabulations. And I wish that I had those typed up to include here, but I worked my secretary until 11:30 on Sunday night getting this typed to be reproduced, and I just did not have the——

Mr. BEST. I think the record will be open for a week or two.

Mr. ERICKSON. That is good. I just did not have the heart to work her past midnight to type those tables as well.

But if you look at tables 3, 4, and 5, they show some very interesting things. Table 3 covers the whole period 1954 to 1973, and I am sorry that it runs over onto two pages. It makes it a little difficult to look at. But the really interesting numbers in that table—they are all interesting—but the particularly striking and interesting numbers on that table are the number of firms in one-firm combines. That is a slight misnomer, but the number of firms in one-firm combines who are nonmajors. the percent of those single firm bids that are nonmajor bids—and these are winning bids only—and you find that roughly half of the winning bids are by firms that are not one of the big eight major companies.

And if you look overall, the last number in the table, the 44 percent, again approximately half of the—for the whole period—were by firms that were not either affiliated with the majors or majors themselves.

Now, if you look at 1973 and 1972 you see two things. The numbers vary a little bit, but in 1973 the number of single-firm nonmajor winning bids was 36 percent, and overall for both single firms and combines which did not include any majors, 75 percent. For 1972 it was 60 and 42 percent.

If you combine those two tables an interesting result emerges. In the combined 1972 and 1973 lease sales, 54 percent of all the winning bids were made by single firms or combines which included no majors. And this compares to an equivalent figure for the all 1954 through 1973 lease sales of 44 percent. So you had a 10-percentage point increase.

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Also in the combined 1972–73 lease sales, 57 percent of all single firm winning bids were made by nonmajor firms, and this compares to the equivalent figure in the 1954–73 lease sales of 49 percent. So that, looking at the two most recent sales years compared to the total track record shows that activity by nonmajors, successful activity by nonmajors has been increasing over time. And this supports, I think very strongly the position that Spann and I hold, that joint bidding arrangements, rather then being a mechanism of collusion or subversion of the free market, are actually a vehicle for entry to that line of activity, offshore drilling, and for risk-pooling, because there are large risks and tremendous sums of capital involved in mounting a successful offshore operation. And there are just—the charge that the offshore area somehow is uncompetitive just holds no water whatsoever.

The rate of return to activities out there is about equal to the competitive rate of return on capital. There are a large enough number of separate entities operating in the offshore areas sufficient to guarantee that you get a competitive result, and in fact you do get a competitive result.

If the firms were colluding, they are not insensitive to amounts of money in the magnitude of $100 million, which was paid recently for one 5,000-acre tract. They certainly would pay less than that. They would not put a billion dollars up front for the Alaska lease sale, for example, as they did, if they could avoid doing that. And they cannot avoid doing that, and the reason they cannot avoid doing that is because of competitive pressure, competitive pressure is too strong.

Mr. BEST. If you do not mind me interrupting?

Mr. ERICKSON. No.

Mr. BEST. You have made a very compelling case that the industry is competitive, both in terms of the number of entrants or the number of participants in the production and distribution stage. Now, let me ask you this.

Were it not for the intangible drilling expense provisions that they get, were it not for the mandatory oil import program which, while it had its defects, still served a purpose of preserving an independent industry, would this industry still be competitive?

In other words, the economists with the Ph. D.'s typically argue free markets, and they are totally opposed to subsidies on the grounds that this is a giveaway. But in fact it may be that the import policies, plus the tax policies, have preserved a very competitive industry which otherwise would be full of monopoly power.

Mr. ERICKSON. That is an interesting observation, and let me address it, and go back and recount a little bit of history and give you a little example.

Dr. Gonzalez, whom I respect very much, discussed some of the problems with market demand prorationing, and in my opinion that is one of the very important reasons for that decline in drilling trend that you showed.

Now, what happened in the late 1950's beginning in the middle of the 1950's was that the market demand factors were cranked down from—oh, say 70 percent average, which the industry was adjusted to—to as low as 28 percent—very severe and prolonged cranking down of those market demand factors.

Now, you do not have to be an expert in discounted cash flow analysis to know that if you stretch out the period over which you get the receipts from investment activity that the rate of return on that investment goes down dramatically. The time value of money works with a vengeance.

Now, the result of that was, as has been discussed—it has come up again and again here—was to make it relatively unattractive to explore and develop oil resources in the United States.

And at this point I would like to say if there is anything that the Congress could do to insure that we never see a repeat episode with prorationing, it would be very worthwhile. Although market demand prorationing as we have known it appears to be dead and gone and good riddance, the apparatus is still in effect. It is still on the shelf. And we still do not have mandatory unitization of oil reservoirs. And if there is anything in terms of a national energy policy that the Congress could do to encourage at least prospective, if not retrospect, mandatory unitization of on-shore reservoirs as well as off-shore, it would certainly be an important policy step in the right direction.

Mr. BEST. Could you just explain to me what mandatory unitization of oil reservoirs means?

Mr. ERICKSON. Well, the way conservation now works—although it is being internally reformed and improved—it still works this way, and it worked this way more vigorously in the past, was to look at the well as the unit of production for conservation regulations. Now, the well is just the teat on the reservoir, and it is the reservoir that is really the geologic and economic unit. And if you look at wells as the unit of production, and if the surface rights over a reservoir are fragmented so that the subsurface rights on that reservoir are fragmented, then you have a lot of different entities drilling holes into it and trying to take advantage of the rule of capture.

Now, it was in order to avoid the waste inherent in that that we adopted mandatory market demand oil prorationing, and that was in part a step in the right direction. But there was a better step we could have taken, and we still could take it. And that would be, rather than to look at wells as the unit of production, to look at the real unit of production, the reservoir, and to require that once a reservoir has been defined and enough wells are drilled so that we know what the outlines of it are and the producing characteristics—petroleum engineers are now sufficiently knowledgeable and their techniques are good enough that we can divvy what the property rights in there are according to the ownership or the fragmented ownership of the surface, but produce it as a unit rather than in a fragmented way.

Professor Stephen McDonald at the University of Texas is, I would say, the foremost academic economic expert on aspects of this problem. He recently wrote a book that was published by Resources for the Future, a 1971 book which you may want to refer to.

Now, back to the competitive question. We were talking about how we cranked down market demand factors, made domestic exploration and development of oil resources absolutely less attractive and relatively less attractive to foreign ventures. And what happened in the beginning or the middle of the 1950's as a result of that, in the middle of the 1950's up until that time the international oil industry had been the preserve of six or seven companies.

At that time, when the incentives changed you got all kinds of smaller medium-sized and even tiny U.S. companies expanding out into the world industry. And that is the best evidence that I can think of that shows three things: one, the essential mobility of resources in this industry; two, the vigor with which the smaller firms can compete, and the fact that they were competing out in the world, and three the world did not have a mandatory import quota. They could have competed in the United States as well, I am sure.

Now, does that address the point that you raised adequately?

Now, a lot has been said this morning about the desirability of allowing markets to clear.

Senator GRAVEL. Doctor, could you just hold on one second and let him just brief me real quick, because I want to get on track?

Doctor, why do you not go ahead now?

Mr. ERICKSON. A lot has been said today about the desirability of allowing markets to clear, and I certainly would strongly second all those sentiments that I heard in that direction, because the current situation we are now in, I think, is the most eloquent evidence available about the disastrous results of inefficacious regulatory activity, and the fact that bureaucrats and administrators are not able to allign incentives and get results as effectively as private individuals acting on their own volition with regard to the situation as they see it, and the incentives and inducements that face them.

Now, allowing markets to clear would have two beneficial effects, No. 1 on production and the other on consumption. In my own opinion, both supply and demand in this industry are reasonably responsive. I have done some econometric work, and you have to take all of that with a grain of salt. You get apparently precise results, you know, but you have to kind of hold those in your hand and weigh them and think about them, and what they tell you most—what they really are reliable for is giving you a good feeling about orders of magnitude. They allow you to systematically appraise the situation and get those kind of results.

I think that both demand and supply are relatively responsive, so that we could expect good effects on energy conservation as a result of demand response to higher energy prices and we could expect, I think, very substantial supply response as the drilling for natural gas as a result of higher prices in the interstate market—as is indicated by activity over the last year.

Now, at this point I want to get into some pretty deep water for me, and that is because I am going to talk about something that is really not in my area of expertise, and that is the political trading situation. But I think somebody needs to talk about it, so I will.

The depletion allowance and expensing intangibles—I wish Senator Ribicoff were here, because as evidenced by the line of questioning that Senator Ribicoff initiated this morning, it is a very sensitive issue and people react to that the same way they react to college professors and say, well, if you are so smart why are you not rich, you know, if the oil industry is so innocuous why does it have these tremendous tax benefits even though it is fully adjusted to them and the resources have flown in and after tax profits do not reflect any of those benefits because they get competed away in bidding for offshore acreage, and so forth.

Now nevertheless, that is a fact. People are upset about the depletion allowance and they are upset about expensing intangibles.

Now, Dr. Gonzalez, who I benefit a great deal from listening to because when he says something generally you want to pay attention to it. What he did some time ago—I have heard him talk in this vein on several occasions—has suggested—sometimes more strongly, sometimes less strongly—that tax incentives are somehow more powerful than prices in terms of stimulating response. And what that turns out to be is a testable hypothesis. There is plenty of data about the industry, and one can build an econometric model. Again, you have to take those results with a grain of salt. And test the hypothesis, if you change the incentives that the industry faces by a given percent, does it make any difference if you change them by 10 percent as a result of tax policy?

Or do you get a larger bang than if you change incentives by 10 percent as a result of price policy?

And Professors Spann and Millsaps and I have gone through that exercise, and to the best of our ability our result comes out—it has a certain commonsense appeal to it—it comes out, although it is couched in all kinds of fancy statistical techniques it comes out that an incentive is an incentive is an incentive. Sure enough, on tax policy, the deplention allowance and expensing intangibles have had a substantial effect on the willingness of the industry to find and develop and hold reserves. But if you talk about it as a percentage change, in incentives they are no more or less powerful than prices policy.

Now, we are currently in our current mass as a result of not allowing markets to clear—the tremendously complicating effects of Federal Power Commission regulation of the well-head price of natural gas, which does not give us enough natural gas on the one hand, and at the same time then shifts demands to fuel oils and aggravates the shortages there on the other hand—you know, that is pretty clear. We do not have to talk a great deal about that.

Is it possible to consider a trade-off?

Could we trade tax policy, the special tax privileges that the industry has, for a once and for all guarantee on deregulation both of the natural gas market for old and new gas—I would argue, to get the benefits on the demand side to the extent that contract provisions would allow—and also to decontrol the crude oil market—we are in the current situation when there is a shortage of crude oil in the United States and the price of crude oil in the United States is several dollars less than the landed price of imports right now. That just does not make any sense at all.

Could we rectify that by trading tax policy for allowing those markets to clear, for decontrolling those markets?

I would hope that we could.

Now, in the past if you talk about tax policy to the industry, even though it has been competitive, and they net after tax do not themselves get any of the benefits of those special provisions—they are passed through to U.S. consumers—if you talk to the industry about that they say, "Gee, boys, we do not want to do that. That is very bad."

And there is good reason for that. For example, if you bid $100 million for a 5,000 acre offshore oil tract on the basis of one set of

tax laws and then the tax laws are changed, that is just like drilling a hole into the vault and siphoning the money out. You are imposing a substantial capital loss on the companies.

However—well, let me amplify. With reserves to production ratio of 10 or 12 to 1, that drainage, that hemorrhage would have a long effect and would be very unpleasant, to say the least. I think that is the most euphemistic way to phrase that.

Now, however, those contracts that the companies are now in are also based on a set of price expectations, and we are at this moment undergoing a revolution in price expectations. Now, how much of a price increase would it take to compensate the industry for the removal of either percentage depletion or both percentage depletion and the expensing of intangibles?

Well, we calculated that, and it depends on what value of oil you think is implicit in the contracts that the industry now has and the producing arrangements that it now has. And I do not know. I have got two numbers, or two sets of numbers, one based on $4 oil and one based on $5 oil. Now, my guess is——

Senator GRAVEL. Are they in your paper?

Dr. ERICKSON. Yes, I know $5 oil, for example, is the kind of price expectations that the industry had in the 1973 lease sale. However, if you are looking at the weighted average of all of their current activity, some of that production is based on situations where they bid and paid bonuses and et cetera on $3 oil; so that a $4 figure might be more appropriate. I use it as illustrative. It might be representative as a weighted average.

If you are talking about $4 oil and you eliminated depletion, the price would have to go up to $4.70 to compensate. If you eliminated both depletion and intangibles, you would have to go up to $5.44 to compensate.

If you are talking about $5 oil as the base upon which you make this calculation, the price would have to go to $5.88, if you eliminated depletion; and $6.80 if you eliminated both depletion and intangibles.

Senator GRAVEL. Doctor you are presupposing that we continue the pricing policies that will be set by Government. Supposing we woke up tomorrow and these policies were not existent, and assume the price could rise to whatever the market conditions would tolerate.

The testimony we had from Treasury this morning was that the maximum would be about a 15-percent rise at the gasoline tank. That I do not think is a horrendous thing, and I do not think most citizens would view it as terribly horrendous.

We do not have the figures translating that back into the crude price, that you were talking about.

Dr. ERICKSON. Right.

Senator GRAVEL. But if we just let it go, will not it seek its level?

Dr. ERICKSON. Yes.

Senator GRAVEL. Supposing we took off depletion and let the free price go, then it would seek its level? In any regard, it will go up by itself to compensate for that deficiency?

Dr. ERICKSON. That is right.

Senator GRAVEL. It is a clearing process that will happen?

Dr. ERICKSON. That is correct, and in my opinion, that would be desirable. It may also be necessary——

Senator GRAVEL. Well, I know why it is politically desirable. It may be necessary in order to secure the free market situation.

But why is it desirable otherwise?

Dr. ERICKSON. Well, if demand curves slope down, and if supply curves slope up, which I think we all pretty much agree that that is the case, then imposing a depletion allowance shifts the supply curve out to the right. And in one of the appendices I have, a little graphical presentation which——

Senator GRAVEL. It has shifted to the left; less cost.

Dr. ERICKSON. I am sorry. I misspoke. It shifts the supply curve out to the right—I mean the left.

Now, if—no, it shifts it out to the right.

Senator GRAVEL. OK, I see that.

Dr. ERICKSON. Are there fewer financial costs per unit of resources; so if you are looking at it this way—you know, you have got price on this axis and quantity on this axis—and the higher the price, the more quantity; then if you impose a depletion allowance, it shifts the supply curve out to the right, and says at any given price, you get more output. And that is true. There is no doubt in my mind about that.

Senator GRAVEL. That is correct.

Dr. ERICKSON. However, then you have the question, is the depletion allowance a neutral or a nonneutral tax provision. Now, I will be quite frank. I do not know whether it is neutral or nonneutral. I do not think anybody knows.

Senator GRAVEL. Does not that go back to the question that you had posed earlier? Perhaps Mr. Best has a comment.

Mr. BEST. Let me just pose this question: What would happen to the competitiveness within the industry, the independents vis-a-vis the majors, if you were to go to a free market without any tax depletion or intangibles?

Dr. ERICKSON. There would be a couple of things happen. First of all, I think the industry would remain effectively competitive, that there would be enough firms. At the extreme margin, you might curtail the activity of some independents who are depending upon putting together drilling funds with tax money from dentists and things like that.

Senator GRAVEL. Which is substantial for independents, because they get out and hustle the people who want that expense off right now.

Dr. ERICKSON. Yes. But in my opinion, it is sort of like kicking motherhood to be saying uncomplimentary things about the independents. And so I say this with some trepidation.

There is all this talk that the independents find the oil, and the majors buy it; you know, and it is really the independent. They drill all the wells, and they find all the oil, and the majors are just kind of along for a free ride somehow, or something like that.

The Oil and Gas Journal said well, let us examine, and let us go back and, first of all, let us see where the oil is. Well, if you identify giant oil fields, the predominance of our reserves resides in a relatively small number of fields. The distribution of field sizes is very skew. And then you go back and say, who drilled those fields? Who drilled the

discovery wells for those fields in which the predominant share of our reserves lie?

You find that most of them were drilled by majors, and that is because to find those big fields—like Prudhoe Bay; who found Prudhoe Bay?—To mount those kind of exploration campaigns where you carefully gather a lot of geological information and shift it through, and then drill a well. And you get bad results, and to think about that for a while. And you are convinced that you are in an area where there ought to be some oil or gas, and you stay with it, and have a longtime horizon, and are willing to commit the funds on a longtime horizon, and knowing that what you are looking is the potential of a big field.

The people that do that, by and large, are the majors. So at the risk now of just sounding outrageous, I would say we could wipe out the independent sector, have only the 50 or 100 biggest firms left in the industry, and it would not be an earthquake. We would not be seriously affected by that.

The volume of discoveries would be about the same, and the industry could adjust to that. It would still be competitive.

Now, I do not think that would happen. I just state that as an extreme case. So that I guess my response to the question—if I remember it, I have been talking so long about this now—what the question was, was what about the independents and competitiveness.

It is two things. One, the independents at the margin, some of the fringe independents would be affected, but that would not be sufficient to reduce the fundamental competitiveness of the industry; nor would it seriously affect the overall performance of the industry in terms of the finding rate of new resources.

Is that responsive to your question?

Mr. BEST. Yes.

Senator GRAVEL. Is there a difference? Who does it impact on the most? If you cut out depletion, does it impact more upon the majors or the independents?

Dr. ERICKSON. Well, if you cut out depletion right now, it would impact most on the majors because they produce most of the oil, and depletion is a benefit that you get only as a result of producing oil.

Senator GRAVEL. Well, what would be the impact prospectively then?

Dr. ERICKSON. Well, I am not sure. If you did it prospectively, I guess it would be neutral.

Senator GRAVEL. Right. So you would not be damaging the private marketplace, but you would vector into a cleaner system by having a trade-off for a free market.

Dr. ERICKSON. That is right.

Senator GRAVEL. So maybe that would be the way to do it; if you wanted to put us in this position you would trade-off the depletion prospectively for securing a free market. That would be cleaner than doing away with depletion totally.

Dr. ERICKSON. Yes.

Senator GRAVEL. You would be altering existing financing plans.

Dr. ERICKSON. That is correct. Yes. However, it would not satisfy one of the problems though. One of the advantages of the proposal, as I see it, is that—almost the next question after it, people say you

cannot deregulate the markets because of those nasty, monopolistic oil companies. And they say, even if they were competitive and you deregulated the market, you would create a lot of windfall gains for them.

So that prospective removal of depletion would not answer the windfall question.

Senator GRAVEL. Well, that is what I had a question on, which I did not get to ask it of Dr. Gonzalez. That was where he talked of—let me read it to you—where he said that—

> The appearance of sharply higher profits from rapid liquidation of old reserves accumulated years ago at a time when the purchasing power of the dollar was much greater then now reflects reduction of capital values, and the effects of inflation, rather than true economic income.

That is probably not accepted by a majority of Congress, nor the people in this country.

Dr. ERICKSON. Now, my feeling about that is, there is some merit in what Dick was saying but that applies to other industries as well as the oil industry. The tobacco industry in Durham has got warehouses that they built at the turn of the century, which are fully depreciated, and they were built with $1,900.

So that I fail to see how that cuts, in terms of making investment in the oil industry, either more or less attractive than investment in tobacco processing or chemicals or what-have-you.

Senator GRAVEL. Well, you are right. And now real estate values go up, and he can charge more than for a building that has a higher replacement cost. But with the oil industry, that would be excessive windfall profits, and should not be done.

Dr. ERICKSON. You have another problem with the windfall business is, suppose you believe the numbers that I have in there earlier about the rate of return in the oil industry relative to all manufacturing. Let us suppose the rate of return on all manufacturing is 12½ percent, and the rate of return in the oil industry is 11½ percent.

If the oil industry rate of return went up to 12½ percent, would that extra percent be an excess windfall profits; or how would you treat that?

Senator GRAVEL. Do you have in your text a chart showing the comparability between oil company profits——

Dr. ERICKSON. I do have table 2, which shows the comparability between the 8 major oil companies and Moody's 125 industrials; and then table 1, which compares the same 8 major oil companies with 10 large industrial concerns.

Senator GRAVEL. Now, your data here is from where? Moody's? Would you explain to us the phenomenon, which I have asked myself time and time again; why with the existence of this, there is a general feeling in the Nation that reasonable people react just like Pavlov's dog when you mention oil companies, like there is a ripoff?

Dr. ERICKSON. You know, there is a strong populist history in the United States, and bigness is confused both with monopoly and with badness. And you know, the oil companies are undeniably absolutely very big, even though each one is small relative to size of the total industry. And that is, I think, the best explanation I can give.

It is unfortunate that that clouds the discussion of rational public policy as much as it does, but it does.

Senator GRAVEL. Has the growth been as a product of foreign activities—historically often the oil companies, like Standard Oil, were busted up at the turn of the century?

Has the growth of all companies been the product of foreign activities, or domestic activities?

Dr. ERICKSON. Both.

Senator GRAVEL. Now, Exxon's growth, is that more attributable to its world position, or its U.S. position?

Dr. ERICKSON. It depends on what period you are talking about. If you are talking about the first half of the century, I would say to its U.S. position. If you are talking about the post-World War II era, a very substantial component of Exxon's growth would have to be as a result of its world operations. Although, I do not——

Senator GRAVEL. Well, Exxon is the second largest corporation in the world. General Motors being the first.

Dr. ERICKSON. Yes.

Senator GRAVEL. I wonder what it was in 1945.

Dr. ERICKSON. It is an interesting question. I would have to confess I do not know the answer. I would guess that Standard Oil of New Jersey has been in Fortune's Top 10 since Fortune has been publishing a top 500.

Senator GRAVEL. Good. I saw this in an API publication, but I am glad we also got it from you as a source. You might be more creditable than the entire API association that we are using on the floor. I am sorry to make that reflection.

Have you given any thought to this phenomenon in public policymaking. That is apparently what saddled the whole effort with respect to what has happened with the Defense legislation we have. It has been thwarted through several administrations. And today with the dilemma we have it is not clear whether or not people will react intelligently on this subject or react with propensity to fear, and hit the whipping boys even harder?

Dr. ERICKSON. My own response to that is to say, thank you for the opportunity to be here, so that I can at least say my piece, and I hope, shed some light.

Senator GRAVEL. That may be good therapy for you and for me and for him, but I do not know what it is going to do for the rest of the country.

Have you any thought or comments on the Btu tax, that we were talking of as a device to fund an energy trust fund? Have you given any thought to that area?

Dr. ERICKSON. Yes. My feeling about that, Senator, is that after I heard you talk this morning, is that—at the very last page of the direct statement, I have got a half a dozen reasons why I think the kind of trade between allowing markets to clear and elimination of special tax privileges that the industry now enjoys might be what we have to do.

And I would add a seventh, which would be it would increase the revenues of the Federal Treasury, and would be a source of funding for the kind of research program that, I agree with you, we need.

Now, whether or not that ought to be in the form of a trust fund or not, I have to admit, I have got some reservations about that.

Senator GRAVEL. Let me ask you something about the competitive market situation. Right now, things are getting desperate, and they will be considerably more desperate 45 days from now. And the advice that some of us will give will be that we need an open market. We need the markets to clear.

And the response to that will be that, well, things are so bad that we do not dare do it. What we need is Government to do it, because not only is there a latent disbelief or lack of faith in the ability of the price system, but there is also the credibility problem.

Do you think that if we went to an open market situation, without rationing, we could handle the trauma of let us say a 25-percent shortage, Arab-induced shortage?

Dr. ERICKSON. I am not sure whether the shortage is going to be as large as 25 percent. I have seen the number in the newspaper. I wish that I had a copy of the study which—I believe it was information that Senator Jackson requested from the Library of Congress, where they talk of a 35-percent shortage; and under the best possible situation no less than a 20-percent shortage.

And I have sat down and tried to figure out how those numbers were arrived at. And I have trouble getting a shortage that is as large as 20 percent. Making some reasonable assumptions like we continue to get two-thirds of what we used to get from Canada, and that Venezuela does not go out, and the refinery yields hold up; I think that the outside numbers may be in the range of 15 to 20 percent.

Now, that is just a very back in the envelope calculation, I have to admit. And I believe—I am not sure that the market can handle that. I think it could have handled it if we, in the summer, had said that that is what we were going to rely on. But to talk about rationing and allocations and all those sorts of things right up until the time of the crunch hits, and then not to impose them, but to rely on the market may strain the market substantially, because people just would not have done the necessary forward planning, which takes at least a matter of months.

I do think, though, that if we are only talking about a, say, 10-percent shortage, that the market could do that quite well, that prices would rise, and we would get substantial adjustments; and we could roll with that in a nonadministered way, in a voluntary way, where everybody made their own individual choices.

And Senator Hansen's hometown folks did not have to go out of business.

Senator GRAVEL. Well has the administered price in the Persian Gulf, and let us say in Africa, which is above $10, has it been translated into our economy at this point in time?

Dr. ERICKSON. No.

Senator GRAVEL. OK. So when that becomes translated into the economy, would not prices rise in any event?

Dr. ERICKSON. That is correct.

Senator GRAVEL. Either that or the oil companies are going to get out of the business awful quick.

Dr. ERICKSON. And if we rely on a tax, it does not create any stimulus for increases in domestic supply, and everybody agrees that we have got to have increases in domestic supply.

A good friend of mine, a former professor who—he is originally a Rumanian, now a naturalized American—had in the Rumanian Government a position that I guess would be equivalent to being Secretary of Commerce in the United States, observed to me once that there is a peculiar thing about the American public, and that is that if we are faced with the situation where we have to eat a lump of something unpleasant, instead of swallowing it down in one gulp and getting it over with, we ask for a demitasse spoon, and eat it slowly and in small quantities.

Prices have got to go up. Everybody agrees that they have beneficial effects on supply. Everybody agrees that they would have substantial effects on demand. Just look what is happening in the automobile market right now; people talk about the love affair of the American with his automobile. And I regard that to be about like his love affair with his first wife.

If the price of gasoline went up, we would see not only adjustments in the kind of cars that people buy, but the number of cars that they buy and how they use them. So why do we not do it, unless we are going to go to a totally administered economy.

Senator GRAVEL. But that is the threat that we face in the short-run panic that may exist in January and February the advocates of regulation will be there. In fact other committees are not talking about less regulation for gas, they are talking about more regulation for gas.

Dr. ERICKSON. Sure.

Senator GRAVEL. And there is rationing, and there is no end to it. And still the criticism of industry is that they are ripping it off.

Dr. ERICKSON. Regulation, particularly of a competitive industry, is a very funny situation. A noted economist has likened it—James McKie has likened it to the famous Joel Chandler Harris story about the tar baby; that is that regulation is in effect a tar baby. If you touch the free market in one place, and then you have to touch it somewhere else, and then somewhere else, you ultimately end up all stuck up with it, and not having accomplished the objectives that you set out to accomplish in the first place.

Mr. BEST. Are you aware of any studies of the State-by-State effects of gas regulation? In other words, what would be the effect of continued strict or even stricter regulations on natural gas prices on a State-by-State basis?

Have there been any studies on that?

Dr. ERICKSON. Well, I am aware of one such situation; that is in my home State of North Carolina, which is a nonproducing State, where we are using a lot of natural gas, and it is for industrial uses, and it is interruptable. And if this whole situation continues, North Carolina is really going to be hurt badly.

Mr. BEST. What about States like Connecticut, Minnesota, or Illinois. Have there been any studies of the impact of stricter controls?

Dr. ERICKSON. Not that I am aware of, although I would imagine that somebody at either the AGA, or the National Petroleum Council must have, and would be worrying about that problem.

Senator GRAVEL. If we could get such studies, I think it would be helpful.

Mr. BEST. I think the Senators from some of those States ought to know the effects of the alternative policies.

Dr. ERICKSON. I certainly agree.

Senator GRAVEL. From your experience, how difficult would it be, let us say, to get a study like that for the New England and North-Central area?

Dr. ERICKSON. I do not think it would be terribly difficult. It could not be done before the end of December. You would probably be talking about a 90-day study. Suppose you were going to put in the maximum, whatever resources it took to get it done; you would still, I think, be talking about a minimum timelag of 90 days from the time that you decided to do it.

Mr. BEST. What would be the logical source for getting such a study?

Suppose we asked the Federal Power Commission, would they really be in a position to study the effects of their own policies objectively?

Senator GRAVEL. No.

Dr. ERICKSON. They are not the agency.

Senator GRAVEL. Mr. Freeman, who was an excellent witness, demonstrated that to us.

I am sorry, I did not hear your answer. But where else could we go besides the Federal Power Commission? Supposing that the Federal Power Commission made information available to this committee and that we had consultants, what would it take to do that?

Dr. ERICKSON. Well, off the top of my head, one of the places you would go, I would say, would be to the State public utility commissions. They may be able to give you much better information than the Federal Power Commission.

I would not rule out going to the Federal Power Commission, but I would certainly get information from both places. You are talking about the New England States. You are talking—and say the Middle Atlantic States as well; Pennsylvania, New York. You are talking about 10 States.

Senator GRAVEL. Do you know a good consultant in the field that would do this for us?

Dr. ERICKSON. Yes. I could recommend a couple.

Senator GRAVEL. Would you get those names, and contact them and see if you can get back to Mr. Best. And we will see if we cannot scrape up the money somewhere, and find out what is involved.

He knows a couple of consultants that might be able to do this.

Mr. BEST. Are you familiar with the work of Professors MacAvoy and Pindyck?

Dr. ERICKSON. Yes. I am very familiar with them.

Mr. BEST. Do your conclusions from your own studies more or less concur with their results?

Dr. ERICKSON. Yes. I have read those results, and talked with Paul and Bob about it. And again, you have to consider in light of how I feel about econometric work, that you can answer questions like, if you raise the price of natural gas a lot, will you get a lot of new gas, a little new gas, or hardly any new gas.

Senator GRAVEL. Well, maybe I am confused. But yesterday when we were talking to one of our witnesses on establishing an econometric model, I thought that this would also be a way to inventory everything that is going on at the same time.

Dr. ERICKSON. It is.

Senator GRAVEL. So not only does it give you magnitudes, but it gives you data to make judgments, which unfortunately, we do not have. It gives data with the necessary accuracy to make our best judgments.

Dr. ERICKSON. However, Paul's model would not be useful for the problem we were just talking about. He talks about the 10 major wholesale markets for natural gas, but I do not think that he would have readily available a breakdown on a State-by-State basis within a consuming area, like New England, for example.

I do not believe so, but he might.

Senator GRAVEL. He is testifying tomorrow.

Let me ask you a question. What do you think it would take to have an econometric model to cover everything? Here we have a society, a cybernetic society, that is totally dependent upon energy for survival and the quality of life. What would it cost to have an instrumentality that would measure and integrate all facets of this, so that we would know what is going on?

$100 million?

Dr. ERICKSON. No. It would not cost that much. You would probably be talking in the neighborhood of several hundreds of thousands of dollars, or more.

Senator GRAVEL. And then you would set up a system?

But let me say if we are defining what I think we are, we would have a system where we would have input from all facets of society; dealing with all facets of energy; with all facets of pricing; and all facets of choice. And this data would be available to Government and, of course, to the private sector. Think what it would mean to the private sector in making the private sector more efficient—in having a general pool of information so that people could make more intelligent decisions.

Mr. ERICKSON. It would be very useful, yes.

For example, it would be very useful to have a better idea. One could press the responsiveness of the demand for gas. I know that Hank Houthakker and Phil Verleger have been working very hard on that problem at Data Resources, and have some ideas about it.

The way they have gone about the problem isn't the only way it can be done, and it is always desirable to try and approach things from a couple of different ways and see if you get roughly the same answers; and that gives you more confidence in the answers you do get, if you do triangulate. And we now do not.

And I do not know—I am pretty much abreast of what is going on—and I do not know anybody other than Hank and Phil that are working on the problem. And it seems to me ridiculous that more people are not engaged.

Senator GRAVEL. Well, if we are lucky we will get them some money. But we are stupefied by the amount, the small amount of money, compared to what would result in an immeasurable benefit to society.

Mr. ERICKSON. I will have to say I am not personally disinterested in your concern about that because presumably if substantial funds were available on that line of inquiry I would be involved somehow, and I would be very happy to be.

Senator GRAVEL. Well, good. If we had disinterested people testifying before Congress, we would never have any testimony.

Can you think of any other questions?

Mr. BEST. Just one final thought on the idea of establishing some independent commission of scientists, engineers, economists who would study the whole question of alternative sources of energy and perhaps give the administrator of an agency who is responsible for research and development advice on the most efficient way of spending money in the short term, in the medium term, and in the long term.

Do you see the need for that type of a thing?

Mr. ERICKSON. Yes; I see a real problem.

To come back to that type of thing we were just talking about; that is, if you just talk about policy planning analysis, we seem to be only doing two different kinds.

One is what are we going to do next month; and the other is what are we going to do in 1985. And nobody seems to be spending an awful lot of time worrying about 1974 through 1978, and those years are going to be on us pretty soon and somebody ought to get to work on them.

And the kind of advisory group that you suggested, I think, would be very useful.

Senator GRAVEL. What about having an advisory group for determining policy considerations? What about the possibility of putting out contracts to private areas based on the percentage of the money spent—one could even fund adversaries? In other words, fund the kind of work you do—you are funded through some device or educational institution or whatever. There are a lot of people that do the same thing.

But if funding were easier, you might not have to attach yourself as an appendage to an educational institution—which may not be bad—but you could operate independently. Some people who might get tired of one facet of industry and who want to be a consultant for awhile, could make some very interesting and independent studies, evaluating what you are doing as part of public policy.

In other words, to chart public policy, go do it; but what happens is that there is a loss of a check and balance. That is why the private sector is so good, because there is already somebody out that wants to beat you to make the profit, and that is why there is a discipline that is built in.

So why do we not do this sort of thing in the public sector? We do not have that built-in discipline, except for the hearing process and the imperfections of congressional action—which is manipulated through bureaucratic size or the administration.

One of the ways to maybe circumvent that and reestablish a check and balance is, as we expand these moneys, to set up adversaries or fund adversaries to go out and act as a force against these negative tendencies inherent in the public sector.

This would have an automatic effect, if for no other reason than that their expertise and their ego would lead them to prove that the policy is wrong.

Mr. ERICKSON. Yes; I am on the board of directors of two public interest groups, Tax Analysts and Advocates and Taxation with Rep-

resentation; and they are in serious financial difficulty. So I am sure that they would certainly like——

Senator GRAVEL. That is exactly what I am driving at.

There are a lot of people that want to go do this, and that would act as a discipline on Government.

You think that would be beneficial?

Mr. ERICKSON. Yes; I think it would be beneficial.

Of course, you do not want to generate just noise; and there is always the danger of that happening. And off the top of my head, I cannot advise you on any kind of good administrative rule of thumb for knowing when you are going to, how to establish the mechanism for this funding so that you get the maximum amount of good input and a minimum amount of noise—you always want some noise; just like bankers are not maximizing if they do not make some bad loans. They never intend to make any bad loans, but in retrospect, some of the loans turn out bad, then you would get some noise out of it.

But you want to be very careful that you are not just subsidizing dissent for dissent's own sake. What you want is reasoned criticism and alternatives.

Senator GRAVEL. That is a valid criticism, but that is the same thing that people in a democracy seeking public office do. You get some good ones and you get some bad ones and you take your chances. That is the frailty of democracy, but it also provides checks and balances. That is just built into any system with human beings.

Very good. I will personally read your testimony in great detail. I am sorry I missed the full presentation of it. But I deeply appreciate your coming forward and testifying; and maybe later on when we have a bill to focus on, you might come back.

Mr. ERICKSON. Thank you very much. I certainly enjoyed being here.

[The prepared statement of Professor Erickson, with appendices follow. Hearing continues on page 259.]

STATEMENT OF EDWARD W. ERICKSON, ASSOCIATE PROFESSOR OF ECONOMICS, NORTH CAROLINA STATE UNIVERSITY; THOMAS J. GRENNES, STEPHEN W. MILLSAPS, ROBERT M. SPANN, HERBERT S. WINOKUR

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COMPETITION IN THE U.S. PETROLEUM INDUSTRY

Competition in the United States petroleum industry is an important topic in the policy discussions surrounding the current energy crisis. Concern over this subject runs the gamut from the marketing of gasoline through refining,

pipelines, oil production, the field markets for natural gas and the activities of traditional petroleum companies in other energy areas such as coal and nuclear power.

In our view bigness is unfortunately confused with monopoly power. This confusion clouds the consideration of rational policy responses to the current energy crisis. The discussion of the competition issue generates a great deal of emotion on both sides of the question. It is too much to expect that we will be able to settle the issue here. It seems to be a permanent feature of political economics. We do, however, hope that we can convincingly illustrate with hard facts some of the reasons why, in our analytical judgment, the U.S. petroleum industry is effectively competitive.

Our analysis will center upon two main areas. The first is the record of long-run profitability in the U.S. petroleum industry. Profitability is an important index of the existence and exercise of market power. The record of long-run profitability in the U.S. petroleum industry indicates that the firms in this industry do not enjoy substantial, systematic market power. This index of effective competition yields positive results whether the comparison is to all U.S. manufacturing, Moody's 125 Industrials, Moody's 24 Public Utilities, or a group of industrial firms known to possess market power.

The second area is the record of bidding for offshore acreage. This second area is particularly important for a number of reasons. First, a common pactice in offshore bidding is for firms to enter joint bidding partnerships for particular tracts. It has been alleged that this practice is motivated by attempts at collusion rather than to pool risks in a competitive economic environment. Second, offshore areas represent a very important component of new natural gas and crude oil supplies. It is important that we be satisfied that this significant portion of the industry is in fact effectively competitive. Third, a major cause of the current energy crisis is the cumulative effect of Federal Power Commission ceilings on the wellhead price of natural gas. This is a striking example of regulatory failure and regulation induced shortage.

It appears that the only permanent solution to this problem is Congressional action to deregulate the field markets for natural gas. But before this can be done, it must be demonstrated to Congress that these markets are effectively competitive. The offshore market is a prominent illustrative case. Our analysis indicates that the markets for offshore acreage and the output from productive offshore leases are effectively competitive.

Profitability

Market power shows up as economic profits. The U.S. petroleum industry has not earned the kind of long-run returns on stockholders' equity that are to be expected for firms that enjoy substantial, systematic market power. Recent profits of the petroleum industry have been much higher than the long-run average. This is in part a result of the energy crisis and its attendant shortages. The energy crisis has been policy induced and is not a result of market power. In addition, the recent percentage increases in profit performance of the industry have to be gauged against a normal base year, adjusted for inflation and compared to the profit performance of the general U.S. economy. Even when these adjustments are made, there may still remain a transitory component which is the result of the energy crisis itself. For purposes of discussion of long-run policy responses, the appropriate measure of profitability is a long-run measure.

Table 1 compares the overall average profitability of the eight major petroleum companies named in the FTC complaint[1] with ten large industrial concerns generally conceded to possess some market power. The comparison indicates that each of the non-petroleum firms earns more than the average for the eight major petroleum companies. The average for the ten non-petroleum firms is 20.2 percent. The average for the eight major petroleum companies is 11.1 percent. The ten-company non-petroleum average exceeds the average for the eight major petroleum companies by 9.1 percentage points, or 82 percent.

[1] These companies are Exxon, Mobil, Texaco, Gulf, Shell, Standard of Indiana, ARCO, and SOCAL.

TABLE I

A Comparison of Rates of Return on Stockholders' Equity between Ten Selected Large Firms in Concentrated Industries and the Eight Major Petroleum Companies, 1972:

Firm:	
General Motors	17.8
Xerox	23.4
IBM	18.7
Burroughs	15.4
Bristol-Myers	17.8
Eastman Kodak	20.4
Kellog	22.3
Proctor and Gamble	19.1
Pfizer	17.7
Eli Lilly	29.8
10-company average	20.2
Average for eight major petroleum companies (1971)	11.1

Table 2 compares the rate of return on stockholders' equity for the eight major petroleum companies with the average for Moody's 125 Industrials on a year by year basis from 1951 to 1971. In 16 of 21 years, the average for the eight major petroleum companies is less than that for the firms that make up Moody's 125 Industrials. Moreover, in eight of the ten years covering 1962–1971, the rate of return for the eight major petroleum companies was less than the return for Moody's 125 Industrials. In one year, 1967; they were equal. In only one year, 1970, did the return for the eight major petroleum companies exceed that of Moody's 125 Industrials—and then by only six-tenths of one percentage point, or 5.8 percent.

In the eleven years prior to 1962, the rate of return for the eight major petroleum companies exceeded the rate of return for Moody's 125 in only three years. These were the consecutive years 1951, 1952 and 1953. On average then, the long-run trend in the return on stockholders' equity for the eight major petroleum companies has been down relative to Moody's 125 Industrials. This points up an interesting anomaly with regard to the use of concentration ratios. On the basis of concentration ratios and other data, the FTC has charged the eight major firms to be anti-competitive. Assuming that there are no errors in the FTC data, the concentration ratios do show an increase in concentration in the 1960's. But this is inconsistent with the profitability data. This highlights the difficulty of drawing inferences from gross concentration data alone and underlines the necessity of appropriately defining markets.

The profitability comparison holds up whether the basis of the comparison is the ten selected firms, Moody's 125 Industrials, all U.S. manufacturing industry or Moody's 24 Public Utilities. In addition, when the rate of return on stockholders' equity for the eight major petroleum companies is compared to the cost of equity capital, the indication is that these firms are operating in a competitive industry. (See Appendix A for more details on these comparisons.)

TABLE 2.—COMPARISON OF RATES OF RETURN

Year:	Moody's 125 industrials	8 largest petroleum firms	Year:	Moody's 125 industrials	8 largest petroleum firms
1971	11.2	11.1	1960	10.8	10.2
1970	10.2	10.8	1959	11.6	9.8
1969	12.2	10.8	1958	10.2	9.6
1968	13.0	12.4	1957	13.2	13.1
1967	12.4	12.4	1956	14.3	14.1
1966	14.2	11.6	1955	15.4	13.7
1965	13.7	12.1	1954	13.2	12.8
1964	13.3	10.5	1953	13.4	13.9
1963	12.4	11.5	1952	13.2	13.6
1962	11.6	10.7	1951	14.6	15.3
1961	10.5	10.4			

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Offshore Lease Sales

It has been charged that joint bidding ventures in offshore lease sales are evidence of a collusive pattern in the petroleum industry which escapes the surveillance of the antitrust authorities. This charge is inconsistent with the record of profitability for the industry (both on offshore activity and in aggregate) and the actual pattern of bidding behavior. The evidence is consistent with the proposition that the industry is in general effectively competitive—and particularly so with regard to offshore activity.

In our opinion, joint bidding is a vehicle for pooling risks involved in offshore operations and serves as a vehicle which enhances entry into offshore activity by relatively smaller firms. This opinion is consistent with an analysis of offshore lease sales by Professor Jesse W. Markham.[2] Markham found that there was no statistical evidence that joint bidding reduces the number of bidders and that joint bidding is not inconsistent with an increase in the number of bidders and the average bid.

This evidence is also consistent with a more detailed analysis of the actual bidding patterns and the rate of return on assets committed to offshore activity. (See Appendix A for a discussion of the rate of return to offshore activity.) We have analyzed the record of bid patterns for joint ventures.

The patterns for winning bids are summarized in Tables 3, 4 and 5. These tables show percentage bids in each category that were made by firms or groups of firms which contained no representatives of the eight major petroleum companies.

TABLE 3.—JOINT VENTURE BIDDING PATTERNS FOR WINNING BIDS, 1954–73 SALES

	Number of bids	Percent nonmajors
Number of firms in combine:		
1	1,121	49
2	356	24
3	145	43
4	206	46
5 and over	69	77
Overall	1,897	44

As Table 3 indicates, approximately half of the winning bids were made by single firms or combinations of firms which included no representative of the eight majors. In addition, almost half of the single-firm winning bids were made by non-major firms. This evidence is not consistent with a situation in which the major firms are able to enforce collusive bidding arrangements as a result of their participation in joint bidding ventures.

TABLE 4.—JOINT VENTURE BIDDING PATTERNS FOR WINNING BIDS, 1973 SALES

	Number of bids	Percent nonmajors
Number of firms in combine:		
1	11	36
2	14	71
3	10	80
4	38	87
5 and over	31	74
Overall	104	75

[2] Jesse W. Markham, "The Competitive Effect of Joint Bidding by Oil Companies for Offshore Lease Sales," in *Industrial Organization and Economic Development* (Boston: Houghton Mifflin, 1970), Jesse W. Markham and Gustav F. Papanek, editors, pp. 116–135.

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TABLE 5.—JOINT VENTURE BIDDING PATTERNS FOR WINNING BIDS, 1972 SALES

	Number of bids	Percent nonmajors
Number of firms in combine:		
1	63	60
2	52	27
3	39	41
4	24	25
5 and over	14	50
Overall	192	42

Tables 4 and 5 confirm the results of Table 3. In 1972, percent of all winning bids were made by non-major firms and 60 percent of winning single-firm bids were made by non-major firms. In 1973, 75 percent of all winning bids were made by non-major firms and 36 percent of all winning single-firm bids were made by non-majors. This is not evidence of collusive bidding patterns.

When Tables 4 and 5 are combined and compared to Table 3, an interesting result emerges. In the combined 1972 and 1973 lease sales, 54 percent of all winning bids were made by single firms or combines which included no majors. This compares to the equivalent figure for all 1954–1973 lease sales of 44 percent. Also, in the combined 1972–1973 lease sales, 57 percent of all single-firm winning bids were made by non-major firms. This compares to the equivalent figure for 1954–1973 lease sales of 49 percent.

These comparisons indicate that for a large number of firms entry is possible into offshore activity, that joint bidding is not always necessary for such entry but that it is a facilitating factor, and that entry has occurred over the 1954–1973 period. (These conclusions are also supported by a similar analysis of second and third place bids.)

Out of a total of 776 joint ventures which submitted winning bids, only 91 (or 12 percent) consisted of majors alone. But 295 (or 38 percent) consisted of non-majors only. One-half of all joint ventures consisted of both majors and non-majors, but the turnover in bidding partnerships was significant. There were no winning combines in excess of three firms which consisted only of majors. These data are a very strong indication that offshore activity is undertaken in a very competitive economic environment.

PRICES AND TAX POLICY IN THE U.S. PETROLEUM INDUSTRY

The general incentives which encourage discovery and development of oil and gas reserves in the United States include oil and gas prices and tax policy. (See Appendix C for a discussion of the details of tax policy incentives.) The petroleum industry enjoys special tax advantages. These tax provisions are often grouped together under the general heading of the depletion allowance, but they include other tax arrangements in addition to percentage depletion. These tax advantages had a positive effect upon the level of reserves that are discovered and developed in the United States. However, the same net effect that is achieved through tax policy in combination with prices could be achieved by prices alone.

A competitive industry can be expected to adjust to tax policy. New resources should enter the industry until there is no differential between the industry's after-tax earnings and the competitive rate of return for the U.S. economy. This is what our profitability analysis indicates. Nevertheless, the industry can be expected to resist attempts to eliminate the special tax advantages which it enjoys. Why is this the case? With regard to the U.S. petroleum industry there are several reasons. These include:

1. Adjustment costs to adapt to the new tax framework;
2. Uncertainty with regard to whether the new framework, if it is just a partial step in the direction of tax parity with other U.S. industry, is only one step in a process which can be expected to continue and,
3. Long-run losses on existing contracts which were made on the basis of the capitalized benefits of the existing tax system.

Only the third consideration, long-run losses on existing contracts which include special tax advantages in their terms, is of concern here. We have a healthy

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respect for the ability of the industry to adjust—if only they knew what the permanent rules of the game were going to be. The second consideration can be made moot by adopting initially a complete adjustment to full tax parity with the rest of the U.S. economy.

The long-run profitability of existing contracts also depends upon the relation of actual, realized prices to the price expectations upon which the contracts were negotiated. If realized prices exceed expected prices, the contracts are more profitable. If realized prices fall short of expected prices, the contracts are less profitable. We are now undergoing a revolution in real price expectations. The price expectations of six months, a year and longer ago are no longer even in the ballpark. But in order for these new price expectations to be realized, markets will have to be allowed to junction. The existence of the depletion allowance and its related tax provisions are a stumbling block for beneficial movements in public policy. This is because otherwise sensible people who are opposed to the depletion allowance on equity or efficiency grounds seize upon extraneous issues. The competition issue is an example. In order for markets to be allowed to function so that demands and supplies are equated and shortages eliminated, it may be necessary to compromise on the depletion allowance. This should be done before the revolution in price expectations is completely capitalized into new contracts. Now is an opportune time.

What is the economic trade-off between the depletion allowance and the price of crude oil? This is a complicated calculation based on the expected present value of exploration and development activity. (See Appendix B for the precise mathematical formulation.) The results, however, can be easily summarized. Assume that contracts were negotiated on the expectation of $4.00 a barrel of oil. Then, to maintain the profitability of long-run contracts, the following prices would have to be realized:

In the absence of percentage depletion alone, $4.70 a barrel oil; and,

In the absence of both percentage depletion and expensing of intangibles, $5.44 a barrel oil.

Both of these values are now well within the range of current price expectations. However, some recent contracts may have been negotiated on the basis of $5.00 a barrel oil. What price adjustments would be required to compensate for the removal of the special tax advantages the industry enjoys for these contracts. On the basis of $5.00 a barrel, the adjustments would be approximately as follows:

In the absence of percentage depletion alone, $5.88 a barrel oil; and,

In the absence of both percentage depletion and expensing of intangibles, $6.80 a barrel oil.

These price adjustments are clearly on the border, if not within, the range of current price expectations. Moreover, most current production was not developed on the basis of expectations of $5.00 a barrel oil. Much of it was developed on price expectations more in the neighborhood of $3.00 a barrel oil. Therefore, even if some properties were to experience capital losses on the basis of sunk costs incurred on the basis of $5.00 a barrel oil, it is more than likely that, on average, these losses would be made up on gains from other oil.

Prices can compensate for the elimination of the special tax provisions the industry now enjoys.

A PROPOSAL TO INCREASE ECONOMIC EFFICIENCY AND IMPROVE THE U.S. ENERGY BALANCE

The U.S. petroleum industry is effectively competitive. In the absence of constraints, the free market forces of supply and demand could be expected to provide us with an efficient allocation of resources. But we do not now enjoy such a situation. Perhaps the most glaring example of this is in the market for natural gas. Prices are too low and are artificially depressed by the Federal Power Commission field market ceilings. The effects of the natural gas shortage exacerbate other dimensions of the energy crisis. The effects of the ceilings are vividly demonstrated in Table 6. What we might enjoy in their absence is illustrated in Table 7. The numbers in Table 7 should be regarded as illustrative of orders of magnitude only. The discoveries volumes are consistent with geological information, but the price series is already out of date (the revolution in price expectations) and too low.

TABLE 6.—NEW, NONASSOCIATED NATURAL GAS DISCOVERIES, NEW CONTRACT PRICES, AND VOLUMES UNDER NEW INTERSTATE CONTRACTS

	New, nonassociated discoveries (TCF)	Cents per MCF	
		New contract price	New contract price in 1958 dollars
Year:			
1953	8.5	13.3	15.1
1954	11.0	11.7	13.1
1955	6.8	14.4	15.8
1956	13.5	14.8	15.7
1957	13.8	16.9	17.3
1958	12.3	18.6	18.6
1959	10.3	18.4	18.1
1960	9.3	18.2	17.6
1961	7.0	17.9	17.1
1962	6.8	17.5	16.5
1963	9.4	17.0	15.9
1964	5.4	16.2	14.9
1965	7.1	17.4	15.7
1966	5.4	17.4	15.3
1967	3.7	18.6	15.8
1968	1.2	19.0	15.5
1969	1.7	19.7	15.4

Source: Foster Associates and American Gas Association.

TABLE 7.—PROJECTIONS OF NONASSOCIATED NATURAL GAS PRICES AND REQUIRED DISCOVERIES, 1972-85

	Real price (cents per MCF)	Nominal price (5 percent a year inflation)	Required discoveries [1]
Year:			
1972	43.5	43.5	13.0
1973	46.1	48.4	14.3
1974	48.9	53.8	15.7
1975	51.8	59.9	17.3
1976	54.9	66.6	19.0
1977	58.2	74.1	20.9
1978	61.7	82.5	23.0
1979	65.4	91.8	25.3
1980	69.3	102.2	27.8
1981	73.5	113.7	30.6
1982	77.9	126.5	33.7
1983	82.6	140.8	37.1
1984	87.6	156.7	40.8
1985	92.9	157.8	44.9

[1] Required annual discoveries of ultimately recoverable nonassociated natural gas (trillion cubic feet).

In the presence of an energy crisis, the situation is complicated. As a result of the regulation induced shortage of natural gas, poor planning with regard to the relaxation of oil import quotas, environmental and other restrictions on the production and consumption of coal, the effect of emissions controls on automobile gasoline mileage, growth in the economy and the Arab oil embargo, the demand for domestic oil production has increased substantially.

At the same time, there are price controls on U.S. crude oil. There has been some relaxation of these controls with respect to "new" oil production, but the average price of U.S. oil is nevertheless held below that of alternative imported oil. Thus, there is an effective quasi-ceiling price on U.S. oil production. The result is excess demand for U.S. oil at the going market price. The excess demand for U.S. oil production represents a shortage at the going market price.

Some policy makers have suggested additional tax incentives for the industry as a means of eliminating the shortage. Additional tax incentives, if they were sufficient to eliminate the shortage, *would* induce an increase in domestic supply. The effect of such a tax subsidy induced supply shift in terms of inefficient resource allocation would be to increase the social cost of the depletion allowance (and related tax provisions) from an amount equal to about $300 million a year to a much larger amount.

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An alternative policy which would be consistent with conservation of scarce energy resources (the tax subsidy induces increased consumption), elimination of the shortage and efficient resource allocation would be to eliminate simultaneously the depletion allowance and the ceiling prices. Such a move would curb tax subsidy induced consumption and expand domestic supply.

The depletion allowance is a political as well as an economic issue. It could well be that the only way to achieve the benefits of market clearing prices in domestic field markets for oil and gas is for the petroleum industry and its spokesmen to compromise on the depletion allowance. In effect, the industry might be able to trade the depletion allowance for deregulation of the wellhead price of natural gas and decontrol of the field market price of crude oil.

In this connection, the industry is currently in a unique position. Existing contracts have been written in such a way that they include within them both a given historical set of price expectations and the capitalized value of the depletion allowance. With no change in prices, elimination of the depletion allowance would create capital losses for the domestic industry. At the moment, however, historical price expectations are increasingly obsolete and a substantial upward revision of anticipated prices is occurring. Thus, the industry is in an economic position to trade away the depletion allowance without incurring short-run losses or adjustment costs. The social benefits of such a trade would be substantial. These benefits would include:

1. Elimination of the regulation induced shortage of natural gas;
2. Permitting the domestic supply of oil to respond to across the board increases in domestic oil prices;
3. Use of the price mechanism to ration oil usage and restrict consumption to that amount at which marginal social costs and benefits were equal:
4. Removal of the depletion allowance as a confounding and acrimonious element in the debate about national energy policy;
5. Defusing the issue of windfall gains as an objection to allowing market prices to become equilibrium prices; and,
6. Improvement in the efficiency of resource allocation.

At a time when the United States is teetering on the brink of prolonging the energy crisis through expansion of inept government controls of fuel markets, such a trade appears especially advantageous.

APPENDIX A

COMPETITION IN THE FIELD MARKETS FOR NEW NATURAL GAS SUPPLIES

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SUMMARY

We have examined structural, behavioral and performance aspects of the U.S. petroleum industry with special reference to field markets for natural gas.

We conclude that in the context in which public policy for natural gas field markets is being set, that the appropriate market definition is a national one. This definition means that concentration ratios for gas supplies are consistent with a competitive industry. Economists often quarrel with regard to the spatial, temporal and product market definitions which underlie concentration ratios. Concentration ratios are also only a partial measure of the effective competition in an industry. We therefore also examine behavioral and performance aspects of the industry.

The performance analysis involved comparing the return on stockholders' equity for the eight major petroleum companies to—

The average for Moody's 125 industrials;
The average for all manufacturing industry;
The average for Moody's 24 utilities; and
The cost of equity capital for these companies.

The conclusion from these comparisons is that the petroleum industry is effectively competitive.

An analysis was also performed on bidding behavior for offshore tracts in the Gulf of Mexico. Many of the bids were made by joint bidding ventures. A discounted cash flow investment model was used to predict bonus bids per acre. Observed bids slightly exceeded predicted bids for the 1972 and 1973 lease sales. This evidence, plus an analysis of bidding partnerships and the record of entry into offshore activity, strongly indicates that the industry is effectively competitive. This evidence is in direct conflict with others' allegations to the contrary based on less sophisticated analysis.

The problems of consequences for consumers of deregulation of natural gas field market prices and the creation of a national energy company are also briefly discussed. The conclusions are that a national energy company, even on the scale of TVA, would only make a marginal long-run contribution to the natural gas supply problem and would make no immediate contribution. In addition the consumer consequences of natural gas field market price deregulation would be higher

prices, but these prices would allow relatively smooth consumer adjustments, would limit necessary abandonments and curtailments, and would call forth substantial new gas supplies.

Our major conclusions are that natural gas field markets are effectively competitive and that the most efficacious solution to the natural gas dimensions of the energy crisis is deregulation of the wellhead price of natural gas.

1. There is a shortage of natural gas reserves and production.

2. This shortage is a result of a variety of factors. Some of these factors include:

Shortages of refinery capacity and crude oil inputs;

Shifts of fuel demands to natural gas;

Federal Power Commission ceilings on the wellhead price of natural gas; and

Uncertainties about the future of regulation of the wellhead price of natural gas.

3. Regulatory reform is a necessary ingredient for a long-run solution of our natural gas shortage.

4. The question of competition in the field markets for natural gas was an important issue in the early, formative years of regulation.

5. Competition in the field markets for natural gas is now a critical issue in the discussion of regulatory reform.

6. The question of competition is an emotional one. This emotion often shows through in statements about the presence or absence of competition. (See for example the statements of Dr. John Wilson before various Senate committees and Appendix A of this statement.)

7. Because of the emotion involved, it is desirable to use empirical analysis to generate light as well as heat.

8. Empirical analysis involves more than simply counting up numbers. Empirical analysis involves framing questions as testable hypotheses. The numbers are then used to test the hypotheses. Whether the test results are positive or negative determines whether a hypotheses is accepted or rejected.

9. Analysis of the degree of competition centers on three areas: structure, behavior, and performance.

10. Analysis of the degree of competition must also include definitions of the product, the industry, the geographic market, and the temporal market.

11. The definitions of product, industry and markets are critical to an analysis of structure. By misdefinition of the relevant market in one direction or the other, such structural indices as concentration ratios may be made arbitrarily high or low. There has been more heat than light shed by analysis of concentration ratios for various dimensions of natural gas field markets.

12. New supplies of natural gas should be the focal point of concern.

13. In the absence of regulatory reform which rejuvenates the domestic search for conventional sources of new natural gas reserves, the long-run solution to the natural gas shortage will more rapidly include imported LNG and domestic SNG. If the solution to the natural gas shortage includes imported LNG from the Soviet Union and SNG from Illinois and western coal in, say, 1980, then the relevant concentration ratios for new supplies of conventional natural gas should not be limited to uncommitted reserves (shelf inventories) in the current year in a narrowly defined area.

14. This broader definition of the geographic and temporal market for new supplies has one important drawback. New supplies of conventional sources of natural gas are, by and large, undiscovered supplies. It is impossible to compute a concentration ratio on something that does not yet existin marketable form. Fortunately, a proxy exists. This proxy is the concentration ratio for current production. Current production reflects the cumulative record of past additions to reserves through discoveries and development. On the basis of concentration ratios for current production, and relative to the rest of the American economy, field markets for natural gas are not very highly concentrated.

15. The problem of drawing conclusions from concentration ratios is compounded by the fact that there is no widely accepted, unique level of concentration which unambiguously separates "monopoly" from "competition."

16. The Congress and the Courts are familiar with the ambiguities of concentration ratios and the rhetoric on one side or the other particular industries in particular proceedings. Because of this, it is desirable to examine the behavior and performance of industries.

17. In the context of natural gas field markets, the most frequently discussed aspects of behavior include:

Inter-firm relations in joint bidding combinations for offshore acreage, and

Affiliated relations between interstate pipeline companies and their producer subsidiaries.

18. Performance in natural gas field markets is difficult to separate from the overall performance of the whole petroleum industry. A relevant dimension of performance involves the relation between price and long-run marginal costs. Rates of return on investment provide an index for this relation. Some data exist for offshore operations. Other data exist for the overall industry (production, transportation, refining and processing, marketing and distribution). Thus it is possible to look at two indices of performance:

Overall long-run profitability for the whole petroleum industry, and

The rate of return to offshore activity.

19. Empirical analysis of behavioral and performance dimensions of natural gas field markets indicate that these markets are effectively competitive.

20. Offshore production of natural gas now accounts for almost 20 percent of total production. Offshore areas are even more important in terms of prospective new supplies. Thus, offshore activity is an important test case for competitive behavior.

21. It has been alleged that the prevalence of joint bidding ventures in offshore exploration is evident of collusion. " . . .[T]here is little or no substantive difference between the end result obtained from the formation of a bidding combine and the end result of a conspiratorial agreement to rotate bids."

22. There are at least two possible explanations for joint bidding ventures: collusion, and risk pooling.

These explanations are not perfectly mutually exclusive, but the patterns of partnership in joint bidding can reveal which is dominant.

23. If joint bidding ventures are collusive, one would expect to see the following pattern:

Stable bidding partnership relations (to minimize the transaction costs of collusion),

Similar firms bidding together (because collusion, not risk pooling, is the dominant motive), and

Potential entrants to offshore activity excluded from joint bidding ventures with the larger firms (to preserve the field for the members of the colluding set).

24. If joint bidding ventures are principally a method for pooling risks, one would expect to see the following pattern:

The incidence of joint bidding increase as firm size decreases (i.e., defense against gamblers' ruin),

A heavy incidence of joint bidding partnerships between unlike firms (to take advantage of dissimilar risk preferences), and

Smaller firms using joint bidding ventures as a vehicle for entry into offshore activity (because the field is open and attractive).

25. The observed patterns of bidding partnerships is most consistent with the hypothesis that joint bidding is a means of risk sharing. The patterns are:

There is turnover from year to year in the membership of bidding groups and market shares are unstable,

The most frequent bidding group is a combination of majors and smaller firms, but majors bid alone and so do smaller firms,

Single firm bids are frequently made by the largest firms, but other firms are also successful single firm bidders, and

Bidding groups which contain a large number of firms are predominantly composed of smaller firms.

For example, in 1973 there were four successful one-firm bids by non-majors. In the two 1972 lease sales, there were thirty-two sucessful one-firm bids by non-majors and twenty-five successful one-firm bids by majors. With regard to the fourteen two-firm bidding groups in 1973, ten had zero majors, one had four majors and none had two majors. With regard to the forty-two two-firm bidding groups in 1972, fourteen had zero majors, thirty-two had one major and six had two majors. In 1973, there were two seven-firm bidding groups with no majors and one eight-firm bidding group with no majors. In 1972, there were two nine-firm bidding groups composed of one major and eight non-majors. Also

in 1972, there was one eight-firm bidding group composed of one major and seven non-majors. There were three seven-firm bidding groups in 1972. Two of these groups had no major and one had one major.

26. There would be no surer way to limit offshore exploration to a few of the largest firms than to require that all bids be made by single firms with no joint bidding permitted.

27. Interstate pipeline companies have affiliated producer subsidiaries. This is a cause for concern to many observers because they correctly presume that transactions between affiliated parents/subsidiary companies may not be completely at arms length. This concern should increase:

As the fraction of sales between affiliated companies increases as a percent of total market sales, and

As the requirements of any parent pipeline company are increasingly supplied by its subsidiary producing company.

28. The percentage of total market sales that is sales between affiliated interstate pipeline/producer subsidiary companies is now relatively low. The percentage of interstate pipelines' requirements that are met by their own producer subsidiaries is also now relatively low. But, in the absence of regulatory reform, these percentages can be expected to increase. Even in the presence of regulatory reform, these parent/subsidiary relations between interstate pipelines and their affiliated producing companies will continue to cloud the issue of competition in the field of markets for natural gas. These relations could be severed by:

Direct legislation, or

Appropriate use of cost based regulation to create incentives for divestiture.

Severing the affiliated relationship between interstate pipelines and their producer subsidiaries could be accomplished in a way which would work no financial hardship on the pipeline companies. Moreover, such divestiture would not have any adverse effect on the social efficiency of natural gas field markets.

29. Bigness is often confused with monopoly. The petroleum industry is a large industry, and the firms within it are also large. Effective monopoly results in a divergence between long-run marginal costs and prices. Prices in excess of long-run marginal costs (including a competitive return on invested capital) result in excessive earnings. These excessive earnings are reflected in higher than normal, above average rates of return on stockholders' equity capital. Thus, the rate of return on corporate stockholders' equity capital is one measure of the presence or absence of market power in the petroleum industry.

30. The Federal Trade Commission has recently issued a complaint which charges the major oil companies with monopoly practices. In the FTC complaint, rates of return are discussed. Rate of return data is relevant to a discussion of whether or not the earnings of companies contain evidence of the exercise of monopoly power. In our judgment, a careful examination of the rates of return for the major oil companies does not indicate evidence of monopoly earnings. Instead, rate of return data indicate that the major oil companies earn a competitive rate of return. In addition, rate of return data indicate that the petroleum industry has been getting more competitive in recent years.

31. For the period 1961–1971, on average, four of the eight major petroleum companies earned a lower rate of return on stockholders' equity than the average for all manufacturing industry. Four of the eight major petroleum companies earned more than the average for all manufacturing. Thus, the rate of return experience for the eight major petroleum companies has not been atypical with respect to all manufacturing. As with any average, some earn above the average and some earn below the average.

32. For the period 1961–1971, on average, six of the eight major petroleum companies earned less on stockholders' equity than the average of Moody's 125 industrials. Two of the eight major petroleum companies earned more than the average for Moody's 125 industrials.

33. If the period is expanded to include the years 1951–1971, there is evidence that the profits of the eight major petroleum were higher (relative to all manufacturing industry and Moody's 125 industrials) in the earlier years of 1951–1960 than they were in the later years of 1961–1971.

34. For the years 1951–1971, five of the eight major petroleum companies earned more on stockholders' equity than the average for all manufacturing industry. Two earned less.

35. For these same 1951–1971 years, five of the eight major petroleum companies earned less on stockholders' equity than the average for Moody's 125 industrials. Three earned more.

36. Relative to the averages for both all manufacturing and Moody's 125 industrials, the eight major petroleum companies were more profitable for the 1951–1971 period than for the 1961–1971 period. This could only occur if they were more profitable in the years 1951–1960 than in the years 1961–1971. Profitability has been decreasing. To the extent that decreased long-run profitability is an index of increased competition, the profitability indices indicate that the petroleum industry has been becoming more rather than less competitive. (This indication is consistent with, for example, the record of entry into offshore activity.)

37. Long-run profitability is the appropriate measure of competitiveness. Petroleum firms have had dramatic increases in profits in recent quarters. Two points must be made with regard to these profit increases. First, a substantial portion of petroleum firms' profit increases are the result of regulatory failures. The chief contributing factors were: (1) failure to relax mandatory oil import quotas in an orderly and expeditious fashion; (2) the regulation induced shortage of natural gas production and reserves; and (3) the subsequent effect of environmental controls to shift fuel demands to natural gas and to prolong the shortages of refinery capacity and refined products. Second, these petroleum firm profit increases must be standardized for inflation and compared to the profit increases in other sectors of the economy. After such a standardization and comparison is made, petroleum firms' recent short-term profits are not extraordinary when viewed relative to the backdrop of the total economy. Rather, they are the signals that in a well functioning economy would cause resources to flow into this industry and ultimately return profits to their long-run levels.

38. Comparison to averages such as Moody's 125 industrials and all manufacturing industry may be misleading. This is because some of the non-petroleum firms in these averages may possess market power. This makes the averages themselves higher than the normal, long-run, competitive rate of return. There is a way to correct for this. A standard procedure in regulatory proceedings is to calculate the cost of equity capital for the particular firm(s) in question. Earnings on equity capital are then compared to the cost of equity capital.

39. Modern, sophisticated analysts typically calculate a range for the cost of equity capital. This is because a range is more reliable than point estimte. Using standard techniques for the years 1967–1971, the range for the cost of equity capital for the eight major petroleum companies is 10.3 to 12.3 percent. The midpoint of this range is 11.3 percent.

40. For this same 1967–1971 period, the average earnings on stockholders' equity for the eight major petroleum companies were 11.5 percent. Within the limits of the precision of such calculations, the earnings on stockholders' equity (11.5 percent) and the cost of equity capital (11.3 percent) are approximately equal. This is what we would expect in an effectively competitive industry operating in an economy with well functioning capital markets. The rate of return data indicate that the eight major petroleum companies are part of a competitive industry and are themselves earning the competitive rate of return. If simple monopoly power or more complex collusive behavior were an important feature for the petroleum industry, one would expect it to show up in the rate of return data. It does not.

41. The rate of return data examined here do not indicate that the petroleum industry has been competitive in all times or in all places. It is well known that some of the classic American antitrust cases involve the petroleum industry. One of the costs of maintaining a competitive economy is constant surveillance by the antitrust agencies. But the recent rate of return do indicate that this surveillance has paid off—at least with respect to the petroleum industry.

42. There is another possible diffculty with regard to rate of return analysis when it is applied to large, integrated companies operating in several distinct markets. This possible difficulty is that the companies may have monopoly power in some markets, but not in others. In such a case, monopoly earnings in some markets may be used to subsidize less than competitive earnings in other markets. The effect could then be an overall rate of return on equity capital equal to the cost of equity capital with monopoly earnings in some markets surmerged in the overall average. (Such a situation leaves unanswered the

question of why a company not regulated on a rate base, fair rate of return standard would persist in operating in a market in which it was earning less than the competitive rate of return. We pose this question, but do not consider it further.) The market in question in these hearings is the field market for natural gas. An important component of the field market for natural gas is the offshore area in the Gulf of Mexico. Nearly 20 percent of our total natural gas production comes from this offshore area, and this area will be even more important in the future. Fortunately, a good deal of data exist which allows the application of rate of return analysis to the offshore area in the Gulf of Mexico.

43. In order to determine if the rates of return in the Gulf of Mexico offshore area are competitive and typical of the competitive rate of return earned by the petroleum industry, we analyzed the available data. This financial and economic analysis included lease bonuses, so it is also relevant to the question of "collusive joint bidding combines". There is one methodological difference between the offshore rate of return analysis and the eight major company average analysis reported above. First, the rates of return are computed on total assets. This is because it is impossible to break out the equity capital components on a disaggregated basis. This difference is adjusted for and does not affect the conclusions. Second, in addition to discussing retrospective rates of return, we analyzed prospective rates of return for the three most recent lease sales. This analysis involved computing empetitive lease bids on the basis of a discounted cash flow model. These results are discussed below. The prospective analysis also required estimating future oil and gas prices. These price assumptions are also discussed below.

44. There have been a number of studies of the rate of return on investment expenditures for offshore exploration, development and production. These studies conclude that the rate of return for offshore activity is approximately equal to the competitive rate of return on investment in the American economy. We have carefully reviewed these studies (including sensitivity analysis) and have concluded that their findings are basically correct. These findngs are consistent with the conclusions of staff studies for the Cabinet Task Force on Oil Import Control.

45. One of the recent studies was done by L. K. Weaver and associates of the Bureau of Mines. This was a very detailed engineering-economics study of a typical, successful 5,000 acre offshore tract in the Gulf of Mexico. The Weaver study indicated that the rate of return on total assets committed varied between 14 and 17 percent—depending on the rate of withdrawal of the oil and gas. The Weaver study, however, was for a successful tract [Not all tracts are successful.[For example, only 40 percent of the tracts leased in 1970 have resulted in commercially feasible production. Some of the currently unproductive tracts may yet become producers, but the effect of some unproductive acreage is to reduce the rate of return toward the competitive rate.

46. An estimate of prospective profitability is of more interest than a study of retrospective profitability. The data underlying the Weaver study is very complete and amenable to adjustment to reflect current economic conditions. We have adjusted the Weaver data on the basis of the current economic situation. Current investment decisions are based on forecasts of future prices and costs. Our adjustments included:

Increasing geophysical, platform and drilling costs to current rates, and
Assuming oil prices of $5 a barrel and gas prices of 65 cents per MCF.

We then used a rate of return on total assets of eight percent and Weaver's estimated reserve data to build a discounted cash flow model which takes into account the fact that in an overall offshore exploration campaign not all tracts are successful. This model was then used to predict bonus bids per acre for the 1972 and 1973 lease sales. The predicted bids were then compared to actual bids as an indicator of the competitiveness of both offshore production activity and the bidding process.

47. The test of competitiveness is the relation between predicted and observed bids. If predicted bids exceed observed bids, then this is an indication that the Federal Treasury is not capturing all the rents from offshore tracts. If observed bids are approximately equal to or exceed predicted bids, then this is an indication that a competitive bidding process is at work. This is a straightforward test, but it must be applied to a number of lease sales. Just as is the case of a computation of the cost of equity capital, a range of data which includes some of the variation from lease sale to lease sale is more reliable. Also, this is a single test and its results must be considered jointly with other available evidence.

48. Our discounted cash flow model predicts bids per acre for the 1972 and 1973 lease sales as follows:

12/19/72, $3,108 per acre;
9/12/72, $2,017 per acre; and
6/19/73; $2,908 per acre.

The average predicted bid for the three lease sales equaled roughly $2,500 per acre. The observed bid for the three lease sales equaled roughly $2,700 per acre. The observed average bid slightly exceeds the predicted average bid.

49. The bidding evidence suggests that the offshore leasing process is highly competitive and that rents resulting from the unit cost advantages of offshore areas are captured by society at large in the form of payments to the Federal Treasury. This behavioral evidence is consistent with the structural evidence from concentration ratios and the performance evidence from the analysis of overall industry profitability.

50. The evidence from the offshore bidding data is especially important for public policy formation with regard to natural gas field markets. It indicates that higher supply prices for new natural gas supplies are the result of the higher costs of securing those supplies. It is true that offshore areas are quite important in current production, and even more important in terms of prospective production. But offshore areas still account for a minority fraction of total production (relative to onshore areas) and will do so for the balance of this decade. It is also true that offshore areas have lower unit costs (net of bonus payments) than do onshore areas. In light of this, two questions may be asked, "What do offshore costs, including bonuses, have to do with onshore costs?; and, Why should we allow prices to rise on offshore gas if those price increases will simply be captured by the Federal Treasury as increased bonus payments?".

There are several points which should be made with regard to these questions.

Offshore costs including bonuses are a reasonable proxy for onshore costs. If the companies could discover and produce onshore gas at lower costs than the costs (including bonuses) for offshore gas, and sell it in intrastate markets, they would do so. The basic economics of maximizing profits by equating at the margin indicates that the unit costs of incremental onshore new gas supplies must be in the neighborhood of those for offshore gas.

Not all offshore tracts are successful and commercially feasible. Higher prices for offshore gas will make some tracts that are not now productive commercially feasible and will also stimulate more intensive drilling. The net effect of this will be to increase offshore areas' gas supplies that will be available to the interstate market. We need all the gas we can get.

Artificially holding offshore gas prices down to a level below that of the best substitute—onshore gas—will encourage waste in consumption. Prices will lag further behind opportunity costs and aggravate the existing shortage. A significant part of the current shortage is demand induced. In addition to finding ways to stimulate supply, public policy should also cause available supplies to be rationed among the highest valued uses. The price system is the most efficient rationing system we know. A way to both stimulate new supply and conserve our scarce gas resources by allocating them to their highest valued use is to allow market clearing prices to operate.

51. Although markets in which prices are allowed to clear demands and supplies are the most efficient rationing systems for allocating scarce resources among competing uses, would not allowing the field markets for new natural gas to clear work an inequitable hardship on gas consumers? A rough calculation is illustrative here. Suppose that the price which would clear field-markets for natural gas is three times the current average level of prices. Further assume that the reserves production ratio is 10:1 and that the prices for natural gas supplies now committed to the interstate market are protected by contracts. Then allowing field market prices to clear would only result in about a 20 percent increase in rolled-in consumer prices. This would amount to a nickel or so per MCF at the burner tip. (This calculation is a rough approximation. A more detailed calculation would have to include adjustments for contract terms, exhaustion rates and market growth.) Consumer prices would further increase as new gas replaced old gas in the pipeline mix. But these increases would be gradual and would allow consumers to adjust smoothly. Moreover, these prices would perform the rationing function discussed above that is so important to the effective conservation of natural gas resources. We believe that consumers would prefer to have adequate gas supplies at prices which reflected the costs of the resource they are using rather than curtailments and abandonments at

artificially low prices. In addition, to the extent that it might be desirable to favor residential (and others) users, it would be possible to require that direct sales to industrial users be made at prices reflecting the marginal costs of incremental new gas supplies.

52. It has been suggested that one part of the solution to the natural gas portion of the energy crisis should be the formation of a national energy company to explore for, develop and produce new natural gas reserves. There is one example of such a venture in another area. This is TVA. The total assets of TVA are about $4,000,000,000. The total assets of Amerada-Hess are $1,378,000,000. Thus, if we were to create a national energy company dedicated to oil and gas production, it would only be about 3 times as large as Amerada-Hess. Even if all the resources of such a venture were committed to oil and gas exploration and production, the contribution of such a venture to the long-run oil and gas supply problem would be marginal. Moreover, we could not create such a national energy company overnight. The natural gas supply problem is here and now. The most promising solution to the natural gas crisis is to allow prices in the field markets for new natural gas supplies to rise to their market clearing level.

53. There has been considerable discussion of the accuracy of reserve statistics with regard to the public policy discussion surrounding field markets for natural gas. Available reserve data have been used on all sides of the debate. Reserve estimation is at best an imprecise science. There is no way to be completely accurate about remaining recoverable reserves until a field is abandoned. We are not surprised at the differences in estimates that have been cited. They are well within the range of error inherent in the numbers.

Of more interest in the current context than remaining proved reserves are the figures for potentially discoverable reserves. These numbers have an even wider range. But they are quite encouraging. The indications are that substantial reserves remain to be discovered in the onshore and offshore United States. If prices are sufficient to cover the costs, these reserves will be forthcoming. There is, however, no sure proof of oil or gas other than the drillbit. If we are to enjoy the benefits of these potentially discoverable reserves, field market prices must encourage the exploration activity necessary to bring them into economic existence.

There have been various econometric studies of the discovery and production process. Econometrics, as reserve estimation, is also at best an imprecise science. Despite the fact that econometric analysis produces numerically precise coefficients complete with standard errors, it is most appropriate to view econometric analysis as providing orderly and systematic insight with regard to orders of magnitude. The proper way to regard the results of econometric analysis is with respect to the following question:

"If we were to substantially increase the field market prices for natural gas, would we get:

Substantial increases in new supplies?
A little increase in new supplies?
Hardly any increase in new supplies?

Econometric analyses of long-run oil and gas supply indicate that a substantial increase in field market prices would call forth substantial increases in new natural gas supplies. This evidence is consistent with estimates of potentially discoverable reserves. Higher field market prices would work to eliminate the natural gas dimension of the energy crisis.

54. Our conclusions are:

Field markets for natural gas are effectively competitive,

The bidding process for offshore acreage is not collusive,

The long-run marginal costs for incremental new gas supplies are substantially higher than the current average field prices, and

If field market prices were allowed to rise to market clearing levels, new natural gas discoveries would eliminate the current shortage.

CRITIQUE OF DR. WILSON'S TESTIMONY

Dr. Wilson of the Federal Power Commission submitted an extensive analysis of competition in the natural gas industry to the Senate Committee on the Judiciary, Subcommittee on Antitrust and Monopoly. Dr. Wilson concluded that

the producing segment of the natural gas industry was not workably competitive on the basis of four assertions. Those assertions were:

The high level of concentration in the industry;

The large number of joint ventures and interlocking directorates in the industry;

The high degree of vertical integration in the industry;

The fact that sellers of natural gas in one market are also buyers of natural gas in another market.

In our review of Dr. Wilson's testimony, we have found numerous errors both factual and logical. A number of these errors are detailed in other sections of this study. In this section we shall recapitulate some of these errors of fact, logic and inference. We also demonstrate that the implications of Dr. Wilson's arguments are not supported by empirical tests.

Concentration in the Natural Gas Producing Industry

In his testimony, Dr. Wilson states:

> In summary, then, virtually any reasonable measure of seller concentration in natural gas markets suggests that there is a substantial degree of dominance by the large producers (Wilson, page 22).

Unfortunately, the data do not justify this conclusion. In the section of our study on concentration, we argue that concentration ratios based on offshore lease acquisitions are the most meaningful measure of of concentration in the natural gas or petroleum industry. Dr. Wilson presents data on concentration in this segment of the industry. His calculations contain a number of errors which bias his concentration ratios upward significantly. The principal error made by Dr. Wilson is his assumption that all offshore joint ventures are collusive in nature. This assumption is never tested. In Dr. Wilson's testimony, he merely asserts it.

We have tested this assumption and found it false. (These tests are described in the section of our study entitled "Joint Ventures: Collusive or Competitive"). The effect of this assumption is to assume his result in advance and bias his numbers upward substantially.

There are other errors in Dr. Wilson's calculations as well. These errors are detailed in our section on concentration. Even if these errors were not present in Dr. Wilson's data, his conclusion is still unwarranted. Using Dr. Wilson's own figures we have argued that the natural gas industry is workably competitive on the basis of concentration ratios. Concentration in the natural gas producing industry is significantly less than that of the American economy as a whole. The only way one could interpret Dr. Wilson's data to reach the conclusion he reaches is to assume that the American economy as a whole is non-competitive. Even if one is willing to make this assumption, one is still left with the result that there are numerous industries in which lack of competition (based on concentration ratios) is a much more significant problem than it is in the natural gas producing industry.

Joint Ventures

Dr. Wilson implies that a large number of joint ventures in offshore exploration, exchange and process agreements, and interlocking directorates are *prima facia* evidence of collusion on the part of natural gas producers and the petroleum industry as a whole. Nowhere in his testimony is this assertion supported by any factual evidence.

We have subjected one of Dr. Wilson's cases of "collusion" to empirical testing. Joint ventures in offshore exploration and development are one example of such "cooperative" behavior cited by Dr. Wilson. Joint bidding ventures may be either collusive arrangements or risk sharing mechanisms without any collusion. The competitive market is well known for devising methods of pooling risks. Each explanation of joint ventures (i.e collusion vs. risk-pooling) has different implications for the types of joint ventures that will be formed. If joint ventures are collusive arrangements, one would expect that joint ventures would consist primarily of large firms and that the majors would not enter into joint ventures with small firms. In other words, the majors would keep their collusion "in the family". If joint ventures are risk sharing agreements, one would expect that small firms would be more likely to enter joint ventures than large firms and that one would observe a large number of joint ventures which consisted of both major and minor firms. (The logic behind these implications are detailed in the section of this study on joint ventures).

We have examined the data on joint ventures provided in Dr. Wilson's testimony. In addition, we have conducted an extensive analysis of every Federal OCS lease sale conducted since 1953. In both cases the conclusion is the same. The type of joint venture observed in practice is more consistent with the risk sharing model than with the collusive model. The most frequently observed joint venture consists of some majors and some minors. There is a much greater likelihood of small and medium sized firms entering a joint venture than of one of the eight majors entering a joint venture.

Vertical Integration in the Natural Gas Market

Dr. Wilson asserts that a high degree of vertical integration in the natural gas market prevents arms length bargaining between pipelines and producers. He states, ". . . virtually all of the largest interstate natural gas pipelines companies are also involved in petroleum exploration and development—either directly or through corporate affiliates," (Wilson, page 79). He lists several large interstate pipeline companies which also own production facilities. The importance of vertical integration depends on the fraction of production that is controlled by interstate pipelines, not the fact that a number of pipelines own some productive capacities. It is interesting to note that none of the eight largest natural gas producing companies (Humble, Amoco, Shell, Gulf, Phillips, Mobil, Texaco, ARCO) appear in Table 17 of his testimony as owners of both major interstate pipelines and production facilities. Thus a significant fraction on natural gas sales are controlled by producers who do not own major interstate pipelines. This would indicate the majority of a natural gas sales are made between independent firms and Dr. Wilson's assertion is false.

Even if a substantial fraction of production were controlled by firms which were both producers and interstate pipelines, Dr. Wilson's assertions would still be incorrect. Suppose vertically integrated firms attempted to establish a price in natural gas fields which exceeded the costs of finding and producing new natural gas. This would increase the profitability of the natural gas exploration and development business. Such an increase in this activity relative to other activities would serve as an incentive for new firms to enter the industry. It is well known that entry into the natural gas business is relatively easy. Currently there are over three thousand corporations involved in the exploration, development and production of petroleum. The number of such firms has fluctuated in response to economic incentives. A number of institutional arrangements, such as joint ventures, increase the case with which small firms can enter this industry.

The high price set by vertically intergrated firms would increase the number of firms involved in the search for natural gas. This would increase the supply of natural gas and depress the price of natural gas. Those forces would continue to operate until the price of natural gas had returned to a level equal to the costs of producing natural gas. Thus the free market would act to prevent the type strategies Dr. Wilson asserts are prevalent in the natural gas producing industry.

The only conditions under which Dr. Wilson's assertion would be true are if a vertically integrated company had a near monopoly on natural gas production and if entry could be prevented. Neither of these conditions exist in the natural gas market.

Producers Who are Also Buyers and Sellers

Dr. Wilson asserts that some producers are sellers of natural gas in one market and buyers in another market (Wilson, pages 88–90). He claims that this prevents market prices from being identical to the free market prices which would result from arms length bargaining. Two simple examples will serve to illustrate the incorrectness of this assertion.

A large number of individuals move from one home to another in the same community. At the same time, they may be both a buyer and a seller in the housing market. If Dr. Wilson is correct, presumably he would allege that existing home owners, when buying a new house, should bid up the price of the home they are buying in order to raise the price of the home that they are selling. This phenomenon is never observed in the housing market.

Our second example deals with a market significantly more concentrated then the housing market. There are only three significant producers of domenstic automobiles: GM, Ford and Chrysler. If Dr. Wilson's assertions that being both a buyer and a seller can increase market prices and profitability, one would ex-

pect that GM would purchase a large number of Fords each year and perhaps that Ford would purchase a large number of Chryslers each year. We do not observe such purchases. We do not argue that the presence of some firms on both sides of the market (in the guise of separate affiliates) as both Interstate pipeline buyers of natural gas and producer-sellers of natural gas, is a matter of no concern. But we do feel that it is not an adequate index upon which to base a charge of a completely controlled market. The problem of affiliated producer subsidiaries of interstate pipeline buyers can be dealt with in a less cumbersome and more direct way than by extending regulation to treat producers which are not so affiliated as if they were so affiliated. Interstate pipeline companies could be divested of their producer affiliates. This could be accomplished by either:

Direct legislation, or

Appropriate use of cost-based regulation to create incentives for divestment of producer affiliates by pipeline companies.

Such divestiture could be monitored by antitrust authorities to insure that none of the largest eight (or twenty, etc.) non-affiliated producers acquired the producer affiliates subsequent to their divestiture. Alternatively, such a provision could be included in direct legislation aimed at divestiture.

Profitability: The Key Test of Conspiracy

The most severe criticism that can be made of Dr. Wilson's study is that his arguments have implications which can be tested with existing data. Dr. Wilson, however makes no such tests. The implications of his arguments are refuted by the data.

Conspiracies are not formed for their own sake. They are formed to seek high profits. This implies that if Dr. Wilson's arguments concerning the collusive nature of the natural gas and petroleum industry are in fact true one should observe high rates of return earned by petroleum firms. In a separate section of this report we analyze long-run profitability in the petroleum industry.[1] The conclusions of that analysis are that large petroleum firms do not earn above normal rates of return. In fact, on average, three of the largest eight petroleum firms earn lower rates of return on stockholders equity than the average rate of return allowed regulated utilities (the average used is Moody's 24 Utilities.) Surely an industry in which three of the largest firms cannot even do as well as the regulated segment of the economy is not what one could claim as an example of a successful conspiracy.

Profitability and Offshore Leasing

The most striking example of Dr. Wilson's willingness to indulge in rhetorical inconsistency, logically unsupportable assertions and suppression of the relevant facts is contained in two notable sentences.

> Consumers can take little comfort from the fact that leases are obtained in an auction market, if there is not adequate competition in the sale of final products. As students of antitrust law will recall, tobacco auctions did not guarantee competition between cigarette manufacturers. (Wilson, page 30)

Apparently Dr. Wilson is not one of those students of the antitrust law of which he speaks.

There were anti-competitive practices in the tobacco industry. These included the sale of products and the purchase of leaf. When firms have monopoly or monopsony power, they are inclined to use them. Higher profits are preferred to lower profits. If the firms in the petroleum industry have monopoly power in the salt of output (an assertion not borne out by the record of their long-run profits),

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[1] Long-run profitability is the appropriate measure. Petroleum firms have had dramatic increases in profits in recent quarters. Two points must be made with regard to those profit increases. First, a substantial portion of petroleum firms' profit increases are the result of regulatory failures. The chief contributing factors were: (1) failure to relax mandatory oil import quotas in an orderly, and expeditious fashion; (2) the regulation induced shortage of natural gas production and reserves; and (3) the subsequent effect of environmental controls to shift fuel demands to natural gas and to prolong the shortages of refinery capacity and refined products. Second, these petroleum firm profit increases must be standardized for inflation and compared to the profit increases in other sectors of the economy. After such a standardization and comparison is made, petroleum firms' recent short-term profits are not extraordinary when viewed relative to the backdrop of the total economy. Rather, they are the signals that in a well functioning economy would cause resources to flow into this industry and ultimately return profits to their long-run levels.

then the same joint "venture combinations" and "interties" which create that power would also generate monopsony power in the purchase of the *sine qua non* for reaping the benefits of their alleged monopoly power. This essential input is prospective producing acreage.

The difference between the oil and gas industry's offshore leasing activity and the tobacco industry's leaf purchases is as the difference between day and night. The tobacco industry monopsonized the tobacco farmers through non-aggressive, percentage, market sharing in their buying.[1] Because of anticompetitive practices, leaf tobacco prices were lower and cigarette prices were higher than they would otherwise have been. The result was high profits for the tobacco industry.

With regard to offshore oil and gas leasing, there is no evidence of non-aggressive bidding. The Federal government is analogous to the tobacco farmer. But unlike the tobacco farmer, society at large (the Federal treasury), recaps the benefits of aggressive bidding in the form of lease bonuses and royalties.[2]

The evidence indicates that oil and gas companies earn no more than a competitive rate of return on offshore activity (see the section on off-shore bidding and leasing). Lease bids for individual 5,000 acre tracts may be as high as $100 million. In the Alaskan lease sale, the total bonus payments approximated one billion dollars. These aggressive bids occur regardless of whether firms are bidding in joint ventures to pool risks or bidding individually. Presumably the companies are not indifferent to sums of this order of magnitude.

If the companies could be sure to be successful in the acquisition of acreage by bidding smaller amounts, they would do so. But competition makes this impossible. Joint bidding ventures are unsuccessful as a mechanism for obtaining an essential, specialized resource on noncompetitive terms. This evidence, together with the long-run profit performance of the industry, and the patterns of lease bidding combinations, indicates that joint bidding ventures are similarly ineffective in creating non-competitive conditions in the sale of oil and gas.

Appendix B

THE EXPECTED PRESENT VALUE FORMULA FOR PETROLEUM OPERATIONS

The expected present value of a petroleum drilling program may be defined as:

$$EPV = Y\left[\frac{(1-t+td)\ (1-r)\ PAR}{-\ 1-t)\ OAR^{(A+1)}} - (1-tx)\ WZR^{(A+i)}\right] - (1-tf)\ (1-y)\ DH - B$$

Where:

t=the corporate tax rate,
d=the rate of percentage depletion,
r=the royalty rate,
f=the fraction of dry hole costs which can be expensed immediately,
x=the fraction of exploratory and development drilling costs which can be expensed immediately,
i—the cost of capital,
P=the price of output,
y=the probability of commercial production,
A=the decline rate,
C=operating costs per barrel of output,

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[1] See William H. Nicholls, *Price Policies in the Cigarette Industry* (Nashville: Vanderbilt, 1951).

[2] Offshore lease bids have been on a fixed royalty, variable bonus basis. The bonuses are typically very high and may correctly be a financial barrier to entry into offshore operations. Nevertheless, a sufficient number of firms are capable of bidding so that least auctions are competitive. As an antidote to allegations of the absence of competition, it may be desirable to change bidding procedures to a fixed bonus, variable royalty basis. In terms of the long-run social efficiency of the system, this change would have at best a negligible effect. But it may be desirable for the reason stated above.

Z=wells drilled per barrel of recoverable reserves,
DH=dry hole costs,
R=recoverable reserves, and
B=bonus payments.

Appendix C

TAX INCENTIVES IN THE UNITED STATES PETROLEUM INDUSTRY

Taxes are a powerful instrument of public policy. They transfer resources from the private sector to the public sector. These resources, in turn, are used to carry out the functions of government and to support other instruments of public policy. The United States Supreme Court once wrote "The power to tax . . . is not only the power to destroy, but also the power to keep alive." Perhaps the respect and fear of such centralized power explains why there is always intense emotional debate over how, and from whom, those taxes will be collected. Debates in the taxation area usually stem from (1) differences in the evaluation of effectiveness (costs vs. benefits) of governmental policy; (2) differences in assessment of the incidence of taxes; (3) differences in opinion over the efficiency of public vs. private enterprise. It seems tax debate is just as inevitable as the tax itself.

The petroleum industry is no exception. Percentage depletion is one of the most hotly debated sections of the Federal Tax Code (henceforth, percentage depletion is used as a shorthand expression for the whole package of special tax provisions affecting the petroleum industry). A large part of the debate has centered around the effects of percentage depletion on the distribution of income (Is the petroleum industry's tax burden "too low" or "too high"?), and the allocation of resources within the economy (including risk compensation and tax neutrality.)

These are not the only issues involved in the percentage depletion debate, however. Any discussion of percentage depletion must also consider the fact that the special tax provisions enjoyed by the petroleum industry are the result of purposeful decisions by policy makers. These policy decisions were made in the pursuit of certain goals, stated or unstated. It is important, therefore, to determine whether or not percentage depletion does in fact achieve those goals and to to determine whether or not percentage depletion must also consider the fact that the special tax provisions enjoyed by the petroleum industry are the result of purposeful decisions by policy makers. These policy decisions were made in the pursuit of certain goals stated or unstated. It is important, therefore, to determine whether or not percentage depletion does in fact achieve those goals and to determine whether or not percentage depletion is the least cost method of achieving those goals.

In addition, there are four important and interrelated considerations in any discussion of the consequences of alterning the special tax provisions currently affecting the petroleum industry. They are:

The size of U.S. oil reserves,
The tax policies under consideration,
The price of domestic petroleum output, and
The degree of U.S. dependence on foreign oil.

If a change is made in any one of these critical variables, there may have to be compensating changes in one or more of the other variables. For example, consider a case where percentage depletion and its attendant provisions were eliminated, but the United States desired to maintain a constant domestic real price of crude oil. If the tax change is made, the United States must then be prepared to rely upon an increasing fraction of domestic oil usage being supplied from foreign sources. Also, domestic oil exploration and production would become less profitable and resources would flow to alternative uses; in the long run domestic oil reserves would fall under this policy. With a fully employed domestic petroleum industry, there are no free lunches. The domestic industry is now practically fully employed.

Policymakers and citizens must often feel a profound sense of exasperation with economists and their analyses. Not only is there a perplexing lack of unanimity in economists' policy prescriptions, but by the time the analytical dust has cleared, policy decisions have often rolled through the issues to which the analysis may once have been relevant. Taxes, however, always remain.

In this paper, I try to avoid controversy. Such a claim is always suspect, but I have tried to present a standard analysis that is rooted in the simplest common denominators of economics—supply and demand theory and marginal analysis. In what follows, we examine the analytical and theoretical dust in the petroleum taxation field in an attempt to clarify what is known and essentially agreed upon and make some conclusions which I believe represents a consensus of professional economists. The major conclusions are:

1. That the dominant argument for percentage depletion must be national security;
2. That tax expenditures are not likely to be the most efficient means for achieving any given security goal.

SPECIAL TAX BENEFITS FOR THE EXTRACTIVE INDUSTRIES

The Internal Revenue Code contains three basic special tax benefits for producers of petroleum, natural gas, and hard minerals. These are:

1. The percentage depletion deduction—section 613 of the Code.
2. Special provisions which permit the *current* writeoff of intangible drilling and development costs for producing oil and gas wells—section 263(c).
3. Special provisions which permit hard mineral exploration and development costs to be written off currently, subject to certain limitations—sections 615 through 617.

In addition, the Treasury Regulations on Income Tax permit oil and gas producers who have elected to capitalize intangible drilling and development costs (instead of a current write-off as in section 263 (c) of the Internal Revenue Code) the additional option of either expensing or capitalizing their dry-hole costs—section 1.612-4(b) (4). Sections 901 through 906 of the Code also provide foreign tax credit benefits.

Percentage depletion allows a standard tax deduction of 22 percent of gross income (price times quantity sold) from oil and gas production and results in a reduced effective tax rate for the industry. The percentage depletion, however, may not exceed 50 percent of net income. This provision limits the effect of the benefit. This is an extraordinary tax benefit because it permits the tax-free recovery of dollar amounts which are far greater than the taxpayer's original investment in the depletable property. This is why the depletion deduction is a subsidy and not just a simple mechanism for depreciating the taxpayer's capital investment. In addition, that portion of the percentage depletion deduction which represents ordinary tax free recovery of capital investments is usually recovered more rapidly than would be the case if computations were made analogously to the computation of depreciation in nonextractive industries. Thus, percentage depletion confers a double benefit:

1. Deductions in excess of initial costs,
2. Deductions of initial costs that are usually accelerated relative to nonextractive industries.

Costs of labor, materials, and other goods incidental to drilling are considered "intangible costs of drilling" and can be expensed as soon as a well becomes productive. This is a benefit because it permits the immediate tax free recovery of capital investments. By most criteria, exploration and development costs would be considered an investment in capital and therefore subject to a depreciation allowance over the useful life of the capital asset.

Expenditures for tangible equipment such as pumps, tanks, and pipes are classified as "tangible costs of drilling." These are treated exactly as depreciable assets in other industries. Geological surveys, lease bonuses and rentals are also considered as expenses to be deducted over the useful life of the asset. These costs cannot be expensed if the 22% percentage depletion allowance is used: they can be expensed if percentage depletion is not used.

Consider the hypothetical example of a firm operating two productive properties as outlined in Table I.[1] The two properties have the same gross income after royalties. However, Property B is allowed a depletion deduction of only $75,000 due to the 50% of net limitation, while Property A is allowed $110,000, the full 22% of gross income. Notice that the costs attributable to the properties include dry hole costs and the intangible expenses of drilling productive wells on

[1] This example follows McDonald (1963), pp. 19–22.

them. Thus, it is possible for finding and development outlay expensing to be competitive with, rather than supplementary to, the percentage depletion deduction.

The firm's income tax liability is based on the consolidated net income derived from the two properties after an additional deduction for business costs not attributable to either property; the distinction between properties is important only for computing the total allowable depletion for the firm. Note here that in the computation of the income tax liability of the firm that the cost of unsuccessful exploration not attributable to producing properties are not competitive with percentage depletion. While no firm would deliberately incur exploration expenses that they knew would be unsuccessful, the deductability of unsuccessful expenses might induce a firm anticipating income tax liability on current producing properties to increase its exploratory drilling.

TABLE I.—COMPUTATION OF ALLOWABLE PERCENTAGE DEPLETION DEDUCTION AND FEDERAL INCOME TAX LIABILITY FOR A HYPOTHETICAL FIRM

	Properties	
	A	B
A. Allowable percentage depletion deduction:		
Gross income after royalty	$500,000	$500,000
Less: Cost attributable to property [1]	200,000	350,000
Net property income before depletion	300,000	150,000
22 percent of gross	(110,000)	(110,000)
50 percent of net	(150,000)	(75,000)
Less: Allowable depletion	110,000	75,000
Net property income after depletion	190,000	75,000
		Consolidated properties
B. Federal income tax liability:		
Gross income after royalty		$1,000,000
Less: Costs attributable to individual properties		550,000
Net property income before depletion		450,000
Less: Allowable depletion deduction		185,000
Net property income after depletion		265,000
Less: All other costs of doing business [2]		115,000
Net taxable income		150,000
Less: Federal income tax [3]		72,000
Net income after tax per tax return		78,000

[1] Includes production expenses, ad valorem taxes, depreciation of tangible well investment, costs of dry holes drilled on property and intangible drilling expenses. Lease acquisition and capitalized exploration costs not included.
[2] Includes costs of dry holes not attributable to producing properties, lease rentals, and overhead and miscellaneous expenses attributable to nonproducing properties.
[3] 48 percent uniform tax rate.

In example, the total depletion deduction is $185,000 which is $18.5% of gross income as compared with the maximum allowable rate of 22%, i.e., the effective depletion rate is 18.5%. Suppose the firm had taken $35,000 in deductions based on capital lease acquisition costs and capitalized exploration costs attributable to producing properties (which cannot be deducted from gross income if percentage depletion is taken). In this case the depletion deduction would exceed the alternative cost based depletion by $150,000 ($185,000 minus $35,000). This is to say that the total deductions from gross income for tax purposes would exceed by $150,000 the total costs actually incurred by the firm and attributable to the income period. It is this excess which measures the advantage of percentage depletion to the firm. The firm's financial net income after taxes, as reported to management and stockholders on the basis of conventional accounting practices, would be $228,000 rather than the $78,000 reported on the tax return. In summary, the effect of percentage depletion can be viewed as a reduction of the effective tax rate on income from oil and gas production (the effective rate in this example is 24% rather than the nominal 48%).

To summarize, the initial value of an asset in most industries is its supply price, and depreciation is claimed on this initial cost. However, in oil extraction,

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exploration and development costs, i.e., the investment in the capital asset, may have little relation to the initial value of the resulting capital asset; this is entirely due to the depletion related special tax arrangements which provide the petroleum industry (and other extractive industries as well) with extraordinary benefits relative to non-extractive industries. In the next section we analyze the major stated goals presented as justification for conferring these benefits.

THE GOALS OF SPECIAL TAX PROVISIONS

The special tax provisions currently enjoyed by the extractive industries are the result of purposeful public policy decisions by responsible government officials. These policy decisions must be made in the pursuit of certain goals, stated or unstated. We limit our analysis to stated goals of the special tax provisions applicable to the petroleum industry. There are multiple goals. They include:

1. The risk argument;
2. The strong mineral industry argument;
3. The tax neutrality argument; and
4. The national security argument.

The "Risk" Argument

This argument contends that mineral producers operate under exceptionally high risk, and therefore deserve compensatory tax relief, i.e. mineral production is riskier than most other types of income producing ventures. In this context, we are discussing *relative* risk taking. Obviously some ventures are riskier than others and the market works to compensate those who succeed at the more risky undertakings. Policemen might argue that walking-the-beat is riskier than school teaching, and they might be right. School teachers might argue that their job is riskier than operating a filling station, etc. The point is obvious, if we do choose to subsidize riskier ventures we might decide risky relative to what? "Exceptional" is no help. We must ask exceptional relative to what, and the essential circularity of the argument is reintroduced. A simplifying assertation is that mineral industry ventures are riskier than ventures in non-mineral producing industries (which are themselves not risk free.)

Riskiness is difficult to define. In part this is because a large element of the appraisal of risk, as in beauty, is in the eye of the beholder. In part it is because the analytics of the concept are slippery, even for people consciously trying to discuss consistently the same thing. A measure of risk is the relative frequency with which an outcome other than the expected outcome occurs. The ratio of successful to unsuccessful wildcat oil wells is about 1:9. Because no one would commit the resources necessary to drill a wildcat well unless he "expected" it to be successful, this 1:9 ratio is frequently used to argue that petroleum exploration is exceptionally risky. However, the ratio itself is remarkably stable. There is variation in the ratio and it is a conditional measure that is itself economically determined [see Fisher (1964), Erickson and Spann (1971)], but that is a detail that does not alter the argument here. Thus, in our simple example, if a firm were to drill 99 wells, it could expect about 11 successes, although it would not know in advance which of the wells would be the successful ones. From the vantage point of an overall exploration campaign, then, the search for petroleum does not appear as risky as it does when only a single well is considered. An analogy to roulette is apt. No one can predict a single turn of the wheel. But for a large number of spins, the proportion of outcomes which are, say, red and odd can be confidently bounded. This safety in numbers does not preclude the possibility of losing large sums on a single venture. This characteristic, however, does not automatically make petroleum exploration more or less risky than other industrial activities. Other industries also display investment outcome which involve large losses on a single venture. Examples are corfam, the Edsel and the Fermi nuclear power plant.

Even if mineral production is riskier, the market mechanism and a uniform corporate income tax could be relied upon to spread risks successfully among different groups, thereby reducing risks to any single person. One might argue that there would be more resources in the oil and gas industry if there were a scheme of risk compensation particular to that industry. Even if this is true, we must ask "to what purpose?" If the answer is, "we need the extra resources for national security reasons," then it must be determined that special tax expenditures are the best cost means to achieve this end.

In summary, the risk argument rests upon two central pillars. The first is that oil and gas exploration is riskier than alternative business activities. Given the continued success of many large petroleum producing enterprises, this assertion is difficult to prove. The second pillar is a lack of faith in the ability of market processes to adapt to risks. We know the market will adopt to equalize the monetary value of differential riskiness, there are virtually no risk free enterprises. If there is differential riskiness in petroleum exploration and production, then it is necessary to show that any increased reserves and output under a subsidy are worth the tax expenditure currently being made to achieve them.

THE STRONG MINERAL INDUSTRY ARGUMENT

We want a strong oil and gas industry. We also want a strong steel industry, a strong technical instruments industry and a strong chemical industry. We want all our industries to be strong, but cannot afford to subsidize them all. Subsidies reduce the market price to the consumer. At the same time, the American consumer is the American Taxpayer; he also pays for the subsidy.

One may argue that we need a strong oil and gas industry in case of a national emergency. This is a national security argument, not a strong mineral industries argument. In the extreme, the strong industries argument is vulnerable. If many industries contribute to the national defense potential, then a partial measure of national security capacity is GNP itself. Because a series of ad hoc industry specific subsidies results in an inefficient allocation of resources, the total GNP is smaller in the presence of such subsidies than it would be without them. Thus, in this very general context, the overall defense capacity is adversely affected by a piecemeal subsidies designed to strengthen particular industries.

The Tax Neutrality Argument: The McDonald Debate

There has been an extended debate among several well-known economists as to whether the present tax treatment of the petroleum industry is "neutral."[2] The neutrality at issue in the debate is whether the corporate income tax affects the allocation of resources in the economy as a whole, including nonextractive industries. The relevant comparison involves, at the least, a uniform corporate income tax and the present system of special provisions affecting the petroleum industry. More precisely, a three-way comparison is necessary. We must compare resource allocation under the following situation:

1. No corporate income tax;
2. A uniform corporate income tax with no special provisions for the petroleum industry (and other extractive industries); and
3. The present system of a corporate income tax with special provisions for the petroleum industry (and other extractive industries).

The present system is neutral if the allocations are the same as they would be under the case of no corporate income tax. In this situation, the special provisions affecting the taxation of income earned in petroleum production promote neutrality. If the allocation of resources under the present system is different than would be the case under no corporate income tax, then the present system is non-neutral. If the special provisions affecting petroleum cause the allocation of resources among industries under the present system to be farther away from the no-tax special provisions, then the special provisions are themselves non-neutral.

Note that this is an efficiency discussion. Efficiency is important to us for it affects national income and therefore our standard of living. That is why this debate is important. However, it must be understood that whether the conclusion is neutrality or non-neutrality, it has no current public policy significance. The reason for this seeming anomaly goes back to the earlier discussion of the economic analysis of public policy decisions. The efficacy of the special tax provisions does not depend upon neutrality or non-neutrality. Rather, it depends upon the policy goals and the alternative means of achieving these goals. Nowhere in this paper is it said that the principal goal of the current special tax

[2] The main contributors to this literature are the following: Davidson (1963); McDonald (1961), (1962), (1964), (1967), (1970); Steiner (1963), (1964); Harberger (1955); Agria (1969).

provisions is of minor importance. Even if the special tax provisions are non-neutral, if they are the least cost way to achieve a well-defined national security goal, then the security gains may be worth the efficiency costs. To the extent that the current structure of tax rates and regulations reveal the intentions of policy makers, it would have to be concluded that tax neutrality is very low on the priority list of policy. Nowhere is it said that tax neutrality is the policy goal of the special tax provisions. However, this debate has provided some useful quantitative information in this area. Therefore, we will discuss this area in more detail in a later section.

The National Security Argument

The national security argument is that extra productive capacity (called reserves) is needed for use in the event of war or other national emergency, and that the special tax provisions are needed to encourage the creation of such reserves. Proved reserves (a concept embracing the potential to bring oil into production at present and expected near future prices) are the main elements of crude oil production capacity. Current output rates (at a given incremental cost per barrel) are positively related to proved reserves. If proved reserves are allowed to dwindle, a specified output rate could only be sustained at increasing costs per barrel.

There is a difference between wartime needs and peacetime needs. In peacetime, national security policy would be focused on developing and maintaining a pool of "extra" proved reserves primarily to avoid being vulnerable to foreign supply restrictions. Therefore, policy should be geared to expanding reserves, but not production. Stimulating both could be self defeating; more resources would be devoted to expanding reserves than would be necessary if production had not been stimulated.

In wartime, policy must be focused on the continued flow of output during the conflict. Oil is an important input in conventional war, less necessary for a nuclear confrontation. If reserves start to dwindle during the conflict leading to increasing costs, at some point it would become cheaper to divert resources to acquiring new reserves rather than try to maintain the needed output rate from the reduced reserve capacity. Thus, during wartime, policy would have to be geared to stimulating both production and proved reserves sufficient to meet war requirements.

Thus, there are two key variables, current output and proved reserves, which must be considered in formulating a national security policy for the oil industry. The acceptability of any tax oriented policy would depend on its impact on reserves alone in peacetime, and its impact on reserves and production in wartime.

Given current discussion regarding the "energy crisis", the increased militance of oil producing nations (specifically the cartels known as the Organization of Oil exporting Countries (OPEC) and the subset of OPEC known as the Organization of Arab Oil Exporting Countries (OAPEC) which have boosted prices and made them stick), and rising Israeli-Arab tension in the Middle East, it is concluded that if there is a policy goal of the special tax provisions to the petroleum industry (other than the unstated goal of income redistribution) then the dominant goal must be to encourage extra productive capacity (called proved reserves) which the U.S. might need during a national emergency. In light of this conclusion, we proceed with an analysis of the resource allocation effects of the special tax provisions.

THE SIMPLE ECONOMICS OF THE PETROLEUM INDUSTRY

An economist's primary concern is with the efficient allocation of the scarce resources of the economy. Efficiency is defined in a very special way. There is an efficient allocation of resources when it is impossible to change prices or outputs to make some consumers better off without simultaneously making others worse off. In a generally competitive economy with no glaring externalities or unexploited economies of scale, the action of market forces results in an efficient allocation of resources. With the exceptions of distortions caused by government (State and Federal) policies, the U.S. petroleum industry has been and is now a competitive industry. Furthermore, the U.S. economy is in general sufficiently competitive to make the implications drawn from the competitive model useful guides for policy analysis.

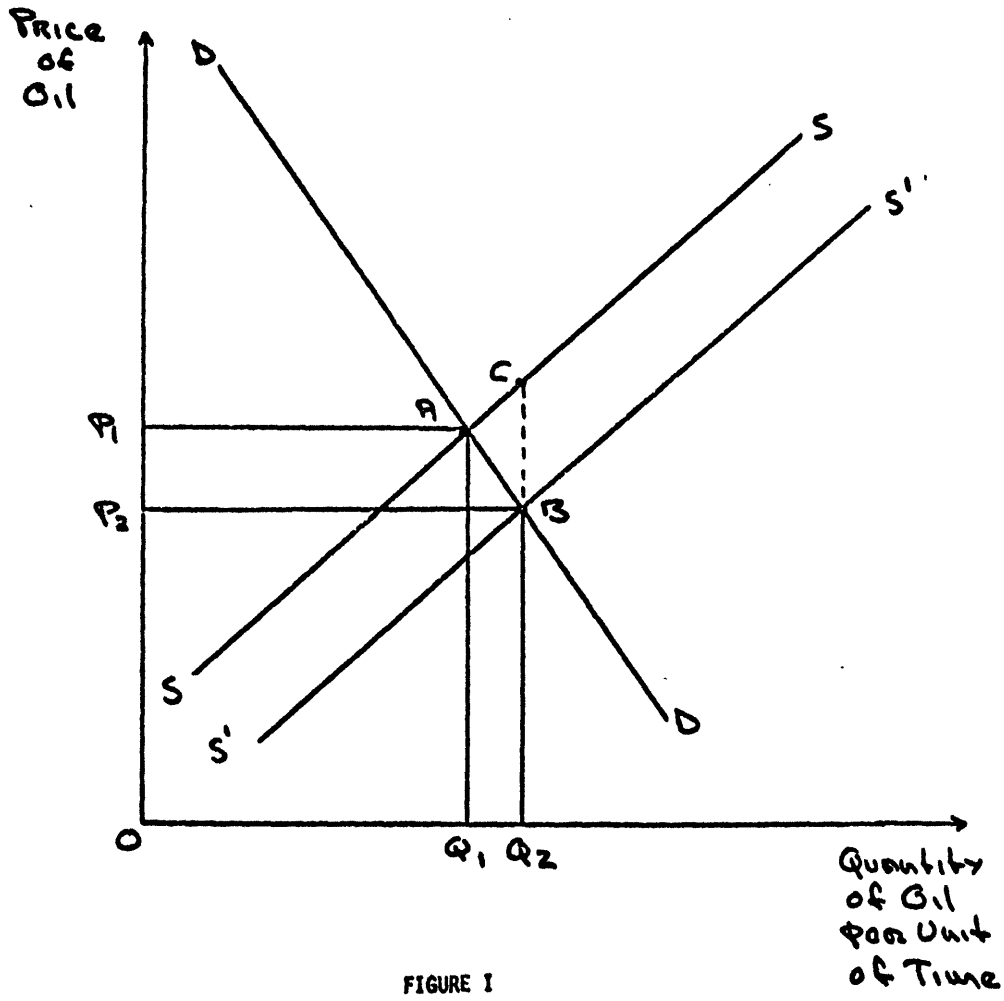


FIGURE I

In figure 1, let DD represent the industry demand curve for oil,[3] and SS represent the industry supply of oil.[4]

In the absence of an energy crisis, the equilibrium price and quantity of oil is at Q_1 and P_1. The effects of the energy crisis and price controls are discussed below. For graphical simplicity, we assume no import sector. This does not affect the logic of the analysis. It is helpful for policy analysis to think of DD as the marginal social benefit curve (MSB)—the value society places on the benefits derived from one more unit of oil, and to think of SS as the marginal social cost curve (MSC)—to include *all* costs to *society* of producing additional units of oil. Thus the efficient allocation of resources in the oil industry, depicted in Figure 1, is *defined* to be the resources required to produce that output at which MSB equals MSC, i.e. the resources required to produce output $O–Q_1$. At any output greater than $O–Q_1$, there are "too many" resources in the industry by efficiency standards; at any output less than $O–Q_1$, there are "too few" resources in the industry.

The depletion allowance is essentially a negative *ad valorem* tax [Davidson (1970)]. It shifts the supply curve of oil to S^1S^1, lowering the price of crude oil

[3] The demand curve slopes down and to the right in the oil industry [see Balestra and Nerlove (1966), Burrows and Domenich (1970), McDonald (1970)].

[4] The supply curve slopes up and to the right in the oil industry. [See Erickson and Spann (1971), Erickson (1968), Elridge (1962)].

to P_2[5] and increasing the output of crude oil to Q_2. This leads to an inefficient allocation of resources ("too many") in the oil industry. The cost of this output increase, in terms of real resources, is the area Q_1ACQ_2 under the SS curve. Consumers value the increased oil output (Q_2–Q_1) by an amount equal to the area Q_1ABQ_2.

The difference between the social costs and benefits of the subsidy, in terms of inefficient resource allocation, is the triangular area ABC (area Q_1ACQ_2 minus Q_1ABQ_2). This is not to say that the special tax provisions are socially undesirable, just that they are inefficient from an economic point of view.

To evaluate a given public policy decision, one must know what the decision is trying to accomplish. The dominant argument for the special tax provisions to the petroleum industry is national security. Two major issues arise with regard to the depletion allowance. First, we do not know whether national security actually requires greater reserves than the market would generate without the tax provisions; and if so, what absolute and relative incremental reserves are required. The submissions to and analysis by the Cabinet Task Force on Oil Import Control suggest that the contribution of domestic conventional reserves to the national security, narrowly or broadly defined, is not nearly so precise or inexorable as simplistic statements often assert. [See The Oil Import Question (1970).] This is a particularly important point when the costs of creating and holding conventional reserves are compared to some substitute means to achieve the same national security objective—for example, strategic stockpiles.

The national security problem requires an answer to the following questions:

1. Does national security require the resources to produce an output such as Q_1, the amount the market would generate without the tax provisions?
2. Or does the national security require the greater resources necessary to produce an apparently inefficient output such as Q_2, the amount generated by the oil and gas industry operating with special tax provisions?[6]
3. Finally, if there is a need for greater domestic reserves, is the necessary increment less than, equal to or greater than Q_2–Q_1?

The second major issue involves the relation between the size of the special tax provisions and the amount of the shift in the supply curve of petroleum. We have little explicit empirical evidence about the extent to which the present special tax provisions actually do create additional reserves. The change in the volume of reserves per percentage point change in the depletion rate is not now known. Such knoweldge is crucial for a determination of how much additional defense capacity[7] (measured by increased reserves) is achieved per dollar of expenditure of taxes foregone and resources misallocated; i.e., the cost-effectiveness of the percentage depletion tax program in achieving the national security goal.

In the presence of an energy crisis, the situation is a little more complicated. As a result of the regulations-induced shortage of natural gas, poor planning with regard to the relaxation of oil import quotas, environmental and other restrictions on the production and consumption of coal, the effect of emissions controls on automobile gasoline mileage, growth in the economy and the Arab oil embargo, the demand for domestic oil production has increased to D^1D^1 in Figure 2.

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[5] Note that the depletion subsidy lowers the price of oil to consumers—from P_1 to P_2. This result, however, is not a free lunch for consumers. It is consumers, after all, who initially provide the subsidy. If the Federal Budget is independent of the size of the depletion allowance, then other taxes must be sufficiently high to offset the tax revenue lost due to the special tax provisions enjoyed by the oil industry. These offsetting taxes cause the prices for other industries and the personal income tax to be higher than they would otherwise be. The amounts involved are large. For example, one special provision, expensing intangibles, costs the treasury about $400 million a year in foregone tax revenue from the petroleum industry.

[6] This is a different question than the question of whether any additional war-making potential created by specific capacities such as Q_1Q_2 causes our foreign policy makers to be less cautious than they would otherwise be. If this is the case, we may produce more war than the global optimum allocation of resources requires. There is casual evidence, however, that suggests that the casuality runs from war-making propensities to the existence of the capacities such as Q_1Q_2, rather than the other way around. Almost none of the petroleum used in Southeast Asia was produced from U.S. reserves.

[7] We ignore the problem of whether state agencies which control production would allow the incremental reserves to be realized as increased production. The assumption here is that in a real national security emergency the decisions of federal policy makers would be paramount.

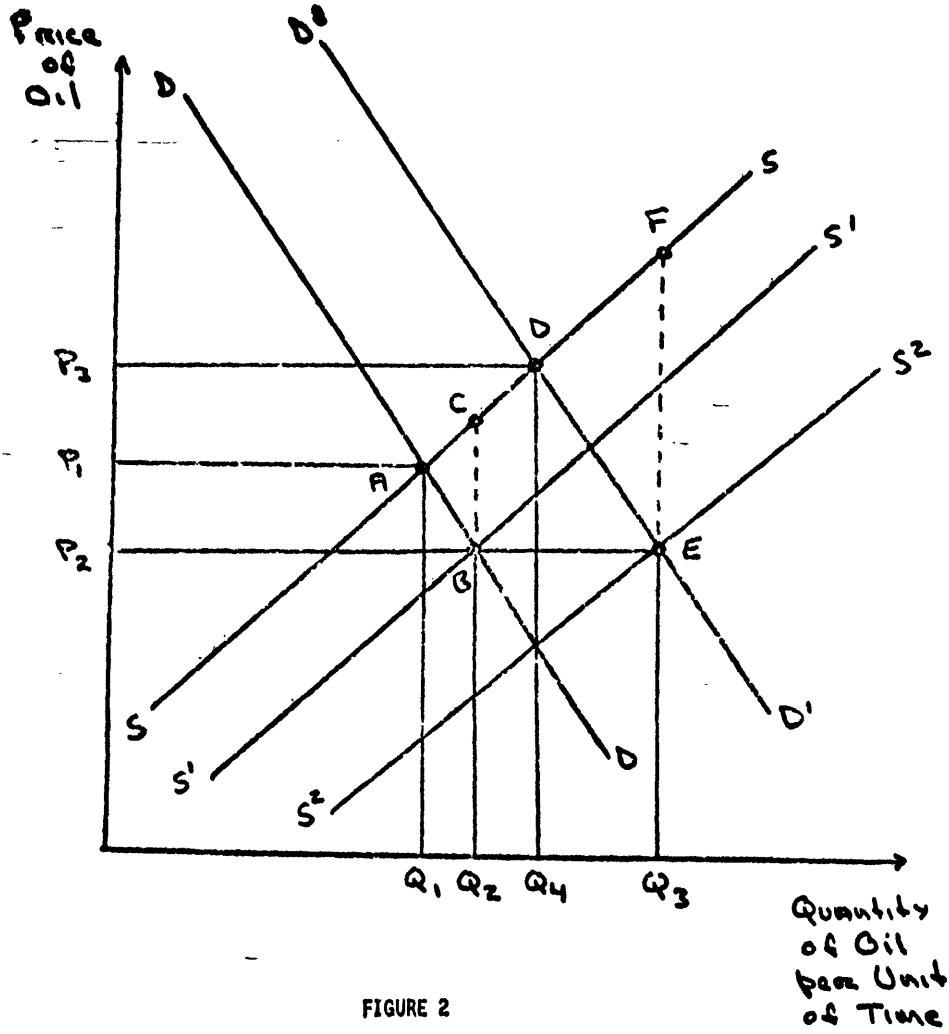


FIGURE 2

At the same time, there are price controls on U.S. crude oil. There has been some relaxation of these controls with respect to "new" oil production, but the average price of U.S. oil is nevertheless held below that of alternative imported oil. Thus, there is an effective quasi-ceiling price on U.S. oil production. The result is excess demand for U.S. oil at the going market price of P_2 equal to the difference between the quantity demanded at P_2 and the quantity supplied at P_2. This difference is Q_3 minus Q_2. The excess demand for U.S. oil production represents a shortage at the going market price.

Some policy makers have suggested additional tax incentives for the industry as a means of eliminating the shortage. Additional tax incentives, if they were sufficient to eliminate the shortage, would induce a shift in the domestic supply curve to S^2S^2. The effect of such a tax subsidy induced supply shift in terms of inefficient resource allocation would be to increase the social cost of the depletion allowance (and related tax provisions) from an amount measured by the area of the triangle ABC to an amount measured by the area of of the triangle DEF.

An alternative policy which would be consistent with conservation of scarce energy resources (the tax subsidy induces increased consumption), elimination of the shortage and efficient resource allocation would be to eliminate simultaneously the depletion allowance and the ceiling price. Such a move would curb tax subsidy induced consumption and expand domestic supply. In Figure 2, domestic markets would clear at a price of P_3 and an increased volume of oil production of Q_4.

The depletion allowance is a political as well as an economic issue. It could well be that the only way to achieve the benefits of market clearing prices in

domestic field markets for oil and gas is for the petroleum industry and its spokesmen to compromise on the depletion allowance. In effect, the industry might be able to trade the depletion allowance for deregulation of the wellhead price of natural gas and decontrol of the field market price of crude oil.

In this connection, the industry is currently in a unique position. Existing contracts have been written in such a way that they include within them both a given historical set of price expectations and the capitalized value of the depletion allowance. With no change in prices, elimination of the depletion allowance would create short-run capital losses for the domestic industry. At the moment, however, historical price expectations are increasingly obsolete and a substantial upward revision of anticipated prices is occurring. Thus, the industry is in an economic position to trade away the depletion allowance without incurring short-run losses or adjustment costs. The social benefits of such a trade would be substantial. These benefits would include:

1. Elimination of the regulation induced shortage of natural gas;
2. Permitting the domestic supply of oil to respond to across the board increases in domestic oil prices;
3. Use of the price mechanism to ration oil usage and restrict consumption to that amount at which marginal social costs and benefits were equal;
4. Removal of the depletion allowance as a confounding and acrimonious element in the debate about national energy policy;
5. Defusing the issue of windfall gains as an objection to allowing market prices to become equilibrium prices; and,
6. Improvement in the efficiency of resources allocation.

At a time when the United States is teetering on the brink of prolonging the energy crisis through expansion of inept government controls of fuels markets, such a trade appears especially advantageous.

The remaining sections of this paper review the existing empirical literature which examines the relationship between tax expenditures and incremental reserves.

Tax Neutrality and Resource Allocation

As mentioned above, there has been debate among economists as to whether the present tax treatment of the petroleum industry is "neutral" with respect to resource allocation, i.e., do the taxes imposed cause resources to be allocated differently than if those taxes had not been imposed?[8] The debate has proceeded at two levels—efficiency and equity; are more resources devoted to oil extraction than would have been under a system of neutral taxation (the efficiency question)? And is the national income distributed differently than it would have been under neutral taxation (the equity question)? We are most interested in the efficiency question in this analysis.

The debate began when Harberger (1955) and Steiner (1959) concluded that the distinctive tax treatments accorded to petroleum producers were non-neutral with respect to resource allocation because these special provisions made it profitable to invest more resources in petroleum than in less favored industries. In the basic model, the effect of a corporate income tax is illustrated in Figure 1 as a shift in petroleum supply from SS to S'S'. If all industries were alike, the depletion induced shift would differentially favor the petroleum industry and result in more resources being allocated to the petroleum industry than are strictly justified by the equality of marginal social benefits and marginal social costs.

The assumption that all industries are alike was challenged by McDonald (1961). McDonald argued that if we assume perfect forward shifting from producers to consumers (and certain other assumptions he thought realistic) the standard corporate income tax alone discriminated against the more capital intensive (a larger amount of plant and equipment relative to labor and materials) and/or the riskier industries. He argued that the petroleum industry fell in this group and therefore would be subject to tax discrimination without some special compensating tax advantages.

Susan Agria (1969), using an approach similar to that developed by Harberger and later by Steiner, compared the total amount of resources invested in petroleum development (operating with special tax incentives) with that devoted to other forms of investment (non-mineral and subject to normal depreciation

[8] *The Oil Import Question*, pp. 53–56.

and tax rates). She found the ratio of petroleum investment to ordinary investment, adjusted for economic rents in the form of lease costs and severance taxes, to be in the range of 1.2—1.3, i.e., 20–30% more capital was invested in petroleum production than would be in other assets operating without the special tax benefits. She also found that incentive to develop existing wells was greater than the incentive to explore primarily because intangible drilling expensing favors drilling productive wells (remember dry holes can be written off immediately) and the depletion allowance deduction varies directly the value of output.

The neutrality or non-neutrality of the special provisions affecting the taxation of income earned in the petroleum industry ultimately depend upon the relative riskiness and capital intensity of the industry, the size of the provisions, and whether or not the corporate income tax is shifted forward to consumers. In a recent article, McDonald (1970) has provided the capstone for the debate. He concludes ". . . the combined effect of percentage depletion and expensing privileges is probably unneutral, thereby inducing an uneconomical allocation of resources to oil and gas production. Under assumptions less favorable to the industry but more consistent with majority professional opinion, we conclude that the distinctive tax provisions are markedly unneutral. Consequently, there are important misallocative effects." (*Editors' Note:* This conclusion rests in part on an assumption that the corporate income tax is not shifted forward. The state of economic knowledge on this subject is very murky. The best assumption may be that part of the tax is shifted forward, part of it is shifted backward to factors of production and part of it is borne corporate stockholders.)

It is also agreed that in order to restore neutrality, all relatively capital intensive industries would have to be taxed at effective rates below the uniform rate, and firms in relatively non-capital intensive industries would have to be taxed at rates higher than the uniform rate. As outlined earlier, the policy implications of the findings to date are nil. Nowhere is it said that tax neutrality is the policy goal of the special tax provisions.

Steiner (1959) left the door open when he argued that deliberate tax non-neutrality may in the best interests of public policy. He wrote:

> The central issue of public policy does not concern whether such provisions affect the allocation of resources among industries but rather whether the social benefits of such effects are worth the costs involved.

The general problem is one of evaluating the costs and benefits of economic incentives such as tax subsidies, direct subsidies or import controls to alter free market solutions in order to achieve some policy goal. For example, the Cabinet Task Force on Oil Import Control favored relying upon existing domestic capacity and reserve storage stockpiles to "increase the ability of consuming countries to respond to a supply interruption."[8] They also concluded that "the present (1970) import control program was not adequately responsive to present and future security considerations." The same basic analytical problem applies to tax subsidies. This leads us to the major empirical attempts to measure the quantitative "cost-effectiveness" of present tax policy towards the oil industry.

THE CONSAD REPORT AND THE NCSU/VPI MODELS

The CONSAD Report

One major attempt to estimate the effect of the special tax provisions for income earned in oil and gas production on the reserve holding behavior of the domestic petroleum industry was a study done by CONSAD Research Corporation under commission from the U.S. Treasury (CONSAD, 1969). The CONSAD report developed two models—a user cost of capital (reserves) model and an industry simulation model. In order to estimate the effects of changes in tax policy on oil reserves, CONSAD first calculated the effect of tax changes on economic incentives while assuming production was held constant.[9] This assump-

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[8] The Oil Import Question, pp. 53–56.

[9] The Mid-Continent Oil and Gas Association immediately criticized this technique in a paper (Mid-Continent 1969) submitted to the U.S. House Ways and Means Committee. Mid-Continent asserted that (a), "the required level of reserves is technologically determined by the level of production," and (b), "the effect of an increase in income taxes on oil companies would be a decline in production not a change in the ratio of reserves to production, which by (a) is technologically determine." From these assertions, Mid-Continent concluded that the way CONSAD formulated the problem was foreordained to show little responsiveness of reserves to taxes when production was fixed, because fixed production means fixed reserves. This affected CONSAD's results more adversely than they admitted, but Mid-Continents' analysis of it was badly flawed and consequently of little value.

tion seriously biased the CONSAD results in the direction of underestimating responsiveness. For a complete discussion of the modeling problems involved, see CONSAD (1969), Mid-Continent Oil and Gas Association (1969), Spann, Erickson and Millsaps (1973), Erickson and Millsaps (1971), Cox and Wright (1973) and Millsaps (1973).

The CONSAD report developed numerical estimates of the changes in liquid hydrocarbon and natural gas reserves which would occur if the percentage depletion allowance were reduced (or eliminated), and if the option to expense intangible drilling costs were removed. These estimates were developed on the assumption that the resultant tax increase was absorbed entirely by the petroleum producers (i.e., *not* passed forward to consumers or backward to landowners).[10]

The specific conclusions of the CONSAD study were:

1. "The elimination of percentage depletion as an option would reduce existing reserve levels by 3 percent and result in an additional $1.2 billion in tax revenue at current production levels.

2. Elimination of the option to expense intangible drilling costs would reduce existing reserve levels by from 1.9 percent to 4.0 percent depending on the alternative tax policy.

3. Percentage depletion is a relatively inefficient method of encouraging exploration and the resultant discovery of new domestic reserves of liquid petroleum. This is in part due to the low sensitivity of desired reserve levels to the price subsidy represented by percentage depletion, and in part to the inefficiency of the allowance for this purpose since over 40 percent of it is paid for foreign production and non-operating interests in domestic production."

CONSAD also provided estimates of the size of the recent tax benefits to the extractive industries and of the size of the stimulus to creation of new reserves of petroluem. Tax expenditures due to the excess of percentage depletion over cost depletion, plus expensing of exploration and development costs were estimated to have run at an annual rate of $1.7 billion, $1.4 billion of which were estimated to have gone to the oil and gas industry. CONSAD estimated that the tax policies then in effect resulted in additions to petroleum reserves worth approximately $150 million per year. If these figures are even approximately correct, spending $1.4 billion to achieve $150 million in additional reserves is extremely inefficient. This judgment, of course, depends upon the accuracy of the CONSAD estimates and the presumption that there is a lower cost means for achieving at least as many additional reserves that are in fact a national security reserve.[11] As noted above, however, the assumptions in the CONSAD report biased their estimate of the tax subsidy induced incremental reserve holdings downward.[12] Nevertheless, the relative magnitudes of the costs and benefits estimated by CONSAD are consistent with an inefficient allocation of resources.

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[10] This assumption represents the "worst case" impacts. If the net increase in tax payments can be passed on to consumers, or be compensated for by a reduction in costs, then the effect on reserve stocks will be smaller than that estimated in this study. In actuality, the results of the increase in taxes would probably be a combination of passing forward to consumers [see Jameson (1968)] and passing backwards to landowners [see Davidson (1970)], reducing costs [see *JPT* (1958) and *Oil and Gas Journal* (1965)], and shutting down excess wells in overdeveloped fields [see *Oil and Gas Journal* (1962)].

[11] For discussions of stockpiling, see *The Oil Import Question* and Mead and Sorenson (1971).

[12] There is a growing body of econometric literature which indicates that petroleum discoveries are relatively sensitive to price changes. [For example, see Erickson and Spann (1970), Erickson (1968), and Spann (1973).] If petroleum discoveries are relatively sensitive to price, then it is not intuitively appealing that reserve holdings should be insensitive to changes in economic incentives.

In addition, there are a number of problems in the formulation and estimation of the CONSAD model. First, the desired stock of reserves, cannot be directly observed. CONSAD used alternative series of *ad hoc* proxies for this variable.

Second, the CONSAD formulation of user cost and some of the data elements in the measure they used can be improved. In working paper, Wright and Cox have shown that CONSAD failed to directly incorporate a term for percentage depletion in its user cost formula causing bias.

Third, inclusion of output directly in the estimating equation poses conceptual and statistical problems. The reserves/production ratio is an economic variable, but it is bounded by technological limits. Estimating the responsiveness of reserves to tax policy while holding production constant biases the effect of changes in economic incentives toward zero. In addition, in the presence of a supply relation between price and output, simultaneous inclusion of both price and output as principal explanatory variables for desired reserves causes X'X matrix to approach singularity.

The NCSU/VPI Models

In conjunction with the energy economics research underway at North Carolina State University and Virginia Polytechnic Institute and State University, two models of the effects of tax incentives on the domestic petroleum industry have been developed [Spann, Erickson and Millsaps (1973) and Millsaps (1973)]. The results of these models are generally consistent with each other. The first model is a mathematical model which uses existing econometric estimates of the supply responsiveness of the U.S. petroleum industry to calculate the effects of changes in tax policy. The second model is a direct econometric estimation using an alternative econometric model of these same effects.

When the mathematical model is used to estimate the long-run effects of changes in the special tax provisions on domestic crude oil reserves, production and prices and to illustrate the numerous trade-offs involved with various tax policy changes, the primary conclusions are:

1. Elimination of the package of special tax provisions accorded the petroleum industry would, over the long run, increase crude oil prices by approximately 24 percent, reduce domestic crude oil output and discoveries by approximately 10.5 percent and reduce crude oil reserves held by about 24.4 percent.

2. Elimination of percentage depletion while retaining the expensing of intangibles would increase crude oil prices by about 9 percent, reduce crude oil output by approximately 4.3 percent, and reduce reserve holdings by about 11.2 percent.

3. Using 1971 as a base, the import ratio would have had to increase to about 37 percent (from 14.6 percent) in order to hold crude oil prices constant if the special tax provisions accorded the petroleum industry were not in force then. For the case in which only percentage depletion have been 28.7 percent in order to hold well-head crude oil prices constant.

4. The special tax provisions accorded the petroleum industry have significant costs. The tax revenue foregone due to these provisions is approximately $2.5 billion. The social cost of the tax provisions in terms of the misallocation of resources attributable to those provisions is approximately $300 million.[13]

The estimates presented here are considerably higher than the CONSAD estimates and indicate a more pronounced effect of percentage depletion and expensing of intangibles on the long run level of domestic oil reserves.

The direct econometric estimation model confirms these results. It has been suggested by industry spokesmen that tax incentives are a more powerful inducement than prices to encourage the domestic petroleum industry to discover and develop new petroleum reserves.[14] The direct econometric estimation model was developed to test this hypothesis.

The results of the direct econometric estimation model with respect to the price and tax effects on the industry's behavior and economic performance are as follows:

1. An increase in prices or a decrease in effective taxes each improve the incentives to discover and develop petroleum;

2. Both price induced and tax induced increases in economic incentives have a significant effect upon the behavior of the industry with regard to discovery and development of new petroleum reserves; and,

3. Equal percentage changes in the economic incentives the industry faces, whether price induced or tax induced, have equal effects upon reserves.

The mathematical and econometric models are both consistent with the position that discussion of tax policy changes should not be approached cavalierly.

Three major points must be made with repsect to the problems just discussed. First, they are not trivial. Correct respectification, variable redefinition and reestimation of a user cost model can be expected to significantly change the results. Second, such an effort is possible. And third, the initial CONSAD work should not be regarded lightly. A considerable amount of opprobrium has been directed toward the CONSAD work. This is understandable in an adversary context. But the CONSAD effort can be viewed in another light. It was a major exploratory effort in an undefined province. Economic research, as does petroleum exploration, produces dry holes. But just as in petroleum exploration, these dry holes may give significant direction to subsequent efforts.

[13] This is an estimate of the inefficient resource triangle ABC in Figure 1.

[14] See, for example, the statement by Richard J. Gonzalez in the panel discussion on general tax reform before the Committee on Ways and Means, House of Representatives, 93d Cong. (Washington: GPO, 1973, pp. 1328–1364).

Significant tax policy changes would have significant effects upon the U.S. energy balance. However, price policy is an effective substitute for tax policy. Were deregulation of the wellhead price of natural gas and decontrol of the field market price of crude oil to be substituted for the depletion allowance and its related provisions, market clearing equilibrium prices would be higher than current estimates indicate. But existing empirical evidence suggests that both the efficiency of resource allocation and the overall U.S. energy balance would be improved by such a combination of policy changes.

CONCLUSIONS

The relevant public policy goal of the special tax provisions which affects the domestic petroleum industry is national security. The Arab oil embargo is an example of a security risk. The depletion allowance has resulted in larger levels of domestic petroleum reserves than would otherwise have been the case. But price incentives would be just as effective as tax incentives to encourage discovery and development—and more efficient. However, if these reserves are fully commited to support domestic production, there is no national security reserve. Moreover, there are social costs associated with the depletion allowance because it induces incremental consumption of our scarce petroleum reserves beyond the point where marginal social costs begin to exceed marginal social benefits. A more reliable and administratively flexible way to provide national security reserves would be through the use of the strategic petroleum stockpiles. This approach was part of the recommendations of the Cabinet Task Force on Oil Import Control. At this time, a politically feasible and economically desirable set of policy changes would be to eliminate percentage depletion, deregulate the wellhead price of natural gas and decontrol the field markets for crude oil.

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Appendix D

OIL AND THE BALANCE OF PAYMENTS

Many observers consider the balance of payments an important constraint on United States oil import policy. Although mandatory oil import quotas were removed in the first half of 1973, tariff and subsidy questions remain unsettled.

Recent trade and business literature is replete with arguments for oil protection offered by the U.S. oil industry and some government spokesmen. These arguments concentrate on the adverse balance of payments effects of current and projected oil imports. The general issue of free trade versus protectionism has always been with us, but recent events involving oil have given it a greater sense of urgency. A new consideration is that currency exchange rates have become much more flexible since 1971, and this has altered the relationship between oil and the balance of payments.

The paper considers three general propositions concerning trade in oil. The first section discusses the proposition that free trade which results in heavy dependence on imports is not the best policy for the U.S. Section; two considers the contention that current and projected oil deficits will result in intolerable balance of payments problems. The last section considers the proposition that oil exporting nations will accumulate large stocks of dollars (petrodollars) and use these hoards to destablish world currency markets.

1. OIL PROTECTIONISM

Net oil imports for the United States were $3.9 billion in 1972 and they are expected to grow rapidly in the near future. Some government and industry forecasts predict deficits of $20-25 billion by 1980 and $30 billion by 1985.[1] There is widespread concern about large oil deficits, and the President and many members of Congress have recently called for a movement toward self-sufficiency in oil. Let us consider the benefits and the costs of importing oil.

A. Specialization

The traditional justification for international trade is that all trading countries benefit from specializing in production and buying from the lowest cost source. In terms of its balance of payments accounts, each country would show surpluses for its low cost products and deficits for its high cost products. Thus, the principle of specialization implies that an observed deficit for a particular product should not be interpreted as a measure of a country's failure but rather as a measure of the gains from trade. For example, an oil deficit of $10 billion means that in absence of trade, domestic resources worth more than $10 billion would have to be diverted from other uses in order to maintain the same volume of oil consumption.

Recent trade data for the U.S. show (see Table 1) the magnitude of certain imbalances. In 1972 the U.S. was a substantial net exporter of machinery ($5.5 billion) grains ($3.5 billion) and chemicals ($2.1 billion), and a large net importer of petroleum ($3.9 billion), automobiles ($3.1 billion), and steel ($2.1 billion). Although each industry is understandably concerned about the balance for its product, it is not clear why national policy ought to be more concerned about the oil deficit alone than the auto or steel deficits or the surpluses for machinery, grains, and chemicals. A county cannot obtain the gains from international trade without encountering deficits for some items and surpluses for others.

TABLE 1.—NET EXPORTS OF SELECTED ITEMS FOR THE UNITED STATES

[In billions of dollars]

	1960	1970	1972
Machinery	+3.8	+0.5	+5.5
Grains and preparations	+1.8	+2.6	+3.5
Chemicals	+1.0	+2.4	+2.1
Soybeans	+.3	+1.2	+1.5
Petroleum	−1.1	−2.3	−3.9
Automobiles and parts	+.3	−2.3	−3.1
Iron and steel	+.2	−.8	−2.1
Coffee	−1.0	−1.2	−1.2
Meat	−.2	−.8	−1.0
Overall trade balance	+4.9	+2.2	−6.9

Source: Data from "Statistical Abstract of the United States," 1962, 1971, and "Survey of Current Business," July 1973.

[1] *Oil and Gas Journal*, Mar. 5, 1973, p. 48; and U.S. Department of Commerce.

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Two other points should be noticed about the structure of the trade balance. First, it changes over time in response to changes in comparative cost and demand. The surpluses for machinery, grains, chemicals and soybeans each increased by more than $1 billion between 1960 and 1972, in spite of a worsening of the overall trade balance of nearly $12 billion. During the same period, automobiles and steel changed from small surpluses to deficits of $3.9 billion and $3.1 billion, respectively, and the oil deficit increased by $2.8 billion. Second, items in the trade account are interrelated to such an extent that a policy which restricts the demand for some import, X, may simply switch demand onto another import, Y, without much impact on the total trade balance. This is one of the lessons which appears to be emerging from U.S. trade policy in the 1960's.

B. Vulnerability to Supply Restrictions

The gains from trade depend not only on the cheapness of imports but also on their reliability. Critics of free trade concede that there are potential benefits from oil imports which are cheaper than incremental domestic supplies, but they emphasize that foreign oil supplies are unreliable, especially those from the Middle East. A policy of free trade in oil may make the U.S. economy vulnerable to two kinds of supply restrictions. First, there may be sudden, but temporary interruptions which will impose short-run costs on the U.S. because of the difficulty of shifting quickly to alternate sources of energy of rapidly expanding domestic production. The cause of the interruption may be either a deliberate embargo by exporters whose purpose is to extort political concession, or it may be in accidental side effect of a civil or regional war involving Middle Eastern exporters. This literature emphasizes that the relevant government's are either hostile toward the U.S., or if friendly, they are politically unstable.

The second kind of problem caused by heavy dependence on imports is that it makes the U.S. vulnerable to the pricing policy of the international oil cartel. A rationale monopolist may never find it prudent to impose a total embargo on his customers, but he will find it prudent to judiciously restrict supply to achieve a monopoly price. Thus, even if exporting nations were politically stable and had no hostility toward the U.S., it would be in their interest to improve their terms of trade and national income by selling oil at a monopoly price. The two problems caused by dependence on imports are standard economic problems, the first is based on the economics of uncertainty and the second is based on the theory of cartels.

C. Temporary Supply Interruption

The cost to the U.S. of a supply interruption depends on the probability of an occurrence, the severity of the supply restriction and the adaptability of the domestic economy. These costs of depending on uncertain imports must then be weighed against the benefits of consuming imported oil and diverting domestic resources to higher valued uses.

How likely is a temporary supply interruption? If the interruption is caused by a deliberate embargo by exporting countries, then the probability depends on the political gains (difficult to measure) and the more easily measurable costs. [Editors' Note: Since this paper was written, the Arab oil embargo growing out of the 1973 Mideast War was imposed.] The direct cost to oil exporting countries is the oil income foregone during the embargo and the loss of future revenue by driving importers toward self-sufficiency. The loss of revenue would appear to be especially painful to most exporting countries because of two characteristics: (1) their low incomes, and (2) their high degree of specialization in oil production. The two major producers in the Middle East, Saudi Arabia and Iran, had per capita incomes of less than $400 in 1969 when the U.S. figure was $4,234 (see Table 2). [Editors' Note: As of November 17, 1973, the embargo shows signs of easing after being in duration approximately one month. See the discussion on stockpiling below.] Dependence on oil imports may present a problem for the U.S. but dependence on oil exports for income is a much more serious problem for these countries because the ratio of export revenue to GNP is much larger for them than the oil import to GNP ratio for the United States.

The severity of an embargo depends on how many suppliers participate. An embargo faces the standard cartel problem of enforcing member discipline. But this is more difficult for the oil cartel because the members of an ordinary, profit-oriented cartel share a common goal, but the political diversity of the oil cartel prevents them from sharing a common political goal. A further complication is

that the international oil logistics network is now controlled by international oil companies.[2] As Table 2 indicates, there are many oil exporters, none of whom dominates the market. The oil exporting countries are not all Arab countries, and there are considerable political and economic differences even between Arab states.[3] Market shares are volatile and new producers such as Libya and Nigeria can emerge quickly and old producers such as Venezuela can decline. In the presence of adequate stockpiles for insurance against short-run interruptions, the major long-run issue would be stability of the cartel. In this connection, the 1980 pattern of outputs, revenues and market shares would be of interest. But as the numbers in Table 2 indicate, these measures are too unstable to be projected with confidence.[4]

TABLE 2.—CRUDE PETROLEUM PRODUCTION AND PER CAPITA INCOME

	Thousands of barrels per day, 1962	Share of world production, 1962	Thousands of barrels per day, 1972	Share of world production, 1972	1969 GNP per capita, in dollars
United States	7,257	0.30	9,437	0.19	4,234
U.S.S.R.	3,660	.15	7,795	.16	1,200
Saudi Arabia	1,388	.06	7,470	.15	380
Iran	1,242	.05	4,829	.10	350
Venezuela	3,253	.13	3,166	.06	1,000
Kuwait	2,017	.08	3,036	.06	3,320
Libya	213	.01	2,292	.05	1,510
Nigeria	68	0	1,941	.04	100
Iraq	954	.04	1,475	.03	310
Canada	626	.03	1,461	.03	2,650
Indonesia	469	.02	1,235	.03	100
World total	24,097		49,620		

Source: "Oil and Gas Journal," Sept. 2, 1963 and Aug. 8, 1973, and "World Bank Atlas."

What would be the cost to the U.S. of a temporary interruption of supply? A rough measure is the elasticity of demand for oil from those sources who are affected, and this elasticity will be larger and the cost of an interruption will be smaller the easier it is for the U.S. to switch on short notice to alternative sources of imported crude or products, or to substitute other sources of energy for imported oil. This will be easier, (a) the more elastic is the demand for oil, (b) the more elastic is the domestic supply of oil from new production private inventories and government stockpiles, and (c) the more elastic is foreign supply from those sources not participating in the embargo. Thus, the more adaptable is the pattern of oil flows in the world economy to a temporary U.S. shortage, the smaller is the cost of a shortage, and the more difficult it is to justify programs such as tariffs, import quotas, or production subsidies which provide insurance against an embargo. Some tentative evidence exists on the short-run adaptability of the pattern of world oil flows. As a result of the policy-induced[5] energy shortage in 1973 in the U.S. economy, spot shortages for certain fuels in certain markets developed. The response was a draw down of inventories, a relaxation of the oil import restrictions on products and then crude, and a flow of products from such unconventional sources as Brazil and Western Europe.

There appears to be some agreement that the demand elasticity for crude oil is small (the Cabinet Task Force on Oil Import Control used —0.1), especially in the short-run. The domestic supply elasticity has two components, new pro-

[2] See M. A. Adelman, *The World Oil Market* (Baltimore: Johns Hopkins for Resources of the Future, 1972). The question is whether the existence of international oil companies increase or decrease cartel stability among the producing countries.

[3] For a discussion of actual and threatened military activities between Arab countries see the Statement by Assistant Secretary of State, Joseph J. Sisco before the House Near East Sub-Committee, June 6, 1973.

[4] For an example of the difficulty associated with such exercises, see W. S. Salant, *et al., The United States Balance of Payments in 1968* (Washington: Brookings, 1964).

[5] The contributing policies included, among others, the Federal Power Commission ceiling on the wellhead price of natural gas, the uncertainties (e.g.; crude sources, refineries location, and the status of Canada) involved in the imminent modifications in the oil import program, and environmental restrictions on fuel use, refinery siting, and offshore drilling. Despite the long-run good intentions behind many of these policies, the short-run effect was to help create the energy shortage of 1973.

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duction and inventories, and the latter appears to be more important in relation to temporary embargoes. Because of supply uncertainty, it is profitable for users of oil (the Defense Department as well as private users) or specialized middlemen to stockpile oil in case of a supply interruption. This profit motive exists for middlemen only if the oil price is permitted to rise during a shortage. It has been argued that because the government will freeze oil prices in the event of a shortage, that private inventories will be too small. Uncertainty about government policy could be reduced by announcing in advance their willingness to let prices adjust during a crisis. Alternatively, the government could subsidize private inventories by fiscal incentives or rely on government stockpiling of oil as alternatives to self-sufficiency.[6] [Editors' Note: The discussion of rationing in 1973 confirms the judgment that the government will act to hold prices down. Even those who want prices to rise in order to ration oil usage advocate use of a sales tax to accomplish this end. This does not encourage the private sector to hold additional inventories. Moreover, policy failures had led to private inventories being lower in the winter of 1973–74 than they otherwise would have been. In addition, contrary to the recommendations of the Cabinet Task Force, new government stockpiling strategies had not been implemented to deal with this type of problem.]

D. Uncertainty of all Supplies

Uncertainty about foreign supply due to political disturbances, cartel restrictions, or acts of God exists for all imports, not just oil. If a special trade policy toward oil is to be justified, it must be shown that the consequences of an oil shortage will be more costly than shortages of steel, autos, rubber, coffee, or other imports. The U.S. is already heavily dependent on imports of many minerals such as copper, iron, lead, zinc, and aluminum, and by 1985 the U.S. Department of Interior projects that import shares will range from 34% for copper to 96% for aluminum.[7] In the case of exhaustible resources such as oil, import barriers offer a curious kind of insurance since the more heavily the country depends on domestic supply for current needs, the sooner that supply will be exhausted and the sooner the country will become dependent on foreign supplies for future needs. The rate of oil import dependency has been increasing and the likelihood of an embargo induced oil import shortage may be higher than for other materials. Nevertheless, the same principles apply. These factors do, however, affect the size of the necessary stockpile.

The supply of imported oil is somewhat uncertain, but so is the supply of domestic oil and substitute sources of energy. Sudden, unanticipated changes in energy policy have radically altered costs of production and the entire pattern of demand for sources of energy. Important changes have occurred recently in policy toward natural gas, coal, electricity, transportation, as well as oil, and those domestic policy changes may have been a more important cause of the current "energy crisis" than the behavior of any foreign governments. If this were true, then the option of importing oil would be a source of stability to the U.S. market rather than a cause of instability. For example, if changes in environmental policy raised the cost of producing domestic oil, the resulting shortage at the initial price would be smaller, and the new equilibrium price would be lower, if oil were freely imported than if it were not. One might ask whether American consumers should be subjected to the uncertainty created by a capricious policy toward domestic oil production when they might be better served by a relatively stable supply of foreign oil.

E. Monopoly Supply Restriction

Just as a rational monopolist does not price his product out of the market neither does he refuse to sell to his customers at a profitable price. Similarly, if the object of an oil cartel were to improve the terms of trade and income of its member countries it would reduce exports not to zero but to the level which yielded a monopoly price. Even if oil exporting countries behave as rational monopolists, they may accumulate dollar balances. This problem is discussed in a later section. A second argument against relying on imported oil views the Organization of Petroleum Exporting Countries as a cartel which attempts to exploit foreign consumers.

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[6] On coping with a supply interruption, see The Cabinet Task Force on Oil Import Control, *The Oil Import Question*, (Washington: Government Printing Office, 1970), pp. 50–55.

[7] Data from U.S. Department of the Interior published in *New York Times*, Nov. 5, 1972.

This second view of the foreign oil supply is more amendable to economic analysis via the theory of cartels. It does not require the assumption that political motives dominate economic motives. Even if the Arab-Israeli dispute were to disappear, oil exporters may behave in generally the same manner as they are now behaving. The rational cartel model merely assumes that each government is concerned about its national income and is aware that competition is less profitable than monopoly. There is ample precedent for this kind of government sponsored cartel, for example, the wheat, coffee, tin, sugar, and olive oil agreements.[8] This view also implies that the cartel members will be aware that excessive belligerence may force its customers into self-sufficiency.

To U.S. policy-makers the problem of confronting a profit-motivated oil cartel is quite different from the problem of facing periodic oil embargoes. If a successful foreign oil cartel confronted Americans with a monopoly price, consumers would still have the option of buying domestic oil. This constraint on the monopoly price would provide some built-in protection against the cartel. Whereas, consumers would be better served by a competitive import price, importing at the cartel price cannot be more expensive than self-sufficiency in oil. There is some price high enough to induce self-sufficiency, and as long as oil continues to be imported, the cartel price must be below that price and some gains from trade will remain.

Of course, the domestic oil industry is not adversely affected by a monopoly oil price, and industry spokesmen do not complain strongly about the high price of imported oil. Concern about the foreign oil cartel is more frequently expressed by government spokesmen and private economists.[9] Indeed a successful cartel must share its monopoly rents with the domestic industry, since foreign and domestic oil must sell for the same price in absence of trade barriers. A foreign oil cartel and oil import barriers can be considered two alternative (but not mutually exclusive) ways to protect the domestic industry. Import barriers may be a more visible form of protection, since the domestic price will exceed the foreign price, while with the cartel no such gap will result. In terms of visibility, the domestic industry may prefer this less obtrusive form of protection to import barriers, but because of the historical instability of cartels, they may provide less durable protection than import barriers. Unlike the case where imports are sold at competitive prices, the cartel provides the foreign and domestic producers with certain common interests.

The allocative effect of the cartel is that total world production and consumption of oil will be smaller (shifting demand to other energy sources) and domestic production will be larger than under competition. World income will be smaller because of the substitution of inferior sources of energy in consumption, and the substitution of inefficient sources of oil in production. The distributive effect of the cartel is to transfer income from oil consumers to oil producers. Part of this is an international transfer from the U.S. to oil exporters and part of it is purely a domestic transfer between U.S. producers and consumers.

The cartel imposes two kinds of burdens on the United States. The first is the international transfer itself, which is no more burdensome than other forms of aid to less developed countries which the U.S. government has either implemented or advocated, although the same set of countries may not be involved and the "aid" may not be used for the same purposes. In the past the U.S. has encouraged and participated in several commodity agreements and recently it has endorsed the policy of trade preferences for the manufactured products of less developed countries. The unofficial OPEC commodity agreement in oil does not appear to differ in kind from these other policies which the U.S. has supported.

The second burden is the loss to consumers for which there is no offsetting gain to cartel members. This is a deadweight loss for the world as a whole, and it results from the pricing of oil at more than its marginal cost which induces socially wasteful substitution by consumers. Cartels, optimum tariffs, and export taxes are inefficient devices for transferring income since the same real transfer could be accomplished by a direct money payment at a lower cost to consumers. Because of this inefficiency, consumers should be willing to either

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[8] On commodity agreements see Harry G. Johnson, *Economic Policies Toward Less Developed Countries*, The Brookings Institution, 1967, ch. 5.

[9] See the writings of M. A. Adelman and James E. Akins who share a concern about the foreign cartel but whose views are quite different.

(a) bribe the cartel to sell at competitive prices or (b) spend an amount up to the transfer plus the deadweight loss to dismantle the cartel.[10]

F. U.S. Monopsony Power

The above discussion assumes that oil exporters can improve their terms of trade by acting in concert. Conversely, the U.S. may possess some monopsony power as a buyer of oil, so that a decrease in U.S. demand would lower the foreign currency price. This is the traditional argument for an "optimum tariff" to improve a nations terms of trade. The monopsony issue has interesting implications for domestic environmental policy with respect to oil. A tax on the consumption of oil will raise the dollar price by less than the tax and lower the foreign currency price, the exact proportions depending on the degree of monopsony power. The cost of a cleaner environment will be shared by Americans and foreign oil exporters. If auto emission controls and similar demand-reducing policies have the same effect on demand (without revenue) [11] as a consumption tax, they will shift part of the burden on to foreigners by improving the U.S. terms of trade. However, another set of environmental policies has the effect of taxing U.S. production of crude oil and refining, and these policies will increase the demand for imported oil and worsen the U.S. terms of trade. Price increases for Libyan sweet crude are an example of effects which worsen the U.S. terms of trade. Arguments to maintain or increase the special tax incentives enjoyed by the U.S. domestic petroleum industry would be an example of policies which would decrease the world price of oil and improve the U.S. terms of trade.

2. OIL DEFICITS AND THE BALANCE OF PAYMENTS

The oil policy chosen by a country depends on the capabilities of the country, the constraints imposed by the domestic and international environments, the objectives of oil policy and the trade-offs between oil policy and other policies. Historically, partial self-sufficiency in oil has been taken as an objective of U.S. oil policy for reasons of national security. Pursuit of this objective led to protection of the U.S. producing industry through mandatory import quotas. A new dimension of oil policy now takes as its objective the contribution of that policy to the balance of payments and the value of the dollar. Those concerned with the value of the dollar concede that there are gains from importing some cheap oil, but that balance of payments considerations must limit the volume of those imports. Presumably, a $20 billion oil deficit could, in principle, be offset by surpluses on other products but this would be difficult and costly. The literature which is concerned about deficits seldom offers specific statements about the adverse effects of large deficits, but presumably these would include the following.[12] First, international reserves would be drawn down to dangerously low levels as a result of defending the value of the dollar in currency markets (in effect paying for oil imports with gold). Second, as reserves are exhausted, import restrictions (tariffs or quotas) must be imposed in spite of their adverse effect on national income. Third, to defend the dollar, inflationary monetary and fiscal policy might be imposed which would reduce employment and national income. Thus, were it specific, the argument might conclude that programs which reduce the oil deficit to the economy are justified because they obviate the need to resort to these more costly devices.

A. Offsetting Surpluses

If imports differ from exports, a given dollar exchange rate will remain in equilibrium as long as there is offsetting lending or borrowing.

Thus, a zero trade balance is not a requirement for an economy—even on average for periods as long as 25 years or longer. For the post-war period, 1946–1971, the rest of the world had trade deficits every year which just offset the U.S. trade surpluses. The requirement for long-run equilibrium is that the foreign

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[10] For a program to dismantle the cartel, see M. A. Adelman, *Foreign Policy*, Winter 1972–73.

[11] Auto emission controls are not a simple tax on gasoline because they increase the demand for gasoline per mile driven by lowering mileage per gallon. The offsetting effect is the reduction in gasoline demand from the higher price of driving a mile.

[12] For example an editorial in the *Oil and Gas Journal*, Oct. 16, 1972 warns that "By the early 1980's the deficit from energy imports alone may well reach $20–25 billion. Such a possible drain on U.S. finance has fearsome implications." However, the fearsome implications are not specified.

exchange market be in equilibrium so that the government neither gains nor loses reserves persistently. Thus, the dollar market can be in equilibrium at the current exchange rate is spite of a large oil deficit either if there is an offsetting surplus for other products or net foreign lending. One form of lending is dollar accumulation by foreign central banks.

Even if a $20 billion oil deficit is realized by 1980, it is possible that a current exchange rates offsetting surpluses will be large enough to yield overall balance. On the export side, the outlook for agriculture and machinery is especially promising (and discussions of further trade liberalization are going on under GATT auspices.) On the import side, automobiles, steel, and textiles had been under strong pressure from imports, and the full benefits of the 20% depreciation of the dollar since 1971 have not yet been fully realized. Already, the trade deficit has decreased steadily throughout 1972. A small surplus appeared in the second quarter of 1973 and increased in the third quarter. For the first nine months of 1973 there was a trade surplus, in spite of the energy crisis. In addition to the lagged effects of dollar depreciation, the U.S. trade deficit should also decline in the future because of strong import demand from both industrial countries and oil exporters which have recently accumulated reserves.

B. Measuring and Interpreting the Oil Deficit

An exchange rate is a price which rations foreign exchange, and if there is a shortage at the current exchange rate, that rate will tend to rise and the dollar will tend to depreciate. It is as serious a mistake to think of the dollar price as immutable as it is to think of the oil price as immutable. Even though the post war international monetary system has been based on fixed exchange rates, a member of the International Monetary Fund is permitted, indeed obliged, to change its exchange rate when that rate is in "fundamental disequilibrium". Thus, if U.S. faced a large and persistent payments deficit in 1980, the pre-1971 IMF rules would oblige the government to devalue the dollar instead of imposing trade controls of deflationary monetary-fiscal policy.

Devaluation raises the dollar price of oil and all other importables which encourage consumers to buy less and domestic producers to produce more. Devaluation also raises the dollar price of exportables (for given foreign currency prices) which encourages domestic consumers to buy less, releasing more for export, and producers to expand output. That these substitution effects of devaluation are strong and their cost is not exorbitant notice the dramatic improvement in the trade balance during 1972–1973 at a time when real income was growing rapidly, unemployment was falling, and the volume of trade was growing.[13]

One should exercise caution in interpreting forecasts of future oil deficits, but this warning does not mean that such forecasts are not useful. They can be interpreted as measuring the magnitude of an oil transfer problem. The traditional transfer problem involves the question of how a country making a money payment could achieve an equal trade surplus to accomplish a real transfer. Specifically, it asks whether a gift or loan of $X to a foreign country would, by altering home and foreign spending, induce a trade surplus of $X for the home country which would accomplish the transfer in real terms. If not, a transfer gap exists which would require currency devaluation or other measures.

In the case of U.S. Oil imports, one can ask whether an increase in demand for oil by 1980 will induce enough additional foreign spending on U.S. goods (and less U.S. spending on foreign goods) to pay for those oil imports in real terms. If not, there is a transfer gap, and the size of the gap helps to estimate, *ceteris paribus*, the magnitude of the devaluation or other policy actions necessary to close the gap. This gap has been estimated for 1980 (see Table 3) by considering four components of oil payments: (1) oil imports, (2) induced foreign spending on U.S. goods, (3) U.S. oil-related investment in producing countries, (4) U.S. income from previous oil investments.

The oil import deficit is expected to increase from $3.9 billion in 1972 to $13.4 billion by 1980. The increased income of oil exporters is estimated to increase their imports from the U.S. from $1.3 billion in 1972 to $3.6 billion by 1980. This assumes that their marginal propensities to import from various countries remains the same as in the recent past. This assumption understates U.S.

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[13] Real GNP grew at the rate of 6.1 percent for 1972, and the unemployment rate fell from 6 percent at the end of 1971 to 4.5 percent by October 1973. *Survey of Current Business*, October 1973.

exports somewhat since devaluation makes U.S. goods considerably cheaper. Income on previous oil-related U.S. investment is estimated to rise from $3.1 billion to $4.5 billion in 1980. Finally, the flow of new oil-related investment is estimated to rise to $7.7 billion, and the total deficit for the four categories of oil transactions is $12.9 billion. The estimated gap of $12.9 billion is based on exchange rate prevailing in January, 1973, and in absence of foreign lending or offsetting surpluses on other specific goods, the gap must be closed by other policy measures such a devaluation. This estimate abstracts from changes in any other exports or imports, except those directly induced by purchases from oil exporters.

TABLE 3.—U.S. OIL TRANSACTIONS AND THE BALANCE OF PAYMENTS

[In billions of dollars]

	1972	1980
Oil imports	−3.8	−13.4
Induced U.S. exports to oil countries	+1.3	+3.6
Earnings on earlier U.S. oil investment	+3.1	+4.5
New U.S. investment in oil countries	−2.5	−7.7
Total	−1.8	−12.9

Source: Herbert S. Winokur, Jr., "Balance of Payments Flows Resulting from Oil Imports," mimeo, 1973.

Estimates of the future oil deficit have received much attention, and it is important that they be properly interpreted. An estimate of the oil deficit for 1980 is not a balance of payments estimates for 1980, since this would require comparable estimates for all other traded goods and capital flows. If the projected oil deficit is $13 billion, there will be neither upward nor downward pressure on the dollar if there are offsetting surpluses for other products or capital inflows totaling $13 billion.

Oil has received more attention from trade forecasters than other products but early trade estimates indicate that U.S. exports and import substitutes will be increasingly competitive in the future and foreign investment in the U.S. should increase. For example, the Chase Manhattan Bank estimates that net exports of three agricultural products; soybeans, feed grains, and wheat, will be $8 billion by 1980.[14] The trade balance for all agricultural products is more sensitive to trade controls, but one estimate for 1985 is for a $7 billion surplus if present trade controls persist and a $13 billion surplus with freer trade.[15] As more evidence about trade in other products is assembled, policymakers will be better able to assess the significance of a given oil deficit. With current limited information, a $13 billion oil deficit does not preclude an overall payments surplus.[16] As a guide to further research, better forecasts of trade in other products might be more productive than further refinements in forecasting the oil deficit.

C. Exchange Rate Flexibility

One reason to be less concerned about payments deficits today than in the past is the greater flexibility of exchange rates. Since August, 1971 when the dollar ceased being convertible into gold at $35 per ounce there has been considerable rate flexibility between all major currencies. Governments have intervened occasionally in currency markets, and the system is probably best described as managed flexibility. The stated policy of the Bank of England and others has been to attempt to reduce deviations from the trend in their currency values without interfering with the trend itself. Since the period prior to the Smithsonian realignment of exchange rates in December, 1971, the major industrial currencies have appreciated by a trade-weighted average of 29% relative to the U.S. dollar (as of August 1, 1973) with the German mark gaining the most, 55% and the Canadian dollar gaining the least, 1%.[17] In addition the currencies of

[14] *International Finance,* Chase Manhattan Bank, Sept. 24, 1973, p. 7.
[15] *Business Review,* Federal Reserve Bank of Dallas, September 1973, p. 8.
[16] For a more alarmist point of view, see Frank V. Fowlkes, "Trade Report/'Petrodollar' surpluses loom as problem for monetary system, U.S. energy crisis," *National Journal,* Aug. 18, 1973, pp. 1211–1217.
[17] A trade-weighted index of dollar depreciation is calculated daily by the Morgan Guaranty Trust and is reported periodically by the *Wall Street Journal* among others.

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nearly all the major oil exporters have appreciated relative to the dollar (see Table 4). If the relevant time period for planning oil policy is measured in years rather than months or days, then exchange rates can be taken as effectively flexible for planning purposes. Forecasts of oil deficits for five or ten years in the future can best be interpreted as forecasts of the behavior of exchange rates.

If a large fraction of future U.S. oil demand can be satisfied most cheaply by imports, they must be paid for by some combination of more exports and less import of other products. Depreciation of the dollar accomplishes this adjustment of the trade balance by increasing exports and decreasing imports over the entire range of traded goods. Alternative policies such as restricting oil imports through tariffs, quotas, or subsidies to domestic production concentrates the entire adjustment burden on one product.

Since exchange rates are relative prices, depreciation of the dollar implies appreciation of all other currencies. In oil exporting countries, local currencies will appreciate (as they have in fact, see Table 4), and prices of imports will fall. For given dollar prices of oil, local currency revenue will fall. As governments seek compensation through higher prices in the form of revised tax, royalty, and participation arrangements, American produced oil becomes relatively more attractive. Exchange rates affect not only the pattern of trade, but also the location of direct investments, and dollar depreciation will affect the location of refineries. Exchange rate adjustment will discourage capital outflows by providing incentives to construct new refining capacity in the U.S. to serve the domestic market.

3. OIL IMPORTS, PETRODOLLARS, AND MONETARY INSTABILITY

The third argument for restricting oil imports is that oil exporting nations will accumulate large stocks of dollars, and this will threaten the stability of the international monetary system, especially the position of the dollar in that system. This threat is summarized by the warning of Hubert Humphrey that "the sheiks of Arabia will control the dollar." [18] However, even under fixed exchange rates and growing oil exports, oil exporting countries did not generally accumulate reserves. Under flexible exchange rates, such accumulation is even less likely.

TABLE 4.—EXCHANGE RATES OF OIL EXPORTERS

[Units of local currency per U.S. dollar]

	1970	April 1973	Percentage appreciation
Saudi Arabia	4.500	3.730	+17
Iran	75.700	68.200	+10
Kuwait	.357	.296	+17
Venezuela	4.400	4.200	+5
Libya	.357	.296	+17
Nigeria	.357	.658	−84
Iraq	.357	.296	+10
Indonesia	374.000	374.000	7

Source: "International Financial Statistics," 1972 supplement.

A. Dollar Accumulation by Oil Exporters

The first part of the argument is an empirical proposition about the demand for dollar reserves by oil exporting countries. In its crudest form it says that this demand is insatiable in spite of the opportunity costs of holding reserves. Some observers treat these costs as minor because most oil-rich nations "don't need the money." [19] This argument is startling since all the major oil exporters are underdeveloped countries by World Bank standards, and except for the three million people of Kuwait and Libya, the per capita incomes are extremely low (see Table 2). Reserve accumulation is a considerable luxury for those in poverty.

[18] *Wall Street Journal*, Mar. 2, 1973.
[19] James E. Akins, Director of the State Department's Office of Fuels and Energy, quoted in *Wall Street Journal*, Apr. 10, 1973.

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A less extreme hypothesis about reserve accumulation by oil exporters is that countries will not add all of their incremental income to reserves, but they will raise the ratio of reserves to imports relative to their past behavior. Table 5 represents some evidence on reserve behavior by comparing the reserve-imports ratio at the end of 1971 for major exporters with the means of those ratios for the decades of the 1950's and 1960's. Of the eight countries considered, six of eight are not behaving differently than they did in the 1950's and 1960's. The two countries which have accumulated dollars are Saudi Arabia and Libya, but there is no general pattern of reserve stockpiling.

The reason that accumulation of dollars has been limited is that there is an adjustment process. Under fixed exchange rates, a trade surplus tends to increase aggregate demand which increases imports, decreases exports and tends to retard reserve accumulation. In addition there is upward pressure on the exchange rate of surplus countries which also stifles accumulation. In fact, the currencies of six out of these eight have appreciated relative to the dollar since 1971.

TABLE 5.—RATIO OF INTERNATIONAL RESERVES TO IMPORTS FOR MAJOR OIL EXPORTERS

	Mean 1950–59	Mean 1960–69	1971
Saudi Arabia	(1)	1.2	2.4
Kuwait	0.5	.3	.4
Libya	1.1	.4	3.7
Iraq	1.0	.8	.9
Iran	.8	.3	.3
Venezuela	.6	.5	.7
Nigeria	1.2	.4	.3
Indonesia	.4	.1	.1

[1] Not available.

Source: International Financial Statistics, 1972 supplement.

B. The Dollar Overhang and Monetary Stability

In fact most oil exporting nations have not been adding substantially to their dollar hoards, but if they did so in the future, what problems would this create for U.S. policy-makers?[20] Would this not aggravate the problem of dollar overhang and destabilize world currency markets? In analyzing the effect of oil exporters on currency markets, it is important to distinguish between a convertible dollar and an inconvertible dollar. The dollar was convertible into gold at the price of $35 per ounce for foreign banks until 1971 but it has been inconvertible since then. Much of the popular concern about monetary instability relates only to the convertible dollar and is of little relevance under current monetary arrangements.

The term dollar overhang refers to the excess of dollar liabilities held by foreign governments over gold and other reserves held by the U.S. government. Because of the fractional reserve arrangement, small conversions of dollars could be accommodated, but massive conversions could not, and this presented a real threat to U.S. reserves until 1971. Monetary fiscal, and commercial policy could not be formulated without considering their impact on reserves. The U.S. was concerned about both the size of foreign dollar holdings and their distribution among governments, since some had higher propensities to hold dollars than others. It was difficult to quantify the threat to U.S. reserves because the commitment to fixed exchange rates gave all private speculators an indirect claim on U.S. reserves. Private speculation against the dollar would cause an excess demand for foreign currencies, and foreign governments were obliged to accumulate

[20] The dollar overhang refers to a stock of dollars at a fixed exchange rate. The flow of dollars into this stock is a function of the real volume of oil trade, the price of oil and the exchange rate. For a given volume of oil trade, and even under fixed exchange rates, it is possible to talk about a potential "oil overhang." If the long-run world supply elasticity of oil is high, the demand elasticity low, and the current real market price above the long-run equilibrium real price, then the "oil overhang" may severely limit the flow of dollars into the dollar overhang. This limitation would be reinforced by flexible exchange rates. See M. A. Adelman, *The World Oil Market, op. cit.*, for a discussion of long-run oil price trends, cartel stability and the real resource costs of substantial increments to world oil supply.

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the excess dollars to prevent their currencies from appreciating, and these dollars became eligible for conversion into U.S. reserves. Thus, sales of dollars by any U.S. or foreign resident or private business firm could contribute to a gold drain as long as foreign governments were unwilling to accumulate dollars indefinitely. The magnitude of the overhang defied measurement because everyone was potentially a speculator against the dollar (including those who owned no dollars).

This threat to U.S. reserves ended when the dollar was declared inconvertible in August, 1971, and concern about the overhang problem lost most of its importance. Since then dollars have been worth as much or as little as sellers could obtain in private markets, and American policymakers have been freed from a major constraint. At the same time there was a worldwide shift in exchange rate policy away from fixed rates, and this general policy shift was quite dependent of the dollar overhang. There were many reasons for the shift but the immediate one was the increased mobility of capital between countries, and this effected all countries not just the United States. The currencies of countries such as Canada and Japan are not held by foreign governments, yet their currencies were floated because of speculative capital flows under fixed rates. In summary, the abandonment of fixed rates reduces the importance of the dollar overhang problem and the contribution to the overhang of oil exporting countries.

With an inconvertible dollar and more flexible rates, the dollar overhang cannot threaten reserves but it may effect the variability of exchange rates. This depends on foreigners behaving differently than Americans and one hypothesis is that for any given stock of dollar assets, the dollar exchange rate will be more variable the larger the fraction held by foreigners and the larger the fraction held by oil exporters. An alternative hypothesis is that if oil exporting countries behave like well-informed speculators they may contribute to increased stability of exchange rates around their long-run equilibrium values. The quantitative significance of both of these hypothesis depends upon the assumption that the dollar holdings of oil exporting countries are a relatively large fraction of total world dollar balances. In this connection, a stabilizing transaction is defined to be one which moves an exchange rate toward its equilibrium value. If a government is supporting a disequilibrium exchange rate, then transactions which we would view as stabilizing might be viewed by that government as destabilizing.

Sometimes the literate characterizes Middle Eastern governments as greedy speculators who are anxious to manipulate their dollar holdings to increase the wealth. However, as long as they have pecuniary motives and are well informed about currency markets, they will disturb market stability no more than the treasurers of IBM, Standard Oil, or any private corporation which deals in currency markets and is obliged to satisfy greedy stockholders. If the dollar temporarily depreciates, well informed speculators will perceive the transitory nature of the movement and buy dollars at the low price and sell them later at a higher price, with the combined effects of (1) reducing exchange rate variability and (2) earning profits. Contrary to the instability hypothesis, this kind of speculation will stabilize currency markets. These governments do appear to have pecuniary motives in view of their aggressive and tenacious bargaining with Western oil companies and if government officials are not well informed about currency markets, they are in a position to hire the most knowledgeable portfolio managers in the world. This discussion of stabilizing behavior also applies to multinational corporations.

The same governments are sometimes portrayed as zealous nationalists who are willing to sacrifice considerable wealth to achieve political goals. They are said to believe that the threat of massive sales of dollars at critical times will accomplish these goals. If such sales occurred they would have two effects: (1) the government involved would lose money and (2) exchange rates would be disturbed no more than by the operations of poorly informed private speculators. For example, if the dollar temporarily depreciated, malicious governments would sell dollars at low prices to push the dollar lower, and later when the dollar recovered, they would have to buy at high prices to replenish their reserves. This process would be partially self-correcting since they would lose money and their impact on the market is likely to be small, since well informed speculators would be delighted to offset their actions by buying dollars at bargain prices. In spite of frequent allegations, no governments have been observed behaving this way.

It should be noted that the dollar holdings of the relevant governments are a tiny share of the total currency market. The combined reserves of the eight largest oil producers (excluding the U.S., USSR, and Canada) were only $10 billion at the beginning of 1973, a figure which was exceeded by the reserves of a number of individual countries such as Germany, Japan, and France.[21] In addition, the U.S. Tariff Commission estimates that multinational corporations possessed $268 billion in liquid assets which they could readily mobilize for speculative purposes.[22] The currency operations of oil exporting countries are so small relative to those of other governments, international banks, multinational corporations and private speculators that they can be safely ignored by those constructing U.S. oil policy. If oil exporting countries held all their reserves in the form of gold or SDR's instead of dollars, it would be no easier to maintain fixed exchange rates than it is with the current dollar overhang.

C. Petrodollars and Foreign Ownership of American Business

Petrodollars have concerned some people because of their threat to the value of the dollar. A more recent concern is that holders of petrodollars may take over major American businesses. Since it is not obvious how Americans suffer from foreign investment, such fears could be dismissed as isolated cases of xenophobia if they were not expressed by people in such powerful positions.[23]

A few facts about foreign investment are appropriate. At the end of 1972, American claims against foreigners exceeded foreign claims against Americans by $50 billion. American investment abroad has resulted in much more direct ownership of business than has foreign investment here. United States investment abroad was 50% direct investment but foreign investment in the U.S. was only 10% direct, and of this total 98% came from Canada and Western Europe.[24] Any new direct investment by oil exporting countries will begin from a very small base. The U.S. government has actively promoted foreign investment for years on the grounds that it benefits both the investor and the host country, and it would be ironic if the U.S. government restricted foreign investment for fear of foreign domination of U.S. industry.[25]

Increased interest in foreign direct investment in the U.S. is not directly attributable to petrodollars, although some popular literature has attempted to link the two issues. Devaluation of the dollar has made the U.S. a less attractive export market and a more attractive location for direct investment. The auto industry has already responded to these forces, with Volvo of Sweden announcing plans to produce in the U.S., while German and Japanese producers are actively considering similar plans. The two problems of foreign direct investment and the U.S. oil deficit are logically distinct and some confusion is avoided if they are evaluated separately and on their own merits. If foreign ownership is judged to be in the national interest, then investment should be welcomed whether the nation has an oil surplus or a deficit.

D. Balance of Payments and Fixed Exchange Rates

Concern about the state of the balance of payments is implicitly based on a system of fixed exchange rates. This is a legitimate fear under fixed rates since the central bank faces the prospect of running out of reserves. This has been impossible since the dollar became inconvertible in 1971, but the fear has survived the change in circumstances. Just as there is no threat to the central banks reserves under flexible rates, there can be no balance of payments problem. The official settlements balance measures the U.S. deficit as the change in U.S. reserves plus increases in dollar holding of foreign governments. Inconvertibility means that U.S. reserves will not change, and the behavior of foreign reserves is beyond the control of the U.S. government. If there is an excess demand for foreign currency in the private market, and if foreign governments defend existing exchange rates by supplying their currencies and buying dollars, this

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[21] *International Financial Statistics*, July 1973.

[22] Study by U.S. Tariff Commission reported in *Wall Street Journal*, Feb. 13, 1973.

[23] See the statement by Nelson Rockefeller: "What is going to happen in these countries—particularly these Arab countries—with these billions they are getting? Are they going to come over here and buy up all our corporations? They could buy the *New York Times*, the *Los Angeles Times* or CBS", *National Journal*, 1972.

[24] *Survey of Current Business*, August 1973.

[25] Congressman John Dent of Pennsylvania has proposed such a bill to Congress. See *National Journal*, Aug. 18, 1973.

will show up as a foreign surplus and an American deficit. Conversely, if rates are flexible, foreign governments need not undertake such involuntary dollar purchases, and all official settlements balances will be zero.

E. Monetary Reform

The present monetary system is not one of freely flexible rates but one of managed flexibility. Active discussions are under way to reform the system and the present system may not survive long in its present form. There are many proposals for reform, but a common element in all of them is greater flexibility of exchange rates than occurred prior to 1971. Even the conservative International Monetary Fund emphasizes that flexibility of rates is an important part of the adjustment process. The U.S. proposal, as set forth by Treasury Secretary, George Schultz, calls for greater flexibility, and it specifies a rule indicating when rates should adjust.[36] The major indicator in the plan is the change in reserves, so that if an oil exporting country continued to accumulate dollars then at a certain point it would be obliged to appreciate its currency.

It appears that policymakers must accept considerable exchange rate flexibility as a present fact and a likely future possibility. In such a world, it makes little sense to ask about the effect on the balance of payment of some particular oil policy. If oil can be obtained more cheaply from abroad it is a mistake to limit imports for balance of payments reasons. Under flexible rates, the balance of payments and the exchange rate will adapt to the oil policy. In the long-run, the only constraint on nation's consumption and investment is its production possibilities. The balance of payments is not an additional constraint, and the allocative problem of how much oil to produce at home should be based on standard benefit-cost considerations.

F. Oil and Dollar Seigniorage

Those who are concerned about a petrodollar problem view the exchange of dollars for oil as disadvantageous to the United States. This is somewhat paradoxical since a much larger accumulation of dollars a few years ago by European governments was widely viewed as advantageous to the U.S. and costly to Europe. It was said at that time that Americans were acquiring real resources in the form of imports or European businesses and paying for them, not with real resources, but with greenbacks. This process was called an "exorbitant privilege" by DeGaulle, and it became known as the seigniorage problem in the economics literature.[37] The hypothesis was that Americans paid non-competitive interest on their foreign borrowing and earned competitive returns on their foreign investment and pocketed the difference as rent or seigniorage. The question of whether Americans do in fact earn seigniorage is an empirical issue. However, since Saudi Arabia and other oil exporters have access to the same forms of dollar investments as France or any other foreigner, then Americans either earn seigniorage on all foreign dollar holdings or on none of them. Thus, if dollar seigniorage exists, petrodollars are a problem for oil exporters and a cheap source of revenue for Americans, and if seigniorage does not exist, petrodollars are a problem for no one. In neither case are they an American problem.

Summary

Balance of payments considerations are an increasingly prominent element in discussions of U.S. oil policy. These considerations begin with the extent to which U.S. oil consumption will be supplied from foreign sources and the terms under which such oil will have access to U.S. markets. The point of departure for these discussions is often some version of oil protectionism. The themes now most often invoked are the balance of payments effects (at fixed exchange rates) of expected large imports of oil and the effects of large dollar accumulations by oil exporting countries on international monetary instability.

Three main conclusions are the following. First, strict adherence to the principle of self-sufficiency is unlikely to be the optimum way to respond to any balance of payments effects of increased oil imports. Oil protectionism results in

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[36] The United States proposal is set forth in the *Economic Report of the President*, January 1973, Chapter 5 and Supplement.

[37] See Mundell, Robert and Swoboda, Alexander, eds., *Monetary Problems of the International Economy*, Chicago, University of Chicago Press, 1969, passim.

worldwide efficiency losses due to misallocation of resources at home and abroad, and it causes an abitrary redistribution of income between consumers and producers of oil.

Second, preoccupation with the deficit for any single commodity is a restrictive way to view the balance of payments. Such emphasis leads to an inefficient policy of concentrating the burden of adjustment on a single commodity instead of spreading it over the entire range of traded goods. Predictions of large and persistent future deficits can best be interpreted as forecasts of the prospective behavior of exchange rates. More flexible rates are not to be feared, and our experience since 1971 has shown that they are compatible with a growing volume of trade and general prosperity as measured by rapid growth of real income and falling unemployment.

Third, concern about increased international monetary instability as a direct result of dollar accumulation by oil exporting countries is exaggerated. The tenacious bargaining by oil exporting countries over their returns from oil sales suggests that they are highly motivated by income. This is supported by the fact that they are generally poor countries as measured by per capita income. In fact, the ratio of international reserves to imports for the major oil exporting countries has been relatively stable. The management of their dollar reserves has not been significantly different from that of countries which do not produce oil, and they appear to present no greater threat to monetary stability than other central banks and multi-national corporations.

LIST OF TABLES

1. Net Exports of Selected Items for the United States.
2. Crude Petroleum Production and Per Capita Income.
3. U.S. Oil Transactions and the Balance of Payments.
4. Exchange Rates of Oil Exporters.
5. Ratio of International Reserves to Imports for Major Oil Exporters.

Senator GRAVEL. The hearings are recessed until 9:30 in the morning.

[Whereupon, at 5:15 p.m., the committee recessed to reconvene at 9:30 a.m. the next day, Thursday, November 29, 1973.]

FISCAL POLICY AND THE ENERGY CRISIS

THURSDAY, NOVEMBER 29, 1973

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.

Congressman Vanik from Ohio, is our first witness.

Congressman, please come forward. Is there anybody with you? You may have your staff members join you at the table if you like.

I would like to say that I am deeply grateful for your participation. We both know that it takes two Houses of Congress to enact legislation. To take effective action on something as momentous as the energy crisis requires the cooperation of our two committees as well as both Chambers of the Congress. The same is true with respect to any attempt to legislate a solution to any of the problems which face this Nation. So I cannot thank you enough for your appearance here today. We welcome you.

STATEMENT OF HON. CHARLES A. VANIK, A REPRESENTATIVE IN CONGRESS FROM THE 22D CONGRESSIONAL DISTRICT OF THE STATE OF OHIO, ACCOMPANIED BY WILLIAM VAUGHAN, LEGISLATIVE ASSISTANT; AND ED MORRISON, LEGISLATIVE ASSISTANT

Mr. VANIK. Thank you very much.

I would say at the outset that I want to express my appreciation to you and your committee for moving into this critical issue in a timely manner. I hope our efforts here and our other individual efforts will help prod other committees into moving into this area of most urgent legislative concern.

First of all, I would like to ask unanimous consent that my statement as prepared is made a part of the record, and I would like to read from it.

Senator GRAVEL. At your will.

Mr. VANIK. It is my feeling that some of our past policies have made a significant contribution to our energy crisis and must be cor-

rected. We must realize it was only a few, short months ago that we relaxed the restraint on oil imports, and I think our tax policies in the past have been designed to use up and deplete our energy resources as rapidly as possible, rather than maximize their value.

And I think at this point we have to find some new solutions to the present crisis through a dynamic approach to tax policy.

I would like to suggest to your committee several areas of legislation on which we have been working.

The first idea I would like to propose to the committee is the concept of an energy research and development trust fund. The energy crisis is not of any short-term duration or disruption. Its impact will last for a decade or more—until we are welling to invest enough money in research for alternative sources of clean, safe, dependable fuel. We must establish a "Manhattan project" for energy research, and this is going to cost a great deal of money. President Nixon estimates $10 billion over a 5-year period. I think these are just ballpark estimates—and where is the money to come from? A Federal commitment of this magnitude will certainly place a tremendous burden on the regular budget; I do not believe that the funds are available in general revenues to provide the allocations that we need. We have got to realize that tax receipts may fall off and there may be some disruptions in our budgetary expectations as a result of the energy crisis. We are going to have increased demands for Federal funds for welfare, for emergency employment, for other things, and the energy research may just be put aside or slowed down because of the critical impact on the budget.

Therefore, I suggest that the only responsible alternative for the regular flow of necessary funds is the establishment of a trust fund. That has many advantages. It establishes an individual source of funding for a vitally needed project. It would take the pressures off budgetary politics. It would provide insurance against arbitrary decisions by the Executive to withhold funding.

In short, a trust fund would guarantee a sustained commitment to the search for alternative energy sources. We have taken this step in the past when our goals demanded. For a large commitment of funds over a long period of time, we turned to the trust fund concept, the social security fund, the highway trust fund. I think our effort in energy research and development fits closely with this pattern.

A small tax on energy consumption, gasoline, natural gas, electricity, and petroleum products would raise a tremendous amount of revenue. For example, as you know, Mr. Chairman a 1-cent gasoline tax could raise $1 billion in revenue. A 4-cent tax could raise $4 billion. As a matter of fact, the industry has already put in its "tax" and moved forward with price increases, and one of the reasons it is expedient for us to act quickly is that if we do not move in with some tax, the industry may move in with some more increases that may preempt the tax increases.

The proposal for a 50- or 60-cent tax on gasoline was incredible, unworkable. I get the feeling that this is almost an unstudied approach to the problem. The purpose of our small tax should be to create a fund which can help solve the problems of energy and which could provide alternative fuels for the combustion engine, which can solve our problem by creating more energy.

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I think our efforts are tremendous. But the real solutions lie in the development of new sources of energy. I think the $6 billion a year would be adequate certainly for a starter. The money would not only be used for research, but for the development or the actual bringing into production of new energy supplies.

I might say at the outset, Mr. Chairman, that the tax plan that I offered and suggest in my bill would provide the following approach: A tax on natural gas of 10 cents per thousand cubic feet, and that would raise $1.4 billion. The 4 cents on gasoline would raise $4 billion. A tax on electricity of one-tenth of 1 cent per kilowatt would raise about $1 billion, and a tax on fuel oil of about one-half-cent a gallon would raise $500 million.

So that we have a program here that would produce upwards of $6 billion, which would not provide an inordinate strain on the consumer and which should not propel market prices up beyond a reasonable limit. I think the consumers of America should realize that this added burden which they must all sustain and which is related to their use of energy, would be designed in the long pull to create facilities which would make this country energy free as soon as possible. It might be a good Bicentennial goal to work for energy freedom.

There would be an exemption from the tax for the small user. I think the bill that I have suggested would probably exempt the retired, the small homeowner, so that the burden of this taxation would rest primarily with those who are inclined to become the larger energy users or those that might be construed as being excessive or more wasteful users of energy.

This size fund would be adequate at this time. Among the types of research it should be used for are solar energy for electricity for heating and cooling.

I might say that I have a company in my area that told me they have developed a solar turbine: for $100,000 they could produce a unit that would produce 40 percent of the energy needs for a moderate-sized office building. It is quite a cost, but it would eliminate much of the need for outside electrical power. I think enterprises like this deserve some type of encouragement. People who build facilities like this deserve some type of encouragement, and if the Government can, it ought to provide viable incentives for developing such things.

We could go into coal gasification and liquification. We ought to go down into deeper oil well projects, try to make better use of thermal energy, and wind power, tidal currents, improved generation of electricity, new forms of conservation devices, alternatives to petroleum as a fuel, such as hydrogen, and the utilization of the thermal-gradients in the ocean.

This tax could be geared to the larger users, those who are excessive and those who are more wasteful. This is all incorporated in my bill H.R. 6194.

I have also proposed legislation that would sort of direct auto efficiency through excise taxes. I have legislation which would provide an excise tax on those automobiles that provide fewer than 20 miles per gallon.

It is an incredible thing how the automobile industry, with all of its great engineers and great skills and scientists and highly paid executives seem to have been completely unaware of the energy crisis.

They were either unaware or deliberately planning to get all of us stuck with a big fat automobile guzzler so we would have an obsolete vehicle as an historic evidence of a period in which America lived with a great deal of folly.

But today, automobile dealers are flooded with automobiles that provide only 6 or 6½ miles per gallon, while the rush is on for the small cars that people want to buy.

I have been trying to alert the automobile industry in Detroit. Early this year I filed my bill and notified all of them. My bill simply provides a tax that is accelerated in accordance with the manner in which the automobile fails to meet the 20-mile per gallon requirement. There is no tax at 20, a modest tax at 18 and 16 and 15 and it gets higher, until it reaches a figure of $600 for some of the present automobiles that are as inefficient as 6½ miles per gallon.

The automobile industry says they have all these problems, because of pollution devices and other things we have incorporated. I would say the 1938 Ford or Plymouth, it would probably meet most of the pollution requirements, probably provide as many as 20 or 22 miles per gallon. The designs are all there. It is just a matter of getting back that old engine out of the custodial system and putting it back into production and giving us the kind of automobile that gave us safety and security and reasonably high speeds and comfort without becoming the tremendous user of gasoline that the modern automobile has become.

My bill provides that they would have until the 1977 model year to comply, so there would be some lead-time before we could apply the excise tax.

I have another bit of legislation on oil recycling. I think taxes could be adjusted to recycle lubricating oil. Each year we waste over 1 billion gallons of used oil. Used oil could be purified to produce a usable lube oil or burner fuel. Today it is simply dumped on the ground and enters our waterways. As a matter of fact, one of our problems is that recycled oil goes on the market under a label which makes it almost impossible to sell. It is perfectly all right, but it has to be labeled as previously used oil. I think the industry was very anxious to put on a label in order to discourage the sale of recycled oil. But we are in different times today and if previously used oil is perfectly all right for your automobile, I do not think we should compel the label to say it was previously used if it meets the industry standards in every other form. I do not think it should be forced to carry a label that is discriminatory and prejudicial to its use.

Mr. Chairman, I know you have an interest in solar energy. We should consider the granting of incentives to the homeowner for the installation of solar devices. I have proposed two measures. The first would allow the homeowner a tax credit for improving the energy efficiency of his residence. This could offset what the homeowner might have to pay by way of the energy tax going into the trust fund. This would include whatever overhead he had for the installation of solar equipment.

This idea has been included as a part of S. 2589, the National Emergency Energy Act.

The second piece of legislation I am sponsoring in this area is a special 5-year amortization schedule for the manufacturers of solar

equipment. This would be limited to 5 years. It is patterned after the pollution control amortization provision which our committee and yours very wisely included in the 1969 Reform Act.

Mr. Chairman, I want to thank you for this opportunity to discuss these proposals. I hope that your efforts here will help prod our committee in the House to move quickly into the area of developing the trust fund and moving forward into these incentive areas of legislation, so that we can really meet the critical problems of the energy crisis that we face today.

I do not believe, Mr. Chairman, that this country can be any more half sufficient than half free. While the President has said he wants this country to be independent of resources, we have got to realize we have to do some things and get some things on the action table. Unfortunately, in his message of a few days ago, he did not create another kilowatt or another barrel of oil. Frankly, I think we ought to move in that direction and quickly; I do not think we have to, even at this point, decide how the energy fund should be used. I think we can be more relaxed about that, but I think we should immediately begin raising the revenue and perhaps delay the issue as to the utilization of this fund until we have a little more time and judgment. But I think there is very little time for us to act with respect to the creation of the fund and to moving with the trust fund program immediately.

Thank you, Mr. Chairman.

Senator GRAVEL. Congressman, let me thank you. I certainly applaud your foresight. I could not agree more. I think the plans we have seen come out of Congress thus far—or the recommendations thus far—have really been addressing themselves to the immediate problem of scarcity. Except for the Alaskan pipeline, there has been nothing concrete to contribute to supply. I could not agree more that the present situation calls out not for only rhetoric, but also for the revenue, the money to do the job. Anybody who is talking about doing something without talking about getting the money is engaging in demagogery. So when you talk about a trust fund you are addressing the problem realistically and honestly. I share your view regarding a trust fund. I have felt strongly about this for some time, and I hope this committee will report out a bill with a trust fund, because therein lies the vehicle to get the moneys that we want. I think we have an opportunity now with the crisis before us, as you point out, to sort of trim down our society, make it stronger, and see that resources are reapportioned more properly.

There are many facets we could cover, and we have covered quite a few of them in the last 2 days of these hearings.

The creation of a trust fund—I think the parallel is the early 1950's when our Nation suffered from the lack of highways—permits the money to solve the problem immediately without competing with other appropriations, going through the dance of Congress to get the money. This vehicle particularly the interstate highway trust fund has really worked very, very well. So if we really want to solve this problem, not just talk about it, we need a trust fund. Our Nation requires an adequate base of energy, and if we do not solve that problem we will be in serious difficulty.

It is the question of raising the funds, the tax side of it, that I wish to discuss with you. There have been many proposals and yours are certainly valid proposals.

I have a suggestion and commend it for your consideration—that is a tax on energy, British thermal units. The difficulty of taxing automobiles or other things are several. You want to dampen those activities and that is a valid reason for a tax. You can tax to raise revenue or you can tax to have an effect on the economy.

However, I find it difficult to make the judgment on a policy basis that we should use the automobile less than a mixer at the home or whether we should use the automobile less than a refrigerator. I have a certain fondness for the free enterprise system because that makes the system work and not Government. I am not afraid to use Government economic tools but I have seen the excesses of Government. Wherever possible, I think, we should let the private sector solve problems. But when you tax gasoline you are saying, in effect, "You are not smart enough, Mr. Citizen, to make a decision on how to apportion your resources so we are going to make it for you. So, therefore, go ahead and leave the lights on in your house if you want, keep the heat on if you want, just drive your auto less." So my suggestion is that we tax energy per British thermal unit. You would go right to the source and levy the tax on a British thermal unit basis, on oil, on gas, on hydropower, on atomic power, on any kind of power and energy that is created in this country, right at the source so that when the tax is there it will be carried forward. When you put it at the source, all of the inefficiencies that you have built into the system of energy are going to compound themselves, because the more inefficient an auto or appliance a person selects, he will be paying more tax. We do not want to reward the inefficiency. By having a British thermal unit tax at the source you then reward the efficient use of energy, and that is really what we are after.

At the same time you do not discriminate against any particular energy source. The burden will be carried right across the total system of energy whether fission, nuclear, MHD, solar, mechanical, tidal, or whatever the source. I do not claim to be a scientist. I agree with you that we ought to get the wherewithal to undertake the task and solve the shortrun problem as well as the long run. The shortrun problem we can solve through incentives, through existing methods. But over the long run we have to encourage energy efficiency.

I would suggest and commend for your consideration a tax to raise $6 billion. We consume 300 million Btu's per capita per year, and such a tax could raise about $6 billion. We would have less bureaucracy if we could go out and collect it at the source. You can go right to TVA and say what is the British thermal unit capacity of your production? Go to the producer of oil and assess the quality of oil and there is your tax. They do all this bookkeeping now for whatever taxing they are doing, so it would not be very, very difficult. It would not take a large bureaucracy to do it. The Congress could annually alter the rate of the tax so we would not have an open end. It would be very difficult to establish a formula as to how much we will spend on solar, liquefication or oil shale. It is much more difficult to do that on a policy basis. We can open the orifice through which the funds will flow and then annually make an examination on the nature of the expenditures and say

we are not spending enough, change the formula for that year or tighten it up. This way, as a society, when we have completed our task, we can shut it off.

I know some people criticize the highway trust funds. They say that it has been too successful, that we have overbuilt. But we do know one thing, that it worked and if we ever need that mechanism again it is there.

I find myself in agreement with your proposal. I share it. I would only commend to your thought the possibility of a tax on energy per British thermal unit which might be more equitable and which would raise the same amount of money.

Mr. VANIK. I would say the primary thrust of what we are talking about is the establishment of a trust fund. I think this matter of how we develop it is a matter of judgment. I think we see substantially eye to eye. I think the problem is what is the most convenient way of collecting the tax.

If the tax reaches the user—as under my approach—it gives him an energy consciousness.

One of the great problems in Congress, is that those people who suggest new taxes usually do not come back to help enact them. I think our electorates are a lot more wise on this issue; I think there is nothing to fear on the general taxation question. Everybody is afraid to suggest rationing or taxation, because these are supposed to be the exits of public life. But I have tried the tax concept in my community, and I want to report to you that my people and my constituency has responded rather reasonably to the issue. Of course, they do not want more taxation. They feel they are already carrying the tremendous burdens of Government. But they are attuned and they do recognize the necessity for facing up to this problem.

There is just one other thing that I wanted to suggest, Mr. Chairman. If we have to provide, for example, through some new processes, the development of shale oil recovery, and it will cost, say, $6.50 or $7 a barrel to produce, then we are always faced with a problem wherein the imports from abroad may rush in at a lower price to help destroy our new technology efforts and markets. I think once we move into the development of our own energy, we will have to protect these sources and take what is produced at the higher price. While it may create some permanent problems for our industry and the consumer, I think that $6.50 a barrel paid to Americans is a lot better than paying $3 a barrel to a foreign source and having that cost flow out or that oil cut off. If it is developed here and paid for here, that increment remains in the United States—and that capability remains viable. I think we have to plan to protect these new sources of energy which are probably going to be developed at a higher cost. We have to insure continuity of a market for the higher cost energy that would be produced through new and extraordinary sources.

I had one other idea, and I think if we do go into this matter of energy creation and development, that some of our world partners ought to decide whether they want to take their side with the payment of homage or whether they want to be partners with us in new energy development. This is the sort of communication with which we ought to be letting our partners in the free world know we think they ought to be partners in free enterprise and development which will be to

their advantage, too, and somehow we ought to bring them into this problem and its solutions.

Senator GRAVEL. Congressman, I want to add two points, because you have evidenced certain thinking and catharsis that I have gone through. I sense from the statement you have just made, we are all going through a metamorphosis. One thing I have come to appreciate in the last 3 days is a very simple fact. When we use incentives—and that is part of the policy we have had in the past—we increase supply and keep the price down low. Obviously, that encourages consumption. That has been the policy in the past.

Mr. VANIK. That is right.

Senator GRAVEL. The next facet, though, is a tax. A tax would dampen consumption, but on the other hand, it would bring in revenue which we would recycle through the bureaucracy of government.

The other possibility—which is something very frightening to people of our political persuasion, but I think on closer inspection may not be so frightening—is a free market. Prices go up, so you have a dampening of consumption which is our goal. Similarly, you get the money into the hands of those who produce the supply. So you do not have to recycle it. So the problem comes, of course, if that is an end goal—and I only commend it to your consideration—then, how can we safeguard the possibility of windfall profits within the private sector which sometimes we are circumspect about? I would only suggest the possibility of an excess profits tax that might address itself to that problem. It may be the answer. Such a free market approach, of course, would not need rationing.

Let us look at the dynamics of rationing. You think you theoretically put a grip on it, but you essentially create a black market, because if I have enough money and want to get more gasoline I will go to you and say, hey, can I buy a few of your coupons, or some enterprising people will get into the business of selling ration books.

The price would still go up in rationing. It goes up because the black market brings it up. So that money, rather than going into the industry to increase supply, goes into a gray area of our society, and we saw that happen during World War II.

But if we had a white market, that is, let the people trade coupons off, we let the poor, rather than get their food market, get this rationing. The only problem is it does not get the money where we want it. Maybe if we had a trust fund we would relieve the present Treasury of the burden to finance energy development and they could use general revenues to relieve the social problems attenuating the crisis.

I just only commend that theory, which is the product of a metamorphosis that I went through. Let me say also that under the structure of the Congress we need a horse. If you will send us a horse we will strap a saddle on and we will both ride.

Thank you.

Mr. VANIK. Thank you, Mr. Chairman.

[Congressman Vanik's prepared statement follows:]

PEPARED STATEMENT OF HON. CHARLES A. VANIK, A U.S. CONGRESSMAN FROM THE STATE OF OHIO

Mr. Chairman and members of the committee: I appreciate this opportunity to present testimony on the vital matter of our energy shortages. I commend the

committee's leadership in establishing this new Subcommittee on Energy to investigate the role our tax policies can play in finding workable solutions for our energy future.

It is my feeling, Mr. Chairman, that some of our past tax policies have made a significant contribution to our energy crisis, and must be corrected. But in addition, we can only find the necessary solutions to our crisis through an imaginative and dynamic approach to tax policy. I would like to suggest to the committee several proposals I have worked on in the area of energy legislation. I hope the committee in subsequent hearings, will be able to investigate some of these matters in depth.

ENERGY RESEARCH AND DEVELOPMENT TRUST FUND

The first idea I would like to propose to the committee is the concept of an energy research and development trust fund. Its impact will last for a decade or more—until we are willing to invest enough money in the search for alternative sources of clean, safe, dependable fuel. We must establish a "Manhattan Project" for energy research, and this is going to cost a great deal of money. President Nixon estimates $10 billion over a five year period. Senator Jackson proposes $20 billion over ten years. These are only ballpark estimates. The total budget cost could be a great deal higher.

Where is the money going to come from? Nobody at this stage seems to know. A Federal commitment of this magnitude will certainly place a tremendous burden on general revenues. If there is an economic slowdown due to the energy crunch, tax receipts will fall off, and fall off drastically. At the same time, the demand for Federal funds will go up—more money for food supplies, for welfare, for emergency employment would be required—where would the new funds for energy research come from? And if the research and development is funded out of the regular budget, it will be subject to the usual budget delays and perhaps even an occasional impoundment.

The only responsible alternative for the regular flow of necessary funds is the establishment of a trust fund. The trust fund approach has many advantages. It establishes an independent source of funding for a vitally needed national project. It would isolate energy research from the pressures of budgetary politics. It would provide insurance against arbitrary decisions by the Executive to withhold funding. In short, a trust fund would guarantee a sustained, massive, serious commitment to the search for alternative energy sources.

We have taken this step before. In the past when our national goals have demanded a large commitment of funds over a long period of time, we have turned to the idea of a trust fund. Social security and the Highway Trust Fund are the most notable examples. Our effort in energy research and development fits closely with this well-established pattern.

A small tax on energy consumption—gasoline, natural gas, electricity, and petroleum products—would raise a tremendous amount of revenue. For example, a 4 cent per gallon tax on gasoline could raise $4 billion in additional revenue. A total trust fund of about $6 billion woud probably be adequate, certainly at this time. The money would be used not only for research but for the *development*, the actual bringing into production or use of new energy supplies. Among the types of energy that could be developed by such a fund are:

Solar energy for electricity and heating and cooling;
Oil shale;
Coal gasification and liquidification;
Geothermal energy;
Fusion research;
Wind power and the utilization of tidal currents;
Improved transmission of electrical energy;
Improved generation of electricity—MHD;
New forms of conservation devices;
Alternatives to petroleum as a fuel, such as hydrogen; and, utilization of ocean thermal gradients.

To avoid a regressive impact, I would hope that the tax could be geared to the largest and most inefficient users of energy, as I have done in my own legislation, H.R. 6194.

AUTO EFFICIENCY THROUGH EXCISE TAXES

Mr. Chairman, there are other areas where tax policy can provide answers to our energy problems. For example, I have proposed establishment of a grad-

uated excise tax on inefficient automobiles, beginning in model year 1977. Our Nation can no longer afford to allow Detroit to produce automobiles which guzzle gasoline at a rate of only 10 or 12 miles per gallon. The automakers can produce cars which are safe, comfortable, and efficient. An excise tax will ensure that they increase their efforts to improve American Automobile efficiency.

OIL RECYCLING

In another area, taxes can be adjusted to encourage the recycling of used lubricating oil. Each year we waste over one billion gallons of this valuable resource. Used oil can be refined—purified—to produce a useable lube oil or burner fuel. Today, largely because of our misguided tax policies, this oil is dumped on the ground or into our waterways.

SOLAR ENERGY

Mr. Chairman, I know a special area of interest for you is solar energy. To insure widespread application of existing solar energy heating and cooling technology, we should consider granting some limited tax incentives to the homeowner and to the infant solar equipment industry. I have introduced two measures to accomplish this task. The first allows the homeowner a tax credit for improving the energy efficiency of his residence. This would include the installation of solar equipment. I note that the Senate has just passed a similar proposal as part of S. 2589, the national emergency energy act.

The second piece of legislation I am sponsoring in this area is a special five-year amortization schedule for manufacturers of solar equipment. This would be a limited incentive—for five years. The legislation is patterned after the pollution control amortization provision we included in the 1969 Tax Reform Act.

Mr. Chairman, I thank the committee for the opportunity to discuss these proposals. I hope that the committee will have the opportunity to explore these approaches in greater detail.

I believe that our two committees—House Ways and Means and Senate Finance—could play a leading role in solving the energy crisis and leading the way to better, cleaner, safer energy supplies.

Senator GRAVEL. Our next witness is a very distinguished person who has been active on the Hill, is very knowledgeable with Government, and who is a person with whom I have a great deal of personal conversation on the energy crisis, a person by the name of Jack Bridges, director, national energy programs, Center for Strategic and International Studies, Georgetown University.

I am happy to have you come forward and share your wisdom not only with us, but the people of this Nation.

STATEMENT OF JACK H. BRIDGES, DIRECTOR OF NATIONAL ENERGY PROGRAMS FOR THE CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES AT GEORGETOWN UNIVERSITY

Mr. BRIDGES. Thank you for that.

My name is Jack Bridges. I am the director of national energy programs for the Center for Strategic and International Studies at Georgetown University in Washington, D.C. I am also a consultant to the Joint Congressional Committee on Atomic Energy, and to the Conference Board in New York City. I have been asked to give the general briefing describing our national energy dilemma that I have given these past few months to a large number of Senators and Members of the House of Representatives. The briefings were initially given in my capacity as a staff member of the Joint Congressional Committee on Atomic Energy.

The briefing follows closely the joint committee print of August 1973, entitled, "Understanding the National Energy Dilemma." As I go through the briefing, I will refer to specific foldouts or parts of the booklet so that a reader can later identify the portion of the material that I am referring to.

If we can put the lights out I will proceed.

Now, the purpose of the briefing primarily is to describe the magnitude and the complexity of the national energy problem. It is not designed as a cure-all device to describe easy ways out.

Start off by looking at the year 1960. We start with the year 1960 for a couple of reasons. That year was a relatively simple one as compared to the energy situation of today. The data is about 10 years old and we know a great deal about it, we do not have to spend too much time arguing about its validity. Notice everything is reduced to the same vertical scale.

In 1960 we were already getting more energy from oil and gas than from coal. You can see the hydro input. We could not draw a significant line for nuclear or other supply systems.

This is foldout B in the committee print.[1] The numbers that we are using, the so-called yardstick, are million barrels per day (bbl/d) oil equivalent. We find this yardstick seems to be something that the layman can relate to.

In 1960 our domestic oil input was about 7.8 billion bbl/d. We took about 300,000 bbl/d of this oil, burned it under boilers to generate electric power; exported about 200,000 bbl/d, then, in fairly sophisticated petroleum products; about 2 million bbl/d was used in residence and commerce. About 75 percent of this was homes, 25 percent shopping centers, et cetera. About 1.3 million bbl/d of oil went into industry and agriculture, et cetera. About 5 million bbl/d of oil went into the transportation sector.

Back to coal, all, of course, domestically produced. We produced in 1960 the equivalent of 5,300,000 bbl/d of oil in the form of coal. We used about 2 million bbl/d equivalent to generate electric power. We exported the equivalent of 500,000 bbl/d of oil in the form of metallurgical coal to Japan and Europe. We used about 500,000 bbl/d of oil to heat homes and apartment houses. About 100,000 bbl/d oil equivalent went into petrochemicals. We still had enough coal-fired railroads operating in the United States in 1960, so that about 100,000 bbl/d of oil equivalent were consumed.

Back to the supply side. Natural gas. We produced 5.8 million bbl/d oil equivalent from domestic sources and imported about 100,000 bbl/d., 800,000 bbl/d oil equivalent of our gas went under boilers to generate power; about 2 million bbl/d oil equivalent to our homes; about 2 million-plus to industry; and about 200,000 bbl/d oil equivalent into petrochemicals.

We consider oil and gas pipelines as part of our transportation network. This small amount shows what we consumed driving those compressors.

The hydroelectricity system in 1960 supplied about 300,000 bbl/d oil equivalent. That was our total supply circuit. Whether it was imported—cross-hatched—domestic—is shown in solid colors.

[1] See. p. 290.

The next area is the conversion area. The only conversion in 1960 was the conversion of significant quantities of oil, coal, and gas into electric power. Later on we will show conversion of coal to gas in this part of the chart. In the electric conversion system in 1960 we took about 300,000 bbl/d of oil, about 2 million bbl/d oil equivalent of coal and 800,000 bbl/d oil equivalent of gas, converting that into electricity and including the hydroelectric input, we produced and started toward the consumer the total of about 1.2 million/oil equivalent. We lost well over two-thirds of the input in the conversion process into useful electricity.

Now we examine the four forms of energy sent to the consumers. We used oil, coal, gas, and electricity. Again, it is to scale. In 1960 we used about 8 percent of our energy in the form of electricity and about 92 percent in the three fossil fuel sources. Now examine the so-called end use areas, it is to scale. The largest was the industry using about 7,100,000 bbl/d oil equivalent. Transportation second, using about 5.3 million bbl/d, closely followed by residential and commercial at a 5 million level; and, of course, the fourth one was the nonenergy or petrochemicals of about 1.1 bbl/d oil equivalent.

The transportation system, with an input of 5.0 million bbl/d oil; 100,000 bbl/d oil equivalent of coal; 200,000 bbl/d oil equivalent of gas moving all of those systems into the transportation circuit, total of 5.3 million, over 75 percent went out the exhaust pipes, radiators as waste heat, and about 25 percent was actually converted to useful mobility.

Looking at industry and residence uses, primarily because they were stationary, we have reversed these conversions. In our homes we lost about 30 percent out of our stacks et cetera. We successfully converted about 70 percent of the circuit, the same in the industry.

Looking at the whole system, this was our conversion loss, the red shown at the top of the chart where we got about this much use of electricity, then these were conversion losses from our homes, industry, and transportation.

Totaling them all, our lost energy in 1960 was the equivalent of 9,900,000 bbl/d of oil. We successfully used about 9,600,000 bbl/d oil equivalent. We used about 49 percent, rejected about 51 percent, and, of course, as you will see a little later on, this was one of our better years.

If you follow and understand this particular flow pattern, then we think we can move quite rapidly in understanding the energy dilemma this country is in.

To review: The first section is the supply side and where it is from. The second is where we have conversion processes into the flow patterns to the consumer, and finally, the overall efficiency of the circuit.

Do you want to turn the lights back on, please?

What we put together was a plastic device to try to emphasize the situation. I guess if I set it right here maybe that will work. It was designed for use by a very small group, but use your imagination and we will get there. This was for 1960. Remember everything is to the same vertical scale.

This is to the year 1950. This is foldout A.[2] Bear in mind it took

[2] See p. 289.

us the total history of the United States to work up to an energy flow pattern of this size. This is the growth pattern that took place between 1950 and 1960. Here is the year 1970—foldout C.[3] We do not see a projection here yet. All of these displays are history. You can see the growth pattern that took place between 1960 and 1970. We doubled our electric generating capacity. We brought more generating capacity in the 10 years than we effectively had in our total up until 1960. In 1970 we could draw a line for nuclear input into the supply side, and we were also showing a line in 1970 for the geothermal systems in upper California. We could also in 1970, by stretching it a little bit, finally show a line for electric consumption in the transportation systems.

Here is 1980—foldout D.[4] Again, on whether we can keep our supplies available, you will want to bear in mind we have fundamentally committed the United States to this kind of flow pattern. We have already ordered every major electric system that will be operating in 1980. We have already started on every rail-based mass transportation system. In model year 1973 we started off with about 100 million automobiles on the road, averaging something like about 13.5 miles to the gallon. The largest seller, the last model year, was either the Chevrolet Impala or Malibu, averaging about 10.5 miles per gallon. The 1973 Vega, comparably equipped gets about the same gas mileage as the 1966 Cadillac. It is time the American public looks at where we are heading.

Of course, by 1980 we will, through a combination of factors, reject about 54 percent of the circuit, probably using around 45 or 46.

This is the year 1990—foldout E.[5]

As you can see, I am starting to run out of plastic at this time. There are about three projections you can find for 1990. We have drawn one of the smaller ones of the three, again if the supply patterns follow through. From 1970 to 1982, the United States will come close to using more oil and gas in that period than in our total year up until 1970, and that includes all the production that we supplied for World War II, irrespective of where it was consumed, for the Korean war and such things as the Marshall plan. Japan and Europe, if they can get their supply, are increasing their energy use even faster than we are. The world as a whole will come close to going up 400 percent in its energy use in about 30 years. Mankind will come close to using more energy from all sources during that 30-year period than in our recorded history up until 1970.

This growth pattern is something we have to face. In less than 40 years we are looking at this kind of a pattern.

Now in the booklets, just to keep the record straight, 1980 on the plastic sheet and device was foldout D, 1990 was foldout E. Foldout F is a sketch to give you an idea of the intersections.[6] In other words, if we intersect the efficiency side of these plastic charts we get an efficiency curve. (Foldout G.)[7]

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[3] See p. 291.
[4] See p. 292.
[5] See p. 293.
[6] See p. 294.
[7] See p. 295.

The next intersection that we try to get people to pay some attention to is end uses, transportation, nonenergy use, industry, or residential and commercial. This cross section is foldout H.[8]

The next one, foldout I,[9] is one we have to pay quite a bit of attention to. It is the form of energy as we use it—as a liquid, as a solid, as a gas or electricity. If we make this kind of pattern in liquid we have to have the refineries, et cetera. We are already ordering electric plants that will not produce their first kilowatt until the early eighties. Electricity goes up somewhere between 500 and 550 percent in this period.

The next intersection (foldout J [10]), is the so-called supply demand curve. This gives you in the solid colors the domestic production anticipated in the history of what we have already done. In crosshatches it shows you imports.

Foldout J is a photograph of the last crosspiece in the plastic device. These are the years 1960, 1970, and 1980. Solid dark blue is the domestic oil production, the bump here would be the impact of the Valdez line if it gets on in 1978. The little piece here is the impact of the oil shale systems if they all get going. The crosshatch blue is the imports we were on until a few weeks ago. Brown is domestic coal. Orange the gas anticipated. Yellow the nuclear system, geosystem in California and the hydroelectricity systems. Just take the space out from this between, and that will be foldout K,[11] and this is the chart you get. This is the basic issue we are trying to get people to understand and be able to talk about.

Here we set in 1973 up to about 37 million bbls/d oil equivalent, something of that range. That 37 million oil equivalent is made up of about 10 million domestic oil, 6½ going toward 7 of imported oil and their products. Around 7 million bbls/doe of coal; 12 or 13 in gas; the nuclear systems right in here are up to about 330,000 bbls/doe, out of 36 million, or about 0.8 of 1 percent. Bear in mind here, we sat in 1960, just 12 years ago at about 22 million bbls/doe. We are now up to about 36 million bbls/doe. Take out these two spaces (imports) and move them up and then you get foldout L,[12] which, of course, is the curve that we are now all paying a great deal of attention to. We now have imports and/or shortages. With the lead times involved in trying to move other systems in taking place of loss of capacities we are going to have some shortage staring us in the face.

Now, on this particular curve you notice something else. It is a so-called surplus oil line of Oklahoma, Texas, Louisiana, and Kansas, several years back. The main reason we put that on is to underscore a point, and that is we fundamentally have known this problem was coming for a long time. We have been predicting the combination of oil, coal, gas, and surplus oil. The way we have been operating would create the kind of problem we are in. It did not develop late one afternoon in 1971, early 1972. But the problem has been so unthinkable to the American public, our business community, et cetera, that we fundamentally ignored it until a while back. We have had a few heart attacks. Now we have everyone's attention that the problem is here.

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[8] See p. 296.
[9] See p. 297.
[10] See p. 298.
[11] See p. 299.
[12] See p. 300.

This is the result of a national energy strategy, written or not, that we have had quite a while. We have created a lot of the things we have with the assurance of energy available to all four of the consumer sections at low cost, often without real regard to the environmental impact or foreign exchange problems, et cetera. Now we are all at once worrying about these problems.

Are we really going as a country to go after energy demand and literally legislate and force it down or wait for shortages to help us bring it down? These are questions that you people, as our leaders, are going to have to face very fast.

Let me emphasize a couple of points that you have to bear in mind. We have to have some direction before technocrats like myself, can give you good trade-outs or reasonable balances on the options we are being faced with. For example, on the pattern shown here, with this type of a demand curve and with the kind of imports we were heading into, you will notice we would have required in the early eighties about 40 million bbls/doe from all of our different domestic systems. If you start off as a national effort to do such things as eliminate the import requirement, even bring demand down slightly as something of the nature as shown here, you can see we will be looking for something like 48 to 50 million bbls/doe. The difference between the two, you have to find eight more Prudhoe Bays and eight Valdezes, or four States of Texas. The magnitude is massive—this has to be understood.

To underscore again, and this is foldout M,[13] the guidance that we are going to have to have on it, are we really going to play with the energy demand curves—and we are not recommending one way or another—are we going to hold them at a certain level and eliminate our demands until those decisions are made? We do not know the total domestic needs. We have to have a direct strategy we want to follow in the future in order to get the results you want.

The demand curves again—foldout N.[14] None of these are our projections. Here we are around 36 million bbl/doe. Continue our trends and it goes off the chart at 110 million bbl/doe in just over 25 years. Here you see the NPC high, intermediate, and low, some work by Shell and the Department of the Interior, the Office of Science and Technology, before they went out of business, et cetera. These different demand curves are based on different moves to bring them down below the present curve. Some of these are, if we let the free market take hold, others are more severe.

To give you an idea of the magnitude and complexity of the problem, assuming we start around 115 level, where we appear to be heading if we could get the supplies, subtract from that, legislate something like 40 horsepower cars, legislate forced airplanes so they could not fly without an 80-percent load factor or better, forced major improvements in insulation of buildings and homes with at least 20 percent saving, forced improvement in energy conversion on the part of industrial use, try to pick up a 10 percent saving in electric generation, add all those together and throw in a 50 percent factor and it brought demand down to 87 or 82 million bbl/doe total energy demand.

We are not saying we could not bring it below that or that circumstances will not bring it below that. We are not saying we ought not

[13] See p. 301.
[14] See p. 302.

go the way. We are not saying we ought not go the way. We are not recommending anything.

Take exercises then at 87 and 82. We made six exercises at 87, two at 82, and as you probably recall, Mr. Chairman, the one at 82 that we have thrown up, has become pretty well known as the curve design to make everyone equally mad. There is no longer a Santa Claus out there. Practically every move we make from here on in is going to upset someone. This one is down to 82 million bbl/doe 25 to 27 percent below where we have been going demand-wise. You will have a lot of people mad at you for pulling it down that far. You will have some mad because you did not pull it down still further.

Here is an input or shortage area double our present import patterns. If you go after self-sufficiency you are up there instead of dropping down. Both of these are moved in a direction to lower the total domestic or green requirement. Starting at the bottom and coming up, and none of these are maximum of what can be done, they are all certain combinations from projections that any of you can find around here. You can make your own balance if you like. This lower 48 oil projection is 2 million barrels per day higher than recent projections. In order to do this we were estimating operations in the Outer Continental Shelf along the eastern coast, three to five times increase in what we are doing presently in the Gulf of Mexico, doubling on Federal lands and producing such as Santa Barbara on the California coast.

Now, coal. You have projections that show anywhere from 60 percent of what we are doing today, if we have no further strip mining and are not able to solve the sulfur problems from underground coal, up to 300 percent of what we are doing today. The one shown is about 270 percent of today. It is sort of a cost balance at the equivalent of $6 per barrel oil in coal. It would require major increases in the price of coal and probably at least triple our present surface mining rates, and an increase underground of at least 50 to 75 percent, to do something of this nature. We would have real water problems staring us in the face.

Domestic gas. From the witnesses you have already had and are going to have, you will find this is one of the hardest displays to show because the projections vary the most. Some people project our gas supplies as oblivion tomorrow no matter what we do. Some people say simply deregulating new gas will solve all the problems.

I am inclined to think the display shown may be a little optimistic.

Next—look at geothermal. The system shown would be a massive one. It would literally convert California, Montana, and Idaho to geothermal systems. You would have built the electric equivalent of about 110 Hoover Dams.

I am not saying we should do something of this nature or could not do more. I am trying to get people to focus on the impact of some of these projects in the total picture.

Hydroelectric systems. If you want to double the system you can expand existing units and/or build new dams. Before one advocates expanding present sites, one should look at the State of Washington with their current water problems. When you start advocating building new dams, consider that about 85 percent of the better known damsites are in parks, wilderness, and scenic areas. Three are in Grand

Canyon. I am not recommending that you dam Grand Canyon, but am pointing out the political depth of such decisions.

Now with reference to Alaska North Slope oil, you can forget either/or. The Valdez line by 1977 or 1978 could be to 1½ million barrels of oil, and the McKinsey in Canada, if we can put it in could add to that. We would need to forget the Teapot Dome scandal long enough to develop NPR No. 4. This would total up to 4 or 5 million barrels per day system.

Next is oil shale. It is no bonanza system. You hear of 600 billion barrels of oil there but there is a catch to it. Only 6 percent of the shale by weight is useful; the rest is waste.

Solar will not be solved fast. We have to get the technology away from the laboratory out to where the systems could be bought by the individual or you will not have an impact. The system shown here would result by converting the southwestern part of the country into an all but total solar and heating approach.

The next area is nuclear fission and fusion. We may be able to prove fusion in the early 90's. It takes us around 8 or 9 years to build a relatively conventional plant. The Japanese are building them in about 5, as you know. The fission systems are about .8 of 1 percent of our total energy system. We are a little past 15 equivalent plants at this stage—30 some-odd reactors. This exercise, by the way, is foldout O in the booklet.[15]

Those of you still with me are aware of the message we are trying to get across. You are right when you mistrust your neighborhood oil company, the situation is probably not as serious as they have been telling you, because the fact is it is worse. It is more complex than any problem we have had to take on as a country. We will be required to make decisions 5, 7, or 10 years before we will see the results.

To quote one of our punchlines which was sort of pulled out by a columnist the other day—in briefing one of the Congressman from upstate New York several months ago he looked at some of these things and said something like good heavens, I will have to make decisions now that my constituents will not realize how smart I am for seven elections from now. Then he slid down in his chair and said, "I will sit out the last six."

We will test our systems like they have never been tested before, because where we are. Foldout P shows we are fundamentallv at a change in a basic era in the U.S. history.[16] Here we are in 1973. We are moving from an era of surplus and large quantities of cheap domestic fossil fuels into an era where we are going to have to start paying more for these fossil fuels as we try to bring other systems into being. What has happened is our demand curve has exploded across the domestic fossil fuels system at such an angle that we have been forced to plunge into the imported fossil energy business. This is what has got us where we are today. We are not ready to get into the yellow area shown or plunge into solar or geothermal or the nuclear systems. We will have to work in all four areas in order to make it go. We will have to bring the demand down and increase

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[15] See p. 303.
[16] See p. 304.

the efficiency of the systems. In addition, we will have to accelerate our move into geothermal, solar, nuclear fusion, fission. We will have to pay the price in dollars, in tradeouts, et cetera, to increase the domestic fossil systems.

That completes the basic presentation on the description of the magnitude and complexity of the problem that we are facing today. It is very tough, as you see, long-range, and it will be with us for a good while.

It is my conviction that it is essential for the American public, the business community, and our various Government organizations to understand the long-range nature of our energy problems. If we do not grasp this aspect of the situation, I am afraid that we will make hasty reactions to parts of our energy crisis in a manner that may actually weaken reasonable long-range solutions. It is for this reason that I am concentrating my personal efforts on attempting to describe the magnitude and the nature of the problem.

Undoubtedly, our fiscal policy will influence and, perhaps, determine the success of our efforts to restore a balance between energy demand and consumption on the one hand, and energy supply on the other. Any comprehensive national energy strategy must include various fiscal incentives, taxation policies, and foreign trade considerations.

It is my opinion that the establishment of a comprehensive long-range energy strategy is essential before we can intelligently determine which fiscal policies should be advocated. If one assumes that the purpose of such a strategy will be complete self-sufficiency in energy for the United States by the year 1980, or even if the strategy calls for 90 percent self-sufficiency in overall supplies, and at least an 80 percent self-sufficiency in any particular sector, then it appears that imaginative and drastic efforts will have to be made immediately. The cost of such an effort will be high—in the terms of increase of dollar cost to the consumers, inconveniences and modification of the lifestyle of the American public, tradeoffs with our desired environmental goals, and other indirect cost items. It is my opinion that the era of cheap and virtually unlimited energy supply of the various fossil fuels is about over. This is the crux of our problem and it must be recognized.

Another thing that should be recognized is that all of the increased costs will eventually be borne by the consumer and/or the taxpayer. There is no way that private industry can be forced to bear these increased costs alone. When one removes the so-called tax "subsidy" to a private company, its increased costs are passed along to the consumer. If one advocates the "Government" solving the problem, then, of course, that cost is borne by the taxpayer. The concept that the Government or industry will bear this burden is an illusion that should be dispelled. I would like to repeat, the increased costs and shortages will be borne by you and me, either as consumers or taxpayers.

A rational fiscal policy can be and should be employed to assist in bringing on various supplementary energy sources. I use the word supplementary because there are no such things as alternatives—one will not completely supplant the other as much as we will have a series

of systems supplementing each other. We will probably have to consider some sort of a basement or guaranteed price over a long period of time in order to get the massive capital requirements committed for construction of significant numbers of coal gasification, coal liquification, oil shale extraction plants, et cetera. As long as oil can be produced in the Middle East at around 20 cents or so per barrel, we cannot expect literally billions of dollars to be invested in basically manufacturing-type plants that may not have payouts for 10 or more years without some assurance that the make or break power of potentially cheap oil will not wipe out the investments.

I am not an economist and am not prepared today to recommend whether tax credits, tax deductions, or depletion allowances are the most effective way to approach the problem. But, as Khrushchev is reported to have said, "Call it what you will, incentives are what get people to work harder."

The concept of an "energy trust fund" is one of the ways that would transfer some of those costs normally borne by all taxpayers to the actual consumers of the energy. It seems to me that it does make some differences as to whether it is applied at the various sources of the forms of energy or whether it is applied at the end products—even if the consumer will pay for it in the end either way. By applying the tax at the source, and doing so skillfully, it may be possible to encourage increased efficiency in our conversion and utilization of energy. I do feel that it is important that a large fund be available. Long-range research and development needs justify such a fund. Furthermore, such a fund should assist in financing demonstration plants and other expenses necessary to bring technology into use to where it can be commercially productive and useful to the public. It should not be limited simply to financing research and development.

In our rush to advocate Manhattan and Apollo-type projects as ways of solving our energy crisis, we are inclined to overlook the fact that a great deal has to be done in addition to simply improving our technology through research and development. An energy trust fund could help bring the fruits of research from the laboratory to the economy. But, great care must be taken to encourage the "garage inventor." The independent inventor has long been a strong force in the advance of the United States technology. Unfortunately, as projects become massive and Government-financed, the tendency is to institutionalize our inventing processes and attempt to literally brand the independent who has spent a decade or so on an idea as some greedy profit-mad soul.

I have no suggestions today as to who or what should administer such a fund if it comes into being, other than the imperative that it be done in close cooperation, if not under the supervision of, the entity that has the responsibility for defining an overall national energy strategy.

Thank you.

Senator GRAVEL. I think the record will show, Mr. Bridges, that my laudatory introduction was an understatement.

Mr. BRIDGES. Thank you.

Senator GRAVEL. I would like to make one brief statement to underscore what you have just presented, and that is, to use a figure of speech, that we bandy around, we are only talking about the United States.

Mr. BRIDGES. Oh, yes, sir.

Senator GRAVEL. And that we represent 6 percent of the world's population, yet consume over a third of the world's energy. What will happen to your model when we place the rest of the human beings on this planet with their aspirations to come to our present level of quality of life, what happens to this planet when that crush takes place between now and the year 2000? It is really frightful to contemplate.

Let me ask another point. Have you done any work to inventory the cost of establishing an energy trust fund? One of the problems we are facing in the operations presented to us is inventory of cost. Translate this into a timeframe, and then based upon that assessment to move into an annual basis with an energy trust fund, the establishment of a Btu tax or users tax so we can channel the flow of money?

My question is have you done any work in the inventorying of the cost of the timeframing of this subject?

Mr. BRIDGES. Just some very preliminary work, and I think all you can say for certain is that if you do target for, say a 90-degree self-sufficiency level by the mideighties or something of that nature, particularly if you provide funds to carry it beyond research and development, it will be well in excess of the $2 billion per year than you would calculate on the $2 billion in 5 years or the $20 billion in 10 years. You would probably start off at a $2 billion rate, within the next year, five or six per year and, in the fourth down the road probably $7 or $8 billion per year if you were helping to finance fullblown demonstration plants.

Senator GRAVEL. So we are talking horseback figures right now. The figures that have been used thus far, $10 billion, $20 billion—these don't even approach a serious resolve by us to come up with the money to solve the problem?

Mr. BRIDGES. As I understand the $10 billion by the administration over 5 years was primarily limited to research and development. The big difference is if you go beyond that stage and start actively helping demonstration plants and underwriting guarantees in order to get these plants on stream at the speed you would like to see them, this really takes you up into astronomical numbers.

Senator GRAVEL. Would a reasonable, astronomical number—and I don't want to scare anybody, but I have seen the figure—be between $50 and $100 billion within the next decade? Would you consider that a reasonable or unreasonable possibility?

Mr. BRIDGES. Probably a reasonable possibility, again it would depend on how far you take the Government into the underwriting of plants.

Senator GRAVEL. How many Members of Congress have seen this briefing you are talking about?

Mr. BRIDGES. This is session 408 in a little over 6 months, and it is about 70 some odd Senators and about 250 Members of the House. Most of the briefings have been on the Hill. I have gone off the Hill about 40 times to date. We have briefed people like the engineering committee of General Motors, some of the officers of one or two of the larger oil companies, some of the labor groups, a great majority on the Hill.

Senator GRAVEL. So that over 50 percent of the policymakers in this country have been privy to this?

Mr. BRIDGES. Yes, sir; over 50 percent have been exposed to what we think the problem is.

Senator GRAVEL. What about the administration, has Governor Love, Rogers Morton?

Mr. BRIDGES. Yes, sir; Governor Love has been over it. Governor Love has one of the plastic devices, Commerce has one, several are in the administration.

Senator GRAVEL. Is it possible for us to acquire one?

Mr. BRIDGES. Oh, yes. One of the reasons I moved out to Georgetown University was to start reproduction of this material. We started about 6 or 8 weeks ago and we have been swamped by the demand. We will make sure you get one, at least on a loaner basis.

Senator GRAVEL. I think it might be well to have one in our section so we can use it.

Mr. BRIDGES. We are in the fourth run on the plastic devices and the third printing of the colored booklet. We have sold 10,000 of them in the past month or so.

Senator GRAVEL. You have improved the artwork, too.

Mr. BRIDGES. It is a little bit easier to read.

Senator GRAVEL. You are getting better funding?

Mr. BRIDGES. We don't have quite the restrictions I did working here on Hill.

Senator GRAVEL. What are your plans for continued briefing and materials?

Mr. BRIDGES. What we are doing at the center at Georgetown is trying to brief and work with several of the major universities in the country, and we are working with some of the State education organizations to try to get materials available at high school levels.

We have produced, in addition to the plastic device and the view graph systems you have seen here, a 35 millimeter slide set that can be used much more economically.

Our next printing on the color book will probably be around 35,000. We are making them available to other universities, to the public. We have now briefed about 17 Governors and we are working quite closely with 12 States at this point. We are trying to get the problem described.

Senator GRAVEL. What about the networks, have the networks thought about televising anything?

Mr. BRIDGES. The problem about this on the media is you make a mistake if you try to do it in less than 35 or 40 minutes. That is a lot of time for a network. As they also point out, every time they get into it it is quite dull as to much of the program and they question how long the public would stay with it.

Senator GRAVEL. I think it is pretty lively. I think people would cringe in front of their sets.

Mr. BRIDGES. All networks are examining possible ways of trying to use it.

Senator GRAVEL. I have a number of questions I would like to pursue, but I would like to share the time available with my colleague. I will follow with some questioning after you have had an opportunity.

Senator DOLE. I appreciate what the chairman has said and what Mr. Bridges has said. Every Senator is participating in energy hearings, and I have another one going on upstairs, and I am not certain which will bear the most fruit or the most energy.

But I think the point that troubles me, and I would guess everyone, is how did it happen? We have gone through the political maneuvering now to point the finger at the administration on the one hand, the Congress on the other, the Democrats or the Republicans or the Arabs, but that does not, of course, solve the problem. It may be a necessary first step for those of us in the political arena, but based on this information which I assume you have had for sometime, people will constantly ask me, with the war in Vietnam over, with that out of the way and with all lessening of demand in other areas, but still it is very clear in one of your—I don't remember which one—the so-called demand explosion.

I am not asking for any answer, I guess, unless you could comment on just how it happened. Why is it that suddenly we have a crisis?

I have searched the records of all those who are breast-beating now and I don't find too many profound statements of 2 years ago or 3. Is there a reason for it?

Mr. BRIDGES. Let me try to talk about that thing with a couple of points. First off, I view the energy crisis as sort of a three-phased thing, and some of them, of course, will overlap. The first phrase is sort of "I don't believe it" for it is literally beyond comprehension. That is the one we are addressing ourselves to here.

The second phase is the "scapegoat" phase where the administration blames the Congress and the Congress blames the administration and oil companies blame environmentalists and the other way around.

But I hope we get into the third phrase fairly soon, and that is bending our back and trying to dig your way out of this. One of the things I was taught a long time ago when I went through the Naval Academy, when you hit an iceberg that is not the time to stand up on the bridge wondering why you hit the iceberg. You have to keep the ship from sinking, get to shore, and then have your court martial to decide how we hit the iceberg.

We get to blame everybody if you want to go back to phase two. Some of the more intelligent hearings actually before the Congress on this subject was probably in 1947 when we were holding hearings on the synthetic fuel act of 1944. There were very good projections then on when our fossil fuels might get to be difficult. We had hearings in 1959, 1961, and 1962, 10 years ago where people like Dr. Hubbard very accurately predicted when our domestic oil would peak.

Almost fundamentally what we have to come back to is, it is very difficult to predict and get someone to believe your prediction when you are predicting something that they can't perceive. The fundamental situation is that the United States simply can't conceive this total problem. Our total history has been one of abundance, and if there is an excuse I think it is that.

The warnings have been around. Again, we have not had the political acceptance of the warnings. We have not had the business acceptance of them. We have not had the media acceptance of them or the public's acceptance of them. I am really sort of expounding on something there is no easy answer to, but all I am sort of pleading for is let's get the hole patcher up and then come back and fight over how it happened.

Senator DOLE. I think we are in at an early stage in the battle over who is to blame for the energy crisis but I would hope that we can look to the causes of the crisis only as they relate to possible solution rather their to allocate blame.

But in any event, just in the past few years we have had changes in the depletion allowances which, according to the charts, would not make much difference anyway.

Mr. BRIDGES. It would make some. We would not——

Senator DOLE. And intangible drilling costs and mandatory oil import programs, a number of things that would discourage domestic production in many areas. That is a point I find difficult to reconcile. If the warning were there, they were not only not heeded, but we were really taking actions counter to the warnings. We were impeding domestic production and holding the oil industry up as a highly profit-making corporation that is not concerned about the environment, and we did a number of things such as halting offshore drilling following the Santa Barbara incident that were contrary to our interests. Everything we were doing indicated we must have had a surplus, because in effect, there was a surplus.

Mr. BRIDGES. Yes, we had a surplus capacity about 1971, but we knew it was disappearing, and we knew pretty well when it was disappearing. The Alaska pipeline, we discovered that in 1968, crude oil.

Senator DOLE. Right.

As you said, you have some answers but you are not suggesting any particular policy. You are not an economist, and did not address yourself to matters of depletion and the economics aspects of the problem. But I think the fuel crisis will be difficult, and it is difficult even now, and I think everyone agrees that it is a serious problem.

I would guess you are not forecasting any great change even if there should be some quick negotiations with the Arabs in the restoration of our oil supply?

Mr. BRIDGES. No, sir, they could open the spigot tomorrow and we would still have a problem this winter. We would still have a problem and sooner or later you all will have to come back and bite the bullet and decide what level you want to keep the United States at self sufficiency.

Senator DOLE. I notice today and yesterday we are still exporting to those same countries who have the embargo on oil shipments to us millions of dollars worth of oil producing machinery and equipment that we find in short supply in this country. The boxes are clearly marked Saudi Arabia. That does not seem to be a farsighted policy unless there are some delicate negotiations going on.

Do you see any real benefit to exporting materials of that kind to the countries that are producing oil and have an embargo placed on shipments to this country?

Mr. BRIDGES. I have no way of knowing the details of something of this nature, and I don't think I could comment on it. I could see if it were part of, as you say, delicate negotiations, this might be one of the best deals we could make. I don't know the details of it.

Senator DOLE. Thank you very much.

Senator GRAVEL. Mr. Bridges, I can't help but reflect that after I received this briefing back in the spring. I calculated to how difficult

it was to get the pipeline through and how we were going to get it through by one vote, that I felt it would take about 3 years to arrive at the consciousness necessary to make the decisions. We would be further down the road than we are. I think in retrospect history may show the Arabs have done us a favor, that that consciousness will arrive sooner, though maybe more traumatic, and I want to quote a statement attributed to General Patton. I will paraphrase it "When you get them by the vitals their hearts and the minds will shortly follow." I think that that is where we are. I think we may have a blessing, where this can be very pessimistic, we can have some faith in our system and have some faith at where we are and if we can solve this problem think of what we have done for all mankind.

Mr. BRIDGES. I agree.

Senator GRAVEL. Let me go into some other questions that I think we have got to get into the record.

One of the problems we must face is our increasing energy consumption projections. I wonder if you would tell us what constitutes our demands and describe some of the factors that continue to force up these demands?

Mr. BRIDGES. One of the reasons I have gone out to Georgetown and am working with the conference board is we are going to try to disect the demand curve, in other words, get to know more about it in our total data system. One of the weakest is this energy demand curve. The way that it has been growing is a combination of factors. We are still increasing our population. Of course, we don't expect to hit a zero population until about 2030 even if we hold with a zero birth rate. We are getting some increase because of population.

The second increase is we are increasing our energy consumption on a per capita basis, the person at the bottom of the heap, ghetto and so forth, as soon as he gets a little money he picks up a few more energy consumption items. So we are increasing on a per capita basis.

Recently our worker productivity, in our factories has been increased actively per man-hour. In other words, when he pushes a button now, as to 10 years ago, a lot more work is done.

Our agriculture systems have been going more energy heavy. We have corn production systems, for example, right now that require much, much more energy per bushel than they did 10 years ago. So it is this combination of the population growth continuing, our moves to increase our standard of living for our people while increasing among other things our per capita consumption, our continuing increase in our worker productivity per unit and our agriculture. It is all of these things that keep pushing it upwards.

What can we do in the way of slowing her down a little bit, I think we again feel it most important—the most important thing is to know more about the demand curve. It will be very difficult for you all in your taxing legislation et cetera, when you are trying to improve our conversion efficiency and things, you are going to have to know more about the energy demand before you can really use the scalpel and go about it.

Senator GRAVEL. One can't help but notice the glaring energy loss in our systems, and that is in the last slide which is hidden by all the others. Could you explain why such losses occur and give us some ideas as to how to improve these conversion efficiencies?

Mr. BRIDGES. Several reasons. One of the main reasons is that the United States is a country that has never had to worry about it before. We have not really concerned ourselves with our energy conversion efficiencies beyond a certain point. You also have to start off and face that the very systems that we use for such things as generating electricity are by nature, say a good coal plant for example, the best ones are about 40 percent useful out of the whole system, and about 60 percent reject. Some of the better nuclear plants are 30 percent in the green. We have done such things in San Francisco, over what we can determine over the past 10 years, about 9 out of 10 buildings you can't even open the windows. The world trade center in New York City is famous, somebody talks about it every time you talk about conversion, the transmission of heating and cooling circuits, it is calculated about 91 percent in the red and 9 percent in the green. It is designed so you will run heating and cooling all year round. In the summer time you will have to run the air-conditioning so the man in the suit is cool, so you will have the heating on in the shade to keep the secretary warm, and in the winter you will have reversed the process.

They estimate that the larger American cars on the highway are 85 or 90 percent in the red, and 10 or 15 percent in the green. The Mercedes diesel is around 30 percent in the green and 70 percent in the red. So you still have a lot of red.

What can we do about it? First off, as the price goes up and the public gets aware of the problem, increasing things, we will have some improvement. We will get to the point where we are willing to pay for waste heat, using it for things. Technically as we get into MHD, better ways of generating electricity, we will get improvement there, fuel cells, but that is decades away.

Senator GRAVEL. The think you have described is a basic problem and also calls for a fairly large increase in import requirements. Would you discuss your feelings of the possibility of this and give us some of your ideas of complete self-sufficiency for the year 1980, the recently announced goal?

Mr. BRIDGES. Self-sufficiency by the year 1980 is going to be very difficult, and I am being blithe with that statement.

First off is the idea of solving this by massive infusions into research and development. That is the easiest phase of the business. The easiest problem we have facing us is getting funding for research and development. You have a lot of people who support it. But what we continue to shy away from is the biting of the bullets that have to go along with it. Talk about coal gasification. We can put a lot of money into improving our coal gasification. Fundamentally we have a lot of ideas about it now, but we have not been willing to face up to a couple of requirements. We have to have the coal, someone will have to dig it up somewhere and pay for the reclamation.

I touched briefly in my statement and the Congressman commented, I noticed, exactly the same thing, before we get literally billions of dollars invested in these things we will have to come up with some way to put a basement under those investments. This will be a very sensitive area, and I am sure you will have a lot of political arguments over that.

We are inclined to talk about self-sufficiency by the 1980's and talk about the Moon or Manhattan thing, and that will be the easiest way,

even with that, the leadtime involved it will not permit self-sufficiency by 1980 even if we go on a crash basis. I can't draw the curves to bring enough of these systems into being by 1980.

The oil shale curves they mentioned yesterday, it is impossible. It will be very tough.

Another phase along the self-sufficiency——

Senator GRAVEL. What was announced about that shale program?

Mr. BRIDGES. The one they announced they were working on for about 4 years, and this was the leasing of six tracts, two in Wyoming, Colorado, and Utah. The concept is through these leases to make it more attractive for commercial entities to build and operate plants. Only time will show if this is true, because while the Government does own the majority of the shale land, there still exists 15, 20-some-odd percent in private hands already.

Senator GRAVEL. What you are telling us is that really all the Government has done with this policy is just put some handout to lease, hoping that somebody will come up with the capital, build the plants, and with the leadtime involved it will be in the 1980's, and that the most we can expect will be about 200,000 barrels a day?

Mr. BRIDGES. They say this themselves. No one is trying to hide anything.

Senator GRAVEL. All the Government has done is lease it?

Mr. BRIDGES. Yes, sir, the program as announced yesterday is one they have been working on 3 or 4 years, and that basically is its concept. It is not if you want to say crash or emergency basis—I am not advocating it should be because of the problems, but we should face what it would require if we were to do that into this self-sufficiency that we are talking about.

The other thing, of course, into the 100-percent self-sufficiency, when you all get into this thing from the foreign trade aspects we may not want to do that. The way New England is fairly geared to the system and our relationships with Canada and Venezuela which we consider good allies, you may not want the target of 100-percent self-sufficiency.

Senator GRAVEL. You comment that it takes the United States 7 or 8 years to build a nuclear powerplant and it takes the Japanese 5. Could you give us more information?

Mr. BRIDGES. We did have some statements to this fact. The first difference and the largest single one is the licensing procedures we have established, but before anyone thinks that will remove the total problem to a much smaller degree than the licensing delays, we apparently are having some difficulties today with the quality control systems that we would like to have and our ability to build them and fabricate them quite as fast as planned. So it is two things. The great majority is the licensing procedure and our ability to build them compared to what the Japanese are doing.

Senator GRAVEL. I am going to pursue this, because you are an expert and have been working with the committee. As you know I am a critic of some of the problems associated with nuclear energy. I get disturbed when we open up the chart, and of course Japan is doing it with a great deal of speed and we tend to compliment them when we get into the nuclear age. One problem that I find absolutely

devastating is the way plants are designed and the inherent risks involved. This goes to the fundamentals of the system. It is analogous to our recent experience with aircraft and the threat of deranged individuals commandeering aircraft and posing a threat to the lives of the people on that aircraft. We are talking in numbers of 100 to maybe 500 people, depending on where the deranged person would cause an accident to take place, maybe more than that. To deal with this risk we have instituted in our society controls to protect people at the airports. The protection against unreasonable search and seizure which our forefathers would would have died for has given a little in the interest of safety. We do it and I do it and you do it because when we board an airplane we want the assurance we are going to land at the other end and some deranged person is not going to destroy us.

We have dropped this whole concept of personal freedom which is what our society is supposed to be all about. If we develop the nuclear powerplants that we are talking about, that all that is required is a sophomore physicist in college or high school to walk into a nuclear plant with some dynamite that could be no more than the size of my fist and he is near Chicago, and I even hate to put this on the record because some person will read this and say this is the formula, but whether we like it or not, he could walk into this powerplant with a walkie-talkie and say, Mr. President of the United States, I have got the city of Chicago hostage and I want $1 billion placed in an account in Switzerland. What could we do at that point?

Mr. BRIDGES. You are asking me that?

Senator GRAVEL. You are a technocrat who understands the risks of that situation, and I, as policymaker, am concerned——

Mr. BRIDGES. My training is electrical engineering, petroleum, et cetera. I am not a nuclear expert, so starting as that vague way of trying to maneuver out of this, I am not sure as a technician that that can be done. I am not sure that a man with one stick of dynamite and not knowing or having any other access could hold Chicago as hostage. I know there are other people that can tell you this better than I can.

As far as nuclear reactors go, my own reaction is I basically have confidence in it that we have worked it to this point where I have made my decision to try to move into nuclear. I also welcome the moves to force a more public discussion of a nuclear system. I think if we have made any real mistake of the development of nuclear power today that is doing it behind the lead shield and it has not been developed in the public's eye as much as other system. For example, if we were to develop aircraft that way to where you and I were raised on a farm and never saw anything other than a pigeon and were taken to Dulles—and told about pianos and bars, they would probably be dragging us upstairs.

Also, I hope we make certain that as we go into the solars and the other areas that we are trying that we will have enough public participation as they emerge to where we won't have the gap between the public's knowledge of these systems as we now have, such things as nuclear——

Senator GRAVEL. Let me add for the record, and certainly it can be challenged and disputed, and I only add it to the dialog——

Mr. BRIDGES. Certainly.

Senator GRAVEL [continuing]. That is that that person at the plant could blow it up. It would not be a mushroom cloud that would take place. It would probably destroy the system so the liquids involved would explode. It would be radioactive. The danger would be an evaporation process that could go into the atmosphere and go into a cloud and that cloud could move around and move just as well through Chicago or over the lake or what have you. The only problem is once it moves over Chicago you can't go back at that point. We have a real estate problem at that point. This is in the area of the unthinkable, except when it happens we will be forced to institute a system of police protection in our society that we might as well turn in our certificate as a free people. We will have done that merely in response to the horror story that was obviously demonstrated here, that we have got to solve the problem, and that is one of the options. That is the only reason I wanted to inject in the record at this time a little more dimension to the horror aspect of our policy options as to what they will mean, because essentially that is what happened to the aircraft. They did a good job of developing the aircraft. There was a great deal of secrecy, but it was opened up. But it was never conceived what would happen that did happen because of our dependency upon technology. I hope we would assess that possibility as we assess our options in the energy field.

We here are blamed for the environmental problems, particularly with reference to such things as the automobile. Could you give us your views?

Mr. BRIDGES. No question but what our concern for the environment has compounded the problem, but again we are talking about a very complex problem, and you can't go one way or the other. In the automobile, for example, you hear comments about how the emission control devices are costing us 8 or 10 or even 15 percent of our mileage. There, of course, is a second move we made that we don't talk about too much these days, that was the move when we took lead out. You compound both of these together and you could have a compound in the range of 15 or even 25 percent.

The other side, we are making our cars heavier, safety requirement of putting iron in the doors to make them heavier, putting in air-conditioning and things of this nature and all of that. The environmental concerns of the automobile has definitely penalized it. It is not the total problem that has drug us down to the 6-mile-per-gallon, part of it, but far and away from being all.

The same thing with reference to nuclear plants. The environmental concern has been a significant part, but not all. Such things as sulfur requirements on coal, a lot of the companies that shifted from coal to oil did not do it just because of the sulfur problem they were having with coal. It was at a time when the oil was relatively cheap and they could use the real estate for other things and wanted to make the shift anyway. So while the environmental concern has been one of the major factors and while, if we removed all the environmental concerns tomorrow, we could take a great deal of pressure off our present problem, it would not eliminate the fundamental decisions we have to make. It would delay them a few years. We still have to come back and——

Senator GRAVEL. Very good. Would you give us some details on the various projects you have described? Take your time in going into oil, gas, and shale.

Mr. BRIDGES. Do you mind if I don't take my time?

Senator GRAVEL. Do you have another appointment?

Mr. BRIDGES. Yes.

Very rapidly, this so-called exercise, the foldout O——

Senator GRAVEL. Mr. Bridges, I don't want to impinge upon your time. We could take that for the record, if you want.

Mr. BRIDGES. Let me take a few minutes right now, because trying to get it into the record later is harder because I am helping create the energy crisis by flying around the country.

The so-called lower 48 oil, everything except Alaska, of course the projections shown there, and they are not our projections, but those projections do not represent a maximum that can be recovered from U.S. oil supplies. We don't know exactly what it would be, of course, because there will be a lot of dry holes involved. If you raise the price of domestic crude say $6 across the board, new and old, or even higher competitively with some of the imported to $10 possibly, we would see possibly considerably more oil than what is shown here. Again, we will have to bite a bunch of bullets. We will have to get down to such things as developing Santa Barbara channel with the trade-offs involved, are we going after the petroleum reserve systems, et cetera. We are past the point of everybody leaving the problem with his neighbor. The coal thing, of course, there you can get projections, again almost anything that you want.

But we do caution that water requirements may be the limiting factor on coal, particularly in Wyoming and Montana, not only water for the processes as you liquify and process but for the land. We don't know what that will involve.

Gas, one of the beauties of gas is by significantly raising the price it will reflect probably fairly fast. We will get an impact within a few years if the gas is there. It will take some holes to find out.

The geothermal oil shale, et cetera, all of those are in the area that will be impacted again by the degree we are willing to throw into the research and development and the degree we are willing to go beyond that and bite the bullets required to make them available. Of course, the coal thing is not resource limited. Oil shale may be limited by water availability and our ability to bring it on.

In the nuclear limitations are probably going to be what you have already talked about, public acceptance. When you go through an exercise of this nature, when we chop some of the options off we will automatically add it someplace else, and it will be fun watching where we add it, because we have already stepped on somebody's feet going up this route. I am trying to underscore what we feel is a basic necessity magnitude and details of the problem and then an imperative definition of what our problem should be so we can start approaching it.

Senator GRAVEL. I asked a question before about costs and policy options, and you are responding to it, but I did not get to the part I wanted to. Could you and your organization help us in a very rapid fashion to cost out some of the policy options so we could begin an inventory? Would it be more than 10 days?

Mr. BRIDGES. I won't be here for 8 of them.

Senator GRAVEL. Let's say at the fastest rate you can get it so we would know the size of that tax that would have to be levied in order to do the job.

Mr. BRIDGES. This assumes that your target would be what, say 90 percent self-sufficiency, 10 or 15 years?

Senator GRAVEL. I think realistically 1985 would be a good target year. Let's say with this caveat, with a 5-percent dependency upon Middle East oil and the rest filling in the imports that we can expect from Venezuela and Canada, potentiality of Alaska, of course.

Mr. BRIDGES. By when?

Senator GRAVEL. Let's say 1985, so that gives us a 12-year stretch.

Mr. BRIDGES. 12 years. We will need that last 5.

Then you also will what, finance through demonstration of units?

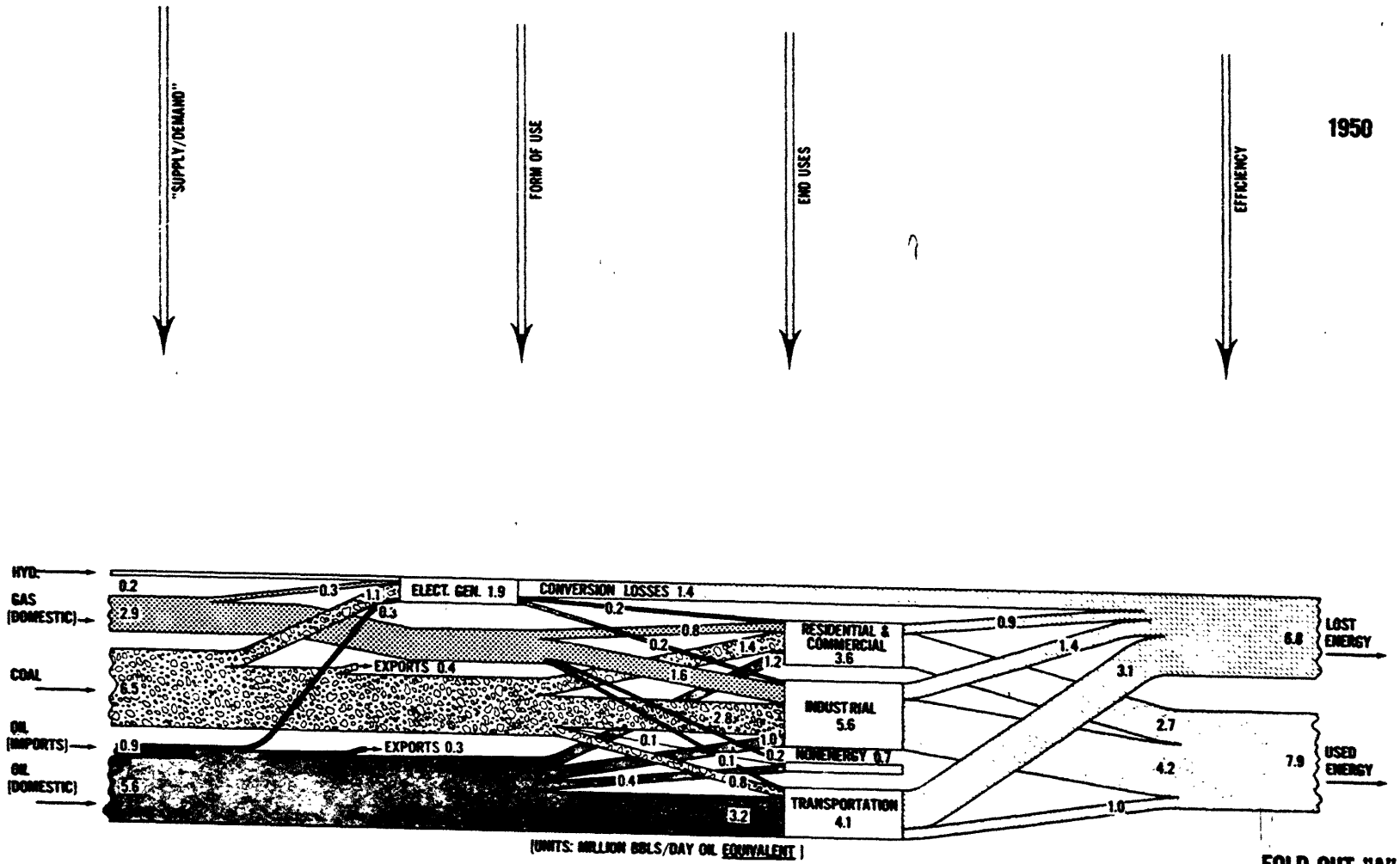
Senator GRAVEL. That R. & D. cost package and the demonstration cost package, will be the public sector. You can say the public sector will need x amount of dollars which we will do through taxation and the private factor will need y amount—which we will take up with Mr. Winger and Mr. MacAvoy this afternoon. When we get the two amounts then we establish it depending on the timeframe. The R. & D. is the small part of the sector cost rise.

Mr. BRIDGES. It will be rough, but we will give you a range.

Senator GRAVEL. Mr. Bridges, I am proud to have an association with you.

Thank you very much.

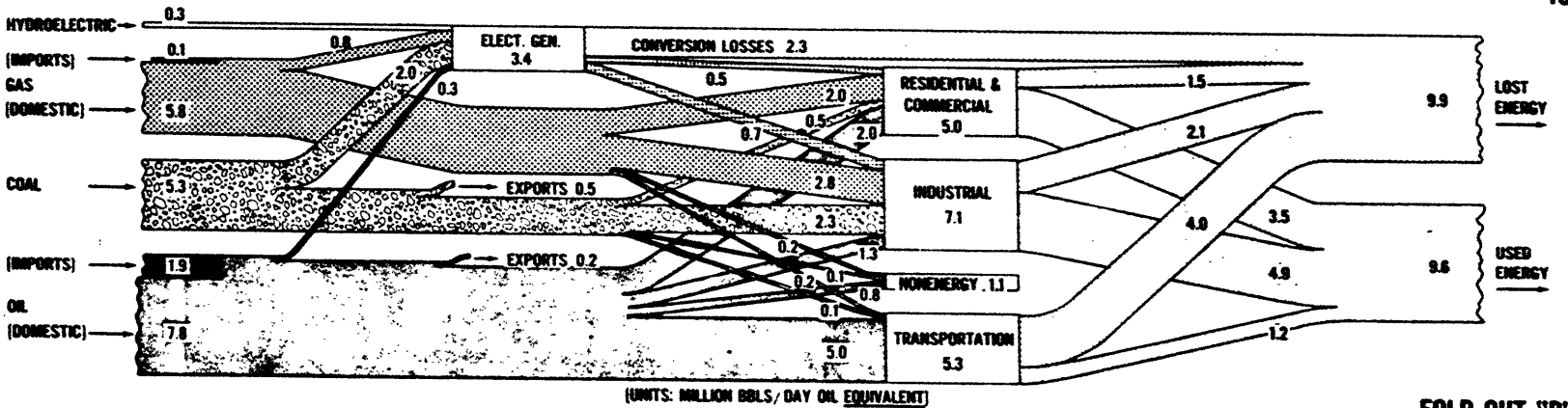
(The charts referred to by Mr. Bridges during his testimony, follow. Hearing continues on page 305.)


"SUPPLY/DEMAND"
FORM OF USE
END USES
EFFICIENCY
1950
HYD.
GAS (DOMESTIC)
COAL
OIL (IMPORTS)
OIL (DOMESTIC)
0.2
2.9
6.5
0.9
5.6
0.3
1.1
0.3
ELECT. GEN. 1.9
EXPORTS 0.4
EXPORTS 0.3
CONVERSION LOSSES 1.4
0.2
0.8
0.2
1.4
1.2
1.6
2.8
0.1
1.0
0.2
0.1
0.4
0.8
3.2
RESIDENTIAL & COMMERCIAL 3.6
INDUSTRIAL 5.6
NONENERGY 0.7
TRANSPORTATION 4.1
0.9
1.4
3.1
2.7
4.2
1.0
6.8
LOST ENERGY
7.9
USED ENERGY
(UNITS: MILLION BBLS/DAY OIL EQUIVALENT)

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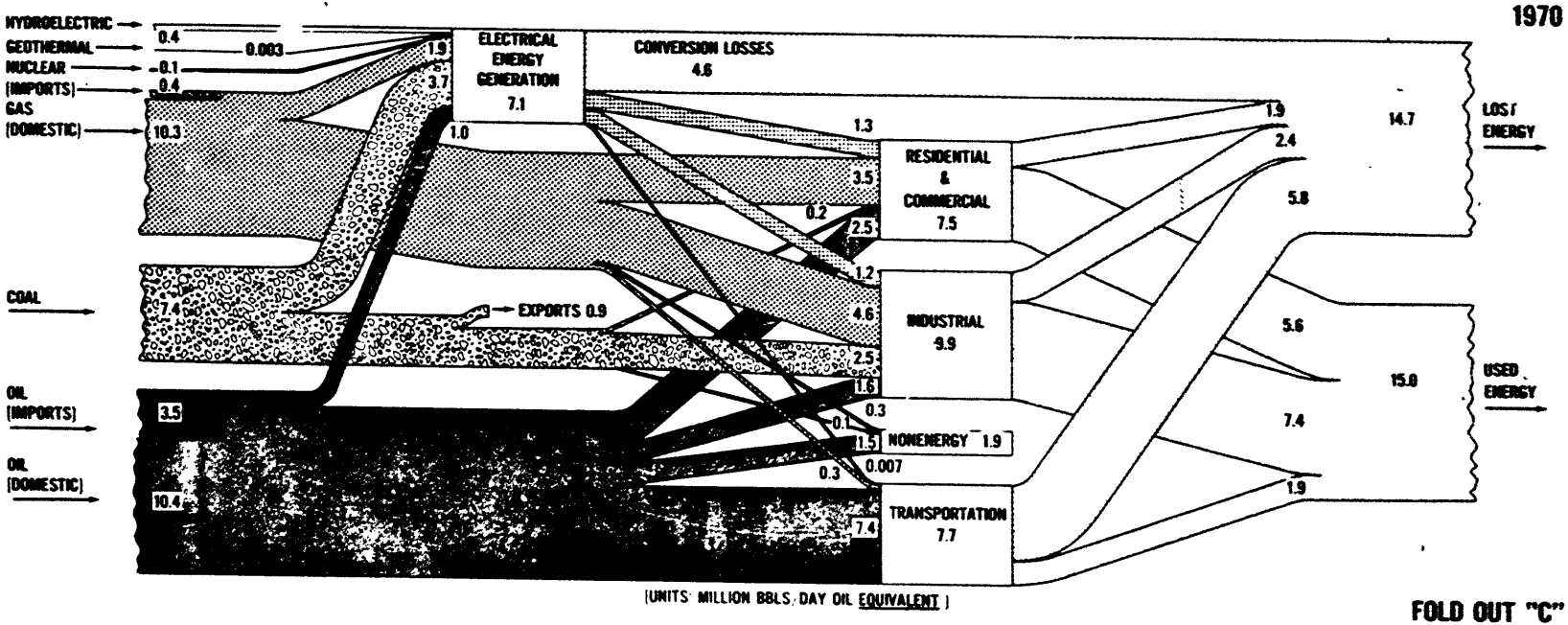
1960



(UNITS: MILLION BBLS/DAY OIL EQUIVALENT)

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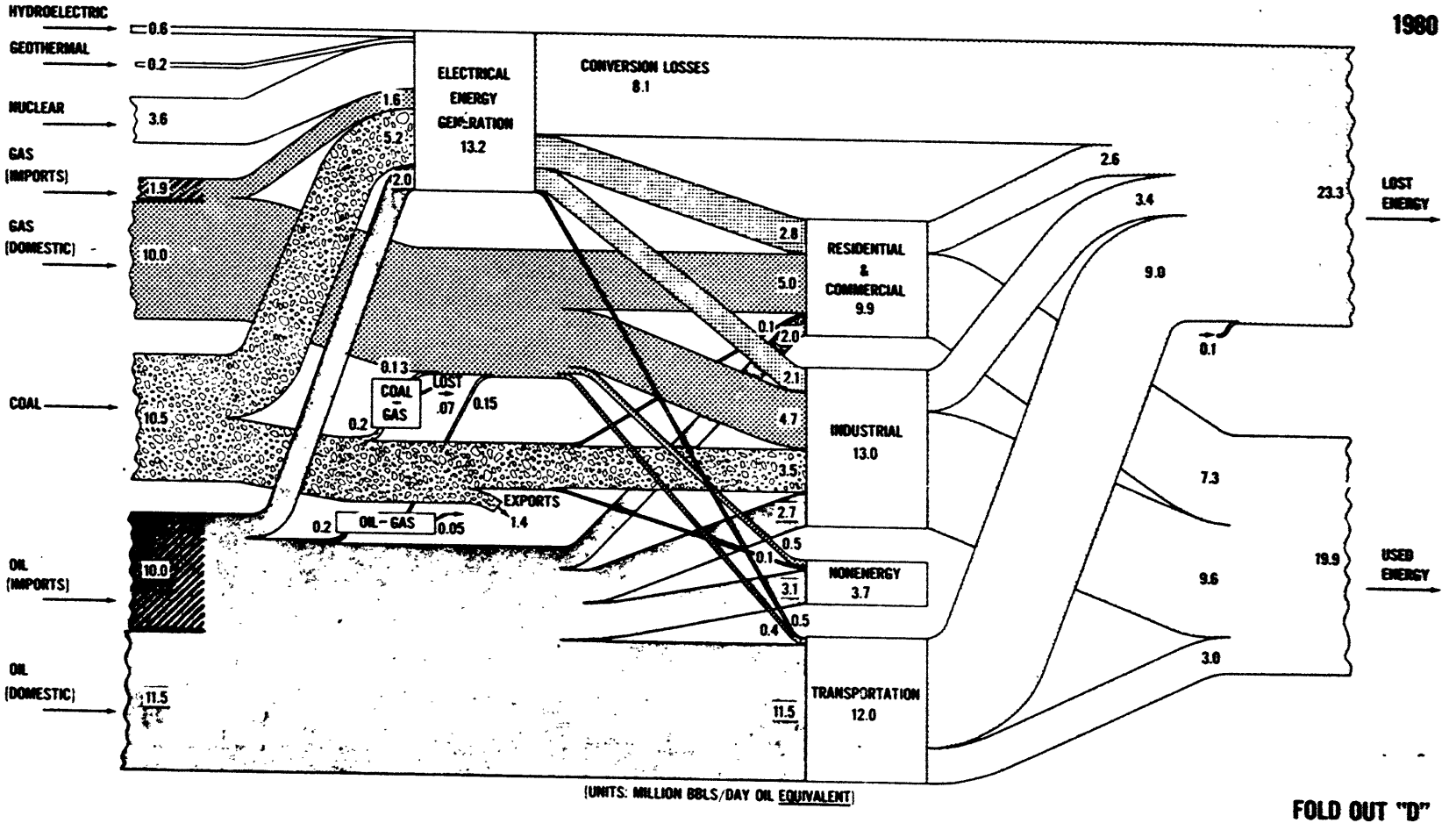
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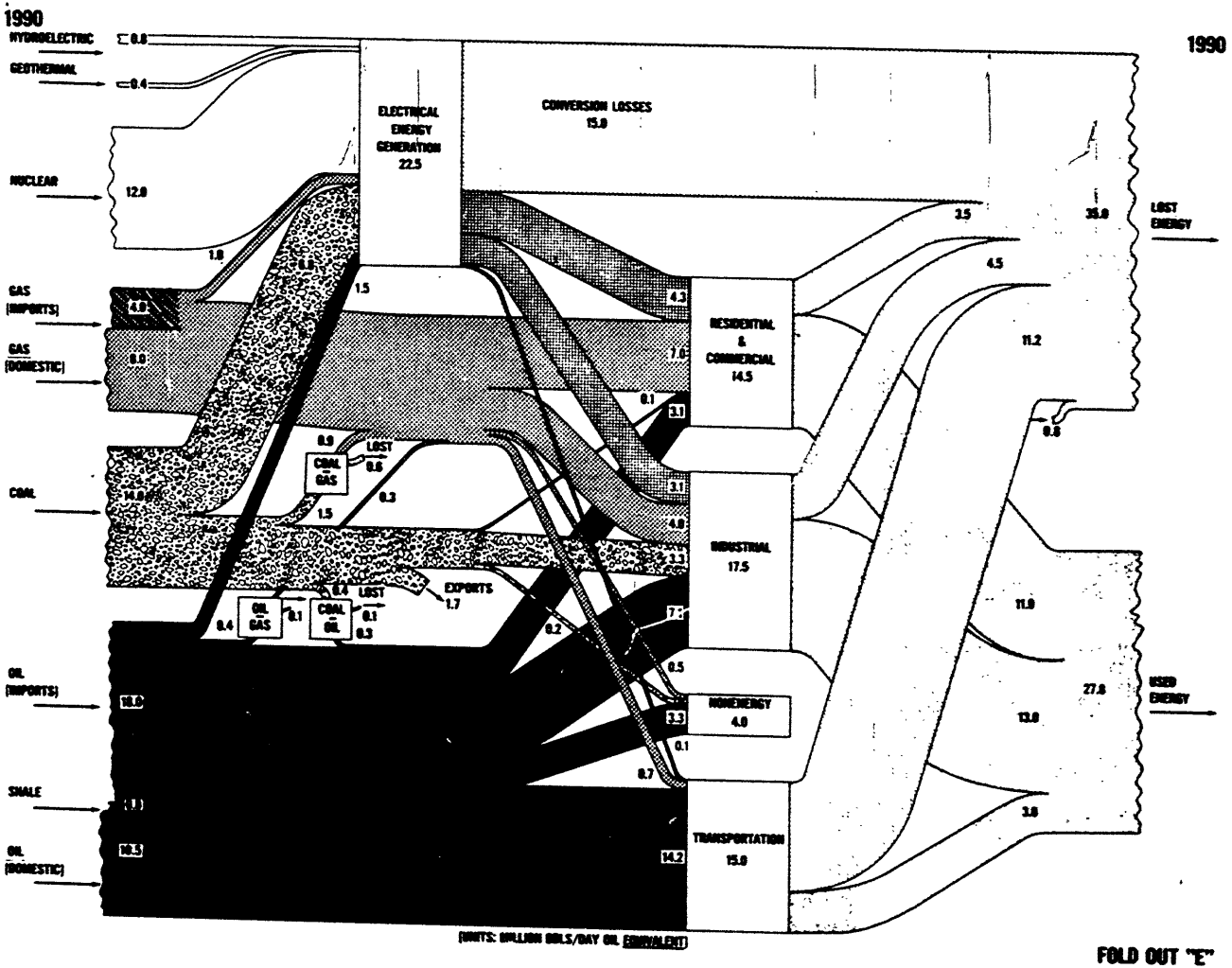
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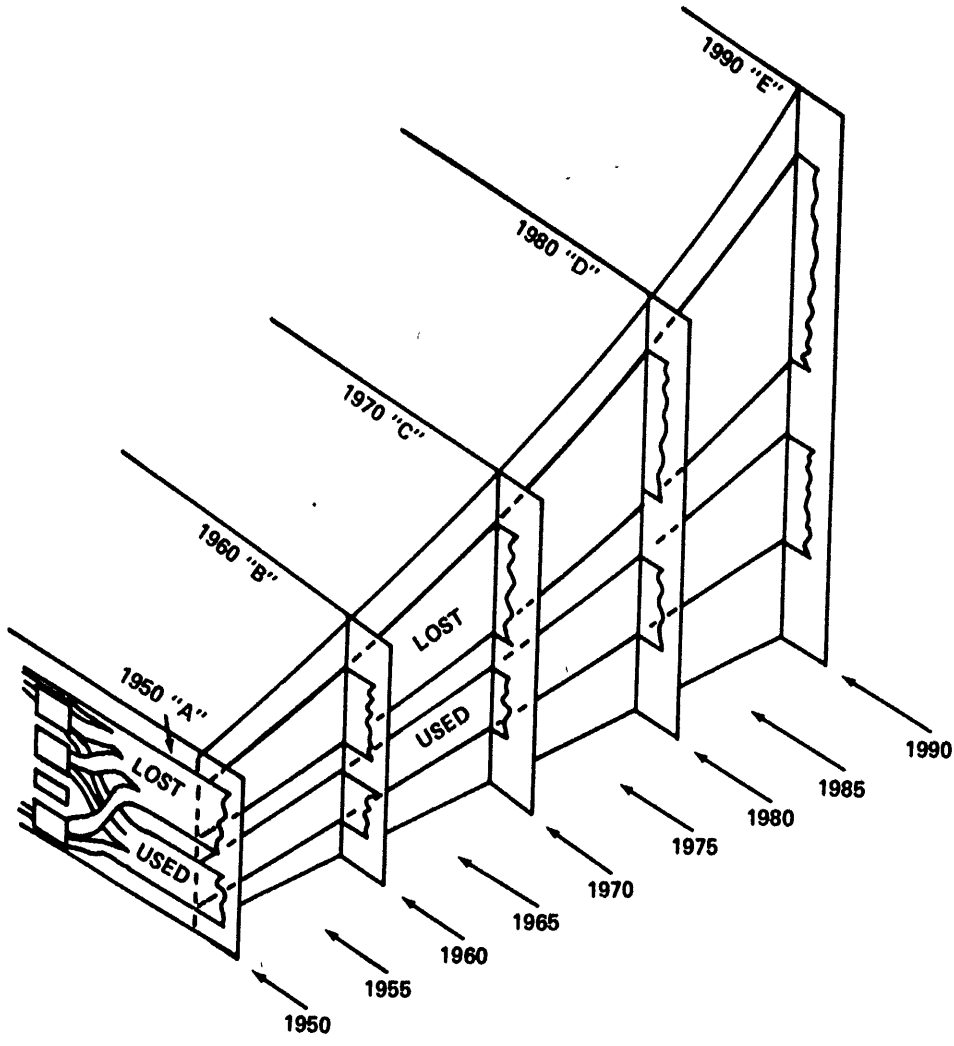
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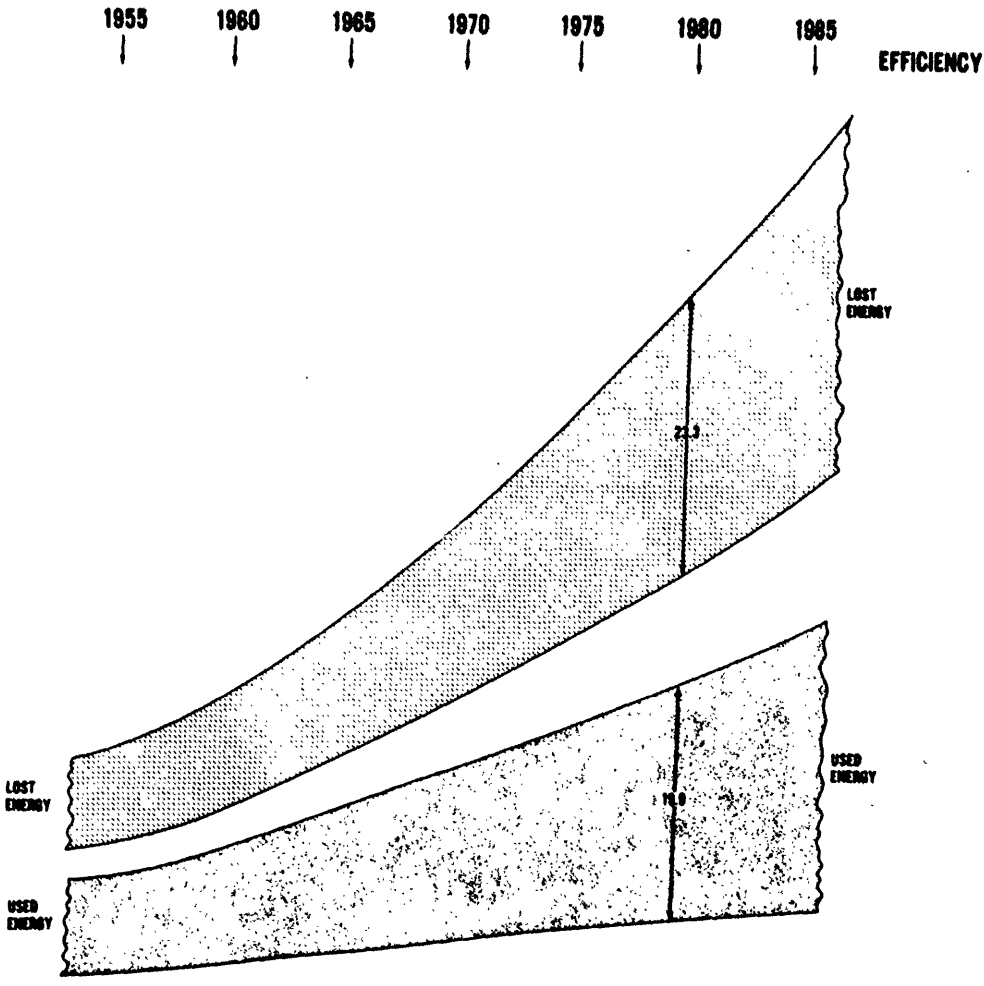
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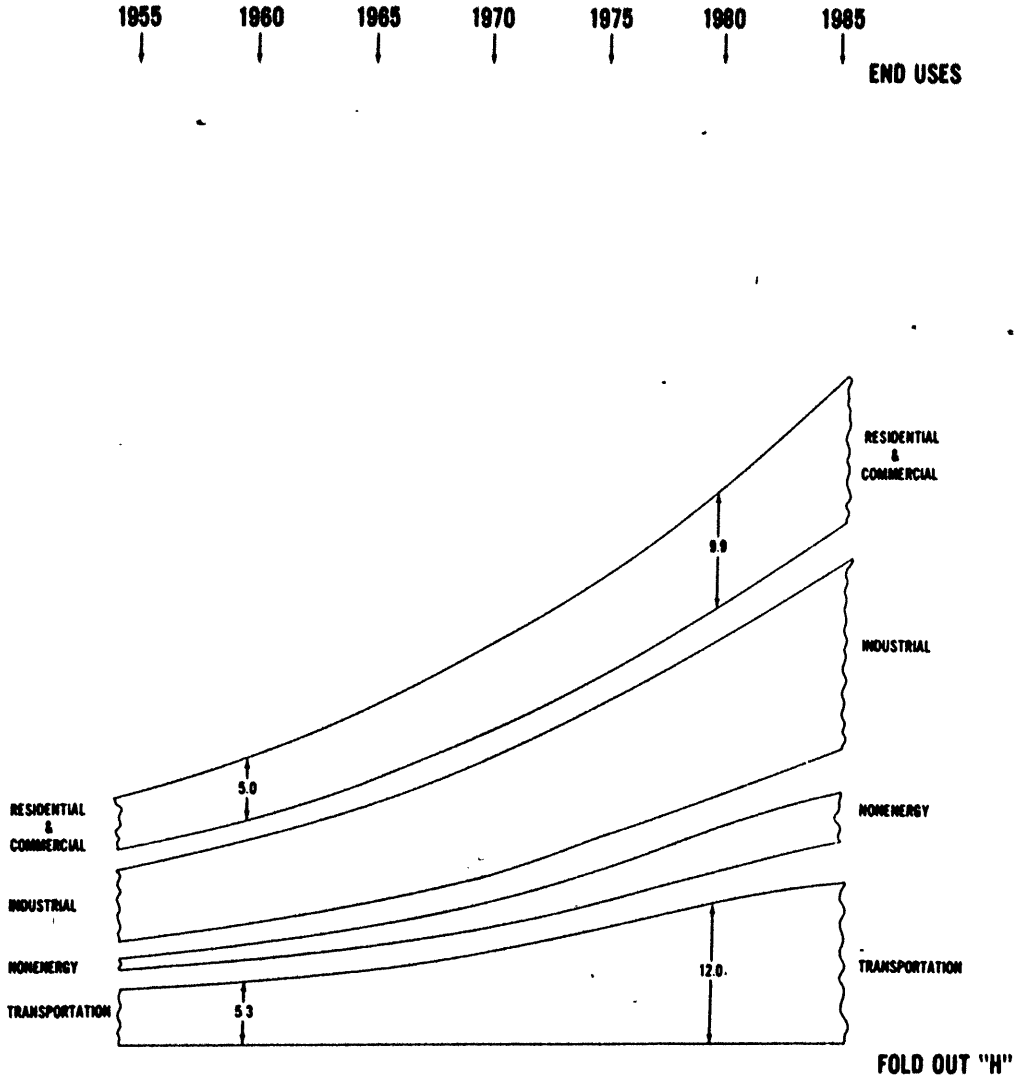
CONSTRUCTION OF "CROSS PLOTS"
("EFFICIENCY" PLOT SHOWN)



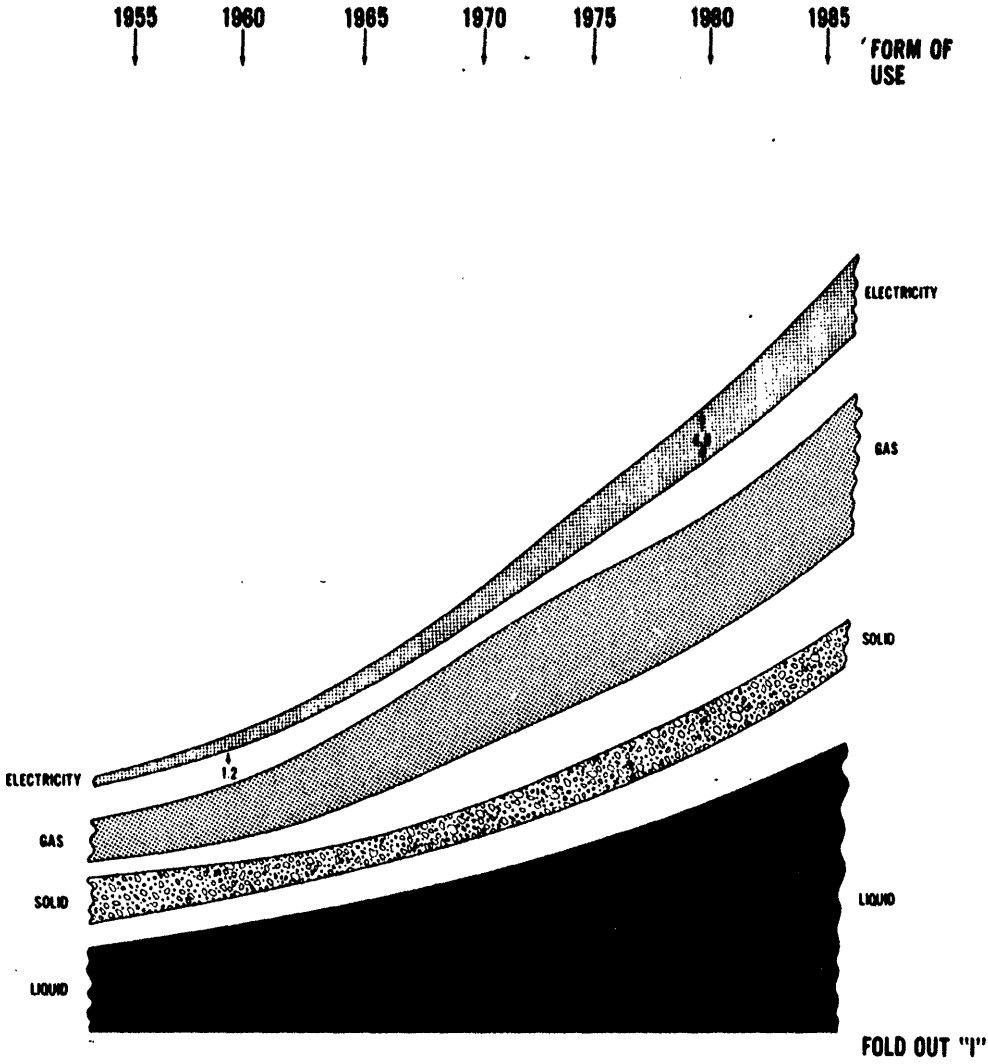


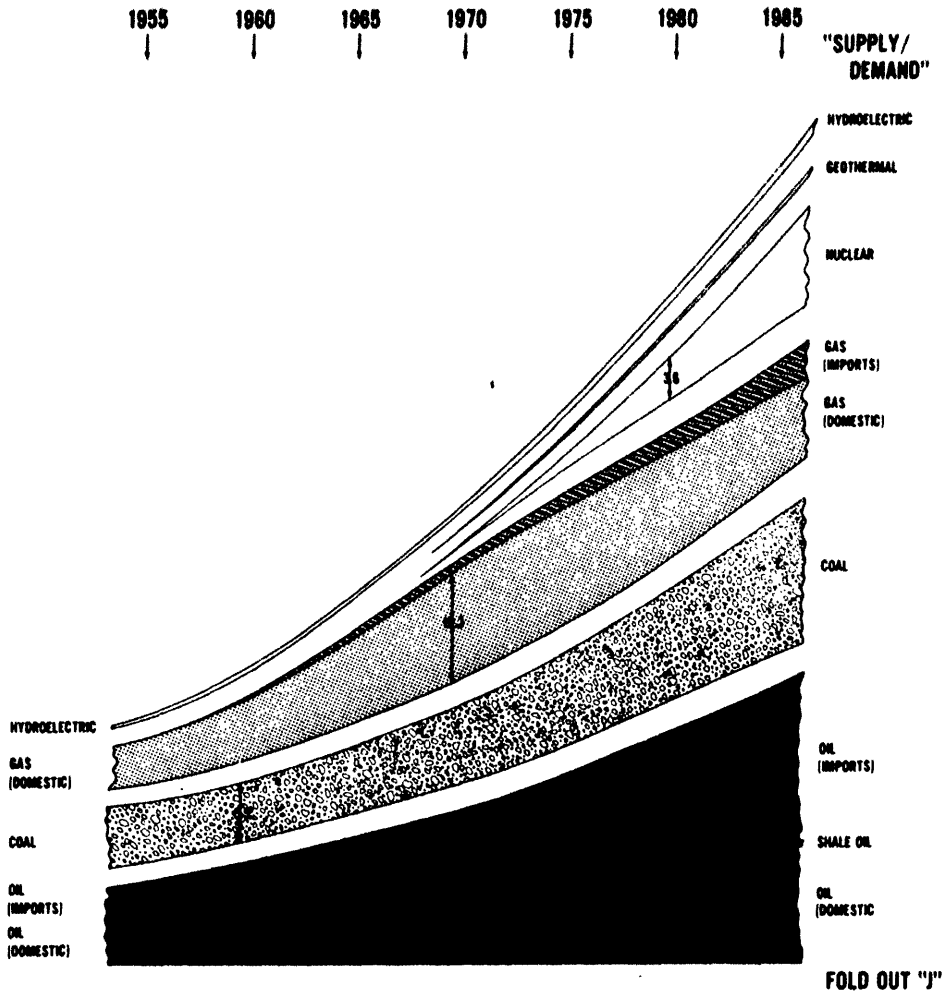
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1955
1960
1965
1970
1975
1980
1985
END USES
RESIDENTIAL & COMMERCIAL
INDUSTRIAL
NONENERGY
TRANSPORTATION
9.9
5.0
12.0
5.3
RESIDENTIAL & COMMERCIAL
INDUSTRIAL
NONENERGY
TRANSPORTATION

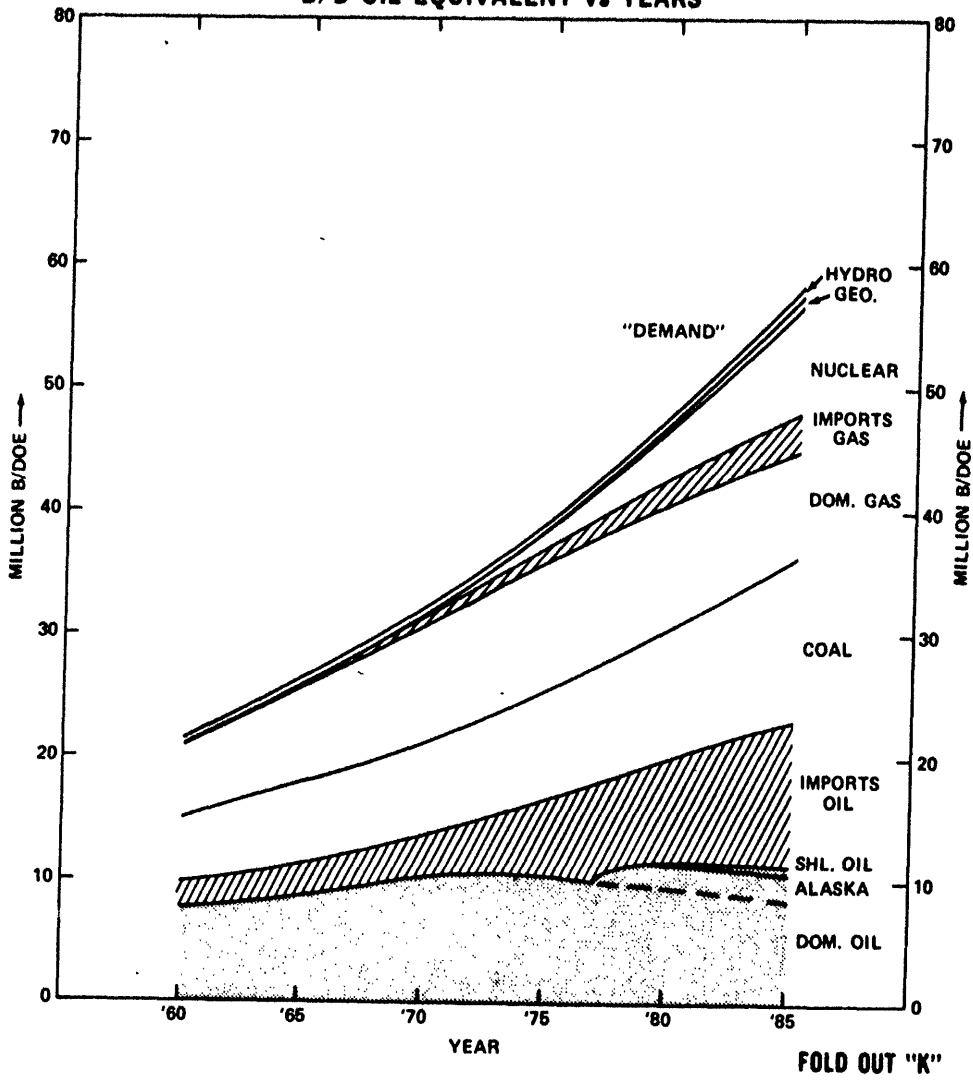
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1955
1960
1965
1970
1975
1980
1985
FORM OF USE
ELECTRICITY
GAS
SOLID
LIQUID
1.2
4.9
ELECTRICITY
GAS
SOLID
LIQUID
FOLD OUT "I"


1955
1960
1965
1970
1975
1980
1985
"SUPPLY/ DEMAND"
HYDROELECTRIC
GEOTHERMAL
NUCLEAR
GAS (IMPORTS)
GAS (DOMESTIC)
COAL
OIL (IMPORTS)
SHALE OIL
OIL (DOMESTIC
HYDROELECTRIC
GAS (DOMESTIC)
COAL
OIL (IMPORTS)
OIL (DOMESTIC)

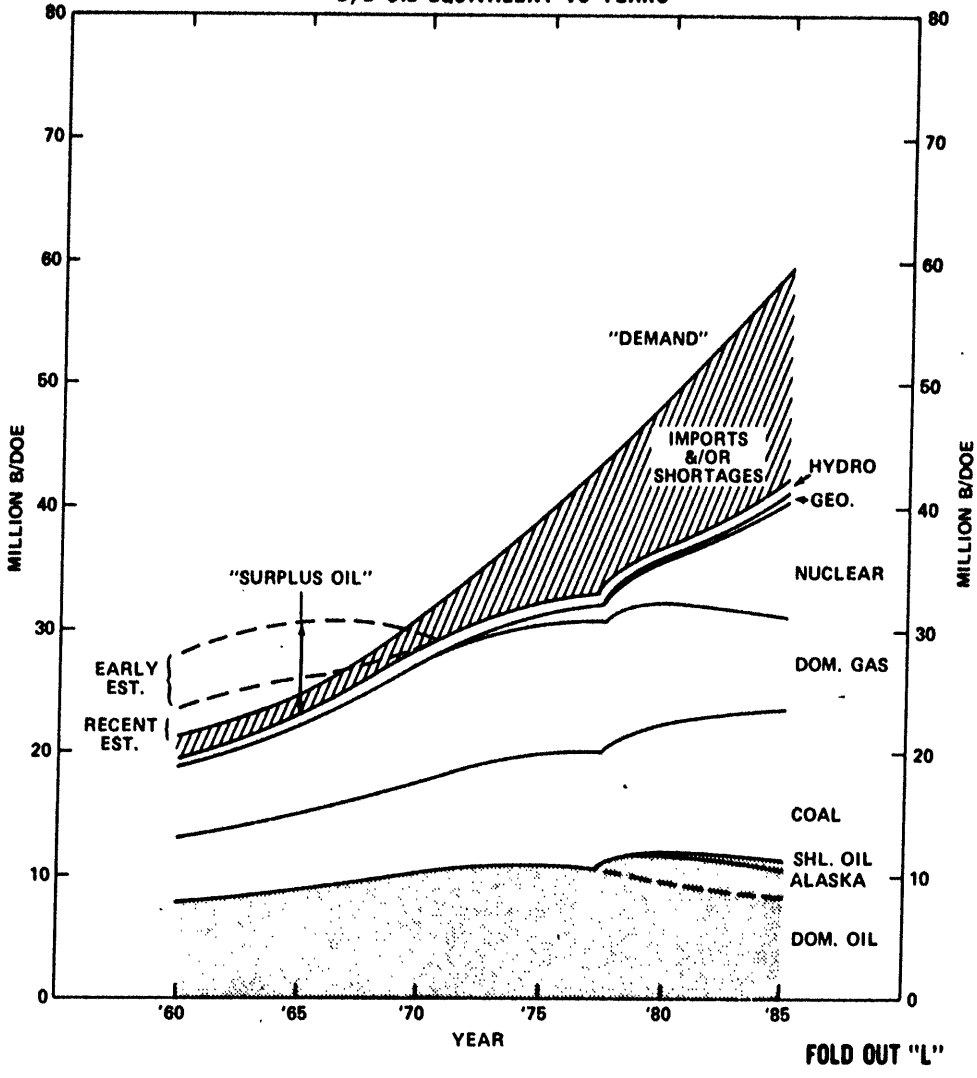
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"SUPPLY/DEMAND"
(FROM "ENERGY DISPLAY")
B/D OIL EQUIVALENT vs YEARS

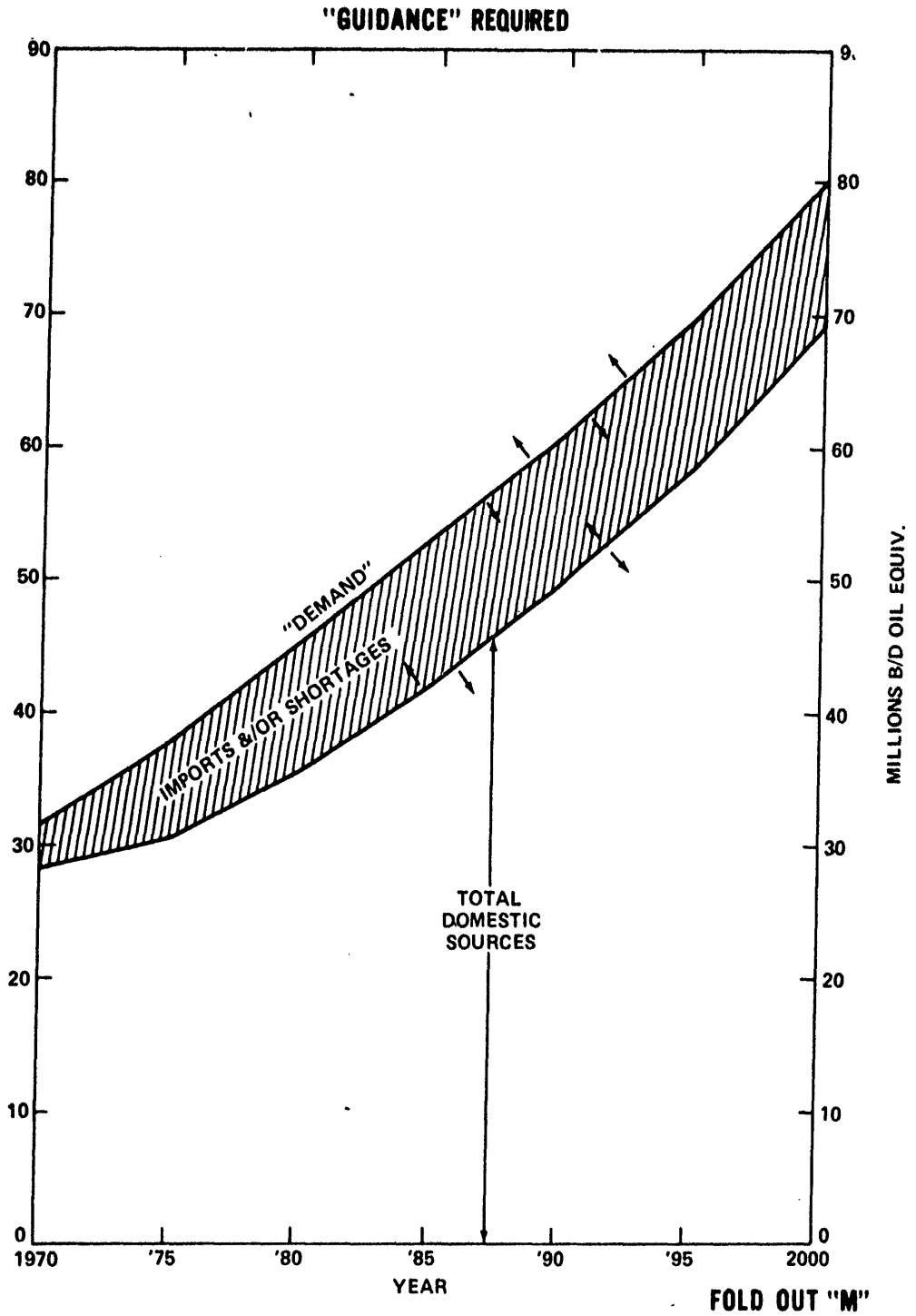


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"SUPPLY/DEMAND"
(1960-1985)
B/D OIL EQUIVALENT vs YEARS

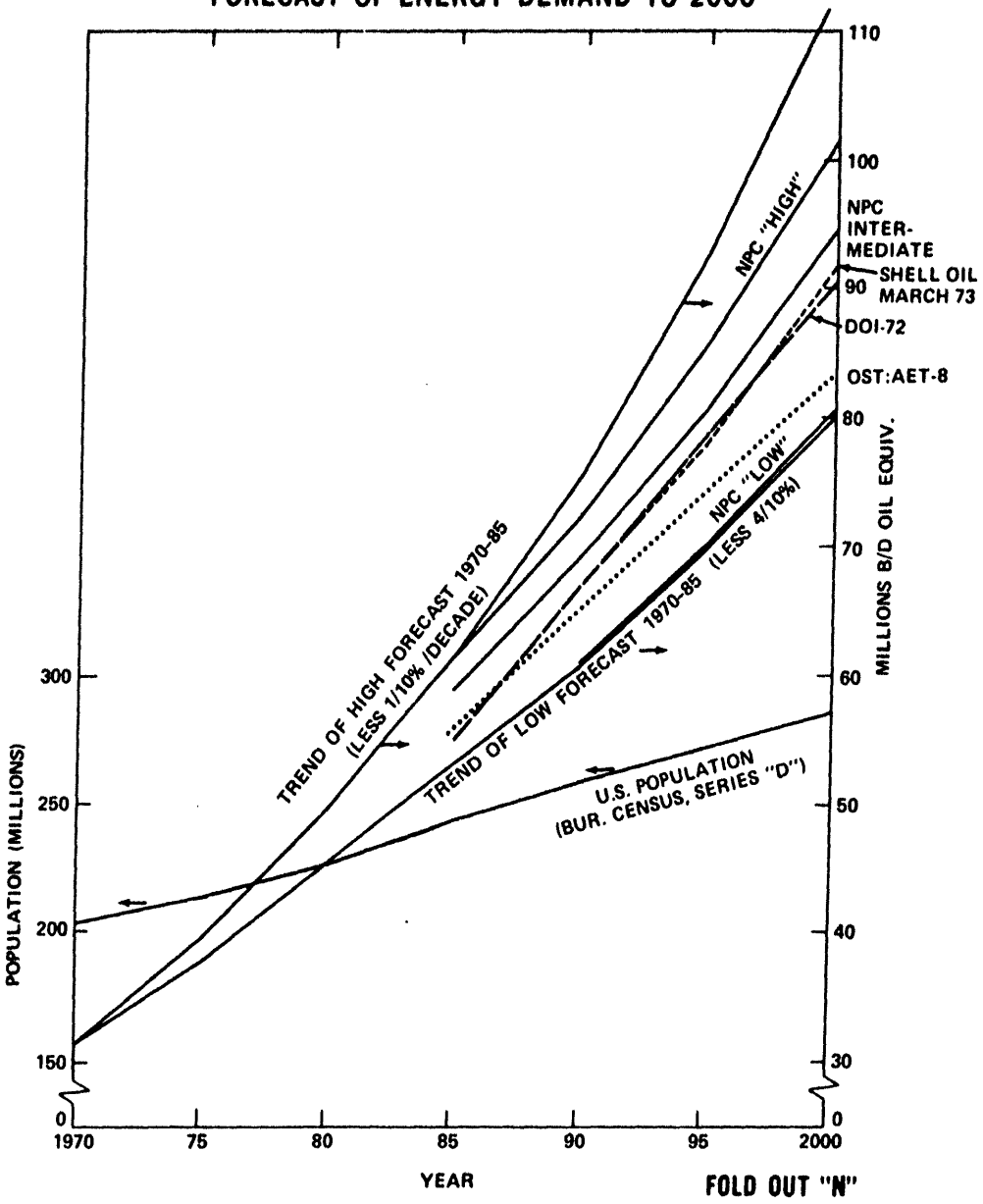


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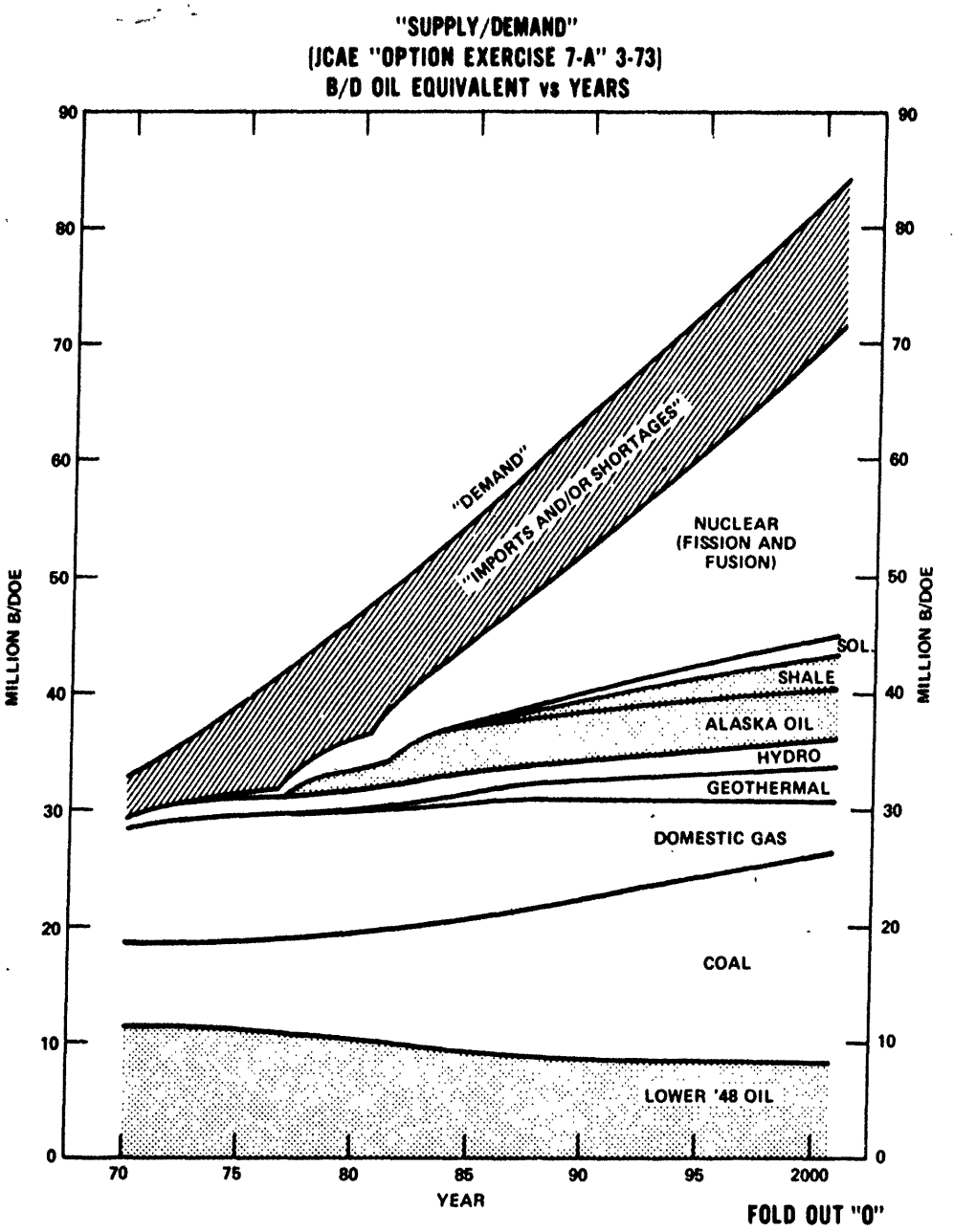


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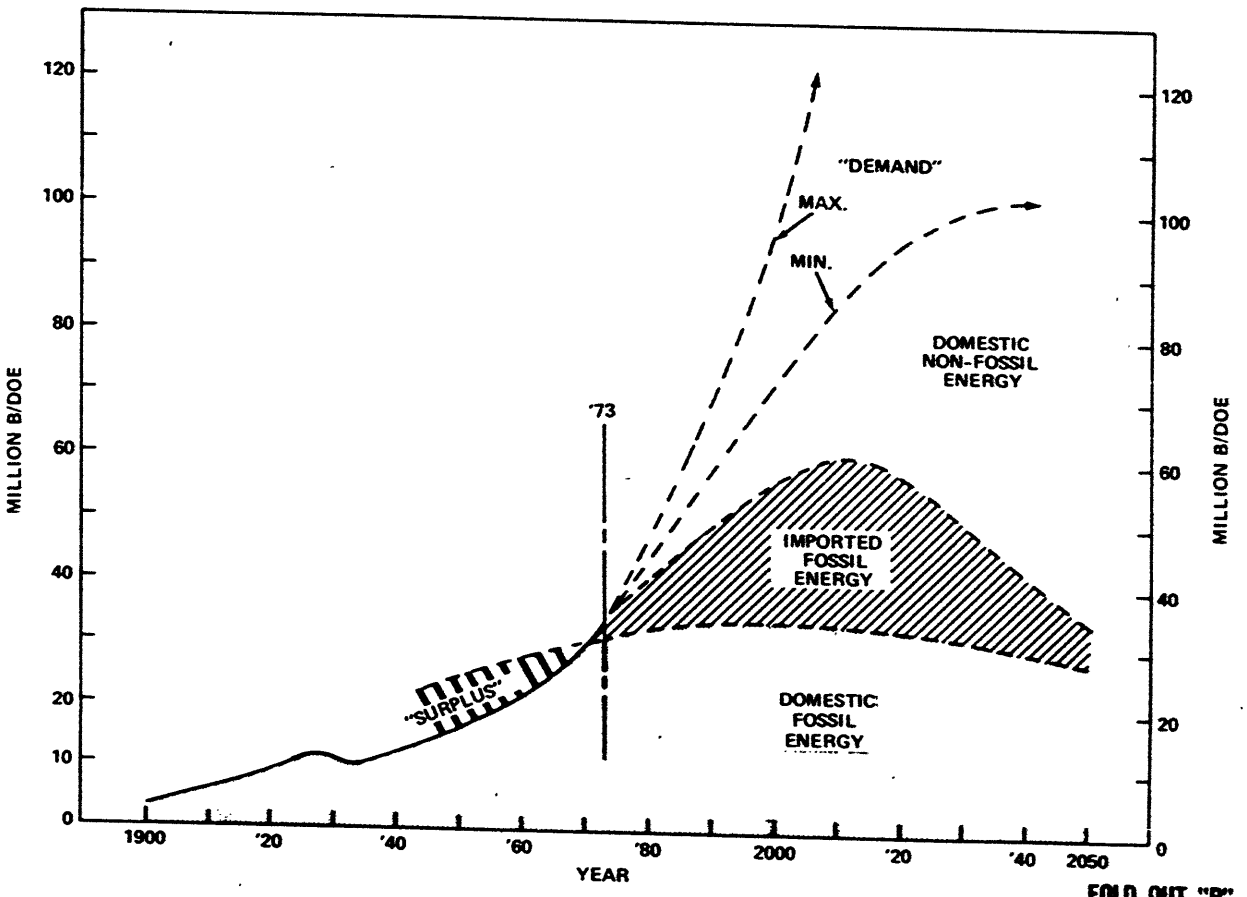
FORECAST OF ENERGY DEMAND TO 2000



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"SUPPLY/DEMAND"
(JCAE "OPTION EXERCISE 7-A" 3-73)
B/D OIL EQUIVALENT vs YEARS
MILLION B/DOE
MILLION B/DOE
90
80
70
60
50
40
30
20
10
0
"DEMAND"
"IMPORTS AND/OR SHORTAGES"
NUCLEAR
(FISSION AND
FUSION)
SOL.
SHALE
ALASKA OIL
HYDRO
GEOTHERMAL
DOMESTIC GAS
COAL
LOWER '48 OIL
70
75
80
85
90
95
2000
YEAR
FOLD OUT "0"

"SUPPLY/DEMAND"
(1900 - 2050)
B/D OIL EQUIVALENT vs YEARS



FOLD OUT "P"

Senator GRAVEL. Our next witness is Dr. MacAvoy, professor at Sloan School of Management of MIT, and I believe he is accompanied by Dr. Pindyck of the same school.

I have not heard these gentlemen before. They come well recommended. I do want to say we have John Winger of Chase Manhattan Bank whom I have met and I have shared his wisdom, so we have an excellent slate of witnesses.

Please proceed at your pleasure.

STATEMENT OF PAUL W. MacAVOY; AND ROBERT S. PINDYCK, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Mr. MACAVOY. Thank you, Senator.

It is a pleasure to come in as a secret weapon without having brandished my swords before.

Dr. Pindyck and I are concerned with the natural gas shortage in the United States. We have been working under the National Science Foundation sponsorship for 2 years on building a large-scale econometric model of natural gas, and we would like to use that model today to provide assessments of policy options for the Senate in dealing with the natural gas shortage.

The natural gas shortage is a rather interesting subsector of the natural energy problem, first, because it is probably the most long-term and systematic of the shortages. Centering attention on reserves, the gas reserve "shortage" began a decade ago. There are alternative forecasts which lead one to believe the gas production "shortage" may continue for a decade or more. The gas shortage is also a very interesting part of the energy problem because it seems fairly clear, using economic and political analyses, that it can be attributed in good part to Federal policies. It is possible to time the beginning of substantial shortfalls in production concurrent with the continued and systematic use of ceiling price controls by the Federal Power Commission.

This morning we would use an econometric model not to place the blame for the shortage, however, but rather to deal with a specific set of pricing, tax, and subsidy plans for ameliorating the natural gas shortage before 1980. I have prepared an 8-page statement which (1) begins with an introduction to the present problems in natural gas, (2) describes an econometric policy model we have developed at MIT to assess solutions to these present problems, and then (3) goes into specific predictions for production, supplies, and demands for the rest of this decade.

The shortage of natural gas in the United States has been increasing steadily over the last 5 years, and is now to the level that it probably exceeds 20 percent of total demands. There is every reason to believe that, with the continuation of present Federal Power Commission regulatory policies, the shortage will not be eased appreciably over the remaining years in this decade. With deteriorating supply conditions for crude oil from the Middle East, and consequent significant increases in prices for gas substitutes, excess demand is likely to expand so as to make up more than one-fourth of total demands in the next few years.

These trends are likely to be at least largely reversible. Changes in Federal Government policies on prices, taxes, and subsidies could reduce the growing shortages of natural gas which would otherwise become critical. In particular, policies directed toward a relaxation of FPC price controls on sales at the wellhead could go a long way toward ameliorating the national shortage. It is possible, in fact, that if wellhead prices were raised sufficiently, the shortage could be eliminated entirely.

Combinations of taxes and subsidies—taxes on users and subsidies to producers—could probably be designed to have the same effect on total demand and supply as an increase in wellhead prices. It is our conclusion, however, that tax and subsidy policies such as this may be more difficult to administer, and are not likely to work as well as a relaxation of price controls.

These conclusions follow from analyses of alternative policies carried out with a large scale econometric model of natural gas field and wholesale markets.[1] In order to provide some basis for making these statements, we review the econometric model in the first few paragraphs below. In subsequent paragraphs, we use the model to evaluate policy alternatives under the presently prevailing conditions of increasing stringency of supplies of foreign crude oil. In the concluding paragraphs at the end of the statement, we consider alternative tax and subsidy policies and their effect on the gas shortage.

Before proceeding it is important that we make clear the timeframe that we are considering in our policy analyses. Events that have taken place since the imposition of the Arab oil embargo have created a crisis atmosphere for energy policymakers. Concern has centered around shortages in natural gas and oil that are likely this winter, and what kind of short-term policies are needed to deal with these shortages. Our attention has been focused on a more intermediate term outlook, in particular the next 5 to 8 years. The price and fiscal policies which we have analyzed will have little effect on the natural gas shortage this winter, but may have considerable effect on demand and supply conditions over the next several years. It is our view that existing shortages, at least with respect to natural gas, are at least partly the result of shortsightedness on the part of policymakers in the past, and continued shortsightedness today could result in even more serious shortages in the future.

AN ECONOMETRIC POLICY MODEL OF NATURAL GAS

The MIT Energy Laboratory, with Paul MacAvoy and Robert Pindyck as principal investigators, has developed a quantitative model of natural gas under National Science Foundation grant No. GI–34936. This model was constructed by fitting statistical equations to historical data on gas reserves, production, and sales at wholesale for regional markets in the 1960's. The reserves and production equations constituted a submodule for gas supply, where the important determinants of supply were geological conditions in that producing

[1] This model and its application to policy analysis is described in detail in Paul W. MacAvoy and Robert S. Pindyck, "Alternative Regulatory Policies for Dealing with the Natural Gas Shortage," *Bell Journal of Economics and Management Science*, vol. IV, No. 2, Autumn 1973.

district, as well as price and cost conditions. The wholesale sales equations constituted a demand submodule of the model, where demands depended upon the size of final retail and industrial sales markets and upon prices charged by the retailer or wholesaler providing gas to the final users. These two submodules were linked together by a set of pipeline price markup equations along with an input-output table showing the distribution of production in recent periods.

The size of the modules has been rather extended in recent versions of the model. Separate equations have been formulated for additions to gas reserves from (1) discoveries, (2) extensions, and (3) revisions for gas not associated with crude oil reservoirs. Separate equations have been provided for these three categories of reserves for gas produced in association with oil. Two separate onshore and offshore equations have been formulated for supply or production out of reserves. Both reserve and production equations are based upon data on 18 production districts in the United States for the period 1964–71. Wholesale demand equations have been formulated for five sectors of the country, with separate equations for (1) ultimate residential-commercial consumption from wholesale demands by retail gas utilities, (2) ultimate industrial consumption when purchased from retail utilities, (3) industrial consumption for gas purchased directly from the interstate pipelines, and (4) intrastate consumption.

The individual modules are operated together as a simultaneous system by inserting Federal Power Commission regulated prices into the appropriate equations. These prices operate as independent variables determining reserves, production, and, after pipeline price markups have been added, wholesale demand. There are other variables included in the model; for example, the availability of geological deposits is an important determinant of reserves and production, as is the structure of lag effects from previous drilling in the region. The model also includes important economic variables which help determine demand, such as population, per capita income, industrial activity in consuming regions, and the prices of alternative fuels. The important policy variable, however, affecting both production and demand, is the set of Federal Power Commission regulated prices at the wellhead.

Policy analysis begins with inserting regulated prices into the model, and then quantifying the effect of these prices on the level of additional reserves and the level of production. The price is fed through and marked up as wholesale price to be charged by pipelines to retail gas utilities and industrial consumers, so as to determine wholesale demands. The difference between supplies of production and demands for production, given the set of controlled or regulated prices, is the "simulated" level of the shortage of natural gas. Policy analysis consists of inserting policy-derived changes in regulated prices into the model, and observing the resulting change in the simulated shortage.

The most important alternative to present policy which we examined is that of reducing current restrictions on field prices. The purpose would be to provide incentives for increasing reserves and production (by higher prices) and to eliminate low value uses for natural

gas (by reducing demands through price increases). The use of market forces to add to supplies and reduce demands would have different effects depending on how rapidly and extensively prices were increased. Immediate and complete deregulation would establish short-term equilibrium prices much greater than those that would persist over the long run—particularly under conditions of shortages in alternative fuels such as fuel oil. The goal would be to gradually ease restrictions on prices so as to move over a 5-year period into longrun equilibrium.

It is important to make clear that our policy option of field price increases does not imply complete deregulation. Our econometric model is a model of a regulated industry, and we assume that that industry will continue to be regulated. We are not analyzing the effects of deregulation on the natural gas industry; rather we are studying the impact on that industry of phased price increases.

EFFECTS FROM A PRICE FREEZE

In order to assess the impact of easing regulatory price restrictions, there has to be a forecast of what is likely to happen under restrictive regulation. Restrictive regulation is meant here to be similar to that implied by the Senate Commerce Committee bill S. 2506 (the Stevenson bill) which calls for an expansion of regulatory jurisdiction for the Federal Power Commission to cover all of the sales at the wellhead (including intrastate sales). The bill specifically sets out standards for price ceilings based upon historical average costs. so that it is assumed that the goal of this legislation is to control field prices so as to stop the price increases now occurring under more relaxed Federal Power Commission regulation in the last three years. The price implication from this interpretation of the motives of the Commerce Committee is that price increases would be limited to approximately one cent per year in the future, where justified by changes in average cost of drilling and production. There are many possible variations on this interpretation. But it is unlikely that price increases much greater than 1 cent per year are implied by the bill, since price increases of 3 cents a year are now being put into effect by the FPC and the bill specifically delineates costing standards which would not allow such 3-cent increases. The general thrust of the legislation is thought to be to hold the line on present prices, so as to prevent gas sales from following the pricing spiral now being realized in fuel oil and gasoline sales.

Holding the price line implies that there will be little additional incentive to explore and develop new reserves, or to restrict demands for natural gas as the price of fuel oil increases. New contract field prices are assumed to rise from roughly 34 cents in 1973 to 41.5 cents in 1980 on average, at a rate of 1 cent per annum; as a result, wholesale prices throughout the United States are expected to rise from a 37.6-cent average to 49.6 cents by 1980. Assuming that wholesale prices as a whole rise at 3½ percent per annum, and population increases at 1 percent per annum, the market for natural gas is expected to grow over this period. Given the events of the last few weeks, it is assumed as well that crude oil prices and wholesale prices for fuel oil will

rise rapidly in the next few years. Specifically, it is assumed that crude oil prices will increase from roughly $5 per barrel to $7 per barrel in the next 18 months—to a level which would maximize profits for the Organization of Petroleum Exporting Countries (OPEC). These conditions in the oil market have strong implications for excess demands for natural gas. Rising oil prices lead to substantial increases in demands for natural gas which cannot be satisfied at the regulated or frozen level of prices for natural gas.

TABLE 1.—THE EFFECTS OF STRICT CONTROLS (SENATE COMMERCE COMMITTEE POLICY)

Year	Field price on new contracts, cents per thousand cubic feet	Additions to reserves, trillion cubic feet	Production supply, trillion cubic feet	Production demand, trillion cubic feet
1972	30.1	9.8	19.4	23.4
1973	33.9	12.6	23.1	24.8
1974	35.0	14.4	23.7	26.6
1975	36.1	17.7	24.6	28.6
1976	37.2	20.8	25.6	30.7
1977	38.3	22.9	26.7	32.9
1978	39.4	24.7	27.8	35.1
1979	40.5	26.7	29.0	37.4
1980	41.6	28.9	30.3	40.0

The effects of strong price controls are shown in table 1, in terms of low levels of annual production (in the range of 23 to 30 trillion cubic feet) and high levels of demands (in the range of 26 trillion cubic feet in 1974 to 40 trillion cubic feet in 1980). Excess demands are equal to the difference between these quantities of forecast production and demand; they increase from approximately 2 trillion cubic feet at the present time to 10 million cubic feet in 1980—by that time, approximately 25 percent of total demands.

This simulation with the model indicates that the application of severe and comprehensive regulatory controls along lines of the Stevenson bill will result in substantial excess demand. The shortage would be so great as to make it impossible for the pipelines to continue to supply all the needs of established consumers. Rationing undoubtedly would have to be put into effect to curtail these demands. This rationing would be permanent, since this is not a short-term shortage. Most of the effects of rationing would be felt in the upper Midwest, where population and industrial growth are large and where the pipelines serving the region come from field producing areas that are most depleted.

THE EFFECTS OF ALLOWING PRICES TO INCREASE

The alternative of relaxing price controls should allow significantly greater annual increases, at least for a few years. It is assumed here that this is the purpose of the alternative administration bill, S. 2048, which, following from President Nixon's April 1973 Energy Message, is taken as a proposal to significantly increase prices on new contracts for gas sold to interstate pipelines. Again, this does not imply complete deregulation—new contract prices would be limited to annual increases set by the Department of the Interior—presumably to keep the increases in line with general cost of living increases. After dis-

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cussions with officials in the administration, we translated the national guideline presumed to be set by the Department of the Interior into an average rolled-in wholesale price increase of 50 percent over the period 1974–80. This much increase over that period implies a ceiling on new contract fuel prices of approximately 50 cents in 1974 (over a 35 cents average price in 1973). There would be a 3-cent per annum price increase each year thereafter. Of course, the actual limitations on prices set by the Department of the Interior might vary from these values, but it is believed that the price series posited here will be close enough to indicate the effect of introducing market forces along lines proposed by the administration.

The policy alternative, along lines proposed by the Administration, has the immediate effect of taking field prices from 34 cents to 49 cents per Mcf on new contracts. This would be the average new contract price over the 18 production districts in 1974 as a result of freeing contract transactions from FPC regulation but subjecting them to Department of the Interior regional increases of no more than 15 cents per Mcf. Field price increases would feed through as price increases charged by pipelines to wholesale buyers so that the immediate impact would be a 2 cents per Mcf increase in wholesale gas prices across the country. By 1980, field prices on new contracts would have risen to more than 73 cents while wholesale prices increase to 64 cents per Mcf. The effect of the price increases would be to substantially increase additions to reserves over a 5-year period and to increase production both because of the reserve additions and because of more intensive depletion of existing reserves. Production is expected to be within the range of 26 trillion to 35 trillion cubic feet over the period 1974–80. At the same time, demands are restricted as consumers attempt to avoid the price increases; home consumers save on heating uses, while industrial consumers reduce process heat by reducing their outputs and by substituing other, then relatively cheaper fuel sources. Excess demand starts out as 0.7 trillion cubic feet per annum in 1974, rises to 1.0 trillion cubic feet in 1975, but then declines to 0.4 trillion cubic feet by 1980. In effect, the use of market forces has the expectation of eliminating excess demand through a combination of (1) additional supplies, (2) output reductions by buyers faced with higher fuel costs, and (3) substitution effects away from this higher priced fuel.

TABLE 2.—THE EFFECTS OF PHASED PRICE INCREASES (NIXON POLICY)

Year	Field price on new contracts, cents per thousand cubic feet	Additions to reserves, trillion cubic feet	Production supply, trillion cubic feet	Production demand, trillion cubic feet
1972	30.1	9.8	19.4	23.5
1973	33.9	12.6	23.1	24.8
1974	49.1	14.4	25.7	26.4
1975	53.2	18.2	27.1	28.1
1976	57.3	22.9	28.5	29.7
1977	61.4	27.4	30.1	31.2
1978	65.4	31.0	31.6	32.7
1979	69.5	34.6	33.2	34.1
1980	73.6	38.3	35.0	35.6

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Our simulation results support the position that phased price increases (leading to a reliance on market forces over the long run) can be used to ameliorate the present and growing shortage of natural gas. As price incentives improve the profitability of additional drilling in the United States, more reserves are likely to be accumulated, and more production can then take place. Most geological estimates indicate that these reserves are indeed available inground, albeit at higher costs of discovery and extraction. A system of price incentives at least as great as those now prevailing in other industries may allow gas supplies to increase considerably. Higher prices to consumers will be more representative of the true value of this scarce resource, and consumer demand should respond accordingly.

TAXES AND SUBSIDIES

As a matter of course, various fiscal measures could be taken to mitigate the current natural gas shortage. Taxes could be imposed on either sales at the wellhead, or on wholesale transactions of the natural gas pipelines, so as to reduce wholesale demands. Holding field prices paid to the producer at levels in keeping with severe regulation, these taxes in 1980 would have to be equivalent to 81 cents per Mcf so as to reduce the demands shown in table 1 to the 30 trillion cubic foot level of production. This is shown in table 3, for each year from 1974 to 1980.

TABLE 3.—TAXES ON CONSUMPTION TO ELIMINATE THE GAS SHORTAGE

Year	Field price on new contracts, cents per thousand cubic feet (table 1)	Production supply, trillion cubic feet (table 1)	Taxes on new contracts, cents per thousand cubic feet	Production demand with taxes, trillion cubic feet
1973	33.9	23.1	0	24.8
1974	35.0	23.7	13.1	26.4
1975	36.1	24.6	26.1	27.9
1976	37.2	25.6	39.2	29.2
1977	38.3	26.7	52.2	30.0
1978	39.4	27.8	65.2	30.5
1979	40.5	29.0	78.1	30.5
1980	41.6	30.3	91.1	30.3

This is a much greater change in price to the gas consumer than implied by relaxation of regulation along the lines of the Nixon bill.

Subsidies could be provided to increase exploratory and development activities, so as to increase the volume of supply forthcoming. Subsidies sufficient to eliminate the shortage, while price is maintained at the level implied by severe regulation as in table 1, would be extremely large. They are shown in table 4.

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TABLE 4.—SUBSIDIES TO ELIMINATE THE GAS SHORTAGE

Year	Field price on new contracts, cents per thousand cubic feet (table 1)	Production demand, trillion cubic feet (table 1)	Subsidy on new contracts, cents per thousand cubic feet	Production supply with subsidy, trillion cubic feet
1973	33.9	24.8	0	23.0
1974	35.0	26.6	12.1	25.3
1975	36.1	28.6	24.2	27.8
1976	37.2	30.7	36.2	30.2
1977	38.3	32.9	48.2	32.5
1978	39.4	35.1	60.2	34.8
1979	40.5	37.5	72.1	37.2
1980	41.0	40.0	84.0	40.0

An amount equivalent to 84 cents per thousand cubic feet for each additional thousand cubic feet of production would be required to bring forth 40 trillion cubic feet per annum, so as to clear demands in 1980. Since this would have to be provided under all new contracts for additional gas—there is no feasible way to distinguish between high- and low-cost gas before the fact—then the amount of the subsidy would be approximately $0.7 billion in 1975, and would increase to $7.4 billion in 1980.[1] This is a much higher level of increased payments to producers than could be expected to result from the simultaneous incentives to both demand and supply implied by phased deregulation of new contract prices.

CONCLUSION

The decade of price ceilings imposed by the Federal Power Commission created 1972–73 shortages of natural gas as great as 10 percent of demand. The operation of OPEC controls over foreign crude oil, if successful in raising crude prices to the monopoly level, has the effect of raising the demands for domestic gas even more. The most effective long-term domestic policy response would be to allow gas prices to increase as well—so as to add to domestic gas production and to eliminate more elastic demanders from the combined oil-gas markets. The simulations reported here establish that this can be done at relatively low domestic gas prices—those on new contracts of 60 to 70 cents per thousand cubic feet equivalent at the wellhead to crude oil at $3.60 to $4.20 per barrel.

Senator GRAVEL. Thank you. Let me pose one question.

With your econometric model, can you project a State-by-State distribution of gas by supply and demand under assumptions of the Commerce Committee's stricter controls that you just spoke of, and decontrol of price under new contracts?

Mr. MACAVOY. To the extent that we could limit our analysis to five regions of the country, we can do that. In other words, we can do it for New England, for the upper Midwest, the west coast. But

[1] One might ask what the impacts of specialized subsidies are likely to be. What might be the impact, for example, of a subsidy (or tax allowance) to producing companies based on all or some part of expenditures on new gas field exploration? Might such a subsidy result in greater exploratory activity than simple price additions (or subsidies) for new or total production? Unfortunately we cannot provide answers to detailed questions like this at this time. This is not because questions such as this have not been of interest to us, but rather because not enough is known at the present time about the economics of exploratory activity to make meaningful answers possible. We would in fact be suspicious of any estimate of exploration response to one or another particular subsidy.

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State-by-State detail cannot be obtained from the model at the present time.

Senator GRAVEL. Could you supply that for the record? I will take it on a regional basis if I cannot take it on a State basis.

Mr. MACAVOY. Table 5 shows regional shortages from the strict price controls implied by the Stevenson bill. As can be seen, more than 40 percent of the national shortage occurs in the north-central area including Indiana, Michigan, Illinois, and Wisconsin. These States contain a good part of domestic industry and natural gas shortages there have a direct negative effect on industrial output. Under decontrol, this shortage in the north-central region would be eliminated—as shown in table 2.

TABLE 5.—REGIONAL SHORTAGES FROM STRICT CONTROLS (SENATE COMMERCE COMMITTEE POLICY)

Year	Excess demand, by region (trillions of cubic feet)					
	West	Northeast	Southwest	North Central	South Central	Total
1977	1.1	1.3	0.9	3.0	0.1	6.2
1978	1.2	1.6	.9	3.4	.2	7.4
1979	1.4	1.8	1.0	3.9	.4	8.5
1980	1.6	2.1	1.1	4.3	.6	9.7

Mr. BEST. Could we ask you for your reactions, do you have any, to the analysis and forecasts that were made this morning by Mr. Bridges?

Mr. MACAVOY. Mr. Pindyck will respond to that question.

Mr. PINDYCK. I think a lot of people have gotten into the enegry business lately, and a lot of engineers have particularly and made projections of one or another energy demand and supply. And I think they are interesting projections, and this is always fun to draw extrapolations and draw special curves, and growth curves. But I think they have a limited amount of meaning.

He used the words demand, and then demand supply, and supply. I do not know what he meant, but usually the amount of energy or the amount of anything that anyone consumes is a function of price. And I think that the amount of energy that the people will consume in the United States will be a function of price; and therefore, just to extrapolate curves, this is a little bit meaningless.

Mr. BEST. Let me pursue that a moment. If oil, gas, and coal were deregulated, and the market were allowed to clear itself, so to speak, what type of an import policy would you need to insure that the investment that would be necessary to bring the domestic supplies could be made in a way that assured confidence that foreign suppliers who may have access to cheaper resources could not then undercut the domestic investment?

Would you need some type of a variable levy on imports?

Mr. PINDYCK. Are you talking about letting prices go up with respect to domestic natural gas?

Mr. BEST. Yes.

Mr. PINDYCK. Prices would have to go up an awful lot before there would be a problem of undercutting from abroad, even with respect to oil, because if oil prices still not go up to $7, if oil prices, let us

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say, stay of $5—well, that corresponds to a natural gas price of close to $1 per thousand cubic feet.

And the kinds of prices that we found for free markets were below $1 per thousand cubic feet.

Mr. BEST. Including the competition with alternative fuels, coal, oil, et cetera?

Mr. PINDYCK. Yes.

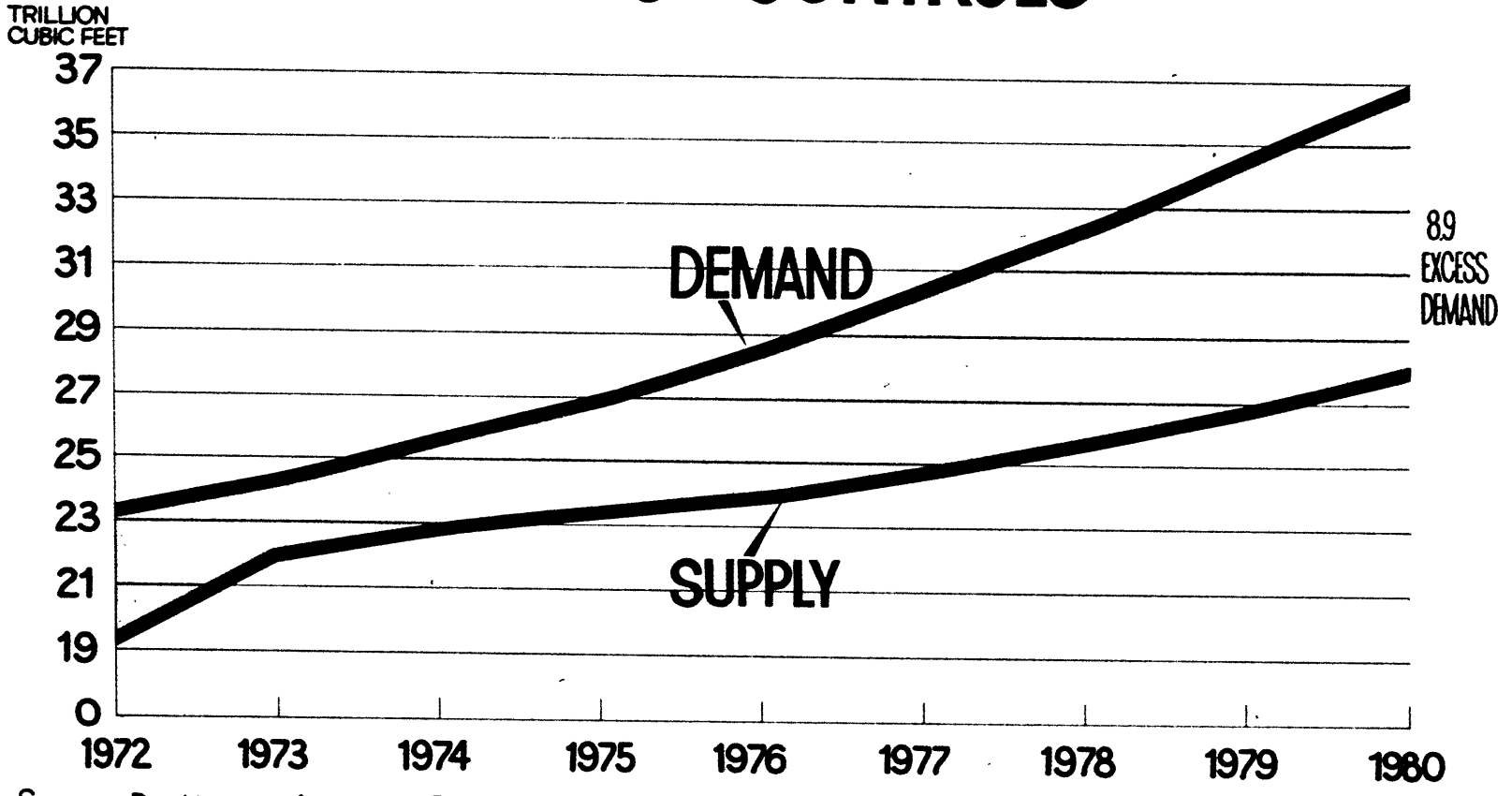
Mr. BEST. Not to interrupt your train of thought, but we had prepared two charts which attempt to illustrate the findings of your study.

And I wonder, Mr. Chairman, if we could put them in the record at this point?

Senator GRAVEL. They will be included in the record and held for committee and floor action.

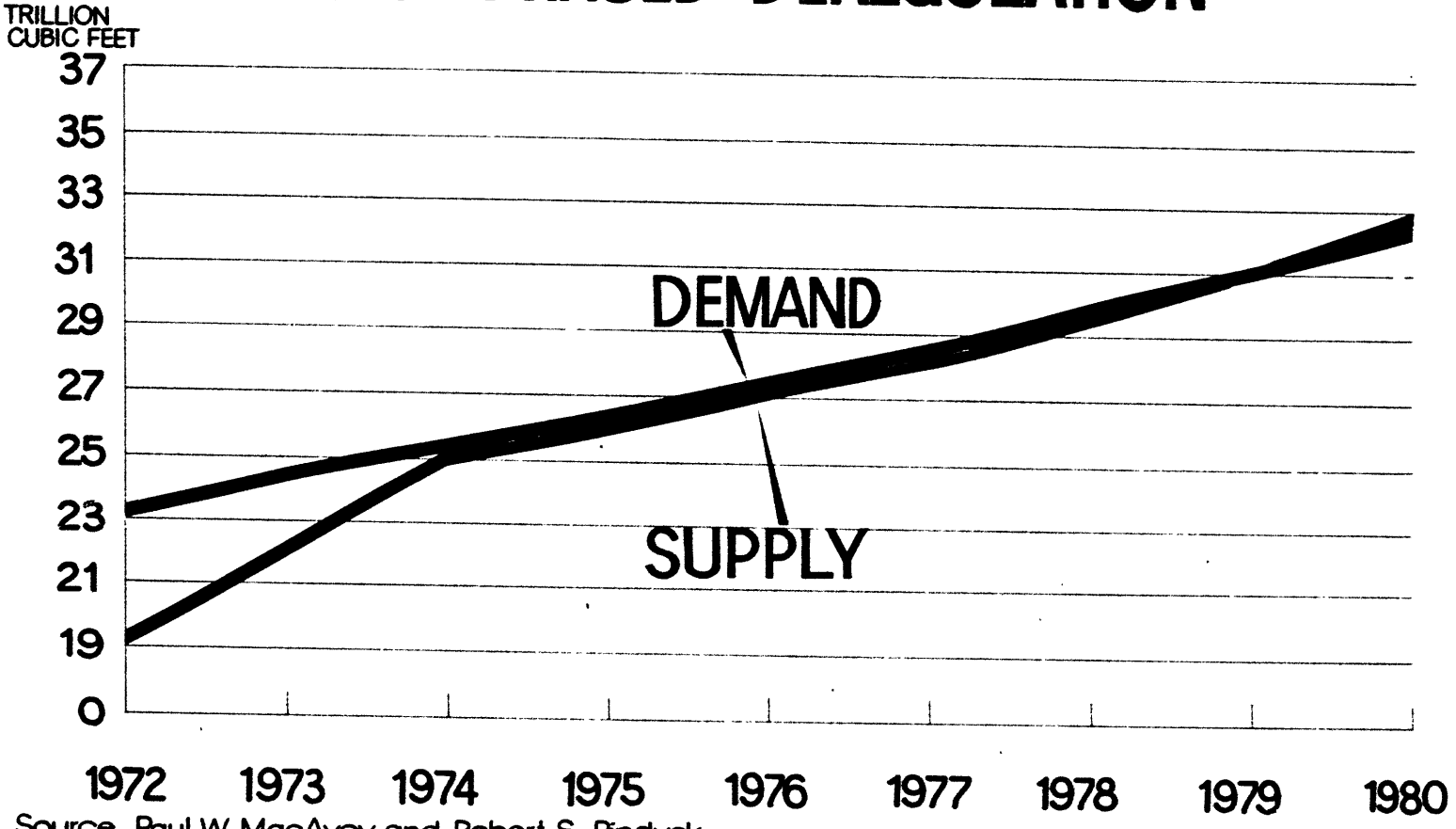
[The information referred to follows:]

THE EFFECTS OF STRICT CONTROLS



Source: Paul W. MacAvoy and Robert S. Pindyck

THE EFFECTS OF PHASED DEREGULATION



Source. Paul W. MacAvoy and Robert S. Pindyck

Mr. MacAvoy. The charts are illustrative, Mr. Best, except I want to take this opportunity to note that the supply-demand gap is no longer big enough. We now forecast a 10 trillion foot gap shortage, because we have put into the model price increases for crude oil from abroad now much greater than those used in the earlier runs with the model. Higher oil prices now appear to be more realistic. The difference between this diagram and tables 1 and 2 of my statement is that the price increase now supposed to occur in the next 2 years is not $1 a barrel, but close to $2 a barrel. The forecast is a price of crude oil equivalent to $7 a barrel landed on the east coast by the middle of 1975. We believe that this is more realistic because it comes close to the level of price which we would charge if we were the Organization of Petroleum Exporting Countries (OPEC) attempting to maximize profits on sales in the United States (the price at that level is short of that sufficient to bring in significant new technologies using coal as a basic resource).

Mr. Best. Well, we will try to revise the charts to reflect the new figures. But if they cannot, the record will state that they actually understate the shortage that will occur if we continue strict controls over natural gas prices.

Mr. MacAvoy. I think that will be fine. All you have to do is to move out or increase the supply and demand so as to increase the gap by 1 trillion cubic feet. The supply of natural gas depends on the domestic crude oil field price. As foreign crude prices go up, domestic fuel prices go up in the model, and this adds to incentives for oil exploration and development, which has the byproduct of finding additional supplies of gas. Thus there is a response on the supply side for natural gas, as the crude oil price abroad goes up.

But gas demand also increases, and by more than the increase in supply, because gas is a close substitute for crude oil.

Senator Gravel. You did the same thing at the Commerce Committee hearings, did you not?

What was your reception there?

Mr. MacAvoy. We attempted to answer the first question that you asked, Senator Gravel, in a bit more detail. I have no excuse for not being as well prepared today. But our approach in those hearings was to provide additional detail on specific regions of the country. We addressed ourselves to Senator Stevenson's specific proposals for holding a lid on prices based on historical average costs. We have responded to those proposals, partially at least, in terms of what this would mean for that part of the country from which Senator Stevenson comes.

Senator Gravel. Could I pose a question here, though not to break your train of thoughts?

When he is saying historical average costs, obviously his historical average cost has not taken the cost of looking——

Mr. MacAvoy. That is right.

Senator Gravel [continuing]. Which is a vital part of the whole thing.

Mr. MacAvoy. These costs of exploration have been increasing.

Senator Gravel. So his historical average cost is a distortion; if you do not pay the cost of looking for what you are going to develop?

Mr. MacAvoy. It is conceptually incorrect to use industrial average costs as the measure of costs for additional output from a stock in resource. The resource is becoming more and more costly to develop; to look back on costs, to set a limit on price, is conceptually incorrect, and will necessarily result in a shortage.

This has been recognized in economics with respect to natural gas for 15 years. Differences of opinion exist on how large the shortage is going to be. There are some who argue that the shortage is going to be very small. Over the next few years—supply is inelastic and demand growth will be contained by competition from other sources of energy. But our findings from the MIT model are that a shortage as large as 20 percent could occur by the end of the decade.

Senator Gravel. But certainly we have the proof that the shortage is there. We have experienced it in the last 10 years. Nobody disputes those facts.

Mr. MacAvoy. Very few. There is always one economist who will dispute anything, but on the whole there is little disagreement about where we are. There is some disagreement about where we are going.

Senator Gravel. But what about the evidence of intrastate activity? Certainly, we have that as fact in the last decade also.

Mr. MacAvoy. That evidence is somewhat misleading, because intrastate transactions are not large enough to result in a set of independent prices. Intrastate will follow along the interstate market if the shortage is small. For a number of years, in fact, the intrastate got all the gas they wanted at a price just a little bit above the regulated interstate price—thereby shifting all of the shortage onto interstate buyers. Now in the last 2 or 3 years, with increased shortage, intrastate buyers have had to bid considerably higher than the regulated interstate price. They have to bid considerably higher than they would have to bid if there were no limit on the interstate price. If we want to phase deregulation, take the lid off the interstate price, the intrastate price would come down, and the interstate price would go up.

So you cannot use the intrastate price now as an indicator of what would happen after you take the lid off the interstate prices.

Senator Gravel. In any one of these tables, do you have any estimates of what would be the effect if we just took the lid off, right now?

Mr. MacAvoy. That is a fascinating question, and Professor Pindyck and I late at night, every once in a while, gear up the computer to attempt to answer that question. We get two-thirds of the way through the answer, and he pulls the plug. Pindyck, the mathematician and econometrition of the two, keeps saying that the model was built on 10 years of regulatory history, so that all of the built-in expectations, the patterns of performance of the producers were in response to a lid on prices, and thus the model cannot be used to predict the market in that regulation.

We can use the model to extrapolate into the future by raising the lid on prices every year. We cannot use the model to simulate a completely deregulated market, because the whole pattern of built-in expectations for that are entirely different from what we have experienced in the past.

Senator Gravel. What you are saying is that all you can do is make an estimate. You cannot make a calculation.

Mr. MacAvoy. That is right.

Mr. Pindyck. You can make some rough guesses.

Senator Gravel. What would be your guesses?

Mr. Pindyck. My guess would be the prices would go up. Let me begin by saying that the markets could clear if we had a first increase of prices; we could clear as we have shown by 1980, or even a little bit earlier, 1978.

I think that under complete deregulation, there would still be clearing of markets but at a still higher price and slightly lower production. And that is not to say that I think that the industry is very ogolopolistic, but it is not completely competitive. And if there was absoluely no regulation, you might see prices go up to maybe at the field level, at the wellhead, to maybe 10 or 15 cents higher by 1980 or by 1978 than we have seen, and then drift back down.

Mr. MacAvoy. You would expect a large blip in the price series.

Senator Gravel. Well, let us look at the next 6 months. This is what we are facing right now. We have got controls on gas. We have got controls on oil. We are talking about rationing.

So what we essentially are going to do is to put a ton of money in black market or into a special type created white market. That is not where we want to get the money. We want to get it at a fairly rapid rate, to provide an immediate incentive.

Now, how serious would it be?

Mr. Pindyck. All you can do in the very short run, in the next 6 months, you cannot do very much about supply in the next 6 months. All you can try and do is try and cut demand, and even demand responds over a fairly long period of time, because people do not rip the heaters out of their homes.

Senator Gravel. But how high would prices go? Let us take my house; it is on gas. We are in a crisis, and I am prepared, and I am sure a lot of people would be in order to continue to supply, to pay considerably more, period. There is no choice. Even if I wanted to make a choice, I probably would make an ultimate choice at this point in understanding the dynamics of it.

So how serious would that be in the short run? If in January we took the lid off, rather than going to rationing, which would be the greater trauma—if we are going to pick out trauma, let us pick a constructive trauma, rather than a destructive trauma.

If we take the lid off in January, what is going to happen in February? How high will prices go, assuming that we have got a responsible community, and they know that if things go wild, obviously the people will report back to Congress in a year's time. And if it is easy to take the regulations off, it is just as easy to put them back on.

And if we have some faith in our system, what do you think would happen?

Mr. Pindyck. I think prices would go up quite a bit, but I think it would be—it is very hard to put a number on it, but I think there would be a distortion of price increases. Some people would be paying a lot.

Senator Gravel. Well, let us assume the utilities, they are going to continue their regulations. We are talking about just the wellhead. So there cannot be that much.

In fact, I have been told that the impact might be less than 10 percent at the consumer level, if you just set the sky as the limit of the production level. That would get a lot of money at that point, or a lot of expectations of money, and people would go out and work very hard at it.

But if you have got the rest of it static, there is no reason for a pipeline company that is already built with its entire infrastructure to also come in and jack up the prices just to take a ride on a market situation. So the utilities would be regulated as they are in the various States.

But we are talking about the guy who produces the gas, and if enough people get into it, it will rise, but they will not come back down. Where we need the trimming of the sail right now is immediately. So if we can have a price to it——

Mr. MACAVOY. Let us consider the possibility of taking the lid off only new contract prices on the argument that all the old contracts for which production is now taking place were set up under other market conditions. There is no reason for allowing those prices to produce windfalls.

Senator GRAVEL. Let me submit a copy with you in your analysis that these contracts, as you pointed out were tracked in time. Most contracts, I understand, have a proviso that if the lid comes off, they go up. They have negotiated the price.

Mr. MACAVOY. That used to be the case in the 1950's.

Senator GRAVEL. But it is not now?

Mr. MACAVOY. The favored nations clauses were removed by—by a Commission order in the early sixties. They are no longer allowed.

Senator GRAVEL. So why not in dealing respectively, let, just let the contracts go on the way they are, and not let anybody revert to anything; so you get a normal clearing that will take place on a turnover basis?

Mr. MACAVOY. Well, on that basis, I forecast that prices on new contracts would go as high as $1 per Mcf. This is a judgmental forecast, and is not taken from our econometric model. Of course it could be more or less, and probably more rather than less.

Senator GRAVEL. You say they will go up to that?

Mr. MACAVOY. They will go up to $1. They now average 34 cents. It will go $1.

Senator GRAVEL. So that is three times?

Mr. MACAVOY. That is right for a short period, but then they will come back down. But by 1978–79, they will be where we tracked prices on table 2.

Senator GRAVEL. Now, what does that mean to the consumer?

I have to go for a vote. Excuse me.

Could you estimate and submit for the record, because this is what we are going to have to show the Congress and the people, what it will cost the consumer if we go this route. And we want to bring in some specifics.

Mr. Best can proceed in some questioning that he has, then we will come back to my questioning, because I am missing some very important stuff at these votes. And if I can impose upon you and also

Mr. Winger, I do not want to miss the pearls of wisdom you people have to give for me, because that is what we are going to have to use.

So you can proceed on his questioning, but we will come back to this one for me.

OK?

Mr. BEST. Suppose the price went to $1 per Mcf? Some studies* that I have seen, indicate that the average homeowner expends something like $155.73 a year for his natural gas bill and that the wellhead cost is 10 to 15 percent of that. So, using that as a basis, and assuming that these studies are accurate, what would be the average annual increase in cost to the homeowner if natural gas were priced, temporarily at least, at $1 per Mcf?

Mr. MACAVOY. Could we have 3 minutes, and I will work through the computer printouts and respond to that?

Mr. BEST. Fine. Dr. MacAvoy, what you can do under these circumstances is to give us your best estimate now and when you send us your transcript, if you have any changes, you can give us a more refined estimate.

Mr. MACAVOY. We estimate, at this point, that moving from a price level of 34 cents, to my judgmental forecast of market clearing at $1 in a few months, would increase that wholesale price to all users by approximately 37 cents in the first year. The wholesaler, in this case, can be expected to pass through, automatically, all fuel price increases.

Now, if the retailers then does the same thing and passes through all price increases that he experiences with the wholesaler, then we might say, very roughly, that 37 cents would be the final increase to ultimate consumers. At the levels of demand forecast in the model, this would be equivalent to approximately $9.2 billion increase in total charges.

Mr. BEST. But to the average homeowner who according to this study, spent in 1972, the residential consumers' average annual gas bill of $155.73. Even a 40 to 59 percent increase in that would come down to perhaps less than $10 per month?

Mr. MACAVOY. The 37-cent increase would be 33 percent on the basis of a 1971 average retail price for natural gas of 1.12 cents per Mcf.

Mr. BEST. How much would that mean in terms of the homeowner's average monthly heating bill?

Mr. MACAVOY. How much does he consume a month?

Mr. BEST. It is in the study, I have just extracted out the only figure that I needed for the purpose of this briefing but we can get that.

Mr. MACAVOY. Multiply the 28 cents times the monthly consumption and that will give you the change in the monthly bill.

Mr. BEST. One comment that was made by a witness on the first day, Mr. David Freeman, who had been an employee of the Federal Power Commission, was that the bottleneck on natural gas was not the control of the fuel prices, but the fact that after the Santa Barbara incident, there was a moratorium on leasing for over 2 years, and that it is the Federal leasing program, not the wellhead price controls, which

*The summary from the Foster Associates Report on "The Impact of Deregulation of Natural Gas Prices" published August 1973, appears at page 504 of this hearing.

are responsible for the decline in production. Do you have any comments on that?

Mr. MacAvoy. If the Federal leasing program had been that important then I would find in the data series for new discoveries, extensions and revisions of gas reserves in the sixties that there was a significant "break" in the form of a significant mediation in quantities at the time of the event that Freeman referred to. We do not find significant breaks in that series, as I recollect, throughout the sixties, but rather a very strong price effect consistently and systematically working so as to reduce discoveries.

The price effect is as follows: Holding the price of natural gas at a frozen level in nominal prices. While the costs of exploration and development are increasing and prices of substitutes are increasing, is essentially to require the real price of gas to go down. As the real price goes down under the FPC ceilings in the sixties, the quantities of additional reserves added to the national stock of reserves also went down without any significant breaks. Firemen's curtailment of leasing applied only to 1 of 22 production districts albeit the largest one. The aggregate of funds in these districts did not show a strong decline in a few years because of particular year-to-year changes in offshore.

Mr. Best. Thank you. You mentioned that you had testified before the Commerce Committee on the effects of maintaining strict controls for various State situations, could you give a qualitative assessment, say, of the effects of maintaining strict controls on some farm States—take Illinois, Minnesota, Indiana—and then say, for some more industrialized States like Connecticut, Ohio, and so forth, in qualitative terms?

Mr. MacAvoy. We have made forecasts of the size of excess demand for five sectors of the country for the years 1974–1980. More than 4 trillion cubic feet of excess demand occurred in the upper midwest. The rest of the shortage was smaller and more equally distributed in the northeast, south central region, and the West Coast region, with the shortest amount of the shortage occurring in the south central region where production actually takes place.

The reason for the energy shortages is that regional differences in responsiveness to gas prices are significant. There is less responsiveness to gas price changes in the north central than elsewhere (as shown in MacAvoy and Pindyck, *op cit*, page 483).* Another reason for regional differences in shortages, is that gas supplies for that region are more depleted. The same pattern of shipment of gas from particular producing fields to final consuming regions is assumed as has taken place over the last few years. The north central region takes a larger proportion of its gas from parts of the producing area that are the most depleted at the present time.

Mr. Best. Does the upper midwest depend significantly on the Texas-Louisiana gas fields for its gas, or on other fields?

Mr. MacAvoy. The upper midwest receives a larger proportion of its gas from the pan handle regions and from central Kansas or Oklahoma which are substantially older and more depleted.

Mr. Best. Is there a dual price situation existing in these regions, one price for intrastate gas and another for interstate? So that if you

*Page 357 of this volume.

are a gas producer, the incentive is to lay pipeline within the State rather than across State boundaries because the intrastate prices are going to be higher?

Mr. MacAvoy. I think that that is the case, Mr. Best. I would not consider the incentive to be any greater than in west Texas or in the gulf coast region of Texas or Louisiana. I would say, very roughly however, that there is less likely to be significant new exploration and development in the Panhandle-Kansas-Oklahoma fields at the prevailing or future prices than there is likely to be in the gulf coast region. That is, if one looks at the pattern of development at the prices given in table 1, a much larger proportion of that development will be in the gulf coast region of Texas and Louisiana than would be the case if the price goes up to 50 cents or beyond. The effect of phased deregulation would be to provide significant new incentives for more exploration and development in the older onshore regions than we can expect from frozen prices.

Mr. Best. So really the net conclusion is that the solution to a dual supply problem or a short supply problem, the way to get continued gas flow to the Midwest, is through deregulation. Some would say immediate which would result in this bellshaped curve that you spoke of; perhaps others would say phase down and have an upward sloping price situation. Either way, the average price will end up being the same.

Mr. MacAvoy. Yes. The situation is almost as though nature provided us with no alternative for the north-central region. This is the most costly location for imported supplies to be made available. We have a pattern of pipeline transmission systems which produced the greatest part of the shortages in the location least accessible to imported supplies.

There is very little alternative to billing to phased deregulation if you want to solve the shortage in the upper Midwest.

Mr. Best. I will ask one more question and then turn it back to the Chairman. You mentioned imports as a marginal solution to certain regions in the country. Would you care to comment on why—with 1,178 trillion cubic feet of gas estimated to exist in this country by the U.S. Geological Survey, would a consumption level of only 22.6 trillion cubic feet—why companies would be interested in going to Algeria and investing $200 or $300 million in LNG which landed in the United States and costs $1.35 Mcf or the Soviet Union—two areas which have not traditionally been considered a secure source of supply for vital raw material—why would American companies make that investment?

Mr. MacAvoy. Because of the distortions in the price mechanism from definition, the price on domestic reserves, along the lines of Senator Stevenson's proposal, is frozen when those reserves are put into an interstate pipeline in Texas, Louisiana, Oklahoma, Kansas, and Mississippi, but the price of gas put into a home delivery system in Boston or Baltimore is not frozen. With the forecast 10 trillion cubic-foot shortage, there is substantial excess demand that can be met at higher prices with very expensive foreign gas. It is profitable for the pipeline to import and charge for this very expensive foreign gas because final regulated costs contain an extremely large capital component which

is not found in domestic production or domestic exploration and development. The capital equipment in liquefication facilities, tankers, and gasification facilities will probably be owned by pipeline companies and included in the rate base for calculation of the allowance profit markup over the Algerian price. That markup will then be part of the wholesale price to be passed on to the final consumer. If the pipeline has a choice between gas at $1.50 Mcf of which one-half is rate base, and gas, according to our model, at 75 cents Mcf, none of which is rate base, it should choose the first over the second. The two distinctions—one in demand from frozen field prices, the other in the choice of foreign or domestic sources from pipeline regulation—forms the continuation of shortage from the point of view of the pipelines.

Mr. BEST. If a company has committed several hundred million dollars for the development of Algerian gas, which they know to be shipped back here at $1.35 Mcf, do they not create a vested interest in seeing that there is a shortage so that that gas can be sold in the United States, rather than in a policy of deregulation? So, has not the price controls in a way created a very perverse situation where it could be that the very industries that are producing the gas, are also now interested in assuming that the shortage continue because they have invested hundreds of million in higher-priced foreign supplies.

Mr. MACAVOY. Yes. I would add to that, that one can even get some indication of the circumstances of these pipelines, from our tables 1 and 3. Table 3 actually gives you a picture of the size of the market for LNG if we hold prices to the Stevenson level. Table 1 says that if you hold fuel prices close to 40 cents for the rest of the decade, you are going to have demand for 10 trillion cubic feet more than you can supply from domestic sources. Thus there is demand for 10 trillion cubic feet of LNG at 40 cents. If the price of LNG goes as high as 91 cents above the domestic price, the demand will disappear, (as shown in table 3). So, the margin available for these LNG importers is such that they cannot go much higher even under a Stevenson shortage, than $1.30 Mcf.

Now there is some disagreement on that. Some pipeline experts would be willing to argue they can make money and sales on $1.50 Mcf if the shortage continues. None of them argue that if you go to phase deregulation that they can make money. The controversy centers on who gets the shortage—if home consumers get it, demands will be less price elastic than shown in table 3. Table 3 provides you with an indication of what the maximum prices could possibly be, under conditions pessimistic to the profits of pipelines, but given that the Senate provides a systematic continuation of the shortages by passing the Stevenson bill.

Mr. BEST. So, those decisionmakers will have to choose between the deregulation of the price, and controls. If they opt for the controls, it will not only be encouraging the development of insecure foreign sources, but also will be encouraging American industry that has developed those foreign resources to actually want the controls to continue so that there is a gap in supply which the foreign sources fill the gap?

Mr. MacAvoy. Yes.

Mr. Pindyck. Could I expand on that a little bit? I think it is an important point because a lot of people say, gee, you know if people are willing to pay $1.25 for Algerian LNG, then to clear markets then really does it not take $1.25 really, the prices would not go up to $1.25, if, indeed, that is what the Algerian gas is going to cost.

That is not the case and it is very important that it is understood that it is not. The situation is very much as if you had a movie, a broadway show in New York, in which the price was—let us say the equilibrium price was $10—$10 would just fill the theater and everyone would have a ticket. There would be no empty seats. And let us suppose that the mayor of New York decided that a new way to enhance the city's cultural life would be to fix the price at $5 for that same broadway show. And, of course, what would happen—and now what may happen—is that there would be scalping. Some people would be buying tickets at $5 and scalping by selling them to other people for $15 or $20. Now, some people would, indeed, pay $15 or $20 to see that show, but that does not mean that the equilibrium price, the market price of that broadway show, which would just fill the theater, is $15 or $20. The equilibrium market price is still $10 and that is the case with natural gas.

If you have a shortage, if we restrict the price to be 35 cents per Mcf at the wellhead, if you restrict the price to below that, there are going to be some people who will pay a lot to have gas and they will pay $1.25 to have that Algerian gas. That does not mean that the equilibrium price will be $1.25. It might be 80 cents, or 70 cents, or something like that. It would be less than $1.25. And that is the misconception that a lot of people have. Many people say, gee, do you not know that if you let prices go up they have to go up to at least $1.25 because that is what the Algerian gas will cost? That is not a valid argument.

Mr. Best. I did not attend MIT but I can understand your point. In the shortage situation the equilibrium price is not what some person who has the money is willing to pay to somebody who has the goods?

Mr. Pindyck. Exactly.

Senator Gravel. Did you figure out the price of what it would be unlimited, let us say at $1 at the wellhead, what that would be to the consumer?

Mr. MacAvoy. We ultimately estimated a very preliminary stage, that this would result in a 30-cent per Mcf increase to the consumer. Mr. Best and I lack one number now to provide some impression as to how big this is. We need to know how much the consumer is paying a thousand cubic feet. I think the number must be around $1.25 retail for small delivery.

Senator Gravel. That is right.

Mr. MacAvoy. So what we are saying is that immediate short-term equilibrium, if passed all the way through the system, wholesale and retail, everybody passes through a price increase but rolls it in so that it gets averaged in with the old price contract, would result in an increase, say, from $1.25 to $1.50 or $1.55. That is nowhere near the kind

of percentage increase that I am experiencing in New England on gasoline and fuel oil. I experienced a 40-percent increase in fuel oil price last year.

Senator GRAVEL. So that is the worst that could happen if we took the lid off?

Mr. MACAVOY. Probably.

Mr. BEST. We know, Mr. Chairman, that the average gas bill for residential homes per year is $155.73.

Senator GRAVEL. I have exhausted my side of it. I could go on for a good deal more, but I think——

Mr. MACAVOY. You gave us a great deal of time and we are most appreciative of the opportunity.

Senator GRAVEL. Thank you, both, gentlemen.

[An article by Mr. MacAvoy and Mr. Pindyck follows. Hearing continues on p. 373.]

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Alternative regulatory policies for dealing with the natural gas shortage

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Alternative regulatory policies for dealing with the natural gas shortage

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Low wellhead ceiling prices over the past decade have led to the beginning of a shortage in natural gas production. If the demand for gas grows as expected during the 1970s, and if ceiling prices remain low as a result of restrictive regulatory policy, this shortage could grow significantly. This paper examines the effects of this and alternative regulatory policies on gas reserves, production supply, production demand, and prices over the remainder of this decade. An econometric model is developed to explain the gas discovery process, reserve accumulation, production out of reserves, pipeline price markup, and wholesale demand for production on a disaggregated basis. By simulating this model under alternative policy assumptions, we find that the gas shortage can be ameliorated (and after four or five years, eliminated) through phased deregulation of wellhead sales, along the lines proposed in President Nixon's April 1973 Energy Message. But the shortage is not reduced by changes in regulatory rulings on prices, even when the rulings allow price increases that are the maximum likely to be acceptable to the Courts. These results are rather insensitive to alternative forecasts of such exogenous variables as GNP growth, population growth, and changes in the prices of alternate fuels.

1. Introduction

■ A substantial shortage of natural gas has been developing over the last few winter heating seasons. Reports of the Federal Power Commission indicate that in the winters of 1970 to 1972 gas supplies were cut off with increasing frequency, and for longer periods of time, throughout the Northern and Eastern portions of the United States.[1]

Paul W. MacAvoy holds the A.B. degree from Bates College (1955) and the M.A. and Ph.D. degrees from Yale University (1956 and 1960, respectively). At the Sloan School of Management, his research centers on the effects of regulation in the energy, transportation, and communications industries. Professor MacAvoy is Editor of *The Bell Journal of Economics and Management Science*.

Robert S. Pindyck received the B.S. and the M.S. in electrical engineering and the Ph.D. in economics from M.I.T. in 1966, 1967, and 1971, respectively. At the Sloan School of Management, he conducts research in the economics of the energy sector, as well as in applications of optimal control theory to macroeconomic and industry policy formation.

[1] In [21].

This has been a matter not only of cutting off supplies in peak periods to industry—as occurred in Cleveland in January 1970 when 30,000 employees of 700 companies were laid off for 10 days as a result of gas interruptions—but of systematic curtailments of deliveries to certain classes of consumers. During 1971 to 1972, seven major interstate pipelines curtailed service throughout the winter season to existing customers. Service entering the Northeastern part of the country from Texas Eastern Transmission Corporation was curtailed by 18 percent, from Transcontinental Gas Pipeline by 9 percent, and from Trunkline Gas Company by 27 percent. Service throughout the region from New Mexico to Southern California was curtailed by El Paso Natural Gas Company by 15 percent. The FPC staff has shown deliveries falling short of the amount of gas demanded for consumption by 3.6 percent in 1971 and by 5.1 percent in 1972, and has predicted that production will fall short of demand by 12.1 percent by 1975.[2]

These estimates encompass recent and expected future *production* shortages. The amounts do not, however, include anywhere near all of the unsatisfied demands for gas. The "markets" for natural gas are not spot markets for production, but rather center on sales of reserves. The pipeline buyer offers to take new gas deposits out of the ground, and pays for this production, so as to deliver gas to residential, commercial, and industrial consumers throughout the United States. The transaction involves the dedication of reserves by oil and gas discovery companies to pipelines, and this is followed by a transaction in which the pipelines make commitments to deliver production to final consumers over a ten- to twenty-year period. The reserves markets have experienced shortages to a much greater extent than shown by recent production shortages (according to one

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This paper reports on the results of Phase II of a project to develop an Econometric Policy Model of Natural Gas, under National Science Foundation Grant #GI-34936. The Phase I version is reported in Sloan School of Management Working Paper #635-72 (December 1972), and the Phase III version, a Domestic United States Oil and Gas Policy Model, will be completed by July 1974. Comments are invited on this interim version.

The results of this project would not have been possible without the support of our research assistants at M.I.T. We would like to extend our sincere appreciation to Robert Brooks, Krishna Challa, Ira Gershkoff, Kevin Lloyd, Marti Subrahmanyam, and Philip Sussman for their energetic and enthusiastic help in developing a computerized data base during the summer of 1972, and in estimating and simulating the model over the past few months. They worked many long hours, and often under considerable time pressure. We received considerable support from the National Bureau of Economic Research Computer Center in the use of the TROLL system for the estimation and simulation of the model, as well as for the maintenance of our data base. We would like to thank Mark Eisner Fred Ciarmaglia, Richard Hill, and Jonathan Shane for their help in using TROLL. We would also like to express our appreciation to Morris Adelman and Gordon Kaufman of M.I.T., and Robert Fullen and Wade Sewell of the Federal Power Commission for their comments and suggestions. Commissioner Nassikas of the FPC, Mr. Charles DiBona of the White House Staff, and staff members of the Senate Commerce Committee were of substantial assistance in formulating policy alternatives. Finally, more than six dozen readers of the Phase I version of the model provided critical comments necessary for reformulating the model along the lines presented below. We are obligated to them all, and absolve them from responsibility for the results by granting them anonymity.

[2] In [20], p. 123.

estimate, new reserves have been more than 50 percent short since 1961[3]). Also, it has been estimated that demands for new production by old and new potential buyers exceeded the total supply of new production available by more than 50 percent.[4] These unsatisfied demands were never registered by curtailment proceedings because most of the new potential buyers simply were refused service from the pipelines. This shortage resulted in additional demands for other fuels.

Production curtailments have immediate effects on the consumer. They may require him to use stand-by heating facilities or possibly to do without heating entirely. The larger shortage of new production contract commitments has more diverse effects. Some consumers are required to go to other fuels—with the result that their consumption costs are increased or that pollution is greater, so that social costs are increased. Other consumers can work their way around the shortage by changing locations or by offering various premia to be put at the head of the queue. In general, the economic and locational effects of the shortage are likely to be significant.[5]

The political consequences are another matter of import. The contract sales of gas at the wellhead and at the city gate are closely regulated by the Federal Power Commission, so that the FPC, the Congress, and the Office of the President become focal points for complaints that regulatory policies have either caused or failed to ameliorate the shortages. With neither producers nor consumers supporting the regulatory process—neither clearly benefiting from the shortage—the possibility of significant political losses for legislators or regulators is substantial.

Reactions to the potential adverse political effects have been along two lines. The first has been to call for the loosening of regulation of contractual agreements at the wellhead. President Nixon in April 1973 called for deregulation of wellhead prices on new contracts; the Chairman of the FPC at the same time argued that "gas supplies are short . . . and the way to encourage more drilling and discoveries

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[3] The estimate was obtained from a four-equation supply and demand model of natural gas reserves constructed on the basis of data over the 1950s and fitted to values of the exogenous variables over the 1960s. The difference between the fitted values of reserves—those that would clear the market—and the actual values of reserves made available in fuel producing markets to go to the East Coast and Midwest was more than 50 percent of fitted reserves each year from 1961 to 1968. See Breyer and MacAvoy [5], pp. 968-976.

[4] *Ibid.*, Table 1, p. 975. This is confirmed in Tables 3, 4, and 5 below, by the year-to-year differences in supply of production falling short of the year-to-year differences in demands for production by more than 50 percent in the 1971 to 1973 period.

[5] An initial attempt is made by Breyer and MacAvoy [5] to measure the economic effects of the shortage on consumers. It is argued there that the reserve shortage is incurred by residential and commercial consumers buying from regulated interstate pipelines, while industrial consumers buying in unregulated transactions do not experience the shortage to the same extent. Because of the magnitude of the amounts short in the 1962 to 1968 period, final residential and commercial consumers are believed to have been made worse off as a group from a combination of lower regulated prices and large shortages. No attempt is made here to refine these estimates with the more advanced econometric model discussed below. But additional work along these lines—leading to an assessment of optimal levels of shortage in terms of economic effects—will be forthcoming in a later article.

may be to let prices rise."[6] Proposals for deregulation are based on the argument that FPC rulings have restricted price increases, despite the fact that cost increases have reduced supplies at the same time that demand has increased. Thus, decontrol would allow higher prices which would clear the market of excess demand and would be an inducement to take on increased exploration and development so as to add to reserve supply.

The second reaction has been to the opposite effect. Proposals have been made to put stronger controls over wellhead contracts. The argument, in part at least, is that producers have been holding back reserves in anticipation of relaxed price controls—and tighter controls would cause them to see the futility of holding back. Draft bills proposed by staff of the Senate Interior and Commerce Committees extend FPC jurisdiction to cover not only interstate sales to pipelines, but all intrastate sales now outside the juridiction of the Federal Power Commission. The requirement that the FPC set "just and reasonable rates" on the basis of historical average costs of exploration and development is reaffirmed. Proposals are made to further the development of artificial gas or liquefied natural gas to replace the short supplies of inground natural gas reserves within the domestic United States. In effect, prices are held constant, and price controls are extended to encompass all relevant sources of supply and demand under this policy.

Another rationale for strengthened regulation is that, "given the relatively large unsatisfied demand for gas, deregulation of natural gas prices would lead to massive increases in wellhead prices to abnormally high levels."[7] There would be little increase in supply—"there is evidence that gas supplies are relatively inelastic in the short run."[8] There is also asserted to be some basis for arguing that present regulation is not the cause for the present shortage. At least, "although cost based regulation was slow in getting started, it is an adequate method of regulation that has been developed in the 1960s. Many of the uncertainties have been worked out. . . . The system of regulation can meet the needs of the 1970s to elicit the necessary supply of natural gas at the lowest reasonable price."[9]

These proposals will be evaluated in this paper. After a more explicit rendition of alternative policies, the industry into which these policies are to be introduced is discussed in some detail. Then an econometric model for policy analysis is described and, finally, the model is used to evaluate the policy options. This evaluation is in terms of the extent to which the alternative options are likely to ameliorate the shortage.

□ **Three policy alternatives.** Frequent assessments of the size of the gas shortage bring forth even more frequent changes in Congress and the Office of the President in proposals for dealing with the gas shortage. Each of these new policies could be catalogued and evaluated—but the results would be so specific as to be relevant only to that policy, and the duration of the policy might well be rather short.

[6] See "F.P.C. Head Urges End to Gas Curbs," *The New York Times*, April 11, 1973, p. 19.

[7] U. S. Senate Commerce Committee [23], p. 4.

[8] *Ibid.*

[9] *Ibid.*, p. 5.

Alternatively, the policies can be characterized along two or three dimensions; this is attempted here, in the expectation that the characterizations will approximate the many specific alternatives to be considered, accepted, or rejected by the Government in the coming three or four years.

The first alternative policy is that of deregulation of wellhead prices of natural gas. The Federal Power Commission sets regional limits on prices for gas dedicated to interstate pipelines; these limits would be loosened or eliminated in a number of specific policy proposals. In general, the FPC price ceilings would be eliminated only after a number of years, by taking controls only off prices in all new contracts signed in each year (the time lag in price increases would be extensive, since most of the flowing gas is under old contracts signed in previous years). Even these prices would not be free to rise to a level that would clear out all the excess demands immediately, since most proposals—including President Nixon's Energy Message of April 1973—decree that there be some national ceiling imposed on new prices in keeping with gradual elimination of the deficit and with antiinflationary price controls. The gradual loosening of price controls is coupled with "short-term" rationing schemes that may involve the extension of regulatory jurisdiction to presently unregulated companies that are bidding up prices. This class of policies can be evaluated in terms of (1) elimination of price controls under new contracts, (2) an overall price ceiling in keeping with a 50-percent increase in *average* wholesale price over five years, and (3) some regulatory jurisdiction over all field sales by the Federal Power Commission.

The second alternative class of proposals centers on more rather than less regulation by the FPC. Prices would be set regionally or nationally on the basis of "cost of service." The cost of service is found by Commission and Court judgment of historical records on average exploration and development costs in the region. All production in the region would come under the jurisdiction of the Commission (except perhaps for the smallest producers, who would be exempt in order to cut down on the number of case reviews). Production under these conditions would admittedly be short of demands; holding prices to historical averages essentially limits reserves or production to amounts equal to or less than historical levels, and these historical levels were not sufficient to meet demands in the past. As a result, attention has to be centered on inducements under regulation for the development of alternative gas supplies, either through manufacture or import in liquefied form. These alternative supplies would be regulated as well. As a result, the second class of policies would (1) set price ceilings close to 1972 to 1973 price levels, with perhaps a one cent per annum increase as historical average costs rise slowly with inflation, (2) place all dedications of reserves and production of gas under the jurisdiction of the FPC, and (3) set the regulated price on manufactured or liquefied gas according to the specific cost of providing these products.

These first two alternatives are basically contradictory, and it does not seem likely that amendments could be made to either that would capture the loyalty of those supporting the other. If neither can be made politically effective, then the relevant alternative—the third—is the status quo, which consists of regulation according to

rulings in recent cases at the Federal Power Commission. In recent years the Commission has followed policies of allowing field price increases in keeping with "changes in average historical costs;" but wide variation in the estimate of such costs has occurred—and the Commission has probably chosen the estimate to be as large as permissible by Court review. Area ceilings reached by negotiated settlements between producers and consumers have been proposed to the Commission, and the Commission has found them to be "reasonable ceiling prices" not outside the range of possible average costs.[10] Comparisons with costs could be made in the near future that would justify higher future prices, if the Commission so willed—comparisons of cost on the most recent contracts for sale of intrastate (unregulated) gas, rather than of interstate (regulated) gas sold over the last few years. The Commission, in the 1970 to 1973 period, allowed prices on new contracts to increase each year by two-and-one-half cents per thousand cubic feet, after having held prices to one-half cent increases each year over the 1960s; the regulator can continue to find estimates of historical average costs that would allow further relatively large price increases. But there are limits to the extent of price increases in keeping with *some* estimate of costs—Court appeals by buyers could lead to rejection of FPC decisions unless there were some justification on cost grounds given in the decisions. Thus, the third class of policies, which can be characterized as maintaining the status quo, includes (1) prices that increase from two to four cents per Mcf in each of the next five years, (2) limited regulatory jurisdiction over intrastate sales, and (3) manufactured and liquefied gas with regulated price ceilings in keeping with their respective costs.

2. Characteristics of an economic model of natural gas reserves and production

■ In order to analyze the effects of these alternative policies, a model of natural gas markets with explicit policy controls has been constructed. The model provides a vehicle for performing simulations using different policy options, so as to indicate the effects of the options on the size of shortages. Thus, its formulation stresses prices, reserve quantities, production quantities, and associated demands for production.

The model, which will be described in more detail in the next section, treats simultaneously the field market for reserves (gas producers dedicating new reserves to pipeline companies at the wellhead price) and the wholesale market for production (pipeline companies selling gas to retail utilities and industrial consumers). The linking of these two markets by interstate pipeline companies is an important characteristic of the natural gas industry. Delivery in the wholesale market is a determinant of pipelines' demands for gas reserves in the field market, and wholesale delivered prices are determined in part by the prices on new reserve contracts in the field market.

In surveying the interaction of these two markets, we shall consider their behavior in the rather complex case when there are excess demands for production. Pricing policies, under both regulation and deregulation, are briefly reviewed for their impact on the size of the

[10] U. S. Federal Power Commission [22]. See also FPC [19].

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shortage. Pricing will be quantitatively analyzed in the econometric model in Section 3 and evaluated in the simulations in Section 4.

□ **Field markets.** These markets are the locus of transactions between oil and gas producers having volumes of newly discovered reserves and pipeline buyers seeking to obtain by contract the right to take production from these reserves. The amounts of reserves committed by the oil and gas companies are based primarily on the amounts of inground deposits of oil and gas. Additions to reserves come about from additions in (1) gas associated with newly discovered or developed oil reserves—"associated" gas reserves—and (2) gas volumes found in reservoirs not containing oil—or "nonassociated" reserves; both result from new discoveries and from extensions of previous discoveries or revisions of earlier estimates of previous discoveries. The amounts actually in place in the producing reservoirs limit the amounts of both associated and nonassociated new gas reserves that can be "supplied" or dedicated to the pipelines.

Needless to say, there is a finite amount of gas in the ground that can be discovered, and thus we should observe a depletion effect on volumes dedicated. It is not our objective to predict how much gas there actually is remaining to be discovered, or when this finite resource will be depleted. But an economic model of the gas industry should at least take this depletion effect into account; we shall do this by using indicators of depletion or of decreasing returns that occurred over the past decade as variables explaining "supply."

There are important economic determinants of the amount of reserves available for commitment as well, and these include prices of new contracts signed by producers, expected future prices under possibly forthcoming new contracts in subsequent years, and changes in average and marginal costs of exploration and development. These factors are widely believed to have substantial effects upon reserve availability, although with considerable time lags. Commitments today to higher prices for new contract volumes might lead to immediate increased planning activities for further exploratory or developmental work; this might lead in a year or two to additional drilling activity and, in a subsequent year or two, to the offering of additional reserves for sale to pipeline buyers.

Production of gas into the pipelines, termed short-run or annual supply, is limited by the amount of reserves available. Production cannot take place at rates greater than some fixed percent of reserves per annum because sandstone contained in the reservoirs is impermeable or because faster rates by "channeling" and sealing off parts of the reservoir may reduce the economic value of the remaining reserves. But up to that limit, more production in this period can take place at higher short-run costs. This is justified if prices are higher. Thus, for both technical and economic reasons, the supply of production out of reserves will be less the lower is the volume of reserves and the lower is the price in the contract commitment.

The demands for new reserves in the field market are manifest in the willingness to buy on the part of pipeline companies and local (direct) consumers. They seek to obtain long-term contracts for the extraction of the reserves. Demand determinants in the field markets include the wellhead price that pipelines and others are willing to pay for additions to their reserve holdings, the amount of reserves

available at a specific location, the location of these reserves, and the final demands for new production by the buyers repurchasing the gas from the pipelines. These demands would be "registered" in the market only so long as there was no regulatory price control which set regional field prices below those at which total demands were equal to the available supplies of new reserves. After 1961, when ceiling prices were put into effect, the demand variable became the exogenous FPC-determined price, since it was lower than the price that would have equilibrated markets.

These characteristics of field markets are found in many futures markets in which raw materials are dedicated for production and refining. The important characteristics of these particular markets are that (1) more will be made available for sale if the buyers offer higher prices (in rough approximation to the competitive "supply" mechanism), (2) the lag adjustment process bringing forth additional supplies of reserves is likely to be long and possibly quite complex, (3) production out of reserves is determined by a combination of technical and economic circumstances, but is likely to be greater the larger the volume of reserves available and the higher the contract prices pipelines are paying for the gas they are taking, and (4) demands depend on prices, but are also derived from final residential, industrial, and commercial consumption.

□ **Wholesale markets.** Pipelines provide gas deliveries, usually under long-term contract, to industrial consumers taking gas right off the line and to retail public utility companies for resale to industrial, residential, and commercial consumers. The amounts of gas demanded by direct (mainline) industrial consumers and retail gas utilities are believed to depend upon the prices for wholesale gas contracts, the prices for alternative fuels consumed by final buyers, and economy-wide variables that determine the overall size of energy markets. If the consumers are industrial companies seeking gas as boiler fuel or process material, the "market size" variables relate to the demands for these companies' outputs and to their investment in capacity to burn fuel or to utilize energy. If the final consumers are households and commercial building owners, then the "market size" variables relate to total population and income.

Wholesale markets also operate with lags. Changes in wholesale prices quoted by pipeline sellers of gas production feed through as changes in final consumer prices and then feed back as changes in final consumer demand quantities; the feedback may take some time because of consumers' commitment to gas burning equipment and the necessity for that equipment to wear out before demands are reduced. As a result, the effects of price changes may be felt only in reduced demands for more gas in subsequent years.

The amount of production provided to industrial and public utility buyers is not determined by a fixed "supply schedule" of quantities at various prices. The pipelines offer service in the form of delivered gas supplies at a markup over the field purchase price for the reserves backing up that production. The price markups are determined by the cost of transmission and add-on profits limited by FPC regulation (following orthodox public utility procedures of finding cost of capital by taking a "fair return" on "fair value" of original investment outlay for pipeline equipment). They vary widely

in level among wholesale markets—there are one to four sources of transmission capacity in most wholesale buying regions—but in most regions the process seems to be to set the markup and then to provide production out to the limit of either reserves or pipeline capacity.

Markup pricing has been formulated to build in significant lags from changes in field contracts. The Commission has followed the policy of allowing the markup for historical average transmission costs plus profit for the pipelines over historical average field prices for gas at the wellhead. This "rolled-in" price at wholesale is thus changed by an increased field price only to the extent that new contract prices change the historical average of all field prices.[11] The full impact of a field price change on wholesale prices would occur only after that change had been in effect for roughly ten years (assuming 10 percent of contracts in each year are new contracts).

There is considerable simultaneity in the behavior of production, reserves, and prices in field and wholesale markets. Field prices determine the availability of new reserves and the production conditions under new contracts at the same time. Changes in field prices are reflected, albeit slowly, in changing wholesale prices and demands for quantities of production at wholesale. This two-level industry can thus be modeled by simultaneous equations estimates of production and prices as they depend upon reserves and conditions in the final markets for energy.

□ **The behavior of gas markets when there are shortages.** The behavior of this "mixed" set of markets—some of which exhibit competitive characteristics of supply while others follow noncompetitive patterns—may be rather complex when there are significant excess demands for production. Structural equations, defined to delineate behavioral patterns, are discussed in some detail later, but for now let us examine how shortages resulting from regulatory policy move through the different layers of transactions for gas reserves and production.

In the field market for natural gas, proved reserves are incremented through the discovery process and depleted through production. The amount of additions to reserves is positively related to some extent to the field price of gas contracts being signed at the locations close to where that volume of new reserves is available. The demands for new reserves by pipelines could be specified in terms of

[11] The effects of rolling in a "one-shot" price increase on new contracts in 1974 can be spelled out in detail. In 1973, the wholesale price is just the wellhead ceiling price P_c plus the pipelines' markup M_t. In 1974, after the ceiling price on new contracts has been raised to P_c', the wholesale price to buyers of new contracts would *not* be $P_c' + M_t$, but would instead be given by:

$$PW_{1974} = P_c + M_t + \frac{\delta Q_{1974}}{Q_{1974}}(P_c' - P_c),$$

where δQ Q is the proportion of "new" production to total production. In 1975, the wholesale price would be given by:

$$PW_{1975} = P_c + M_t + \frac{\delta Q_{1975}}{Q_{1975} - \delta Q_{1974}}(P_c' - P_c),$$

and in 1976, it would be given by:

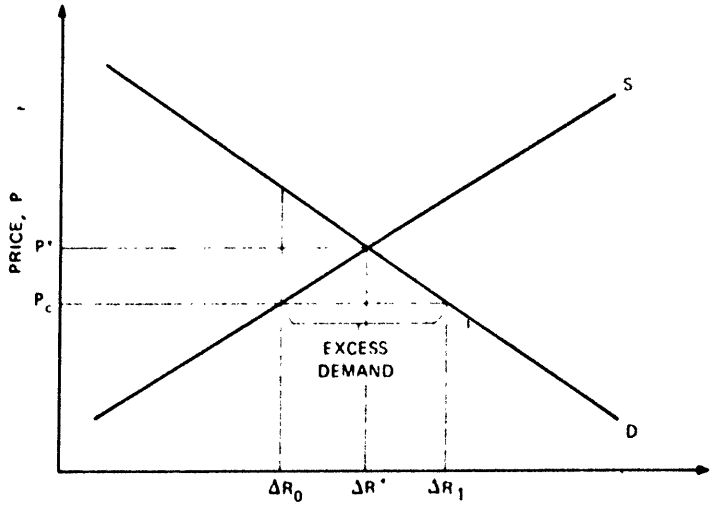
$$PW_{1976} = P_c + M_t + \frac{\delta Q_{1976}}{Q_{1976} - \delta Q_{1975} - \delta Q_{1974}}(P_c' - P_c).$$

The wholesale price would continue to rise until $\delta Q/(Q - \sum \delta Q)$ reached a value of one; at that point, prices would be fully "rolled in."

field prices, but under conditions of shortage, the regulated ceiling price P_c prevails rather than the market demand price P^*. This is illustrated in Figure 1. Under conditions of shortage, the quantity

FIGURE 1

SUPPLY AND DEMAND FOR ADDITIONAL RESERVES

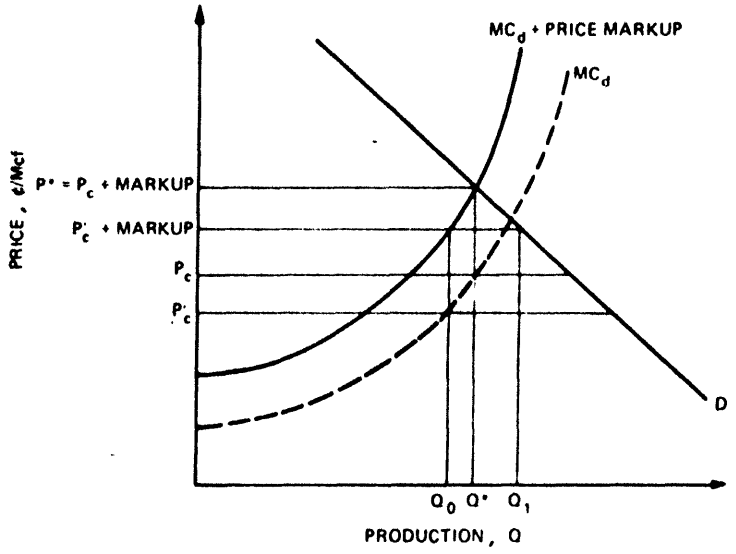


realized is on the supply but not on the demand function, with the result that the demand function is not observable. At the same time, production out of reserves is affected by the reserve shortage. The supply curve for gas production consists of a marginal development cost curve which represents the cost of incrementing gas production (by running existing gas development wells at higher capacity or by drilling new development wells). The demands for gas production consist of wholesale volumes taken by final buyers from the pipeline systems at prices equal to field prices plus the pipeline markups. The final demands could conceivably still be satisfied at the beginning of the reserve shortage, as a result of the pipelines' calling on existing reserves to produce at a higher rate.

Sufficient production under a condition of reserve depletion cannot be had indefinitely. Eventually, the amount of reserves available to back production is reduced, and supply of production at ceiling prices is reduced. As the reserve backing becomes smaller, production tends to fall, and a gap is opened between the demands for production and the supplies that will be made available.

The marginal cost curves, the price markup, and a wholesale demand curve are all shown in Figure 2. In this diagram, the ceiling price is sufficient to bring forth production Q^* which clears the market at wholesale price P^*, which is just the field price plus the pipeline's markup. Under these conditions, the demand curve for production is "registered in the market" or observable as a total quantity demand at one specific price level. However, if the regulated field price is reduced to a level P_c', excess demand will result equal to $(Q_1 - Q_0)$. The supply of production is reduced by price disincentives to a level below the demands put on the pipeline system by retail gas utility companies serving final residential, industrial, and com-

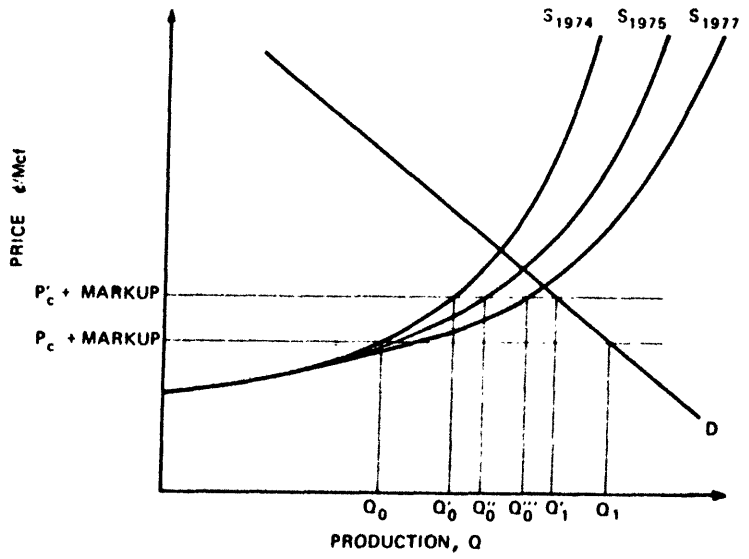
FIGURE 2
SUPPLY AND DEMAND FOR PRODUCTION



mercial consumers. There are shortages in both field reserve and final production markets.

How would an increase in the ceiling price eventually cause a reduction in the production shortage? Consider, for example, an increase in wellhead ceiling prices under FPC regulation. When the ceiling price is increased, the production cost curve remains fixed initially, since reserve levels would not change immediately, and therefore marginal production costs would not change. The higher price, however, would soon elicit more production out of given reserves Q_0' and also reduce demands for production from Q_1 to Q_1' (as shown in Figure 3). Thus, even within the short run, excess

FIGURE 3
SUPPLY AND DEMAND FOR PRODUCTION



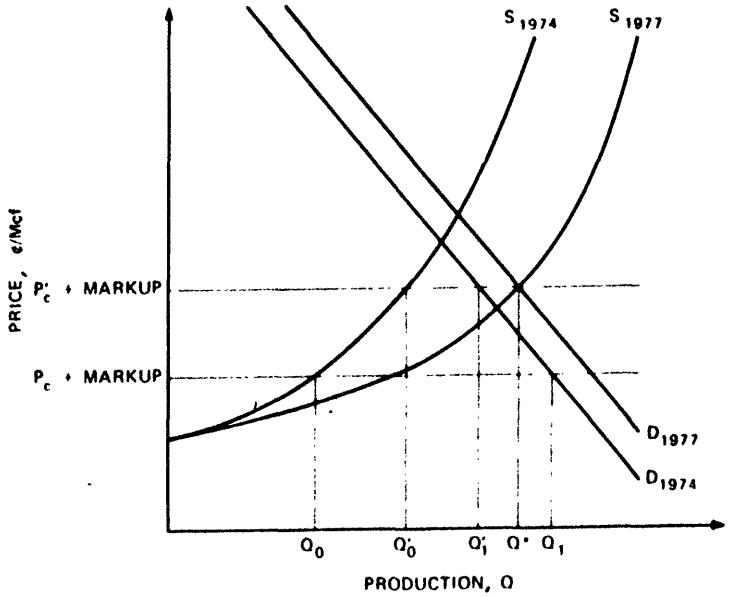
demand would be decreased by a price change from $(Q_1 - Q_0)$ to $(Q_1' - Q_0')$, although the change may not be substantial because the "roll-in" pricing practices of the Commission would dampen the demand effect.

After a few years, however, it is likely that reserve levels will have been increased as a result of the higher level of new contract prices. Higher ceiling prices would stimulate more exploratory drilling which, in turn, should result in new discoveries of gas that would add to reserve levels. At that point in time, a given level of production could be induced at lower marginal development costs because of the presence of higher reserve levels. The supply of production curve would have shifted to the right. Even if demand were to remain at Q_1', an increase in supply to Q_0'' would reduce the extent of the shortage. After a few more years, the full effects of the ceiling price increase would have occurred, with the supply of production shifting farther to the right so that excess demand would fall to the even lower level of $(Q_1' - Q_0''')$.[12]

Of course, if we could increase the ceiling price by just the right amount—to shift the supply curve enough to make up for past excess demand and the present and independent shifts in the demand curve (stemming from increased population, national income, etc.)—we would reach a situation where there was no excess demand in 1977. This is shown in Figure 4. Note, however, that *until*

FIGURE 4

LONG-RUN EQUILIBRIUM



1977, there would still be some amount of excess demand. In the first year after the price increase, for example, excess demand will be

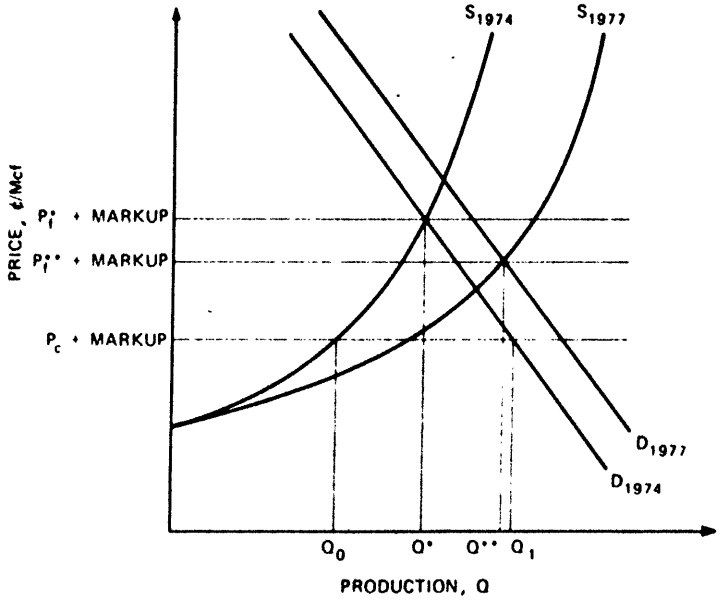
[12] This analysis assumes that the pipeline markup is constant with respect to the level of production and that the difference between (P_c + price markup) and (P_c' + price markup) is equivalent to the "roll-in" price increase allowed under regulation. The econometric model discussed later deals with these matters of detail in specific price markup equations.

$(Q_1' - Q_0')$; not until 1977, when the supply curve, demand curve, and price line all intersect at the same point, would there be a level of production, Q^*, that resulted in no excess demand.

What if the field price of all gas were immediately and completely deregulated? This would result in a field price increase to the level P_f^* which, when the pipeline markup is added on, would clear the production market immediately (as shown in Figure 5; the supplies

FIGURE 5

EQUILIBRIUM UNDER COMPLETE DEREGULATION



and demands for production are both equal in one year to Q^*). This substantial price increase would not be the end of the story, however. After three or four years, the supply curve would have shifted to the right, again because increased exploration and discoveries in response to the price increase would have added substantially to the reserve base. The demand curve would perhaps also have shifted to the right after three or four years, but the net result would probably be a decrease in price and further increase in quantity of production over the four-year period. This is illustrated in Figure 5 where the 1974 equilibrium quantity Q^* is increased over time to Q^{**} as the equilibrium field price P_f^* falls to P_f^{**}.

These examples indicate that pricing policies have a three- or four-step effect upon the size of the shortage, and it may take several years before the full effects of a price change become apparent. The econometric model presented in the next section allows us to analyze these dynamic effects of alternative price changes quantitatively.

3. An econometric model for policy analysis

■ Most previous econometric studies of natural gas have investigated either demand or supply of gas, but have neglected the simultaneous interaction of these two sides of markets. Balestra, for example, in his classic study of the demand for natural gas by residential and commercial consumers, assumed a perfectly elastic

supply curve for production.[13] This assumption was probably justified during the 1950s and 1960s, since production of gas for final consumers took place on an "as needed" basis from large stocks of reserves; but it would not continue to be valid during the 1970s, however, as total gas demand exceeds production constrained by smaller reserve levels. The supply studies of Erickson and Spann and of Khazzoom,[14] similarly, are admirable attempts at defining and testing some of the relationships that exist in the gas industry, particularly those accounting for reduced reserve levels under price controls. But, to the extent that policies are changed in the future so that markets clear, and demand is once again observed, models of only the supply side of markets will be inadequate to represent the effects of policy. If the industry is to be properly understood, then, production and reserve supply-demand levels of the industry have to be analyzed as a simultaneous system.

The model developed as part of this study consists of a set of simultaneous econometric relationships among several policy-related variables. Variables endogenous to the field market include, on the supply side, nonassociated and (oil) associated discoveries of gas reserves, extensions and revisions of associated and nonassociated reserves, and wells drilled. These variables directly or indirectly depend on the field prices paid by pipelines in new contracts for gas. Field prices would be endogenous if demands could clear, but after ceiling prices were set by the FPC in the 1960s, this variable became an exogenous policy variable.

Endogenous variables in the wholesale market include demand for production of gas and wholesale prices for three wholesale delivery sectors: mainline industrial sales, sales for resale that are ultimately industrial, and sales for resale that are ultimately residential and commercial. Throughout the 1960s wholesale production demand was approximately satisfied, even though there was excess demand for reserves (of course, reserve-production ratios dropped dramatically during the decade), and thus wholesale demand equations can be estimated from data generated in this period.

An equation for marginal development costs (the "supply curve" for production in field markets), when combined with pipeline wholesale price markup equations, provides an estimate of volume of production sent to wholesale buyers. This allows us to determine excess demand by comparing estimated "production out of reserves" transmitted to the wholesale markets with estimated demands for production at wholesale.

There is no single field market, nor is there a single wholesale market, in the United States. Producers throughout the country do not take their gas to the Chicago Board of Trade in order to make offers of sale to pipelines. Rather, there are several "regional" field markets and several "regional" wholesale markets, and the natural gas industry is characterized by the spatial interrelationships of these markets. In our econometric model, field reserve and production equations are estimated for supply regions to account for the regionalization. Wholesale demand equations are estimated for each of five parts of the country (each part roughly representing a regional

[13] See [2].

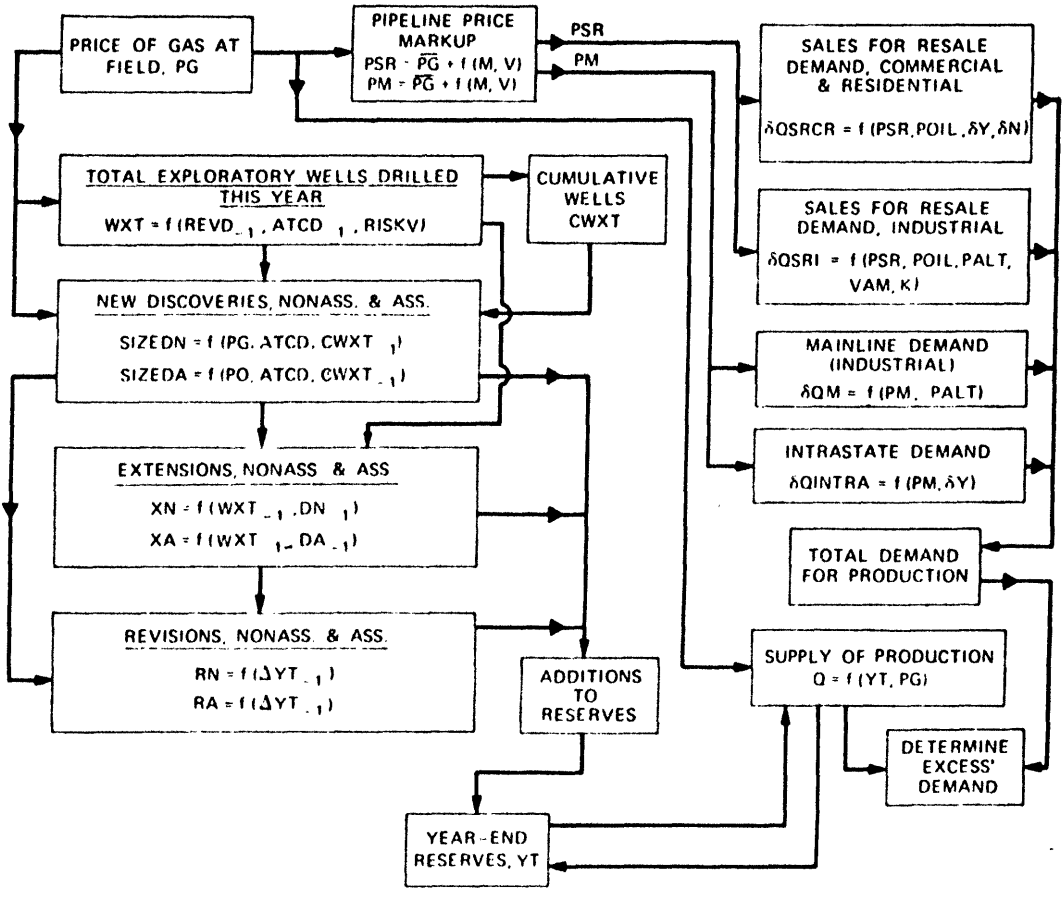
[14] See [8] and [14], respectively.

industrial and retail utility buyer's market). Gas from each production district in the country is allocated to one or more of the wholesale consumption regions, according to the average allocation proportions that prevailed in the past. In this way, excess demand can be computed on a regional and country-wide basis.

□ **Structure of the model.** The organization of the model is illustrated in Figure 6. Note, however, that this figure leaves out (for simplicity)

FIGURE 6

THE MODEL



the spatial interconnections between production districts and regional wholesale markets. In the model as it actually runs, the wholesale prices of gas (for mainline sales and for sales for resale) are computed for each region of the country by taking the wellhead price of gas at the production source and by adding a markup based on pipeline mileage and volumetric capacity. When a wholesale consumption region is supplied by more than one production district (as is usually the case), wellhead prices, mileages, and capacities are weighted according to previous actual proportions of production from each district. Let us now look at the individual parts of the model in more detail.

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The field market

Probably the sector of the natural gas industry most difficult to capture in a conceptual model is the supply of new reserves. Most of the current controversy over regulatory policy centers on this sector—whether or not reserve additions have been "too low," as a result of past regulatory policy. Since actual additions to reserves through new discoveries are realized by a complicated process involving a large number of technological factors, it may seem naive to try to model the process by using a set of simple econometric relationships. However, structural equations can be formulated to link economic and technological variables that are important in gas reserve additions and to describe most simply and directly the regulatory effects.

The major component of new reserve additions consists of new discoveries of both nonassociated and associated gas [nonassociated gas (N) is dry gas, while associated gas (A) includes both "dissolved" gas recovered from oil production and "free" natural gas forming a cap in contact with crude oil]. In our model, the discovery process begins with the drilling of wells, of which some will be successful in discovering gas, some will be successful in discovering oil (with associated gas), and some will be unsuccessful (i.e., dry holes). The drilling of wells depends largely on economic incentives. In our model, it is dependent upon prospective revenues from oil and gas production, average drilling costs, and a measure of drilling risk.

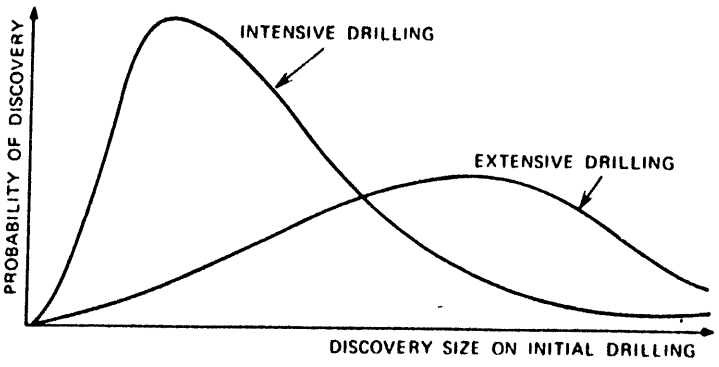
The model translates drilling activity into actual discoveries through two size-of-discovery variables—one for nonassociated gas and the other for associated gas. The size-of-discovery variable for nonassociated gas, for example, gives for any district and any year the average number of Mcf of gas discovered per well drilled. The size-of-discovery variables themselves are explained partly by economic variables (e.g., oil and gas prices and drilling costs) and partly by a depletion effect, in which extensive well drilling in the past (measured by cumulative wells drilled) makes it more difficult to discover gas in the present.

Drilling may be divided into two basic modes of behavior, depending on whether it is done *extensively* or *intensively*. In extensive drilling, few wells are drilled, but those that are drilled usually go out beyond the frontiers of recent discoveries to open up new geographical locations or previously neglected deeper strata at old locations. Typically, this would include drilling farther offshore, or onshore but at very great depth. Here the probability of discovering gas is rather small, but the size of discovery may be comparatively large. When drilling is done intensively, many wells are drilled in an area that has already proven itself to be a source for gas discovery. Here the probability of discovering gas is larger, but the size of discovery is likely to be very small. In Figure 7, typical probability distributions for discovery size are shown for each mode of drilling behavior. Relative to the intensive drilling mode, discovery size for extensive drilling has a larger expected value but also a larger variance.

The producer who is engaged in exploratory activity has, at any point in time, a choice as to whether any increases in his drilling activity will be extensive or intensive, and this choice will be influenced by changes (or expected changes) in economic variables

FIGURE 7

DISCOVERY DISTRIBUTION



—field prices and drilling costs.[15] The actual influence of these variables will depend on the producer's geological portfolio (i.e., the set of regions over which he has drilling rights), as well as on his translation of present and past prices and costs into expectations of future prices and costs. Suppose, for example, that drilling costs decrease. As a result, a producer might decide to accept greater risk and drill on the extensive margin, with the result that average discovery size will (*ex post*) increase. On the other hand, the producer may own partially drilled reservoirs that now are worth drilling out. If this is the case, he might decide to drill on the intensive margin with a resulting *ex post* decrease in average discovery size. Thus it is not possible *a priori* to determine whether the effect of a decrease in drilling costs on average discovery size will be positive or negative. The same is true for the effects of a change in the price of gas.

Higher gas prices should indeed result in more drilling, but we would expect that over the years the size of finds will decrease as our finite resource stock begins to get depleted. One may model the exploration and discovery process stochastically as sampling without replacement, so that the expected value of discovery size would decrease as the sampling process went on.[16] It is not our object to try to predict how big the total stock of gas yet to be discovered is,[17] but we would like to embody a "depletion effect" in our model, at least to the point of being able to extrapolate the long-run decreasing returns to industry size that have occurred over the past decade. We do this by including cumulative wells drilled as an explanatory variable in our "size-of-discovery" equations. If the level of drilling activity is the same next year as it is this year, we would expect to see the level of new discoveries drop somewhat, and this is what would indeed happen if discovery size depended negatively on cumulative wells drilled.

Additions to gas reserves can also occur as a result of extensions and revisions of existing fields and pools. These extensions and re-

[15] See Fisher [9].

[16] See Kaufman [13].

[17] Industry spokesmen have claimed that higher gas prices result not only in more drilling activity, but also in a shift to the extensive mode resulting in larger discovery size. While we would expect higher gas prices to elicit more drilling, it is not clear that the additional drilling will be more extensive. Our results do show a positive relationship between price and discovery size, but with a low elasticity.

visions could be expected to depend on (1) price incentives, (2) past discoveries of gas, (3) existing reserve levels, and (4) the cumulative effect of past drilling. Extensions, which are influenced by (1), (2), and total drilling activity, are somewhat easier to model than revisions.[18] Revisions of established reserve levels, on the other hand, are often erratic and difficult to predict. Although there may be some effect from prices in certain regions, revisions are basically proportional to prior discoveries and reserve levels.

New discoveries (DN, DA), extensions (XN, XA), and revisions (RN, RA) are combined to form additions to reserves. Aside from changes in underground storage (ΔUS), which we model as a constant percentage of production, the only major subtraction from reserves occurs as a result of production (Q). Thus, for any time t, in a production district j, total gas reserves are given by the identity:

$$R_{t,j} = R_{t-1,j} + DN_{t,j} + XN_{t,j} + RN_{t,j} + DA_{t,j} + XA_{t,j} + RA_{t,j} - Q_{t,j} - \Delta US_{t,j}. \quad (1)$$

Since the supply of new reserves is so determined, if the wellhead price of gas were not regulated, or if regulation were ineffective, then the demand for new reserves could be given by an equation for pipeline offers to buy reserve commitments at specified new contract wellhead prices. Since 1962, however, there has been excess demand for new reserves, and thus the demand function for new reserves has not been observable. Instead, the price has been given by the exogenous ceiling price.

Production out of reserves

The supply of production as a function of price is simply the marginal cost (in the short term) of developing existing reserves so that a particular level of annual flow can be achieved (e.g., by drilling development wells and then operating them). Clearly, marginal production costs will depend on reserve levels relative to production, and as the reserve-to-production ratio becomes small, we would expect marginal costs to rise sharply.

Let us examine what marginal costs would be corresponding to a production level q out of proved reserves R.[19] Assuming a constant decline rate, a, in percent per year,

$$a = q/R = 1/\text{reserve-production ratio}, \quad (2)$$

we can write the proved reserve level as

$$R = q \int_0^\infty e^{-at} dt = q/a. \quad (3)$$

Then for a discount rate δ the "present-Mcf-equivalent" (PME) of a constant production level q is:

$$PME = q \int_0^\infty e^{-(a+\delta)t} dt = q/(a+\delta). \quad (4)$$

[18] Extensions can result from either exploratory or development well drilling. Our model does not explain development well drilling, and therefore only exploratory wells are used to explain extensions.

[19] Our thanks to M. Adelman and M. Baughman for their assistance on this part of the model.

Now we assume that the development investment, I, needed to obtain the production level q is given by:

$$I = A + ce^{\beta a}q, \tag{5}$$

where A is a start-up cost, c is constant over the range of zero well interference, and β is a parameter with value around 10. Thus, when a is small (e.g., the reserve-production ratio is larger than 10), I will be roughly linear in q, but when a becomes larger (e.g., the reserve-production ratio approaches 5), an exponential rise in costs begins to predominate. The marginal development cost (MDC) is then given by:

$$MDC = \frac{dI}{d(PME)} = \frac{dI}{dq}\cdot\frac{dq}{d(PME)}$$

$$= \left(\frac{\partial I}{\partial a}\frac{da}{dq} + \frac{\partial I}{\partial q}\right)\cdot\frac{dq}{d(PME)} \tag{6}$$

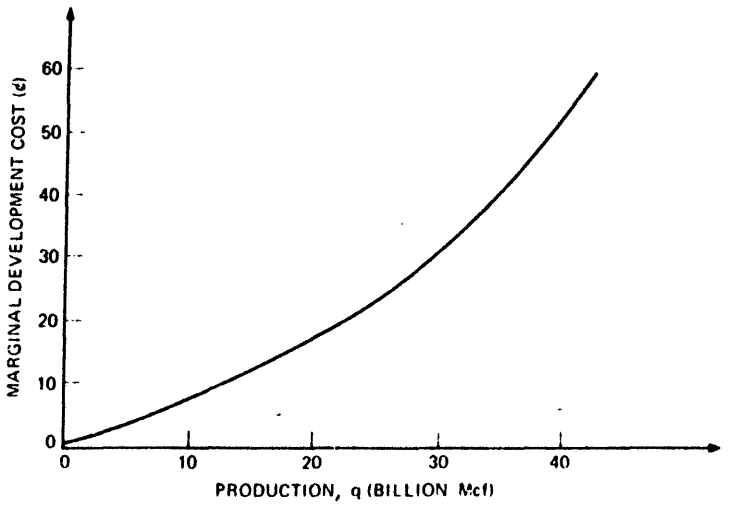
$$MDC = \left(\frac{c\beta}{R}e^{\beta a}q + ce^{\beta a}\right)\cdot\frac{(a+\delta)^2}{\delta}$$

$$= (\beta a + 1)ce^{\beta a}\frac{(a+\delta)^2}{\delta}$$

$$= (\beta a + 1)c\delta e^{\beta a}\left(1 + \frac{a}{\delta}\right)^2 \tag{7}$$

This marginal cost curve is illustrated in Figure 8 for $\delta = 0.1$, $\beta = 10$, $c = 10$, and $R = 0.2$ trillion Mcf. For small values of a

FIGURE 8
HYPOTHETICAL MARGINAL COST CURVE



(i.e., large reserve-production ratios), the curve is predominantly quadratic, and when a becomes large, the curve begins to look more like an exponential. We estimate a marginal cost curve (which becomes our supply curve for production out of reserves when price is set equal to marginal cost) that is essentially exponential. Aside from

the fact that this gives a better fit to recent data, it is also in keeping with our goal of calculating excess demand for gas under conditions of declining reserve-production ratios.

The wholesale market

Supply of production out of reserves has to be measured against demands for that production after it has been transmitted to wholesale markets by pipelines. The demands for production are approximated by curves fitted on a disaggregated basis, namely by wholesale demand equations for (1) gas sales for resale (split into commercial-residential gas and industrial gas, on the basis of percentages distributed to these two groups for ultimate consumption), (2) gas sales directly off the pipelines for consumption, and (3) intrastate sales by producers and pipelines to final consumers. The wholesale prices of gas (disaggregated into a "sales-for-resale" price and a "mainline sales" price) are computed by adding a markup to the field price based on (1) the mileage between the production district and the consuming region, and (2) the volumetric capacity of the pipelines.

The demand equations follow a general formulation, in which the quantity demanded is dependent on wholesale price, the price of alternative fuels, and "market size" variables, such as population, income, and investment, which determine the number of potential consumers. In all of the equations, the dependent variable will be *new demand*, δQ, rather than the level of total demand. In the short run, as Balestra has shown for residential gas,[20] the level of total demand should be relatively price inelastic and would depend on stock variables that do not change much in time (e.g., the total stock of gas-burning appliances for residential gas). New demand, however, should respond to the price of gas and to the price of competing fuels (decisions to buy new appliances, for example, are affected by fuel prices). The new demand for gas, δQ, is made up of the increment in gas consumption $\Delta Q = Q_t - Q_{t-1}$, and of replacement for continuation of old consumption. To find replacement, total residential and commercial gas demand could be considered to be a function of the stock of gas-burning appliances, A:

$$Q_t = \lambda \cdot A_t, \tag{8}$$

where λ is the (constant) utilization rate. Then, if r is the average rate at which the stock of appliances depreciates, the replacement demand for gas includes $r\lambda A_{t-1}$, and total new demand is

$$\delta Q_t = \Delta Q_t + r\lambda A_{t-1}. \tag{9}$$

Now substituting (8) into (9) gives:

$$\delta Q_t = \Delta Q_t + rQ_{t-1}. \tag{10}$$

Thus, new demand for gas is the sum of the incremental change in total gas consumption (ΔQ_t) plus the demand resulting from the replacement of old appliances.

Our *a priori* assumption is that *new* demand depends on prices and total income (through purchases of new appliances), and that the *level* of *total* demand is itself a function of income and popula-

[20] In [2].

tion. Thus, we have for residential and commercial demand:

$$\delta QSRCR_{t,k} = f(PSR_{t,k}, POIL_{t,k}, \delta Y_{t,k}, \delta N_{t,k}, K_{t,k}), \quad (11)$$

where *PSR* is the sales-for-resale wholesale price, *POIL* the average price of oil, *Y* disposable personal income, *N* the population by state, *K* new capital expenditures, and all in region *k*, and

$$\delta Y_{t,k} = \Delta Y_{t,k} + rY_{t-1,k} \quad (12a)$$

and

$$\delta N_{t,k} = \Delta N_{t,k} + rN_{t-1,k}.^{21} \quad (12b)$$

The form for industrial demand is similar to that for residential and commercial demand. The prices of gas and oil at wholesale determine additional demands, and the "size of the market," as measured by value added in manufacturing or capital outlay, also sets new demands. The equation is:

$$\delta QSRI_{t,k} = f(PSR_{t,k}, POIL_{t,k}, VAM_{t,k}, K_{t,k}). \quad (13)$$

The model is closed by spatially interconnecting production districts with consuming regions. A flow network is constructed which, based on relative flows calculated from 1970 data, determines where each consuming region obtains its gas. Average wholesale prices (again both for sales for resale and for mainline sales) can thus be computed for each consumption region in the country, since mileages and volumetric capacities are then determined. The equation form is:

$$PSR_{t,k} = \bar{PG}_{t,k} + f(M_{t,k}, V_{t,k}) \quad (14)$$

for "rolled-in" average field price $\bar{PG}$, mileage *M*, and volumetric pipeline capacity, *V*. Given the markup, wholesale demand (by type) is then also computed for each region of the country. Wholesale demands can be summed to produce total demand for each region of the country, and since we know what the transmission of production will be to each region of the country, we can determine excess demand.

□ **Estimation of the model.** The model was estimated using pooled cross-section and time-series data. The time bounds of the regressions are different for different equations, not only because of data limita-

[21] Balestra [2] distinguishes between two depreciation rates, one for gas appliances and the other for alternative fuel-burning appliances, since lifetimes for appliances using alternative fuels may be different. He then estimates the two depreciation rates by estimating an equation of the form:

$$QSRCR_t = a_0 + a_1 PSR_t + a_2 \Delta N_t + a_3 N_{t-1} + a_4 \Delta Y_{t-1} + a_5 Y_{t-1} + a_6 QSRCR_{t-1}. \quad \text{(i)}$$

The depreciation rate for gas appliances is then given by $(1 - a_6)$. (His results, however, gave an estimated value of a_6 that was always greater than one, which cannot be justified theoretically.) The all-fuel depreciation rate comes out of equation (i) as either the ratio a_3/a_2 or a_5/a_4. Thus, the equation is overidentified, and the depreciation rate can be obtained only by estimating (i) subject to the constraint of $a_3/a_2 = a_5/a_4$. (The resulting estimation problem is nonlinear, but Balestra uses an iterative method suggested by Houthakker and Taylor [12] to obtain an estimated depreciation rate equal to 0.11.) Following Balestra in estimating these depreciation rates, we obtained a single rate for the West region equal to 0.07 and use this both for industrial and for residential and commercial demand.

tions, but also because of structural changes over time in the industry. Wholesale demand equations, for example, were estimated using data only from 1964 to 1970, even though data were available from as far back as 1960, because it was felt that demand elasticities had changed considerably during the 1960s as a result of new air pollution standards.[22]

Cross sections were also different for different equations. Field market equations were estimated by pooling data from all of 18 FPC production districts, while individual sales-for-resale wholesale demand equations were estimated over what were considered to be the proper regional wholesale markets, and thus each used data pooled from five to ten states. District breakdowns and time bounds are summarized for all equations of the model in Table 1.

TABLE 1

CROSS SECTIONS AND TIME BOUNDS FOR THE MODEL'S STOCHASTIC EQUATIONS

EQUATIONS	DISTRICTS POOLED	TIME BOUNDS
WELLS (WXT)	ALL 18 FPC PRODUCTION DISTRICTS*	1964 - 1971
DISCOVERY SIZE (SIZEON, SIZEDA)	ALL 18 FPC PRODUCTION DISTRICTS	1964 - 1971
EXTENSIONS & REVISIONS (XN, XA, RN, RA)	ALL 18 FPC PRODUCTION DISTRICTS	1964 - 1971
PRODUCTION FROM RESERVES (QS)	ALL 18 FPC DISTRICTS	1962 - 1971
PRICE MARKUPS (PSR, PM)	40 SALES-FOR-RESALE REGIONS (SEE BELOW), PLUS 15 MAINLINE SALES REGIONS (SEE BELOW)	1956 - 1969
SALES-FOR-RESALE DEMAND (RESIDENTIAL/COMMERCIAL AND INDUSTRIAL)		
NORTHEAST	NEW ENGLAND, NEW JERSEY, NEW YORK, PENNSYLVANIA, OHIO, MARYLAND + DELAWARE + WASHINGTON, D.C., VIRGINIA, WEST VIRGINIA	1964 - 1970
NORTH CENTRAL	ILLINOIS, INDIANA, MICHIGAN, WISCONSIN, IOWA, MINNESOTA, MISSOURI, NEBRASKA, SOUTH DAKOTA	1964 - 1970
WEST	ARIZONA, COLORADO, IDAHO, NEVADA, NEW MEXICO, UTAH, WYOMING, CALIFORNIA, WASHINGTON, OREGON	1964 - 1970
SOUTH CENTRAL	KANSAS, ARKANSAS, OKLAHOMA, TEXAS, MISSISSIPPI, LOUISIANA	1964 - 1970
SOUTHEAST	FLORIDA, GEORGIA, NORTH CAROLINA, SOUTH CAROLINA, ALABAMA, KENTUCKY, TENNESSEE	1964 - 1970
MAINLINE DEMAND (INDUSTRIAL)		
GAS-PRODUCING STATES	COLORADO + WYOMING, KANSAS, KENTUCKY + OHIO + PENNSYLVANIA + WEST VIRGINIA, LOUISIANA, MISSISSIPPI, OKLAHOMA + TEXAS	1964 1970
NONPRODUCING STATES	ALABAMA + GEORGIA, ARIZONA, ARKANSAS, FLORIDA, ILLINOIS, IOWA + NEBRASKA, MINNESOTA, MISSOURI, TENNESSEE	1964 1970
INTRASTATE SALES	CALIFORNIA, NEW MEXICO, WEST VIRGINIA, KANSAS, TEXAS, OKLAHOMA, LOUISIANA	1964 1970

*THESE INCLUDE TEXAS 1, 2, 3, 4, 6, 9, 10, CALIFORNIA; COLORADO UTAH, KANSAS, LOUISIANA NORTH, LOUISIANA SOUTH, MISSISSIPPI, NEW MEXICO NORTH, PERMIAN (=NEW MEXICO SOUTH + TEXAS 7C + TEXAS 8 + TEXAS 8A), OKLAHOMA, WEST VIRGINIA + KENTUCKY, WYOMING.

Statistical results

The regression results described below were obtained by using two-stage least squares[23] whenever unlagged endogenous variables

[22] A test of this hypothesis and a more detailed study of demand will appear in a future paper.

[23] It should be pointed out that this model is "almost" block recursive, i.e., it can be broken up into two large blocks of equations (one determining reserves and the other determining production), and the simultaneous interaction of these

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appeared on the right-hand side of an equation. All of the equations are linear in form, with the exception of the equation describing production out of reserves, which is logarithmic in the price term (marginal production costs are an exponential function of production and reserves). The *t*-statistics are shown in parentheses below each estimated coefficient. Also listed for each equation are the R^2, *F*-statistic, standard error of the equation, Durbin-Watson statistic, and the mean of the dependent variable. Note that the Durbin-Watson has limited meaning, since error terms may be autocorrelated across time and/or across cross sections, and these effects are not separated.[24]

One of the difficulties in constructing a model of this sort is that one must work under the constraints imposed by the previously mentioned data limitations. Data for many variables are either difficult or else impossible to obtain, particularly for years prior to 1966. In addition, many of the data are extremely noisy. As a result, a good deal of compromise was often required in estimating equations between functional forms that were theoretically pleasing and those that lent themselves to the existing data. This should be kept in mind when interpreting the estimation results.

Field market equations

The field market portion of the model contains seven stochastic equations that explain total exploratory well drilling (*WXT*), nonassociated and associated average discovery size (*SIZEDN*, *SIZEDA*), extensions (*XN*, *XA*), and revisions (*RN*, *RA*). Nonassociated and associated new discoveries (*DN*, *DA*) can be determined from the two identities:

$$DN_{t,j} = SIZEDN_{t,j} \cdot WXT_{t,j} \tag{15}$$

$$DA_{t,j} = SIZEDA_{t,j} \cdot WXT_{t,j}, \tag{16}$$

and the supply of new reserves is then determined from the identity in equation (1).

Exploratory well drilling responds to three economic incentives, all of which are exogenous to the model. The first of these, a surrogate for anticipated returns from exploration, is total revenues (deflated by a GNP price index), *REVD*, from sales of new oil and gas at the wellhead. Exploratory drilling may result in the discovery of either gas or oil, so total revenues are used as an explanatory variable. Note that changes in the price of gas (or the price of oil) can affect drilling activity through this revenue variable.

Average total drilling costs (also in deflated terms), *ATCD*, are a second explanatory variable; rising costs are expected to have a

blocks is weak. For example, equations (17) through (23), together with the exogenous ceiling wellhead price, determine equilibrium in the market for new reserves, and while additions to reserves certainly have a strong impact on wholesale production markets, this impact occurs over a number of years since price increases are rolled in and marginal production depends on total reserves and not new reserves. Thus, two-stage least squares was applied on a block-by-block basis.

[24] It is reasonable to expect, in fact, that the error terms are autocorrelated both across time *and* across districts. We did not attempt to correct for the problem of serial correlation in this version of the model (although we shall in a future version). District heterogeneity can be one source of cross-sectional autocorrelation, and this was dealt with at least in part by the use of district dummy variables.

negative impact on drilling. The third explanatory variable, *RISKV*, provides a measure of relative risk between different regions. It is a purely cross-sectional variable that does not change in time, and is the sample variance (measured over recent years) of payoff size in each district. Finally, three dummy variables are introduced (*DDA*, *DDB*, *DDC*) to account for heterogeneity among four broadly defined regional field markets in the United States. The estimated equation is:

$$\begin{aligned} WXT = {} & \underset{(9.17)}{439.39} + \underset{(3.81)}{934.53}DDA + \underset{(0.40)}{83.75}DDB + \underset{(3.24)}{137.48}DDC \\ & + \underset{(2.22)}{3.156 \times 10^{-4}}REVD_{t-1} - \underset{(-4.79)}{4.43 \times 10^{-3}}ATCD_{t-1} \\ & - \underset{(-2.74)}{2.13 \times 10^{-7}}RISKV \end{aligned} \tag{17}$$

$$R^2 = 0.495 \quad F = 17.2 \quad S.E. = 193.6 \quad DW = 0.36$$
$$\text{Mean}(WXT) = 359.2.$$

Here it can be seen that "cash flow" (as measured by $REVD_{t-1}$) has a positive effect on drilling, while costs and risk have negative effects. All three effects are statistically significant. Thus, drilling increases as lagged prices increase and as lagged costs and risk decrease.

Economic variables influencing the size of nonassociated discoveries per well include the wellhead price of gas, *PG*, and average drilling costs per well of exploratory drilling, *ATCD*. As explained earlier, the signs of these variables cannot be predicted *a priori*. A third explanatory variable is the cumulative number of wells drilled, *CWXT*. This is expected to have a negative impact on discovery size, since it represents a depletion effect. Finally, three district dummy variables are added to the equation. The resulting equation is:

$$\begin{aligned} SIZEDN = {} & 815.62 - \underset{(-2.78)}{600.69}DDA + \underset{(-0.94)}{189.70}DDB + \underset{(0.63)}{825.43}DDC \\ & + \underset{(2.05)}{28.89}(PG_{t-1} + PG_{t-2} + PG_{t-3})/3 \\ & + \underset{(5.86)}{0.0131}(ATCD_{t-1} + ATCD_{t-2} + ATCD_{t-3})/3 \\ & - \underset{(-3.18)}{0.301}CWXT_{t-1} \end{aligned} \tag{18}$$

$$R^2 = 0.631 \quad F = 29.9 \quad S.E. = 578.3 \quad DW = 0.74$$
$$\text{Mean}(SIZEDN) = 602.4.$$

The equation explaining the size of associated discoveries has the same form, except that the price of oil, *PO*, is used instead of the price of gas:

$$\begin{aligned} SIZEDA = {} & \underset{(1.64)}{50.60} + \underset{(2.65)}{106.96}DDA + \underset{(2.67)}{48.34}DDB + \underset{(4.02)}{30.02}DDC \\ & - \underset{(-1.64)}{14.30}(PO_{t-1} + PO_{t-2} + PO_{t-3})/3 \\ & + \underset{(2.24)}{3.138 \times 10^{-4}}(ATCD_{t-1} + ATCD_{t-2} + ATCD_{t-3})/3 \\ & - \underset{(-1.84)}{4.590 \times 10^{-3}}CWXT_{t-1} \end{aligned} \tag{19}$$

$$R^2 = 0.601 \quad F = 26.3 \quad S.E. = 34.6 \quad DW = 1.06$$
$$\text{Mean}(SIZEDA) = 38.5.$$

Together, these two reserves equations show strong lag effects by price and cost averaging and strong depletion effects (with the coefficients of most variables statistically significant). The price effects are in opposite directions. The price of gas has a strong positive effect on size of nonassociated discoveries while the price of oil has a negative (but insignificant) effect on the size of associated discoveries. These effects can occur in this combination because of aggregation of intensive and extensive drilling across districts; their net impact, as prices increase, however, is likely to be increased discoveries.

Extensions of nonassociated gas depend on previous gas discoveries (relatively higher gas finds are a stimulus to extend gas rather than oil fields), and on total exploratory drilling. Exploratory drilling is used as a proxy for total exploratory *and* development drilling. (Extensions also result from the drilling of development wells, but this variable is not included in the model.) The equation also includes district dummy variables to account for the significant cross-sectional heterogeneity:

$$\begin{aligned} XN = {} & \underset{(0.430)}{2.204 \times 10^4} + \underset{(5.63)}{1.33 \times 10^6} DDA + \underset{(11.04)}{1.56 \times 10^6} DDB \\ & + \underset{(0.55)}{3.639 \times 10^5} DDC + \underset{(1.93)}{237.1} WXT_{t-1} + \underset{(1.24)}{0.137} DN_{t-1} \end{aligned} \tag{20}$$

$$R^2 = 0.725 \quad F = 67.6 \quad S.E. = 3.2 \times 10^5 \quad DW = 0.87$$

$$\text{Mean}(XN) = 2.88 \times 10^5.$$

The equation for extensions of associated gas is altogether comparable in form; associated discoveries replace nonassociated discoveries, but otherwise the dummy regional variables and the wells variable are the same:

$$\begin{aligned} XA = {} & \underset{(-0.11)}{-1054.93} + \underset{(5.20)}{2.323 \times 10^5} DDA + \underset{(4.44)}{1.205 \times 10^5} DDB \\ & - \underset{(0.17)}{1947.44} DDC + \underset{(2.11)}{48.00} WXT_{t-1} + \underset{(2.53)}{0.722} DA_{t-1} \end{aligned} \tag{21}$$

$$R^2 = 0.693 \quad F = 57.7 \quad S.E. = 5.8 \times 10^4 \quad DW = 1.60$$

$$\text{Mean}(XA) = 4.43 \times 10^4.$$

Revisions of nonassociated gas (RN) depend on the same regional dummies and on the *change* in the previous year's reserves of gas. Large short-run increases in reserves increase the revisions in the following year (which in fact are adjustments to established discoveries). The equation is as follows:

$$\begin{aligned} RN = {} & \underset{(1.19)}{6.87 \times 10^4} + \underset{(5.95)}{1.138 \times 10^6} DDA - \underset{(-3.60)}{6.864 \times 10^6} DDB \\ & + \underset{(0.373)}{3.438 \times 10^4} DDC + \underset{(4.963)}{0.239} \Delta YT_{t-1} \end{aligned} \tag{22}$$

$$R^2 = 0.398 \quad F = 18.2 \quad S.E. = 4.5 \times 10^5 \quad DW = 1.65$$

$$\text{Mean}(RN) = 2.66 \times 10^4.$$

Note that there is no long run effect from the ΔYT_{t-1} term. Thus, a one Mcf increase in the *stock* of reserves implies about 0.24 Mcf increase in the *flow* of nonassociated revisions one year later.

Associated revisions (RA) are extremely erratic and difficult to explain with a simple linear regression model. There seems to be no relationship between this variable and lagged reserves of gas, primarily because associated revisions are linked more closely to oil reserves (which are not explained in this model). We modeled associated revisions by relating them to the previous year's change in reserves and the regional dummies, although the relationship is somewhat dubious:

$$\begin{aligned} RA = &-2234.90 + 4.863 \times 10^5 DDA + 3.240 \times 10^5 DDB \\ &(-0.07) \qquad (4.56) \qquad (3.04) \\ &+ 3.550 \times 10^4 DDC + 0.106 \Delta YT_{t-1} \\ &(0.69) \qquad (3.94) \end{aligned} \tag{23}$$

$$R^2 = 0.289 \quad F = 11.2 \quad S.E. = 2.5 \times 10^5 \quad DW = 1.71$$
$$\text{Mean}(RA) = 1.83 \times 10^4.$$

Production out of reserves

Two equations are estimated to predict the supply of production out of reserves, one for Louisiana South, and another for the remainder of the United States. Louisiana South is a large producing region with cost characteristics somewhat different from the rest of the country, and is therefore treated separately. Although data were available from 1955 to 1971, the nationwide production equation was estimated using only data from 1965 to 1971, since it was only in these years that production approached full short-term capacity. The Louisiana South equation, however, is estimated over the range 1962 to 1971 in order to have a sufficient number of degrees of freedom (only one production district is involved, so there are only as many data points as there are years).

In both equations, total production Q is regressed against the log of the wellhead price PG and against total reserves YT. This yields a supply of production equation of the form:

$$PG_{t,j} = \alpha_0 e^{\alpha_1 Q_{t,j} - \alpha_2 YT_{t,j}}, \tag{24}$$

with α_0, α_1, and α_2 all positive. This approximates (for reserve-production ratios less than 10) the marginal cost curve of equation (7). The nationwide equation also contains two regional dummy variables, one for the Permian region (DDB) and the other for the region including Oklahoma, Kansas, and Texas Railroad Commission Districts 2, 3, and 4 (DDC). These dummy variables help to account for district heterogeneity that remains even after Lousiana South is excluded from the sample.

The estimated equations are shown below.

United States, excluding Louisiana South (1965 to 1971):

$$\begin{aligned} Q = &-5.053 \times 10^5 + 1.823 \times 10^6 DDB + 5.879 \times 10^5 DDC \\ &(-1.30) \qquad (16.10) \qquad (7.43) \\ &+ 2.4755 \times 10^5 \log(PG) + 0.0240 YT \\ &(1.85) \qquad (5.57) \end{aligned} \tag{25}$$

$$R^2 = 0.838 \quad F = 122.5 \quad S.E. = 2.59 \times 10^5$$
$$\text{Mean}(Q)^{15} = 8.117 \times 10^5$$

[15] This mean pertains to an average district, since we are pooling cross-section and time series data.

Louisiana South (1962 to 1971):

$$Q = \underset{(-11.25)}{-4.663 \times 10^7} + \underset{(9.16)}{1.0465 \times 10^7 \log (PG)} + \underset{(8.45)}{0.2576\,YT} \tag{26}$$

$$R^2 = 0.964 \quad F = 79.7 \quad S.E. = 4.53 \times 10^5$$
$$\text{Mean}(Q) = 4.941 \times 10^6.$$

Both of these equations show positive and significant effects of prices and total reserves. Thus, with higher prices, both short- and long-run production should increase (as in Figures 5 and 8).

Wholesale price markups

We assume that as long as pipelines are operating within their capacity, the markups over field prices are a function of mileage M_k and volumetric capacity V_k of the lines transmitting to region k. Without regulation, the pipelines would set markups so that the sales-for-resale price would be

$$PSR_{t,k} = [e/(e+1)]\overline{PG}_{t,k} + [e/(e+1)]MC_{t,k},$$

where e is demand elasticity in region k, $\overline{PG}$ is field price, and $MC_{t,k}$ is marginal costs of transmission to k. With regulation, markups on the field prices are prohibited [or $e/(e+1) = 1$] and the markups on $MC_{t,k}$ might be reduced. Transmission costs $MC_{t,k}$ are a function of M_k, $V_{t,k}$. The wholesale price equations thus have the simple form:

$$PSR_{t,k} - \overline{PG}_{t,k} = f(M_{t,k}, V_{t,k}) \tag{27}$$

for price on "sales for resale" to retail gas utilities and

$$PM_{t,k} - \overline{PG}_{t,k} = f(M_{t,k}, V_{t,k}) \tag{28}$$

for price on "mainline" sales to industrial buyers. Here, $\overline{PG}_{t,k}$, the "roll-in" wellhead price for wholesale region k, is determined by averaging the wellhead prices from flowing production in those regions which feed pipelines that transmit gas to region k. The mileage variable $M_{t,k}$ and the capacity variable $V_{t,k}$ are similarly defined, i.e., in terms of the average values of these variables from production regions to the wholesale market region k. The "markup" is the excess of the price over field costs as calculated by the coefficients of the independent variables in mileage and capacity.

Both of the explanatory variables M and V have been defined for each state with respect to five final sales regions. Regression equations have been calculated for each region; since they do not differ significantly from the national equation, only the national is reported. For sales for resale, the wholesale price is given by:

$$PSR = \overline{PG} + \underset{(18.28)}{12.561} + \underset{(18.66)}{0.712M} - \underset{(-10.57)}{3.3185 \times 10^{-4}V} \tag{29}$$

$$R^2 = 0.561 \quad F = 356.2 \quad S.E. = 5.823 \quad DW = 2.25$$
$$\text{Mean}(PSR) = 17.42.$$

Note that the coefficient of volumetric capacity V is negative, since a larger capacity implies lower average costs. For mainline sales, our markup equation is given by:

$$PM = \overline{PG} + \underset{(4.73)}{5.365} + [\underset{(12.29)}{0.914} + \underset{(5.96)}{0.446}DDA]M - \underset{(-1.76)}{5.895 \times 10^{-5}V} \quad (30)$$

$$R^2 = 0.825 \quad F = 158.8 \quad S.E. = 2.45 \quad D.W. = 2.16$$
$$\text{Mean}(PM) = 13.91.$$

Here the mileage variable has a district dummy because of significantly higher markups in the Middle Atlantic states.

Wholesale demand for gas

Wholesale demand is broken into three major categories: sales-for-resale demand, mainline sales demand, and intrastate demand. Sales-for-resale demand is further broken down into gas that ultimately is resold for residential/commercial consumption and gas for industrial consumption, and for each category separate equations are estimated for each of five regions of the country. Mainline sales were broken down into a number of classifications. Attempts were made to calculate regression equations separately for mainline demand in producing states and for mainline demand in nonproducing states, on the hypothesis that the first set of demands would be more price elastic (since buyers could go to intrastate producers). With the data available, however, the differences were not observable and these categories were dropped. Intrastate sales were split between those in the South Central region (which were included in the total South Central equation) and those elsewhere.

New or additional demand $\delta Q = \Delta Q + rQ_{t-1}$ is used as the dependent variable in all equations. Assuming that all fuel-burning equipment has an average lifetime of 14 years, we have chosen a single depreciation rate r equal to 0.07. Explanatory variables besides the price of gas include the wholesale price of oil ($POIL$), income (δY), population (δN), value added in manufacturing (VAM), capital investment by industry (K), and a price index of alternate fuels ($PALT$).

Sales-for-resale demand equations are presented for each market region below. In the South Central, Southeast, and West regions, residential/commercial and industrial sales are aggregated together. Prices have been very low and demand has fluctuated considerably in these regions. Hence it is difficult to obtain stable estimates of demand elasticities on a disaggregated basis. In the West region, the price terms are statistically insignificant, but these variables with t-statistics slightly greater than one are retained in the equations (to show whatever price elasticity there is, whenever possible). As a general rule, variables with t-statistics greater than two are considered significant. All equations are estimated over the time bounds 1964 to 1970.

Northeast—residential/commercial:[26]

$$\delta QSRCR = \underset{(0.04)}{-1587.65} - \underset{(-1.21)}{9.117 \times 10^2 PSR} + \underset{(2.53)}{5.371 \times 10^4 POIL} + \underset{(5.33)}{63.33\delta N} \quad (31)$$

$$R^2 = 0.356 \quad F = 9.56 \quad S.E. = 2.47 \times 10^4$$
$$\text{Mean}(\delta QSRCR) = 2.76 \times 10^4.$$

[26] Durbin-Watson statistics are not shown for the wholesale demand equations since data formatting problems made their calculation impossible here.

Northeast—industrial:

$$\delta QSRI = \underset{(0.81)}{2.589 \times 10^4} - \underset{(-1.90)}{1.079 \times 10^3 PSR} + \underset{(2.01)}{3.057 \times 10^4 POIL} + \underset{(5.55)}{1.975 VAM} \tag{32}$$

$$R^2 = 0.395 \quad F = 11.3 \quad S.E. = 1.87 \times 10^4$$

$$\text{Mean}(\delta QSRI) = 1.91 \times 10^4.$$

North Central—residential/commercial:

$$\delta QSRCR = \underset{(1.76)}{3.47 \times 10^4} - \underset{(-2.10)}{1.108 \times 10^3 PSR} + \underset{(11.56)}{14.43 \delta Y} \tag{33}$$

$$R^2 = 0.725 \quad F = 78.9 \quad S.E. = 1.60 \times 10^4$$

$$\text{Mean}(\delta QSRCR) = 2.6 \times 10^4.$$

North Central—industrial:

$$\delta QSRI = \underset{(0.51)}{1.174 \times 10^4} - \underset{(-1.28)}{9.65 \times 10^2 PSR} + \underset{(1.37)}{8.192 \times 10^4 POIL} + \underset{(7.76)}{39.25 K} \tag{34}$$

$$R^2 = 0.529 \quad F = 22.1 \quad S.E. = 1.90 \times 10^4$$

$$\text{Mean}(\delta QSRI) = 2.3 \times 10^4.$$

West—total:

$$\delta QSRT = \underset{(0.23)}{-1860.89} - \underset{(-1.00)}{2.287 \times 10^2 (PSR_{t-1} + PSR_{t-2})/2} + \underset{(1.02)}{9147.21 (POIL_{t-1} + POIL_{t-2})/2} + \underset{(23.62)}{26.70 VVC_{t-1}} \tag{35}$$

$$R^2 = 0.901 \quad F = 200.1 \quad S.E. = 1.67 \times 10^4$$

$$\text{Mean}(\delta QSRT) = 2.3 \times 10^4.$$

South Central—total:

$$\delta QSRT = \underset{(1.40)}{1.287 \times 10^5} - \underset{(-0.21)}{1.389 \times 10^4 DDA} - \underset{(-1.50)}{5.332 \times 10^3 PSR} + \underset{(5.20)}{276.67 K} \tag{36}$$

$$R^2 = 0.803 \quad F = 51.8 \quad S.E. = 6.55 \times 10^4$$

$$\text{Mean}(\delta QSRT) = 1.008 \times 10^5.$$

Southeast—residential/commercial:

$$\delta QSRCR = \underset{(1.93)}{2.16 \times 10^4} - \underset{(-3.55)}{1.612 \times 10^4 DDA} - \underset{(-2.31)}{5.841 \times 10^2 PSR} + \underset{(2.21)}{1.124 \times 10^4 POIL} + \underset{(1.26)}{1.521 \delta Y} \tag{37}$$

$$R^2 = 0.267 \quad F = 4.1 \quad S.E. = 5.75 \times 10^3$$

$$\text{Mean}(\delta QSRCR) = 7.61 \times 10^3.$$

Southeast—industrial:

$$\delta QSRI = \underset{(1.35)}{2.260 \times 10^4} - \underset{(-3.30)}{2.147 \times 10^4 DDA} - \underset{(-2.01)}{8.714 \times 10^3 PSR} + \underset{(2.85)}{6.012 \times 10^4 PALT} + \underset{(1.67)}{2.086 VAM} \quad (38)$$

$$R^2 = 0.373 \quad F = 6.55 \quad S.E. = 7.1 \times 10^3$$
$$\text{Mean}(\delta QSRI) = 1.34 \times 10^4.$$

The mainline industrial demand equation is shown below.

Mainline sales:

$$\delta QM = \underset{(3.52)}{3.389 \times 10^4} - \underset{(-3.59)}{1.079 \times 10^3 (PM_t + PM_{t-1})/2} + \underset{(2.71)}{3.447 \times 10^4 (PALT_t + PALT_{t-1})/2} \quad (39)$$

$$R^2 = 0.149 \quad F = 8.77 \quad S.E. = 1.79 \times 10^4$$
$$\text{Mean}(\delta QM) = 1.2 \times 10^4.$$

Finally, an intrastate demand equation has been estimated as follows:

$$\delta QINTRA = \underset{(2.19)}{1.317 \times 10^4} - \underset{(-1.95)}{10.85 (PM_t + PM_{t-1})/2} + \underset{(3.49)}{2.906 \delta Y} \quad (40)$$

$$R^2 = 0.213 \quad F = 7.17 \quad S.E. = 2.02 \times 10^4$$
$$\text{Mean}(\delta QINTRA) = 7.23 \times 10^4.$$

These equations show negative price effects on demands, with statistically significant coefficients in six out of ten equations. The strongest effects were in the regions closer to producing centers (with more alternative sources of energy). Alternative fuel prices are important in determining mainline industrial sales. Size-of-market variables, such as consumer incomes or industrial investment or output, do not appear to be consistent causal factors in all sectors of the national gas market.

Interregional flows of gas

In order to calculate estimates of excess demand by consuming region (and underproduction by production district), we must have some estimate of how gas flows from the wellhead to the point of final consumption. We make estimates of interchange at an aggregate level using the demand regions, *W*, *NE*, *NC*, *SE*, *SC* and production regions, *P1*, *P2*, *P3*, *P4*, *P5*, *P6*, *P7*, *P8*, as defined below:

W—West: Arizona, California, Oregon, Washington, Idaho, Wyoming, Nevada, Utah, Colorado, New Mexico

NE—Northeast: New England, New York, New Jersey, Pennsylvania, Ohio, West Virginia, Kentucky, Maryland (and Delaware), Virginia

NC—North Central: South Dakota, Nebraska, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana

SE—Southeast: Tennessee, Alabama, North Carolina, South Carolina, Georgia, Florida

SC—South Central: Kansas, Texas, Arkansas, Oklahoma, Louisiana, Mississippi

P1—Texas Railroad District 10, Oklahoma, Kansas

P2—New Mexico San Juan, New Mexico Permian, Texas 8, Texas 8A, Texas 7C

P3—Texas 1, Texas 9

P4—Texas 2, Texas 3, Texas 4, Texas 6, Louisiana North, Louisiana South, Mississippi

P5—Colorado, Wyoming

P6—Canada (exogenous production)

P7—California

P8—Kentucky, West Virginia.

The flows of gas from production region to consuming region as estimated for 1970 are shown in Table 2. In each box is an integer

TABLE 2

GAS FLOWS – 1970

SALES f_{jk} g_{jk}	W	NE	NC	SE	SC	TOTAL PRODUCTION
P1	235 0.069 0.055	82 0.020 0.019	1765 0.413 0.418	0 0.000 0.000	2136 0.247 0.506	4218 0.192
P2	1675 0.497 0.512	0 0.000 0.000	646 0.151 0.197	0 0.000 0.000	955 0.110 0.292	3276 0.149
P3	0 0.000 0.000	14 0.003 0.043	60 0.014 0.184	14 0.009 0.043	237 0.027 0.729	325 0.014
P4	0 0.000 0.000	3630 0.888 0.296	1776 0.416 0.145	1530 0.990 0.125	5293 0.607 0.428	12,229 0.558
P5	478 0.141 0.959	0 0.000 0.000	20 0.004 0.400	0 0.000 0.000	0 0.000 0.000	498 0.022
P6	305 0.090 1.00	0 0.000 0.000	0 0.000 0.000	0 0.000 0.000	0 0.000 0.000	305 0.013
P7	676 0.200 1.00	0 0.000 0.000	0 0.000 0.000	0 0.000 0.000	0 0.000 0.000	676 0.030
P8	0 0.000 0.000	359 0.087 1.00	0 0.000 0.000	0 0.000 0.000	0 0.000 0.000	359 0.016
TOTAL DEMAND	3369 0.153	4085 0.186	4267 0.194	1544 0.070	8621 0.393	21,886 1.000

which represents the flow from the particular production region (row) to the consuming region (column). The decimal to the left of this number (f_{jk}) represents the fraction of the consuming region's demand which comes from that production region, while the decimal to the right (g_{jk}) represents the fraction of gas from that production district going to a particular consuming region. Then, letting Q_j

equal production in district j and letting D_k equal demand in region k, we can calculate:

(1) $Q_j - \sum_k [f_{jk} D_k]$ = production shortage in producing region j

and

(2) $D_k - \sum_j [g_{jk} Q_j]$ = excess demand in consumption region k.

The numbers in Table 2 were derived from FPC data as follows:

(1) The FPC *Sales by Producers of Natural Gas to Interstate Pipeline Companies* (1970) was used to determine for each pipeline company the distribution of purchases from each production region.

(2) These purchases were then distributed to the various consuming regions (if they went to more than one) by using an estimation process based on the *FPC Form 2 Reports on Sales for Resale and Mainline Industrial Sales* by interstate pipeline companies and by using the FPC map, *Principal Natural Gas Pipelines in the United States 1968*. In many instances the companies' purchases and sales were divided into several nonoverlapping flows. These were then easy to determine. In others, it was necessary to estimate the actual flows, since more than one production region could be tapped for sales to more than one consuming region along the same pipeline. In these cases, judicious use of the Form 2 data was necessary to resolve the overlapping. It is believed that the resulting matrix is accurate enough to make estimates of excess demand.

(3) The third step was to determine the size of intrastate and field sales[27] to each region. This was done by determining the difference between the total interstate sales coming from each production region and the value given for total production from that region by the AGA's *Reserves of Natural Gas*. The difference was then attributed to intrastate and field sales in the demand region containing the production region. In only one case (Permian Basin) was it necessary to split the intrastate production into two demand regions. This was accomplished by using the Bureau of Mines' consumption of natural gas data (Bureau of Mines, *Minerals Yearbook*) to determine total consumption for New Mexico. The quantity of intrastate sales necessary to bring New Mexico's interstate consumption up to the level of the Bureau of Mines' total consumption was added to the matrix. The remaining intrastate sales from the Permian Basin were then added to the South Central region.

This completed the flow table from which the fractions were easily calculated.

□ **Historic time period simulation of the model.** The model is used to predict the response over time of production supply and demand to a changing regulated field price. In order to help interpret (and also evaluate) these predictions, it is useful to examine a simulation of the model performed over an historic time period. If, for example, this

[27] Field sales are sales to an oil producer for pressuring purposes. They also include pipeline fuel.

simulation showed an increasingly upward bias in production supply over time, this could be taken into account when interpreting the model's predictions for future excess demand.

The model was simulated over the period 1966 to 1970, using historical values for all of the exogenous variables, including regional wellhead prices. The results of this simulation are shown for production supply and demand and for the wholesale price in Table 3. In

TABLE 3

HISTORIC SIMULATION OF PRODUCTION SUPPLY AND DEMAND

YEAR	(1) SIMULATED PRODUCTION SUPPLY (TRILLIONS OF CU. FT.)	(2) SIMULATED PRODUCTION DEMAND (TRILLIONS OF CU.FT.)	(3) ACTUAL PRODUCTION (TRILLIONS OF CU. FT.)	(4) SUPPLY ERROR [(1)-(3)]	(5) DEMAND ERROR [(2)-(3)]	(6) NEW CONTRACT FIELD PRICE (CENTS)	(7) SIMULATED AVERAGE WHOLESALE PRICE (CENTS)	(8) ACTUAL AVERAGE WHOLESALE PRICE (CENTS)	(9) AVERAGE WHOLESALE PRICE ERROR [(7)-(8)]
1966	19.4	15.6	17.5	1.9	1.9	17.7	30.0	26.0	+4.0
1967	19.6	16.3	18.4	1.2	-2.1	18.1	30.3	26.1	+4.2
1968	19.8	17.1	19.4	0.4	-2.3	18.5	30.7	26.4	+4.3
1969	20.0	17.9	20.7	-0.7	-2.8	19.3	31.2	27.5	+3.7
1970	20.5	18.8	22.0	-1.5	-3.2	21.8	32.0	29.7	+2.3

MEAN SUPPLY ERROR = 0.3 MEAN DEMAND ERROR = -2.5 MEAN WHOLESALE PRICE ERROR = 3.7
RMS SUPPLY ERROR = 1.3 RMS DEMAND ERROR = 2.5 RMS WHOLESALE PRICE ERROR = 3.8
MEAN ACTUAL PRODUCTION = 19.6 MEAN ACTUAL WHOLESALE PRICE = 27.14

addition to listing the simulated values, actual values, and errors for each variable, we calculated the mean and root-mean-square (*RMS*) simulation errors.

Note that simulated production supply is larger than the actual production levels in 1966, 1967, and 1968, but smaller than actual levels in 1969 and 1970, with a deficit of over two trillion cubic feet in 1970. Most of this error occurs in Louisiana South and offshore Louisiana in the Outer Continental Shelf. There more is found than forecast, probably because of a stepped-up program of Federal Offshore Leasing. With a continuation of the usual Leasing Program, forecasts in the 1970s should be more accurate. Production demand is underestimated slightly at first, but strongly later, with an error that grows from about 1.9 trillion cubic feet in 1966 to about 3.2 trillion cubic feet in 1969. At least part of the reason for the underestimate of demand is the *overestimate* of the average wholesale price. The simulated wholesale price is about 4.2 cents too high from 1966 to 1968, and three cents too high in 1969 to 1970. This is because of more gas' flowing from small production regions in the simulation than in the real world (the small regions have higher markups). Such an error, while part of the *backcast*, would not persist over long *forecast* periods, because of depletion of reserves in small regions.

It would appear that the model's forecasts should be viewed as having a margin of error (probably negative) of at least one or two trillion cubic feet. This should be taken into account when interpreting the policy analyses that are presented in the next section. Excess demand may turn out to be somewhat more than what we forecast, and the price increases necessary to eliminate excess demand may actually be a few cents more than those which we present.

■ With long lags from price changes to exploration, development, and production changes, it might be expected that very little additional supply would be forthcoming in the next five years from increased field prices. Given "roll-in" pricing in wholesale markets, field price increases would be passed through very gradually as wholesale price increases. Consequently, there might be only limited reductions in demand as a result of the price increases, as well. These possibilities can be investigated by completing several simulations with the model using alternative policies (in so far as these policies are reflected in alternative field prices), where the model has been set up to approximate roughly the conditions likely to be prevalent in the late 1970s.

The "gas economy" of the last half of the 1970s can be described in any number of ways, varying from quite expansive (because of shifts of energy demands to natural gas) to quite restrictive (because of reduced prices for alternative fuels as new coal-using technology is developed and as vastly increased supplies of oil resources become available). The expansive view, when introduced into the econometric model, would result in large increases of demands, while the more restrictive expectations would have quite the opposite effect. When these conditions are replicated in the model, by introduction of appropriate values of exogenous variables, the size of the shortage becomes either larger or smaller. The approach taken here is not to choose an extreme set of values of the exogenous variables to be inserted into the model; rather, we choose a set of values that follows from "median" conditions likely to prevail in energy markets in the near future.

The important exogenous determinants of demands for gas include state-by-state value added in manufacturing, population level, income, and capital equipment additions. It is forecast that value added, income per capita, and capital additions will grow at 4.2 percent per annum (based on the *Data Resources Quarterly Econometric Model* forecast for the period 1972 to 1980). These rates of growth are in terms of constant dollars; we have chosen a "median" expected rate of growth of prices close to 3.5 percent per annum (based on both the *Thurow-Ripley Long-Term Econometric Model* of Data Resources and the *DRI Quarterly Econometric Model*). Thus, value added and capacity grow at 7.7 percent in current dollar terms. It is assumed that the rate of growth of population will be limited to 1.1 percent per annum for the rest of the decade (in keeping with the assumptions used in the economy-wide models for generating the rates of growth of value added and capacity).

Other exogenous variables that determine the percentage share of total energy markets that will be realized by natural gas are: (1) wholesale prices of alternative fuels in residential and commercial consumption, and (2) wholesale prices of alternative fuels for industrial use. Both are expected to increase at 5.0 percent per annum in real terms and 8.5 percent per annum in current dollar terms. These exceed the forecasts of the National Petroleum Council,[18] but are close to an extrapolation of 1970 to 1973 price behavior that would essentially double oil prices over the 1972 to 1980 period.

Exogenous determinants of supply of reserves and production

[18] In [17].

include the field price for crude oil in the producing regions, and the average drilling costs for oil and gas together. It is expected that oil prices in the field will grow at the 8.5 percent rate per annum in current dollar terms (again exceeding the National Petroleum Council's predictions).[29] Average drilling costs are expected to increase at 6.8 percent per annum, in keeping with the trend of cost increases over the 1960s and early 1970s.

These values of the exogenous variables, together with assumed percentage increases of gas prices on new field contracts, can be inserted into the econometric model to produce simulated values of additions to reserves and to production by field region. Also, the model can produce simulations of demands for new production and for total production, and average wholesale prices for different classes of consumers in each of the wholesale markets. Each of the alternative regulatory policies implies a different series of field prices; separate simulations for each price series can be used to describe results of a policy and then can be compared with those for other policies.

□ **Partial deregulation of field prices.** A large number of alternative proposals have been made under the rubric of "deregulation of field prices." These have included complete and instantaneous deregulation on the one hand, and a slightly higher rate of increase of FPC-controlled prices on the other hand. But the central proposal is probably to allow new contract prices to seek their own levels, subject to a national ceiling on all new prices that would keep average wholesale prices from increasing by more than 50 percent over the subsequent five-year period. This policy has been simulated as a price increase of 15 cents per Mcf on all new contracts in 1974 over a 29.6 cents per Mcf price level on new contracts in 1973. Prices would increase an additional 3.0 cents per year after 1974, as part of the (allowed) response to rising drilling and operating costs.

The impact of the price increases on new discoveries of reserves would not occur in 1974, but rather would be spread over the period 1975 to 1978. It is expected that 1975 new discoveries would be slightly more than 9 trillion cubic feet—almost 30 percent more than the previous year (as shown in Table 4, for the econometric model simulation for "Deregulation"). By 1976 new discoveries would increase to the level of 11 trillion cubic feet, and by 1979 would be 19 trillion cubic feet. Total additions to reserves (including new discoveries, extensions, and revisions) would track new discoveries rather closely. A major part of the impact of price increases would be felt within four years, as an increase in annual additions 10 trillion cubic feet greater than previously experienced. The full impact would not be felt, however, until 1980, when total additions had leveled off at 34 trillion cubic feet, an amount approximately 21 trillion cubic feet greater than the 13 trillion realized before this series of price increases.

Production out of reserves can be expected to increase more quickly. The new contract field price increases would make it more profitable to increase the level of development of existing reserves. Over a longer period, the additions to total new reserves induced by price increases would provide more "reserve base" for more produc-

[29] *Ibid.*, pp. 40 *et seq.*

TABLE 4

ECONOMETRIC MODEL SIMULATION RESULTS FOR POLICY ALTERNATIVE "DEREGULATION"

YEAR	NEW DISCOVERIES (CONTINENTAL U.S., TRILLIONS OF CU FT)	TOTAL ADDITIONS TO RESERVES (CONTINENTAL U.S., TRILLIONS OF CU FT)	TOTAL RESERVES (CONTINENTAL U.S., TRILLIONS OF CU FT)	SUPPLY OF PRODUCTION (CONTINENTAL U.S., TRILLIONS OF CU FT)	DEMANDS FOR PRODUCTION (CONTINENTAL U.S., TRILLIONS OF CU FT)	EXCESS DEMAND FOR PRODUCTION (CONTINENTAL U.S., TRILLIONS OF CU FT)	NEW CONTRACT FIELD PRICE (CONTINENTAL U.S., CENTS PER Mcf)	AVERAGE WHOLESALE PRICE (CONTINENTAL U.S., CENTS PER Mcf)
1972	5 7	9.8	237 7	19.3	23 3	4 1	26 3	33 6
1973	6 1	12 7	229 0	22 1	24 4	2 3	29 6	36 7
1974	7 1	13 8	218 5	25 0	25 4	0 3	44 1	42 0
1975	9 1	15 4	208 8	26 0	26 4	0 3	47 7	45 8
1976	11 4	18 3	201 3	27 1	27 4	0 3	51 3	49 5
1977	14 1	22 2	196 5	28 2	28 5	0 3	54 9	53 3
1978	17 1	25 9	194 5	29 5	29 7	0 2	58 4	57 1
1979	19 1	29 9	195 3	31 0	31 0	0 0	62 0	61 0
1980	22 4	34 6	199 7	32 8	32 4	0 3	65 5	64 9

tion. As a result, the supply of production would be expected to increase from 22 trillion cubic feet in 1973 to 32 trillion cubic feet by 1980. The increased production—mostly out of existing reserves—reduces the reserve-production ratio from 10:1 to slightly less than 7:1 at the lowest point. Price increases provide incentives to take out a larger proportion of reserves.

The demand side of gas markets experiences attrition as a result of the pass-through of the higher new contract field prices to the wholesale level. The wholesale prices do not increase very rapidly. Because of the large number of old contracts still outstanding at the end of the 1980s, the average wholesale price at that point in time falls short of the new contract field price level by 0.6 cents per Mcf. But wholesale prices rise on the average from the 30 cent level in the early 1970s to 64 cents by 1980, and the increases affect consumer demands. The demands for production by residential, commercial, and industrial users throughout the country rise from 24 trillion cubic feet in the early 1970s to only 32 trillion cubic feet by 1980. The expansive effects of increased investment, consumer incomes, and population are dampened by price increases. In the absence of the field and wholesale price increases, demands would have increased from 24 trillion cubic feet to 37 trillion cubic feet.[30] Therefore, as a result of an approximately 50 percent increase in wholesale prices spread over a 7-year period, *total* demands for production are decreased by 14 percent (from 37 to slightly more than 32 trillion cubic feet by 1980), and *additions* to demands are decreased by 40 percent (from 13 trillion to 8 trillion cubic feet).

The results of this policy of "partial deregulation" are to raise prices and to reduce greatly the magnitude of the gas shortage. Price increases, while substantial, eliminate the production shortage after five years, so that by 1979, the supply of production and the demand

[30] This estimate has been made by simulating with the same values of exogenous variables but with one cent annual field price increases after 1974, as in Table 5.

for production are both approximately 31 trillion cubic feet. In subsequent years, supplies again match demands rather closely; in fact, the small excess supplies (or negative deficits) would probably lead to rebuilding of the reserves base and to some price softening on new field contracts.

It might be asked whether the market clearing in these simulation results is highly sensitive to the choice of particular values of the exogenous variables. This would not seem to be the case. Simulations were also carried out with "high" and "low" sets of values of the exogenous variables; the "high" values included real rates of growth of value added, income, and plant and equipment outlay of 4.4 percent per annum, of population of 1.3 percent per annum, and real price increases for alternative fuels of 6.0 percent (residential and commercial use) and 6.0 percent (industrial use). These additions are matched by oil field price increases of 6 percent per annum in real terms. The rate of inflation was maintained at 3.5 percent per year. The result would be expected to increase demands for gas substantially—but also to increase supplies of both oil and gas (particularly associated gas reserves). The simulation with "high" values of the exogenous variables shows, in fact, production out of reserves to exceed 33.3 trillion cubic feet by 1980, because of the substantial additional volumes of new discoveries. Demands for reserves in this "high" value case exceed 33.7 trillion cubic feet so that markets come very close to clearing with production supplies and demands roughly equal in the last year of the decade.

"Low" values of the exogenous variables would be quite similar to the "median" values, except that value added and per capita incomes would increase one percent less per annum, and both field and wholesale prices of alternative fuels increase at 3.0 percent.[31] In this simulation, the low values of field prices for oil dampen incentives for exploration of (associated) gas, so that annual new reserves by 1980 are approximately 3.2 trillion cubic feet less than shown in Table 4. The supply of production out of reserves is also 1.1 trillion cubic feet less, but demands for production are dampened from 32 trillion cubic feet in 1980 to 29 trillion cubic feet, so that more than enough production is supplied to meet demands over the period 1976 to 1980. Altogether, the shortage is eliminated in 1980 in the "high" value case and in 1975 in the "low" value case.

The impression is that "deregulation" that results in field prices in the 50 to 65 cent range over the rest of the decade would clear production markets of excess demand. There is some chance that there would still be a shortage, if "high" values of exogenous variables increased demands for gas more than reserves and production. But the most likely values of exogenous variables, even the "low" values, would clear production markets, with low reserve backing the only indicator of a gas shortage.[32]

□ **Strict "cost of service" regulation of field prices.** One criticism of regulation is that prices have been allowed to creep up at the rate of

[31] It is assumed that prices would increase at 3.5 percent per annum in money terms, in the "low" value case as well as the "median" and "high" value cases for simulation.

[32] It might be possible to say that there is still a shortage. This is because the reserve-production ratio is as low as 7:1 when production supply equals produc-

2.5 cents per annum on new contracts, when there has been little "cost justification" for this to occur. It is argued that the Federal Power Commission should follow traditional procedures for setting prices—that is, full reviews of the historical costs of providing gas should be undertaken and prices should be limited to these costs. It is expected that under this regimen, price increases under new contracts would be limited to one cent per annum. This would result in average wholesale prices limited to the 40 to 48 cent range over the rest of the 1970s (as shown in Table 5).

TABLE 5

ECONOMETRIC MODEL SIMULATION FOR POLICY ALTERNATIVE "COST OF SERVICE REGULATION"

YEAR	NEW DISCOVERIES (CONTINENTAL U.S., TRILLIONS OF Cu.FT.)	TOTAL ADDITIONS TO RESERVES (CONTINENTAL U.S., TRILLIONS OF CU. FT.)	TOTAL RESERVES (CONTINENTAL U.S., TRILLIONS OF CU. FT.)	SUPPLY OF PRODUCTION (CONTINENTAL U.S., TRILLIONS OF CU. FT.)	DEMANDS FOR PRODUCTION (CONTINENTAL U.S., TRILLIONS OF CU.FT.)	EXCESS DEMAND FOR PRODUCTION (CONTINENTAL U.S., TRILLIONS OF CU.FT.)	NEW CONTRACT FIELD PRICE (CONTINENTAL U.S., CENTS PER Mcf)	AVERAGE WHOLESALE PRICE (CONTINENTAL U.S., CENTS PER Mcf)
1972	5.7	9.8	237.7	19.3	23.3	4.0	26.3	33.5
1973	6.0	12.7	229.0	22.0	24.3	2.3	29.6	36.6
1974	7.1	13.8	220.8	22.8	25.6	2.8	30.5	38.4
1975	8.1	15.2	213.6	23.4	26.9	3.6	31.3	40.1
1976	9.2	16.8	207.5	24.0	28.5	4.5	32.1	41.7
1977	10.4	18.7	202.7	24.7	30.3	5.5	33.0	43.3
1978	11.9	20.8	199.3	25.7	32.2	6.6	33.8	44.8
1979	13.6	23.2	197.6	26.7	34.4	7.7	34.6	46.4
1980	15.7	26.3	197.5	28.0	36.9	8.9	35.5	48.0

The effects of such limited price increases on reserve and production supply would be substantial. New discoveries would increase by little more than one trillion cubic feet per year for the remainder of this decade, and total additions to reserves would be limited in 1980 to 26 trillion cubic feet per year. The supply of production out of reserves would range from 23 trillion cubic feet in 1974 to close to 28 trillion cubic feet in 1980. Altogether, additions to reserves are approximately 3.7 trillion cubic feet less per year than under the "deregulation" policy shown in Table 4.

The demands for production would be much greater when prices are held within this range. Total demands for new production increase by 1.3 to 2.5 trillion cubic feet per annum (as shown in Table 5). Total new demands by 1980 are expected to be more than 37 trillion cubic feet, 5 trillion cubic feet greater than under price increases associated with "deregulation."

Excess demands persist over the remainder of the decade. Indeed, the gap between supply and demand for production increases as time passes, from approximately 3 trillion cubic feet in 1974 to 9 trillion cubic feet by 1980. The impact of this "cost of service regulation" policy is to exacerbate the excess demands that already exist,

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tion demand—the backing for production is still very slim, imposing uncertainty on the buyers as to whether future production is forthcoming after gas-burning equipment has been installed. This is to say that, at equilibrium levels of production, there is still excess demand for *reserves*.

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so that the shortage would be close to 25 percent of the total demands for production by 1980.

These conditions can be expected whether the "median" values, the "high" values, or the "low" values of the exogenous variables are used in the simulations. When "high" values are used, the size of excess demand in 1980 exceeds 9.6 trillion cubic feet per year, because additions to demands from market growth and price incentives exceed additions to (associated) supply from oil price increases. When "low" values are used, the excess demand is limited to 6.5 trillion cubic feet per year. But, in all three cases, the shortage increases over the remainder of the decade, and is equal to 20 percent of the demands for production.

□ **Maintenance of the regulatory "status quo."** Continuation of present regulation is envisioned as maintenance of the 1970 to 1972 policy of allowing price increases on new contracts of 2 to 4 cents per Mcf each year. The cases on field pricing brought before the Commission for the rest of the decade would be decided on any number of "cost" bases, as long as the result would be a price series for new commitments of reserves as shown in Table 6—with annual

TABLE 6

ECONOMETRIC MODEL SIMULATION RESULTS FOR POLICY ALTERNATIVE "REGULATORY STATUS QUO"

YEAR	NEW DISCOVERIES (CONTINENTAL U.S., TRILLIONS OF CU.FT.)	TOTAL ADDITIONS TO RESERVES (CONTINENTAL U.S., TRILLIONS OF CU.FT.)	TOTAL RESERVES (CONTINENTAL U.S., TRILLIONS OF CU.FT.)	SUPPLY OF PRODUCTION (CONTINENTAL U.S., OF CU.FT.)	DEMANDS FOR PRODUCTION (CONTINENTAL U.S., TRILLIONS OF CU.FT.)	EXCESS DEMAND FOR PRODUCTION (CONTINENTAL U.S., TRILLIONS OF CU.FT.)	NEW CONTRACT FIELD PRICE (CONTINENTAL U.S., CENTS PER Mcf)	AVERAGE WHOLESALE PRICE (CONTINENTAL U.S., CENTS PER Mcf)
1972	5.7	9.8	237.7	19.2	23.3	4.0	26.3	33.6
1973	6.0	12.7	228.9	22.1	24.3	2.3	29.6	36.7
1974	7.0	13.8	220.5	23.0	25.6	2.5	32.4	38.9
1975	8.3	15.2	212.8	23.9	26.9	2.9	35.1	41.2
1976	9.7	17.1	206.1	24.9	28.3	3.4	37.8	43.7
1977	11.3	19.4	200.8	26.0	29.9	3.9	40.6	46.2
1978	13.2	22.1	197.3	27.2	31.6	4.4	43.3	48.9
1979	15.5	25.4	195.8	28.6	33.4	4.8	45.9	51.7
1980	18.3	29.2	196.8	30.2	35.5	5.3	48.5	54.6

increments of approximately 3 cents per Mcf per year leading to new contract prices in 1980 of more than 50 cents per Mcf. Such price changes would not be easy to put into effect—each requiring multiple applications for certification of new contracts under conditions different from the previous year's certification and each requiring estimates of (increased) costs of providing the new contract production. The allowed increases—if the best that can be provided by a commission trying to reduce the shortage, but operating within orthodox regulatory "cost-pricing" procedures—would raise average wholesale prices from 37 cents to 55 cents by 1980. They would have a perceptible effect on both supplies of reserves and production, and demands for production.

Supplies of reserves are expected to increase at a slower rate under

these conditions than under "deregulation." The increments of new discoveries and total additions to reserves are shown in Table 6; total additions each year fall short of those for Table 4 by 5 to 6 trillion cubic feet at the end of the decade. The supply of production out of reserves is almost 3 trillion cubic feet less each year as a consequence. The combination of successive 3-cent increments leading to a higher final price, and of near-certainty of the occurrence of these increments, leads to some additions to both reserves and production. But these are not enough to eliminate the shortage.

Demands for production on the other hand are greater than under "deregulation." The successive increments of 3-cent new contract field price increases pass through as average wholesale price increases only gradually. The new contract field price is approximately 16 cents per Mcf higher in 1980 than in 1974, and the average wholesale price is about 15 cents higher. As a result, demands for production increase from 25 trillion cubic feet in 1974 to 35 trillion cubic feet in 1980. These demands at the end of the decade are 8 trillion cubic feet per annum greater than under the higher-priced "deregulation."

As a result of lower additions to supply and higher additions to demand, the shortage increases. In the mid-1970s the total supply of production would be from 2.5 to 3.5 trillion cubic feet less than the demand. By 1979 or 1980, further net increments of demand increase the shortage each year until it levels off at 5.3 trillion cubic feet. This short fall is a lower percentage of demand than under strict "cost-of-service" regulation (and the increments of supply are larger under the "status quo" than under "cost of service" in 1974 to 1980).

The use of "high" or "low" values of exogenous variables again does not affect the outcome of this policy. Markets are not cleared of the shortage under the "status quo" by using "low" values of exogenous variables, nor are they cleared by using "high" values of exogenous variables. The increment by which demands exceed the supply of production in 1980 equals 3.0 trillion cubic feet in the "low" simulation and 6.1 trillion cubic feet in the "high" simulation. In all of the simulations of continued regulation, policies of the Federal Power Commission that allow maximum legal price increases each year do not of themselves eliminate the shortage of production.

□ **Comparisons of alternative policies.** In comparing the alternative policies, it should be remembered that the econometric model presented in this paper is, of course, subject to some error, and as seen in the historic simulations, this error would most likely produce an underestimate of actual demands. Thus, the price increases consistent with our scenarios might actually be a few cents lower than those which we present here. Nonetheless, the qualitative results supporting deregulation would still hold. The government could "deregulate" by legislative act and reduce the production shortage to negligible size within four to five years. The FPC could not likely achieve the same result by stretching the standards for justifying price increases so as to allow increases of 3 cents per annum.

Both of the alternatives are preferable to strict "cost of service" regulation. Regulatory stringency is expected to increase the size of the shortage from approximately 3 trillion cubic feet of production per year at the present time to 9 trillion cubic feet per year by the

end of the decade (as in Table 5). Synthetic or liquefied gas plants which can produce at costs more than 65 cents per Mcf would be justifiable as investments under regulation, because they would ameliorate the shortage. That is, the gas industry would likely have to turn to more costly alternatives for synthetic supplies, *given the size of the "strict regulation" shortage.* Given strong political and economic reasons for reducing the shortage, the "strict regulation" way of doing so is going to be the most prolonged and the most costly.

Appendix

List of variables and data sources

■ The variables used to estimate the model, including sources of data, are listed below. The list is divided into field market variables and wholesale market variables. Following AGA procedures, all offshore data are included in the appropriate onshore district.

□ **Wells.**

WXT: Total exploratory wells, successful or otherwise.

CWXT: Cumulative value of exploratory wells (*WXT*), from 1963 to *t*.

REVD: Index of average deflated revenue from gas and oil for each production district.

ATCD: Average drilling cost per well of exploratory and development wells, from *Joint Association Survey*, (AGA/API/CPA).

RISKV: Index of the variance in size of discoveries over time by production district. This is a pure cross-section variable which does not change in time.

AFX: Average depth of an exploratory well (averaged over total wells).

□ **Reserves.** All data from AGA/API/CPA *Reserves of Crude Oil.* Only available in disaggregated (i.e., associated-dissolved, nonassociated, by production district) form from 1966 except for year-end reserves (*YN*, *YA*, *US*) which we have from 1965. (Disaggregated data extrapolated for 1964 and 1965 to provide starting values for lagged and unlagged endogenous variables in the historical simulation.) Data are given in millions of cubic feet.

SIZEDN: Average size of nonassociated discoveries, by production district (averaged over total wells, dry and successful).

SIZEDA: Average size of associated discoveries, by production district (averaged over total wells, dry and successful).

DDA: Dummy variable for Louisiana South.

DDB: Dummy variable for the Permian producing region.

DDC: Dummy variable for Kansas, Oklahoma, TRRC Districts 1, 2, 3, 4, and 10.

DDD: Dummy variable for Lousiana North, Mississippi, New Mexico North, Pennsylvania, West Virginia-Kentucky, Wyoming, TRRC6 and TRRC9.

YN: Year-end nonassociated reserves. Reserves as defined by the AGA.

YA: Year-end associated-dissolved reserves. See *YN.*

YT: Year-end total gas reserves. $YT = YN + YA$.

YO: Year-end oil reserves.

US: Year-end reserves in underground storage other than in their original locations.

XN: Extensions of nonassociated gas. Includes any newly proved reserves already established in pools and fields.

XA: Extensions of associated-dissolved gas. See *XN.*

RN: Revisions of nonassociated gas. Includes any proved *decreases* in size of proved reserves discovered by drilling of extension or development wells or changes (+ or −) resulting from better engineering estimates of economically recoverable reserves in established pools.

RA: Revisions of associated-dissolved gas. See *RN.*

FN: New field discoveries of nonassociated gas (discovered by new field wildcats).

FA: New field discoveries of associated-dissolved gas. See *FN.*

PN: New pool discoveries of nonassociated gas.

PA: New pool discoveries of associated-dissolved gas.

DN: $= FN + PN$. Total new discoveries, nonassociated.

DA: $= FA + PA$. Total new discoveries, associated-dissolved gas.

□ **Production.** All data are from AGA/API/CPA, *Reserves of Natural Gas*, and are available in disaggregated form from 1965 for gas (and 1940 for oil). In 10^6 cubic feet and 10^3 barrels.

QN: Production of nonassociated gas, i.e., net production.

QA: Production of associated-dissolved gas, net production.

QO: Production of oil.

QSRI: Sales for resale which will end up as industrial sales are determined by multiplying total sales for resale (from FPC Form 2 Reports) by the fraction of total industrial natural gas consumption (from U.S. Bureau of Mines' *Minerals Yearbook*).

QSRCR: The difference between total sales for resale and industrial sales for resale. (See *QSRI* for sources.)

QINTRA: The difference between total consumption of natural gas by state and total mainline sales plus sales for resale plus field sales in that state. Figures on total consumption by state are taken from Bureau of Mines'

Minerals Yearbook, as are total field sales. Mainline sales and sales for resale figures are from FPC Form 2 Reports.

QM: Total mainline industrial sales volume by interstate pipeline companies by state and year (1955 to 1970) in Mcf, from FPC Form 2 Reports.

QSRT: Total sales for resale volume by class A and B interstate pipeline companies, by state and year (1956 to 1970) in Mcf, from FPC Form 2 Reports.

L: Losses and waste, by states (Texas, Louisiana, and New Mexico undivided). From API *Petroleum Yearbook*.

□ **Prices.**

PG: New contract price of interstate sales of gas at the wellhead, from Table F, FPC, *Sales of Natural Gas*, for 1952 to 1971, in ¢/Mcf. (Compiled by Foster Associates, Inc.)

PO: Wellhead price of oil in $/barrel for 1954 to 1971, from Bureau of Mines' *Minerals Yearbook*.

POIL: Average price in dollars per Mcf-energy-equivalent of fuel oil paid by electric power companies by state, from Edison Electric Institute, *Statistical Annual of the Electric Utility Industry*.

PALT: Price of alternate fuels in dollars per Mcf-energy-equivalent. Weighted average (over kilowatt-hours generated) of prices of fuel oil and coal consumed by electric utility industry in generating electric power, by state and year from 1962 to 1969. (See *POIL* for source.)

PM: Price of mainline industrial sales made on a firm basis, by state and year from 1952 to 1970. Data taken from FPC Form 2 Reports, in $/Mcf.

PSR: Price of sales for resale in $/Mcf from 1956 to 1970, by state and year. Data taken from FPC Form 2 Reports.

PRATIO: $= PG/PO$.

M: The distance from the center of a producing region to the population center of the consumption region.

V: The sum of the squares of pipeline diameters entering the state, by state.

VAM: Value added in manufacturing in millions of dollars by state and year, from 1958 to 1969 (interpolated for 1968). Data taken from U. S. Department of Commerce, Bureau of the Census, *Annual Survey of Manufacturers*.

K: New capital expenditures in millions of dollars; see *VAM* for source.

VCC: Value of construction contracts by states in which work was done, from 1956 to 1970, in millions of dollars. Data taken from *Statistical Abstract of the*

U.S. and from F. W. Dodge Corporation, *Dodge Construction Contract Statistics Service.*

Y: Personal income by state, from 1956 to 1969, in millions of dollars. Data taken from U. S. Bureau of Economic Analysis, *Survey of Current Business.*

N: Population by state and year, from 1955 to 1970, in millions. Data taken from U. S. Department of Commerce, Bureau of the Census, *Current Population Reports.*

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Senator GRAVEL. Our next witness is Mr. John Winger, vice president of Chase Manhattan Bank, a person whose name is often quoted as an authority. I have relied on you as an authority and I have heard many of my other colleagues do so also.

We are honored to have you, and look forward to your contribution very, very much, and appreciate your patience in sitting through the hearings thus far.

Nice to see you again.

STATEMENT OF JOHN G. WINGER, VICE PRESIDENT, THE CHASE MANHATTAN BANK

Mr. WINGER. Mr. Chairman and members of the subcommittee, my name is John G. Winger. I am a vice president of the Chase Manhattan Bank in New York and am manager of the bank's energy economics division. I have been associated with the bank as an energy economist for the past 24 years. I am appearing before you today to discuss the financial requirements of the energy industries; in other words, the funds they will need to provide an adequate supply of energy.

In trying to make my point I have prepared this testimony on the basis of two time periods and for two geographical areas. The first time period, which I will call the short term, relates to a situation in the United States that has nothing to do with the current crisis in the Middle East. The second part of the testimony deals with a longer term and the outlook for oil throughout the non-Communist world. And I hope as I proceed to tie the two time frames together.

My testimony today will prove more meaningful if two vitally important facts are understood at the outset. First, we should recognize that the satisfaction of virtually all needs for goods and services involves the use of energy. In fact, I cannot think of a single business activity that is not dependent to some degree upon some form of energy.

In the United States, as much as 70 percent of all energy consumption is related to business activities. For a long time there has been a consistent relationship between energy consumption and the Nation's gross national product, measured in constant dollars. And there are no apparent reasons for expecting this relationship to change in the future. Obviously then, an adverse impact on the Nation's economy would be the certain consequence of an energy shortage.

Second, we should also realize that the supply of energy is directly related to the expenditures made to provide that supply. That principle applies to all forms of energy—fossil fuels, water power, nuclear power, and the various exotic forms not yet in use. If the expenditures required to find, develop, or otherwise make available a supply of energy are insufficient, a shortage will surely occur no matter how abundant the basic energy resources.

The United States does not lack basic energy resources—an enormous additional supply could be made available if the necessary expenditures were made. But the Nation is now on the threshold of a serious energy shortage because the required capital investment has been inadequate for a long period of time.

It is a shortage that existed before the current crisis in the Middle East. Our concern about the likelihood of an energy shortage was aroused nearly 20 years ago when we first detected the signs of inadequate capital spending. The failure of the energy industries to spend more was not the result of an arbitrary decision on their part—it was instead the result of faulty policies of Government that prevented the generation of the necessary capital funds.

The Nation must now live with the harvest those policies have reaped. Numerous business activities are now unable to obtain all the energy they require and the situation is certain to worsen in the years immediately ahead. By 1976, the energy needs of the United States are expected to be 20 percent larger than in 1972. But there is no possibility that the supply of energy can be increased that much. Let's consider separately the outlook for each of the various sources of energy.

The supply of natural gas will actually be lower in 1976 than it was in 1972. Production cannot be increased because the capital expenditures needed to find and develop a new supply have been inadequate for the past 2 decades as the result of restrictive price controls.

The same price controls created competitive conditions that prevented the generation of the capital funds needed by the coal industry to expand its productive capacity. And there is now a shortage of coal despite the known existence of vast coal reserves. In fact, the United States has within its borders one-third of all the coal in the entire world. Only a modest increase in the supply of coal is in prospect for 1976, not only because of the financial limitations, but also because of environmental restraints on both the production and the burning of coal.

An even smaller increase is in prospect for water power because only a small number of damsites remain to be developed in the United States. Conceivably nuclear power might be expanded substantially but environmental restraints, the failure of the Atomic Energy Commission to license new plants soon enough, the continuing failure of contractors to deliver plants on schedule, and problems associated with the enrichment of nuclear fuel will all operate to restrict severely the growth that actually can be achieved by 1976.

Because of the extremely limited ability to expand the supply of other forms of energy, the demand for oil in 1976 is expected to be fully one-third greater than in 1972. But none of the increased needs can be satisfied from domestic sources. There is absolutely no possibility that oil from the North Slope of Alaska can be brought to market as soon as 1976. And other domestic supply is expected to decline as a result of the long lasting inadequate search for new reserves in the past. Therefore, all of the increased demand will have to be satisfied with imports—if possible. That means imports must more than double by 1976 and constitute more than half of the Nation's total oil supply.

But there is no likelihood that the United States will be able to import as much oil as it will need in 1976. In recent years, the petroleum industry has been unable to build new refineries as a result of environmental restraints. Consequently, market needs have had to be satisfied increasingly with imported refined products.

The refinery deficiency cannot possibly be overcome by 1976, and the need for imported refined products at that time will be more than

twice as great as in 1972. But it cannot be satisfied—there is not enough spare refinery capacity anywhere in the world now, and there will not be enough in 1976 either. Moreover, the governments of other nations can be expected to place an embargo on the export of refined products if their internal needs are not fully satisfied. As you know, the U.S. Government recently took a similar action in respect to agricultural products. In addition, there is the continuing possibility that some of the major crude oil exporting nations may restrict the outflow of oil for either economic or political reasons, as is now happening in the Middle East and Africa.

Under the most favorable circumstances that can be expected, and this does not include the current shutdown in the Middle East, the United States will experience a 5-percent shortage of energy in 1976. But it is quite possible that the shortage could be as great as 15 percent.

As more and more business activities are forced to curtail operations because of a lack of energy, a chain reaction can be expected. Shortages of other commodities and goods, and rising unemployment, are among the certain consequences. It is inconceivable that the gross national product can continue to grow as much as otherwise might be expected if the supply of energy is inadequate.

These, of course, are developments that hopefully will bring forces of correction into play. But they are likely to be slow in coming. The United States must develop its own basic energy resources. It cannot depend upon outside supplies; there simply is not enough elsewhere.

Government must take several constructive steps before domestic resources can be developed. It must remove the price controls that prevent the generation of sufficient capital funds and stifle the incentive to invest. It must permit much greater development of the energy resources located on the vast public lands under its jurisdiction. And it must rewrite the environmental law to make it more realistic, practical, and compatible with the Nation's overall needs. Until such legislation is enacted, much of the development of energy resources can be obstructed.

At best, the United States is destined to experience an energy shortage for several years to come. Whether conditions improve thereafter will depend upon how soon corrective forces are applied.

Now, since it is quite obvious that the United States is going to depend on outside sources of oil for more than half its needs as early as 1976, it is unrealistic to look at our own situation in a vacuum. We must consider the world scene, since we are going to depend upon that scene for so much of our supply, at least for several years to come.

An energy shortage is by no means limited to the United States. It looms for the rest of the world as well. Time does not permit a full discussion of the prospects for all forms of energy, so I am going to concentrate on the outlook for oil alone.

Oil is the single most important form of energy; it will satisfy a much broader range of purposes than any of the other forms. Between 1970 and 1985, oil alone is expected to be called upon to satisfy nearly 60 percent of the total energy needs of the non-Communist world.

On a worldwide basis, and quite apart from the current cutoff in the Middle East and Africa, the availability of oil can be termed tight. And it is likely to become even tighter. In the brief period ranging from 1970 to 1985, the world will consume nearly three-fourths of the total proved reserves of oil now in existence. Obviously, the proved reserves—or underground inventories, if you will—in 1985 will have to be much larger to accommodate a worldwide demand for oil that is expected to be more than twice as large as in 1970. Therefore, the petroleum industry will have to find twice as much new oil in the 1970–85 period as it did in the preceding 15 years.

In any business activity where a product is involved, we know that inventories must increase in some realistic proportion to the expansion of the market demand. And we know also that inventories must be strategically located through the market territory. In the case of oil, the world's inventories, or proved reserves, have not grown in pace with market needs since 1957. And we know also that these inventories are not strategically located. They are concentrated to a great degree in the Persian Gulf and African nations.

If the industry is to find as much oil as the world's markets will need, it must greatly expand its search. And that will necessitate, of course, a much greater capital investment. Approximately $450 billion will have to be spent for capital purposes between 1970 and 1985—far more than the $104 billion actually invested in the search for petroleum in the preceeding 15 years.

In addition, the petroleum industry will need to spend another $360 billion for refineries, tankers, pipelines, storage equipment, and marketing facilities. Therefore, if the world's needs for petroleum are to be fully satisfied, the industry will have to invest more than $800 billion in the 1970–85 period. That is four times more money than was spent in the previous 15 years.

It will need to spend that much more money for several reasons. First, there is the need to discover a great deal more oil. Secondly, there is the need to find oil in more costly areas. I have recently returned from Europe, and the consensus of everyone I talked to about activities in the North Sea indicated that it costs 10 times as much to find oil in that area as in the Persian Gulf area.

But we know there are good, sound reasons for conducting the search in the North Sea. And, if we are going to have reserves better located in respect to market needs, the industry will have to look in more expensive areas throughout the world.

Additionally, we know that there was underinvestment in the past as a result of unfavorable economic circumstances that existed in many parts of the world. Finally, we can find no realistic basis for believing that inflationary forces can be brought under control as long as the efforts deal with symptoms rather than causes.

There are other financial needs to be met, of course. For debt service, enlarged working capital, and dividends the industry will require nearly $550 billion. The total financial requirements for the 15 years, therefore, will amount to $1,350 billion. There are reasons for doubting that the industry can generate such an enormous amount of money.

Let me give you some of the details we have considered in our organization. We have reasoned that prudent management of the petroleum industry is not likely to borrow more than 25 percent of the total

amount of $1,350 billion. The reason for this is that the petroleum industry extensively utilizes off-the-balance-sheet financing. This can be regarded as a hidden form of debt, and when it is included, the total debt ratio would exceed 35 percent.

And also this indicates the opinion of many management representatives of the industry who have spoken on this subject recently.

Senator GRAVEL. Sir, would you go through that again? I do not think I fully understood, and you were talking about a very important point. Would you restate it?

Mr. WINGER. The petroleum industry is considered a high risk industry, and therefore, it cannot depend upon borrowed capital to the degree as an electric utility can with a guaranteed rate of return.

To go on with our calculations—we have decided that 25 percent of the total financial needs is the most that prudent management will borrow. We are not able to measure precisely the amount of off-the-balance-sheet financing, but believe that it ranges between 12 and 15 percentage points.

Senator GRAVEL. So let us say, using the round figures, a trillion dollars, let us say they would borrow that, about $250 billion.

Mr. WINGER. That is right.

Senator GRAVEL. Now, off-the-balance-sheet is—what is that again now?

Mr. WINGER. Well, I am speaking in terms of percentage points. If we consider that $250 billion in that case as being 25 percent, we can add to that approximately 15 percent more, or $150 billion of hidden debt that is in the form of off-the-balance-sheet financing.

Senator GRAVEL. That is what I do not understand, what do you mean off-the-balance-sheet financing?

Mr. WINGER. Well, it takes various forms. One of the most widely used is service station leaseback arrangements. There are similar situations in respect to various forms of hardware, processing plants, storage facilities, and so on.

Senator GRAVEL. Could you carry me through the example of that service station leaseback?

Mr. WINGER. Let's consider a hypothetical petroleum company, and assume 500 service stations are built by the company, and then are sold to someone else and leased back. They are sold in order to——

Senator GRAVEL. So it is not their debt; it is the debt of the person who buys the service station, but it is part of the infrastructure of the industry which they caused to come into being?

Mr. WINGER. The effect is the same as in the case of long term borrowing. A sum of money becomes available in the present and there is a continuing obligation to pay in the future according to the terms of the lease.

Senator GRAVEL. Somebody makes the capital expenditure, and it is just like a real estate transaction where a large chain would lease a store from someone. It does not appear on their balance sheet as a capital item, but they are committed to the lease payment which advertises the capital item held by somebody else.

I understand now. Thank you.

Mr. WINGER. There is a great deal of this type of financing and it acts as a brake upon the willingness of management to incur a high direct debt that does appear on the books.

Senator GRAVEL. It brings in more equity, diversification of equity, or diversification of source. In other words, a small group of people can put their bucks together and buy something like this and be part of the industry but have a guarantee of a company. That adds 15 percent. Now we are still working toward that trillion.

Mr. WINGER. Well, as I said, we cannot measure that as precisely as some of the other things, but we believe it ranges between 12 and 15 percent.

Senator GRAVEL. OK.

Mr. WINGER. Going on, if we start with the amount of money we think the industry is likely to borrow and add to that the expected capital recovery based upon past investment and needed future investment, we can calculate the amount of net earnings that will have to be accumulated over the 15-year period. The indicated amount is $655 billion.

If the industry were to generate that total volume of net income over the 15-year period, it would have to achieve an annual growth in earnings of 18 percent between 1970 and 1985. And it would have to achieve about a 16.5 percent rate of return on its investment.

Senator GRAVEL. That would be a constant. It would have to be at that level and stay at that level for that period of time in order to have the cash flow from earnings to move into these expenditures in that same time frame?

Mr. WINGER. That is right.

Senator GRAVEL. So that would give you your trade.

Mr. WINGER. Well, now, to give you some additional parameters let's suppose that the industry borrowed 30 percent rather than 25. In that case, the growth of its earnings would be reduced—required growth, I should say, would be reduced from 18 to 16½ percent. If the industry should borrow as much as 35 percent, then the required growth in earnings would be 15 percent.

We have the question which is constantly raised in financial circles and also within the industry itself—is it politically realistic to think that the industry will be able to generate that amount in earnings? We can look at the past record for guidance. In the preceding 15 years the industry achieved an 8 percent annual growth in earnings; in the last 10 years, slightly more than a 5 percent growth in earnings; and the 4 years ended in 1972, less than 1 percent growth in earnings.

Senator GRAVEL. You are not talking from your text now, right?

Mr. WINGER. Yes; I am inserting additional facts. I should have mentioned that.

Senator GRAVEL. The last 15 years have been 8 percent growth?

Mr. WINGER. Yes, and in the last 10 years, a little bit more than 5 percent.

Senator GRAVEL. The last 10 years of those 15.

Mr. WINGER. And in the 4 years ended in 1972, less than 1 percent annual average growth.

Senator GRAVEL. What is the base?

Mr. WINGER. 1970 is the base year.

Senator GRAVEL. And what amount of earnings did you have in the base?

Mr. WINGER. We use our 30 company study group as a base. The group constitutes more than three-fourths of the industry throughout

the non-Communist world and its combined earnings in 1970 amounted to $6,638 million.

Senator GRAVEL. Could you do that for us? In fact, Mr. Winger, would you be kind enough to maybe make us a little chart of this? We could try it in staff, but I think with the expertise you have; you have probably in-house—just this one chart would be very valuable to us.

Mr. WINGER. Yes.

Senator GRAVEL. I think it really makes a very strong case about earnings; and as you know, that is the biggest problem we have in the conventional wisdom, that the oil companies are unconscionably getting rich at everybody's expense; and that is why they are at fault.

Mr. WINGER. As a matter of fact, we had made that kind of chart for the 30 companies that comprise the bank's study group.* This is a group of companies whose financial performance the bank has studied for many, many years. This group has, up until the current year, represented more than three-fourths of the petroleum industry in the non-Communist world.

I say has, because as a result of participation agreements that proportion has changed. But we are thoroughly convinced, as a result of our other studies, that the financial experience of this group quite accurately reflects that of the industry as a whole.

Now, in the first 9 months of this year, that group of companies has achieved a 59-percent increase in earnings. We do not expect the fourth quarter, for a variety of reasons, to show any gain. If the group's earnings this year show, as expected, a 50-percent increase, they would nevertheless fall more than a billion dollars short of the amount required to be on the 18-percent average annual growth trend.

Senator GRAVEL. What accounts for that growth at this point for this year—scarcity, foreign operations?

Mr. WINGER. Well, there are a number of factors, some of which are abnormal. For the most part, the growth in earnings has been achieved outside the United States.

Senator GRAVEL. So the domestic companies, which is the activity which we are primarily concerned with, have not experienced that kind of growth?

Mr. WINGER. They have not fared nearly as well.

Senator GRAVEL. Will your study—excuse me. Will your study show this? You say you have a booklet on the analysis of these 30 companies? Will that show us that?

Mr. WINGER. We are not able to make that kind of split on a quarterly basis because the data are not available. We will be able to make the division on an annual basis after our survey is completed 5 months from now. We do know, however, as a result of some of the announcements that have appeared in the media and also from our own discussions with a number of the companies, that the major part of the increase did occur outside of the United States.

I can say to you as a result of my having recently completed 5 weeks of travel abroad that the awareness of the energy shortage is much greater virtually everywhere else than it is here in the United States.

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*The material referred to appears in an attachment to Mr. Winger's statement, pp. 426 ff. of this volume.

And that awareness, of course, has had an effect upon the marketplace and the willingness of consumers to pay higher prices.

There are also technical conditions involving the relationship of the companies with the producing nations that have created an abnormal increase in earnings this year. But the nations comprising the OPEC groups arbitrarily established new terms in October which will automatically maintain the posted price for oil at a level 40 percent above the market price. And that change will severely limit the size of earnings in the future.

If the group were to generate enough earnings in 1974 to be on trend, it would have to achieve a 30-percent increase over this year's earnings. And if the group's earnings next year were to be on trend and also make up the deficit for 1971, 1972, and 1973, they would have to be 70 percent higher than this year.

So, despite the large percentage changes, there is still an undergeneration of earnings relative to the capital needs of the group, and of course, the capital needs reflect the world's needs for petroleum.

We have before us the very serious question of whether or not it is realistic to expect that the industry will be able to generate such earnings; or, in the light of political realities throughout the world, is this impossible?

If it is not possible, the industry will not be able to maintain its capital expenditures. The indicated need to spend $450 billion for finding and development through the world in the 15-year period requires a 13-percent annual increase in such capital expenditures.

The industry in the past 15 years increased such capital expenditures at an annual rate of 5.5 percent. If the expenditures continue throughout the 1970–85 period at a 5.5-percent rate, the industry would spend only $200 billion in its search for petroleum instead of the required $450 billion. And since there is a direct relationship between the amount of money spent and the amount of petroleum found, the industry obviously would not find enough. And in that case we could, indeed, expect a progressively worsening worldwide shortage of energy.

I am sorry I must paint such a bleak picture.

Senator GRAVEL. Could I ask a question there? Is there enough money in the world to do this? We are just talking about out requirements. The balance requirements of the world are accelerating at a faster rate, assuming they do not seek the same rate of sufficiency that we seek because their trade patterns are different and can sustain probably something different than we can, and their political role in the world is somewhat different than ours, but just looking at the totality of the needs, is there enough capital available to do the job, just in energy? I am not talking about other areas, which I think, of course, compete with capital also.

Mr. WINGER. This is exactly the kind of question that is being raised increasingly these days within the capital markets—is it possible—because it is recognized that one of the basic reasons why our energy needs in the United States will increase in the years ahead relates to a basic demographic factor. Because of changes in the birthrate in the past, we are now in a period that will witness a very large in-

crease in the size of the age group that ranges from 20 to 35. This is the time in life when the demand for goods and services is greatest—people get married, establish households, and equip those households with everything that goes in them, including babies. Bankers refer to this particular age as the age of dissaving.

Senator GRAVEL. Dissaving. They have not even gotten to the age of saving. That comes after.

Mr. WINGER. They are not a source of savings nor a source of capital. But the satisfaction of the needs of all these people, plus those of the rest of our population, will stimulate economic activity and that leads to the belief that there will be a very vigorous demand upon the capital markets from all the rest of our economy.

In responding to your question, I think it would be helpful if I added a bit more perspective—so let's return to the outlook for the United States and measure the financial needs of some of the other energy industries.

The capital requirements of the electric utilities in the United States in the same 15-year period from 1970 to 1985 will amount to nearly $500 billion. The total financial needs of this segment of the energy industries will be close to $600 billion. And, in this particular case, about two-thirds of that amount of money will have to come from the capital markets.

The natural gas utilities will have a need for about $135 billion in this period of time; and then we come to the domestic petroleum industry. Now, in the past——

Senator GRAVEL. Mr. Winger, unfortunately I have to go and vote. I would hope that you would continue, and Mr. Best here has some questions. But if you feel there are some particularly important areas that you want me to hear, if you would just be patient, just wait and I will come right back.

He may have some questions, but you continue on. And I will be reading the record in any event.

Mr. BEST. Mr. Winger, that $1.3 trillion figure is to develop worldwide energy resources to satisfy a worldwide demand, is this correct?

Mr. WINGER. Yes.

Mr. BEST. It does not really say anything about what it would cost to develop U.S. indigenous resources to meet U.S. demand and to reduce our dependency upon foreign imports to, say, 15 or 20 percent.

Has the Chase Bank or any other group done any studies that you are aware of which would answer that question?

Mr. WINGER. We have. We know as a result of our financial surveys for so many years that, of the total capital investment of the petroleum industry throughout the non-Communist world, about 70 percent is carried on by American companies. Of the total capital investment devoted to the search for petroleum, approximately 80 percent is carried on by these companies.

Now, these expenditures made by American companies are, to an important degree, made possible as a result of earnings generated outside of the United States where the market is now substantially larger than within. And while we might say that these earnings should be repatriated to the United States and spent here, people in other parts of the world will argue against that; they say these earnings were gen-

erated from gross revenue that came out of their pockets. And the companies therefor have an obligation to spend where it will help them. Actually, the capital investment will take place where the best return is promised.

Since our needs for energy in the United States are so vital, it is imperative to create a climate for investment here that at least equals or is greater than that in any other part of the world. We are in trouble today because we have not done that in the past. We have permitted the climate to deteriorate.

Mr. BEST. That is exactly the point. There was a table that was provided to us, which perhaps we could find or make available to you, which shows that because of the nature of our own tax system, $1 million invested in the United States in oil and gas investment and $1 million invested abroad, all other things being the same, would yield a greater economic benefit to the foreign investment than to the U.S. investment.

Now, at a time when the United States is denied the fruits of the foreign investment—and indeed, the American investments, say, in the Middle East may be supplying some of Europe's and Japan's dire needs, but they are not supplying ours—does it make sense to have a tax system which in fact encourages the foreign investment over the U.S. investment where you are trying to get a system established where the United States will not be do dependent upon the foreign supply which could be cut off?

Perhaps our tax system, without penalizing anybody, should aim at encouraging domestic investment even more than foreign investment, which was the point I think you made.

Mr. WINGER. Well, we need a tax system that will attract capital investment not only on the part of the American-owned companies, but other companies as well. I was recently in Europe, Latin America, and the Far East in connection with a bank-sponsored program. It was a program that has gone on for the past 11 years and is sponsored by the bank to promote investments in the United States and get more capital throughout the world effectively working.

And from people in all of these areas I learned of their concern about investing in the United States. They are fearful about what can happen here, changing political conditions that will have the effect of making the United States a poor choice of the numerous investment opportunities available to them.

Mr. BEST. Well, let us assume for the moment that the Congress and the Executive act wisely and there is a healthy investment climate in the United States. When you have indigenous resources of oil of 346 billion barrels; of natural gas of 1,178 trillion cubic feet; of coal, 394 billion tons of coal; uranium, 1.6 million tons; and oil shale, 100 billion barrels; and our consumption is less than 1 percent of those figures, we are a country which could, if we wanted to, adopt a policy, become relatively self-sufficient in energy unlike Japan which could not if they had all the capital in the world.

But our policies maybe in the past have sought to allow companies—and it was wise policy at the time—to invest where the resources are. And we know that in the Middle East 63 percent of the world's reserves of oil are; but if you wanted to spend your money—the lifting cost in Saudi Arabia is 6 cents a barrel as opposed to over $1.00 here—it

seems that it makes a lot of sense to invest your money here. Well, that is history.

Can we rely on Saudi Arabia to supply 40 or 50 percent of our needs in 1985? I think it is clear that the answer is no. So we do not want to direct capital just to the place where the resources are the cheapest; but to direct capital to the place where it would be most secure, and then it will cost more.

Do you agree with that?

Mr. WINGER. Yes, because it is quite obvious from our studies that unless the petroleum industry can devote more money to the search for petroleum, Saudi Arabia and the other oil producing countries will not have enough to supply our needs and the needs of the rest of the world. It simply will not be there.

So some agency, either the industry as we know it, or some other agency will have to spend the money. If the industry does not spend it, then we are faced with the question of who will.

Will it be the producing country governments, or might it be the governments of consuming countries? But whether it is the private industry or whether it is government, the costs still will have to be paid. And we are very much concerned at present because we see storm clouds on the horizon that can make our current energy situation rather mild by comparison unless forces of correction are brought into play.

Mr. BEST. One thought that Senator Gravel has which I can bounce off of you and you can take it back to New York with you and meditate on is that in the past when you wanted to do a job we established a ready source of funds which were automatically raised and disbursed. When we wanted to build highways after World War II we established the Highway Trust Fund. We did the same thing recently for airports and their facilities. We have a Social Security Trust Fund to take care of the elderly.

Well, if we are going to raise the capital necessary to resolve the energy problem, do we need an energy trust fund which would be financed by some type of a tax system, whether it be a Btu tax at the source or a tax at the consumption level, which would then be used both to finance research and development for new sources of energy and also to provide the loan guarantees that you may need as a banker to provide money to the fellow who wants to invest in oil shale or in coal gassification equipment, or in solar energy, or some other form of energy?

Has your bank ever considered the need for some type of a trust fund for energy which would help attract the private capital, and to use the private finance industry, to encourage private industry to do the job just as we did with the Highway Trust Fund and so forth?

Mr. WINGER. Well, such ideas have been considered, and indeed they have been attempted on a much smaller basis by individual companies, something similar to that—trying to tap other sources of capital. We must, of course, realize that the monetary resources of the Nation are in the nature of a closed circuit. We must recognize that government and the private economy compete for the same sources of money.

We need to consider where the money is going to come from. It would have to come largely from taxpayers and taxpayers and consumers are one and the same. I think that we have good reason for

continuing faith in our economic system. It has served us very well indeed, until we began about 30 years ago to interfere with its performance. And that is really why we are in trouble today.

I do not reject the idea of a trust fund, but I think we ought to go back and again, with a little faith, see if our economic system will not function once more as it did in the past. If that fails then we should consider this idea.

Senator GRAVEL. Let me just interrupt there. I did not hear the question, but I heard the answer.

In the trust fund we are talking about the public area, so there is no way that we can get large sums into the public area without a substantial raise in taxes. The private area, the area that you essentially have treated in your paper, is another problem altogether. But with the trust fund all we are going to do is take money where the private sector cannot do it. So if you ask the question, can the private sector do the job, there? The answer is, no way that the private sector right now, of its own volition, not if it involves some exotic type of prototype design and construction of solar energy activities or fusion reactors. That is just not going to happen.

So how do we get the money to do that or to pay for some prototype activities if it is not through the public sector?

Mr. WINGER. Well, I would come back to that in this way. If we study the history of the petroleum industry from 1859 up until the present, we would learn that most of the petroleum, oil and gas which has been found since that time has been discovered in areas that were once considered either barren or beyond reach. Twenty years ago the maximum depth in which a drilling operation could be carried on in water was 10 feet. Today, they are drilling in excess of 800 feet.

Technological progress went on because there was a need for it. The Drake well in 1859 went down 60 feet. That was as far as they were capable of going at that time. Today we have drilled in excess of 30,000 feet in this country, and recently the Russians announced that they have started two wells that they intend to take down to 50,000 feet.

Well, what lies between 50,000 and 30,000 feet? No one really knows because we have not been there. Geological knowledge is in a constant state of evolution—oil being found where it was not believed to have existed before.

I emphasize oil because of its versatility. We do not know how much there is remaining to be found. I have provided numbers today based on past experience. But there is no guarantee that if this money is spent that the oil is going to be found. We will not really know until a truly exhaustive search has been made. And in my opinion, we cannot afford not to make that search.

But I think we should recognize that management is more capable than any of the rest of us in determining whether capital is better employed in the conventional search for petroleum, or whether it ought to be used to produce synthetic liquids and gas from coal, or to develop the shale or tidal power or solar power. And I think through the taxing mechanism we can provide incentives, tax incentives, that will insure that a certain amount of money will be spent on R. & D.

We have, I think, as much hope for encouraging results by that means as we would have with one gigantic program. The risks would be much lower and, conceivably, the net results much better.

It may be that the program would be premature, that we would start down some other avenue before we had really exhausted the potential of the avenues we are now on. Once again, I believe we should have more faith in our economic system than is apparent.

Senator GRAVEL. But that is not the conventional wisdom, though now, Mr. Winger, that the industry has performed very well. In fact, the conventional wisdom of the Nation is just the opposite. The conventional wisdom now is that the oil crisis is a product of a conspiracy, one; two, that the oil companies have been ripping it off.

In the face of the flight of capital that you point out, and in the face of the lesser amounts of return compared to other manufacturing interests, with these very facts before us, the conventional wisdom in the Congress and in the Nation is just the opposite.

I understand the phenomena. It is a product of ignorance, but it is a phenomena that we have to face as we try to develop a policy and seek agreement of Congress on policy, because Congress only mirrors the perception of the people in this country.

Mr. WINGER. Well, our problems really commenced with the passage of the Natural Gas Act in 1938 and the subsequent decisions in respect to how that act should be implemented. And as an unfortunate result, we prevented the development of our basic energy resources. We created an energy market wherein neither domestic oil nor domestic coal could possibly compete with gas, and this situation, as you know, continued without correction and reduced our once vast, huge reserves of gas to the present inadequate level.

Had we not done this, had we let market forces develop all through the period since 1938 up until the present, I doubt very much that we would have a shortage either of petroleum or of coal. But we created that situation, and I do not think that we can blame the management of the energy industries because capital was utilized elsewhere.

I am thinking particularly of the smaller independent producers who simply picked up their capital marbles and went in other yards to play.

Senator GRAVEL. Not just the small independent company—Gulf Oil is in the real estate business and is essentially becoming a conglomerate rather than just an oil company.

Mr. WINGER. Yes, because we did not give them the incentive to continue as just an oil company. And Gulf Oil and the other large major companies all depend very heavily upon the results of the efforts of the independent producers. So in effect we caused the independent producer to diversify into other areas of economic endeavor. We caused the major companies to do that also, and we have also caused the major companies to take the earnings generated abroad and invest them abroad, because by tinkering with our economic mechanism in this country, we created a climate for investment that was not attractive. On the other hand, we might very well have had the major foreign oil companies investing in the United States had the climate remained sufficiently attractive.

So I think the failure of the system is the result of our tinkering with it, and not the functioning of it.

Senator GRAVEL. How do we sell that to the people in this country, and in turn the Congress?

Mr. WINGER. Well, I make a lot of speeches in the course of the year—more than 100—and many of them are to the man in the street. And I find that man pretty understanding, quite a reasonable fellow, when I try to communicate with him in terms that he can understand.

I do not know that any of our major industries, including the banking business, communicates effectively with the man in the street. And I am not sure that Government does that either. I am more impressed with the results of the relationship in Japan, where government and industry function in greater harmony than in this country.

I think the man in the street is confused. He really does not understand what is going on when industry in this country is attacked because it is big. And I do not know how we are going to help ourselves and retain our position in the world community of nations, unless we begin to work in greater harmony than we have in the recent past.

Mr. BEST. I just wanted to focus on what the chairman said regarding the trust fund. The trust fund concept is not viewed as an alternative to a free market in the United States. I think that there is general agreement among most of the witnesses that—in fact, all of them that I am aware of except one—have suggested that a free market is a good answer to the U.S. problem.

But a free market also, it seems to me, has to be viewed in the context of the international competitive situation. If you had a free import policy and a free domestic market, I am not sure that you would have the 10,000 independents that are still left in the United States which do produce a significant quantity with the indigenous resources that we have.

So what are your views with regard to a free domestic market where the price might go up to, say, $7 a barrel or $6.50, or whatever is the equilibrium price, coupled with an import policy which would reduce the U.S. dependency on foreign sources of energy?

Mr. WINGER. Well, the United States was once the price leader of the world. It no longer is, and it is not likely to be in the future. It is now a price follower, and whatever we pay for energy in this country, if we are going to have enough, will have to be based upon world prices, and also based upon the cost of alternate forms of energy. We have seen the coal industry in the United States devastated ever since World War II, partly by technological changes, but also because of this impact created by the regulation of the price of gas. The coal industry is desperately in need of capital funds. Now, where can the money come from?

Let's look at the coal industry. It is comprised of a half a dozen sizable companies and a very large number of small family owned operations. The latter simply cannot cope today, because they can load at best only part of a carload of coal a day when the modern electric utility needs train loads. We cannot really expect them to generate the amount of capital needed to develop the coal industry as an alternate to imported oil.

Conceivably, the oil companies and the electric utilities can be a source of capital. But yet, I am aware of a deep suspicion on the part

of people in government whenever an oil company acquires coal reserve. They seem to think that this is an evil scheme to monopolize the energy business.

Now, if we had the capital funds to develop coal, and if we had environmental regulations that would permit the development of coal, if we had a price for coal that was sufficient to carry on the mining and also restore the land so we could achieve a better environment at the same time, what would the price of coal have to be?

We do not know because the coal industry has been devastated for the past 25 years as a result of the price controls on natural gas. Now, conceivably if the coal industry is permitted to develop, if the capital formation can go on and we remove the environmental restraints, we may then find a price for coal as such, or coal converted to synthetic liquids and gas, that would limit the price of foreign oil. And when that happens, we might know what the competing costs of various forms of energy would be. We do not know that now, and we really cannot find out until we permit market forces to determine what that price is.

Mr. BEST. As a banker, would capital be attracted into gasification of coal or any of these other alternatives in the hundreds of millions or billions of dollars that are necessary unless the investor was assured that after making the investment there would be a market, and that if it costs 80 cents an Mcf for the gas from the coal, that that gas would then still be competitive with alternative sources of energy? If a substitute could be found say in Saudi Arabia where the lifting costs are about 13 cents a barrel—even though right now it is selling at a high price, because there is a sellers market—but it could drop if we bring on new productive capacity, and you know the international price was much below our domestic prices for so many years until they got a sellers' market and then were able to operate OPEC effectively.

But if we do not preserve, if we do not preserve a domestic industry and attract the capital, and then say that imports will not increase after you make that investment—who is going to spend the money to invest in our own indigenous coal or whatever?

It is the import policy that I am trying to drive at.

What type of import policy would we need to attract the capital in our own domestic industries?

Mr. WINGER. First, there was an article in the "New York Times" this morning relating to the sale of some of the government oil in Algeria for more than $16 a barrel. Now, that equates to about three dollars an Mcf for gas. I have no idea that $16 a barrel is going to be the ultimate world price for oil. It may be. It may be higher, it may be lower. But if it is going to be much lower, than there will have to be surplus of energy throughout the world to get it lower. And the only way we are going to have a surplus of energy to get that price moving to lower levels is to make the investment to develop the energy supply, and I think the first part of your question referred to what the capital market or the supplier of capital would be willing to provide.

I cannot speak for all of the capital markets, but for some elements I know the opinion today is that the energy industries must have their capital needs satisfied, because if this does not happen then there will

be a cloud over all other investment because our economy will suffer. We will be unable to carry out our social programs, and we will not be able to achieve a better environment.

We must have the energy, and if the price gets to a level that will, say, put a strain on some of us, that is the best way I know of, of keeping down the wasteful use of energy.

Senator GRAVEL. Could I ask a question in that regard?

Could not the plummeting of the stock market in the last week or so—obviously in anticipation of the contraction that will take place in the economy—but could not also the plummeting be a kind of a cloud, too, because there is no visible policy for the Nation in these perilous times, and then if a policy were charitable and if the marketplace saw that we were going to vector the necessary capital incentives to the energy area, that this in itself would cause some strength to come back to the stock market?

Do you think that is a reasonable statement?

Mr. WINGER. Well, I cannot pose as a market expert. If I were I would be out playing golf someplace right now. But based upon what some experts are saying, yes, the reaction of the market does reflect the concern that we are drifting. We are without a policy—or rather, we have had a faulty policy for the last three decades that has brought us to this predicament. We need a better policy. It is not really the absence of a policy. And if we have——

Senator GRAVEL. How would you characterize that policy?

I think that is very important.

How would you characterize that policy that we have had?

Would you describe that to us?

Mr. WINGER. Well, I think our policy could be summed up in just a few words. It has been a policy of trying to keep the price to the consumer as low as possible, without recognizing our capital needs. We have forgotten that our chosen economic system is the capitalistic system. We say we support it. We say we do not like the other systems, but then we turn right around and obstruct the performance of our chosen system. It has brought the Nation to a perilous point now, and the market is reacting to that.

There was another part of your question that I failed to respond to, and that is that we should remember the tremendous leverage of the small change in the consumer price. If the petroleum industry were able to find reserves at the same cost as in the past, and if it tried to maintain self-sufficiency of 60 percent, the industry's capital needs between 1979 and 1985 would be something in excess of $200 billion. There would also be other financial needs, but let me concentrate just on the capital needs.

If the industry wanted to raise that self-sufficiency by 1985 to 75 percent from about 60 today, our calculations indicate the need to spend $50 billion more over that period on the search for petroleum. To be able to spend $50 billion more would require generating $100 billion more, because another $50 billion would have to be paid in taxes to the Government on higher revenue. We know of course that if market forces are permitted to function that the petroleum industry would generate that $100 billion by changes in all of the petroleum products. But we have heard stories to the effect that the price of gaso-

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line was soon going to exceed $1 a gallon, and we wanted to test that idea.

So we programed the computer to generate all of the $100 billion dollars solely through the sale of gasoline. And we learned that, that it could be done with a 12 cent a gallon increase in the price of gasoline. And then, when we integrated that increase with the other costs of owning and operating an automobile, the total cost would go up by 4 percent, which is fairly manageable.

Senator GRAVEL. This matches very closely to the figures we had from Mr. Hickman yesterday when he talked. On the outside, you could see a rise of 15 cents of oil. To some, that is disaster. But to yourself and I think to ourselves that is how you get the capital to go find the product.

Mr. WINGER. To some it is also disastrous not to have enough gasoline to get to work. And I think we need to bear in mind that as a result of the construction of our Interstate Highway System we have created a gigantic strip city. This is where most of the growth has been in the last 20 years, not in the central cities, nor is it in large cities at all. It is occurring in smaller cities, but for the most part it is in the strip city.

And the only way to get to and from work is by automobile. And it is not always practical to go to and from work in car pools, either, because people in communities may go off in all different directions. And the price of gasoline, even with 12 cents more, even for the lowest salaried working person, is not a major amount.

We can look at 1972, when the total cost of running automobiles, heating homes, operating all appliances—the total direct cost of energy-represented less than 5 percent of the average family's income. Now, approximately another 5 percent is devoted to savings. That leaves them 90 percent paid out for food, shelter, clothing, medical care, recreation, and the cost of government.

Somewhere in that 90 percent there are expenditures, I believe, for all families that are less essential and can be cut back if need be. There really is not a choice. We are going to have to pay enough to satisfy our energy needs or go without.

Senator GRAVEL. I have one other question. Does it make any sense for a Senator or a Congressman to vote funds to defend Israel and at the same time to vote to maintain strict controls over natural gas prices which according to the experts, encourages American companies to invest in Algerian gas or in gas from the Soviet Union, which then puts their State and their districts sort of dependent upon the very source of supply which is very insecure, and the very countries that have the fate of Israel in their hands?

I mean, can you see any rationale for a policy of maintaining a price on natural gas which causes this kind of a shortage and creates an incentive to go to Algeria, when Algerians are at war with Israel?

I am sorry, but I just do not see the rationale.

Mr. WINGER. Well, as you stated the question, it does not make sense. But with your permission I would like to add a qualification to that, because those organizations that have sought to go to Algeria have been the natural gas companies. As I am sure you recognize, a regulated utility must always grow. If it is not growing, it is liquidated,

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because it is constantly writing off its rate base. And the circumstances have really driven these utilities to the wall. They are fighting desperately for survival, and to survive and to continue to satisfy the needs of their existing customers, they have to resort to desperate means and take high risks, risks that really are not warranted for any regulated industry. But, they are doing their very best. And that is why they will go to such sources and pay a very high price, knowing that it is risky.

Senator GRAVEL. I was not questioning the motives of either the investor or the Senator or the Congressman. I was just trying to explore the rationale for a policy. I can understand why, if there is going to be a shortage and there is a control on the wellhead price, that somebody is going to say, well, let us get the gas anyway, because there is a market there and we will be able to sell it at $1.35, and so forth, an MCF. But, what if the public policy rationale for encouraging that type of an investment, and at the same time trying to spend billions of dollars in that part of the world on the other side. It just seems to me——

Mr. WINGER. Well, I think I could go right along with you and add a number of examples to your list. And I cannot provide a satisfactory answer to such a question, and satisfy in my own mind why we do some of the things we do. I have never been able to do that, because it does not make sense to me.

Senator GRAVEL. I would like you to tell us what you said about utilities and the base, and what this causes us to do, which you elaborated on. This was to my first question.

Mr. WINGER. Well, this could be answered much better by someone from one of these utilities. But the rate base, the rate that they are permitted under regulation to charge is based upon their investment. And if——

Senator GRAVEL. The capital investment they have?

Mr. WINGER. If their market is growing and their capital investment grows, then their base is growing. Then if they have a declining volume of gas, their market is shrinking, and there is no reason for making an additional capital investment, they would be writing off more than they would be adding.

Senator GRAVEL. But once the whole capital investment has been amortized and paid off, then why should they—there is no reason to continue charging that to the consumer.

Mr. WINGER. Well, that would be more realistic if they did not have such a large amount of debt.

Senator GRAVEL. Well then, there is obviously a disparity between the retirement of debt and the writeoffs of the capital goods that should go together.

Mr. WINGER. And also this incentive to diversify. What we have seen some of our gas utilities go heavily into other areas of business because they see no growth opportunities in respect to the market.

Senator GRAVEL. I have another vote again. I think we have exhausted all of the questions. And the item that I asked you for, Mr. Winger, if that could be provided that would be really most helpful to us.

Mr. WINGER. Yes, we can do that.

Senator GRAVEL. And I cannot thank you enough for the contribution you have made to the case in point, and I think we will be using your material extensively. Thank you.

And these hearings are adjourned.

[A statement by Mr. Winger, and two documents submitted by Mr. Winger, follow. Hearing continues on page 490.]

OUTLOOK FOR ENERGY IN THE UNITED STATES TO 1985

(By John G. Winger, Vice President; John D. Emerson, Energy Economist; Gerald D. Gunning, Associate Energy Economist; Richard C. Sparling, Financial Analyst; and Arthur J. Zraly, Associate Energy Economist, The Chase Manhattan Bank)

FOREWORD

Energy is absolutely essential to the welfare of the United States. Because all human life depends upon energy, the nation could not possibly do without it. Denied a sufficient supply of energy, any developed country would progressively revert to a primitive state.

Anyone who doubts the importance of energy should try to imagine what conditions would be like without it. With no energy, the nation's economy would come to a standstill. There would be no production of raw materials, no industrial activity, no manufacturing, and no commercial enterprise. If none of the primary sources of energy were available, it would be impossible to generate electricity. And the countless needs for electricity everywhere could not be accommodated.

Because there would be virtually no agricultural activity without energy, very little food could be produced. And the food could not be cooked even if it were available. Lacking energy, homes and all other buildings could not be heated—or cooled.

Except for walking, there would be virtually no means of transportation without energy—not even bicycles could be manufactured. Private automobiles, aircraft, trains, trucks, buses, ships, and rapid transit systems would all be halted. Neither people nor freight would be able to move.

Most of the activities of government could not be carried on if there were no energy. Schools, churches, hospitals, doctors, and dentists could not function effectively. And most communication would cease. Radio and television sets could not be operated and programs could not be transmitted. Newspapers, magazines, and books could not be printed—there would be no paper, no ink, no power to operate the presses, and no means of delivery. Mail service would be almost nonexistent.

Without energy, the nation would be virtually defenseless. The vast defense system that has been created at enormous cost would be rendered largely ineffective if its operations were limited by a lack of fuel or if necessary support activities were halted for the same reason. Surely, the perilous nature of that condition must be apparent to all.

Although a total lack of energy is not a realistic prospect for the United States, there is an actual and growing potential for an inadequate supply. And a lasting shortage or even a temporarily interrupted supply can have a devastating impact upon the nation's economy, its standard of living, and its defense posture. It is imperative therefore that the future energy needs of the United States and the potential for satisfying them be known. And it has been the purpose of this study to measure as percisely as possible both the needs and the supply prospects for the period ranging from 1970 to 1985.

This report is another in a continuing series that was initiated many years ago. It brings up to date and is an extension of a similar study published in 1968 that related to the energy outlook for the 1965–1980 period. Developing problems discussed in that report have since become more clearly defined. It is now obvious that the United States is faced with a very serious situation in respect to its energy supply. And, unless positive corrective actions are taken immediately, the problems will become critical.

INTRODUCTION

The Sources of Energy

In the beginning, man had to depend solely upon his own muscles to provide the energy to satisfy his limited wants and needs. Later, he discovered new sources

of energy to do his work for him. He learned how to use the energy of the wind and falling water. And he also learned how to harness the energy of animals. But man's most rewarding discovery was the use of fire. For it has been the many and varied uses of the energy released by burning some substance that have done the most to enrich man's life and raise his standard of living. Without them, most other important discoveries and developments would not have been possible.

Man first used fire to keep him warm. And today the use of fire for heating continues to rank among the most important of all uses. At an early date man also began to use fire for cooking food. And that too continues to be among the most essential uses. Fire was also man's earliest source of light. And currently it is still involved in the production of most of the artificial light utilized by man.

By applying the heat of fire to water man learned how to produce steam, thereby setting the stage for the invention of the piston steam engine and later the turbine steam engine. With these inventions a vast new world opened up for man. His capability for production was increased enormously. For the first time it became possible to manufacture at lower cost a wide variety of merchandise in large factories with machinery powered by steam engines instead of producing a limited amount of expensive goods by hand in small shops or in the home. And the products of the factories could be transported much farther and faster with steam-powered locomotives and ships. Later, man learned how to produce electricity. And steam engines enabled him to generate electricity on a large scale, thereby further expanding his productivity and well-being.

Still another vitally important use of fire began with the invention and development of the internal combustion engine. Once more man's productive capacity was greatly enlarged. And his ability to transport himself and the goods he produced was revolutionized. Today, automobiles, trucks, buses, aircraft, and railroad locomotives are virtually all powered with internal combustion engines. Most agricultural machinery and mobilized construction equipment is also powered with such engines.

Clearly, man's controlled use of fire has contributed enormously to his progress and welfare. Currently, as much as 86 percent of all the primary energy consumed in the United States is devoted to the various methods of utilizing combustion. And, obviously, there is an enormous need for combustible materials. At first, primitive man used wood for burning and for a long time thereafter it continue dto be an important source of primary energy. But, with the growing availability of other sources, the use of wood declined and there is no longer any significant consumption in the United States. The ability of coal to support combustion was discovered early in history and eventually coal became the world's principal source of energy. As recently as 1940, coal was still the single most important source of primary energy utilized in the United States.

Oil was discovered in Pennsylvania in 1859 and for many years thereafter it was used primarily as a fuel for lamps. But with the invention and development of the automobile the needs for oil began to expand rapidly. Because it is a liquid, oil is more versatile than other forms of primary energy. And, as a result of that characteristic, many uses for oil rapidly developed in industry, commerce, agriculture, and the home. By 1950, oil had displaced coal as the nation's leading source of energy.

Originally, natural gas was a by-product of the search for oil. It was found associated with oil and also in reservoirs by itself. At first, it was considered of little value and for a long time only the gas associated with oil was produced. Part of that production was utilized locally and the rest was simply flared to the atmosphere. But, after World War II, the true value of natural gas as a primary source of energy was recognized and there were vigorous efforts to develop widespread markets for it. Because of its excellent combustion characteristics and the exceptionally low price charged for it, gas began to be used at a rapidly increasing rate. And, by 1958 it displaced coal as the nation's second most important source of energy.

Falling water was another of man's earliest sources of energy and it continues to be used extensively. At one time the energy created by the movement of water was applied directly to operate machinery of various kinds. But today it is used almost exclusively for generating electricity. Of the total amount of primary energy utilized in the United States currently, water power represents nearly 4 percent.

Nuclear power is the nation's newest source of energy. The practical application of nuclear power to peaceful purposes became a reality only within the past

few years. With minor exceptions, the direct use of nuclear energy is limited to the generation of electricity. But for that purpose it promises to be of rapidly growing importance as time goes on. Because it is so new, nuclear power currently constitutes less than 1 percent of the over-all energy supply in the United States. It will, however, become a more significant proportion in the years ahead. Although heat is involved in the nuclear reaction, combustion does not occur in the usual sense that is meaningful to the layman.

Strictly speaking, anything with the inherent ability to perform work may be called energy. And in that sense, there are many sources, including human beings and animals. But for practical reasons, the scope of this study is limited to those five primary sources that perform the great bulk of all the nation's work—oil, natural gas, coal, water power, and nuclear energy. There is a tendency on the part of some to think of electricity as a primary source of energy too. But actually it is not—it is considered a secondary source because a primary source necessarily must be utilized to produce electricity.

Energy as a raw material

For the most part, the five sources of energy are used to perform work. But some are utilized for other important purposes as well. For example, most of the organic chemicals produced in the United States are derived from petroleum. Coal can also be used as a chemical feedstock. And from these chemicals a wide and rapidly growing range of important products is produced in turn. Petroleum is also utilized extensively as a paving material for the nation's streets, roads, highways, and parking lots. And much of the roofing material used in the United States is produced from petroleum. More than three-fourths of the nation's rubber supply is also derived from petroleum. And the use of petroleum as a lubricant is, of course, widely known. It is also possible to produce food from petroleum. An important ingredient in the manufacture of steel is the coke that is produced from coal. Currently, these and other uses of primary energy as a raw material together represent 10 percent of the over-all consumption of energy in the United States.

How energy is measured

There are various methods of measuring energy. But, obviously, when several forms of energy are considered together, a common unit of measurement must be employed. Because several of the measurements are technical, they are not meaningful to laymen. Experience has demonstrated, however, that the barrel used for measuring oil is more readily and broadly understood because it is the unit most easily visualized. In this report, therefore, all the sources of energy will be expressed in barrels of oil equivalent. When appropriate, however, other units of measurement will also be utilized.

The major markets

All the various uses for energy are far too numerous to discuss individually. But they all fall within one or the other of five major market categories. They are listed below according to their current size:

Energy market:	*Percent of total*
Industrial	32
Electric utilities	25
Transportation	24
Residential	14
Commercial	5
Total	100

Electric Utilities are not final consumers of primary energy but instead are processors, converting it to electricity which is then sold to ultimate consumers. Of the total amount of electricity currently generated, 68 percent is sold to industrial and commercial consumers who use it for business related purposes. And the remaining 32 percent is sold to residential consumers for their various private needs.

Automobiles and all other privately owned vehicles are currently responsible for somewhat more than half of the primary energy consumption in the Transportation market. And airlines, railroads, trucking fleets, buses and all other mobile equipment operated for business reasons are responsible for slightly less than half.

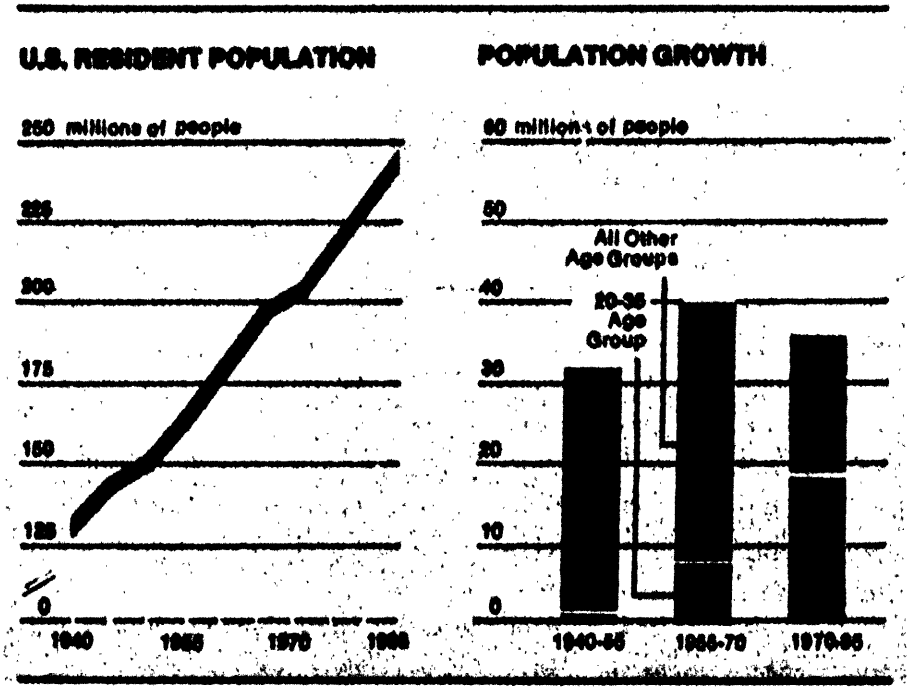
Of the total amount of energy consumed in the United States, both in primary form and as electricity, two-thirds is used for business related purposes and one-third is utilized for all private, nonbusiness needs.

THE DEMAND FOR ENERGY

People are basic

The satisfaction of the needs of people for goods and services is the basic force underlying the nation's economy. And, obviously, the future requirements for energy will hinge upon the number of people, their needs, and the resulting economic activity.

Population growth has continued uninterrupted throughout the history of the United States. And further growth is in prospect. The Bureau of the Census has made four separate predictions based upon various assumptions in respect to the future birth rate. And one of the more conservative forecasts has been selected for the purposes of this study. According to that estimate, the nation's population will increase by 37 million between 1970 and 1985 to reach a total of 241 million. The population increase is certain to expand the requirements for energy. Not only will the 37 million additional people be consuming energy directly, but a great deal more will be used in the process of satisfying all their other needs for goods and services.



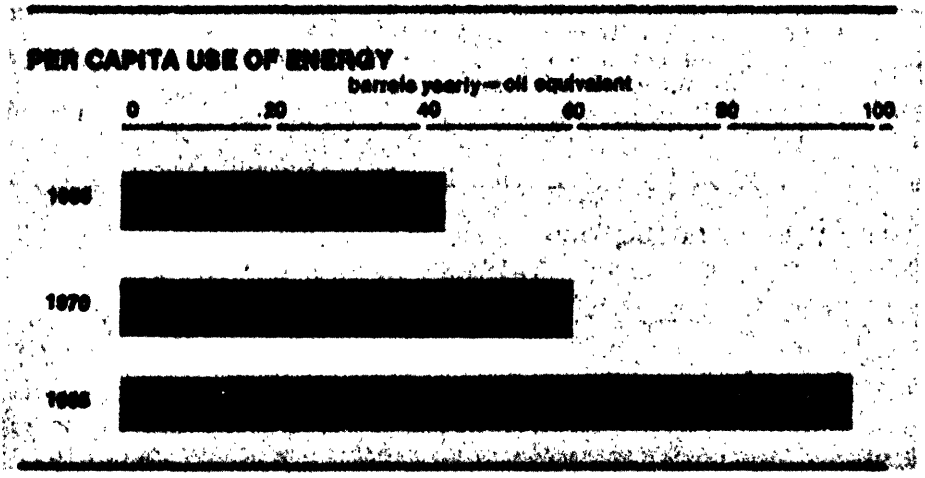
Reflecting variations of the birth rate in the past, the number of people in the age group that ranges between 20 and 35 will increase dramatically. It will be a development of great significance because that age group influences economic activity much more than any other. Within that age span most marriages occur and consequently most new households are established. Also, the parents of most of the babies born are in that age group. To equip the households and accommodate the needs of growing families, a wide range of products must be purchased. It is indeed the time of life when the need for goods and services is greatest.

Because the people who will enter the 20 to 35 age group between 1970 and 1985 are already living, it is virtually certain that the size of the group in that period will increase by 19 million—or as much as 44 percent. Compared with the fifteen year period immediately preceding, the expansion of the group will be well over twice as great—and it will be nearly eighteen times larger than in the fifteen years before that. Clearly, the economic activity required to satisfy the indicated needs for goods and services must increase at a rapid rate. And, as a result, the needs for energy will expand rapidly too.

The per capita use of energy

With growing economic activity and a rising standard of living, the per capita use of energy has increased steadily in the past. It has doubled within the last 30 years. And evidence that it will continue to grow at even a faster rate is unmistakable. Each individual consumer will increase his use as he continuously strives to improve his living standard. And the average per capita use will surely rise as a result of the great amount of energy that will be required in the process of satisfying the soaring demand for goods and services on the part of the 20 to 35 age group.

Efforts to improve the environmental quality of life will also raise the per capita consumption of energy. If current attitudes continue to prevail, an enormous amount of work will have to be done in the years ahead and a huge amount of energy will be required to achieve the desired results. An additional



stimulus to increasing per capita energy use will be provided by continuing efforts to improve the economic and social well-being of the underprivileged. There are also other progressive changes in the manner of energy utilization that indicate higher consumption rates per capita.

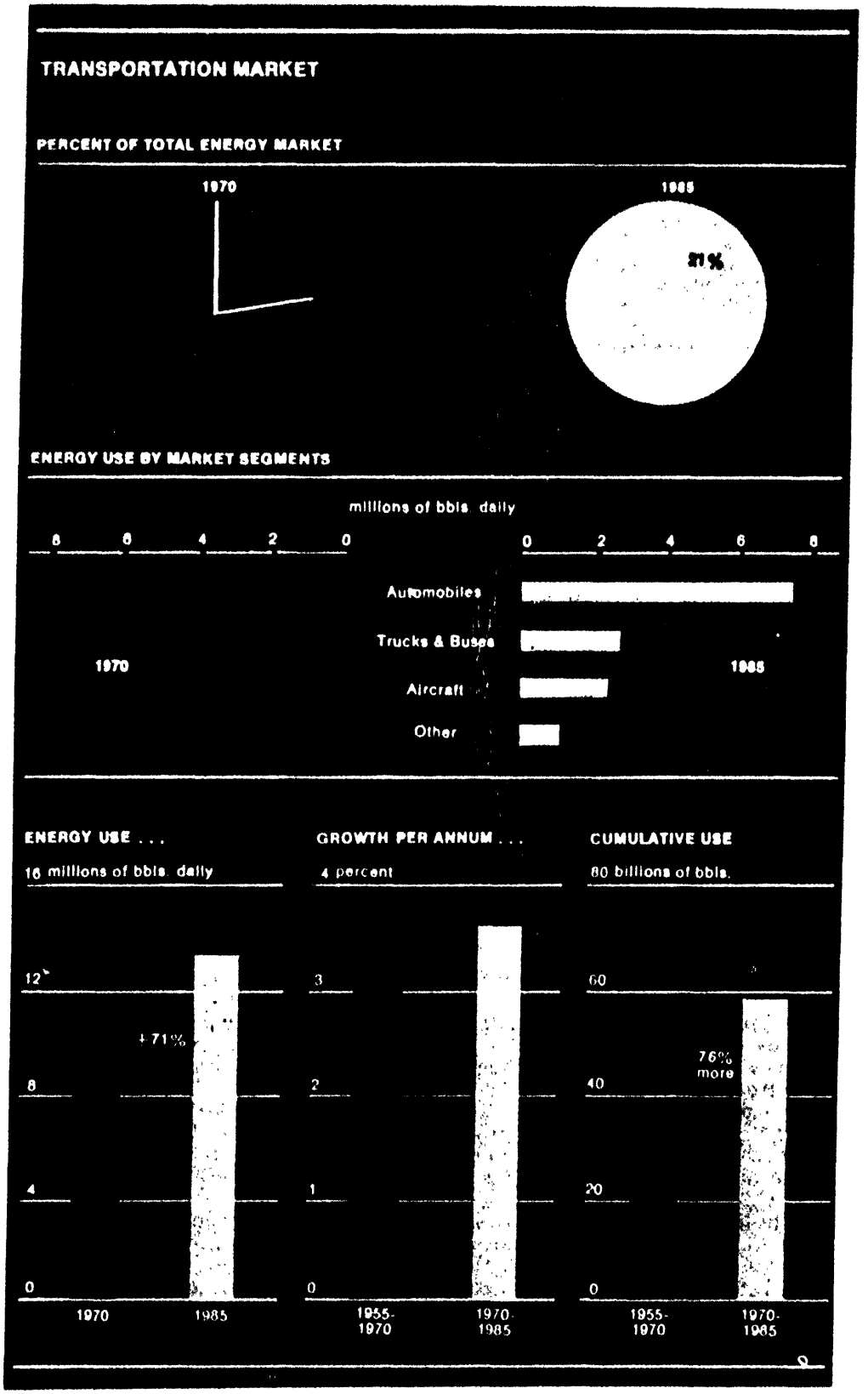
Considering all the factors involved, the growth of per capita energy use is likely to accelerate in the years ahead. And, by 1985, it is expected to be nearly two-thirds greater than in 1970. Some of the details are revealed in the discussion to follow relating to the growth prospects within each of the five major energy markets.

The transportation market

Although it is not the largest of the major energy markets, the Transportation market is of prime importance. To a significant degree, developments within the other markets reflect the influence of evolving factors within the transportation sector.

Throughout the history of the United States that influence has been evident. Because of the vital needs for transportation, the earliest cities were located near harbors and navigable rivers and lakes. Industrial centers developed adjacent to those necessary waterways. And agricultural activities too were carried on nearby.

With the coming of the railroads, however, the dependence upon water transportation gradually diminished. New cities, towns, and villages were built along the routes of the railroads. Industrial operations were concentrated near the hubs of the expanding rail networks. And agricultural activities were conducted in areas that paralleled the railroads.



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The progressive development of automobiles, trucks, buses, and aircraft represented other important milestones in the evolution of the nation's transportation system. And they have had far-reaching effects in the determination of where people worked and lived. Within recent years, two separte developments have begun to exert a major influence and their full impact will become more apparent in the years ahead. One is the construction of the remarkably efficient Interstate Highway System and the other is the extensive use of jet aircraft. Together, these developments have provided far greater latitude in terms of where economic activities can be carried on. The far corners of the nation have been brought within easy reach and a much larger proportion of the land area can be productively utilized. No longer must economic expansion necessarily be limited to the more congested areas.

History teaches that congestion and pollution have always gone hand in hand. When transportation facilities were limited, congestion and associated pollution of various forms were to a large degree unavoidable. But with the opportunities for economic dispersal provided by the continuing improvement and expansion of the nation's transportation facilities there is also the potential for alleviating the problems of pollution.

For many reasons, the nation's energy requirements for transportation purposes can be expected to grow at a vigorous rate between 1970 and 1985. There will be a greater movement of more people, more raw material, and more finished products over broader areas. Automobiles, trucks, railroads, aircraft, buses and other transportation facilities will all be used more extensively.

The vast majority of working people in the United States use automobiles for transportation. For most of them it is their only means of getting to and from work. A high proportion of the nation's families need automobiles to carry on essential family business—for shopping, for transporting children to and from school, church, the doctor, the dentist, etc. And the family car is by far the most widely used form of transportation for vacation and other recreational travel.

Four-fifths of the nation's households now own at least one automobile and nearly one-third own two or more. By 1985, almost 21 million additional households are in prospect. And the proportion of multicar households is expected to rise substantially, too, because much of the population growth is likely to occur in suburban areas and smaller cities rather than in central cities. The ownership of automobiles by business organizations and government is also destined to increase at a rapid rate. To accommodate the nation's expanding needs for transportation, the total number of automobiles in use is expected to increase by nearly 50 percent between 1970 and 1985. And the total number of trucks and buses is likely to rise by 40 percent.

There will also be a large increase in the number of licensed drivers. Population studies indicate the likelihood of more than 150 million by 1985 compared with 111 million in 1970. The fuel consumption per licensed driver has risen steadily in the past and the upward trend is expected to continue with the increasing dependence upon the automobile for essential transportation purposes. The huge increase in the size of the 20–35 age bracket—an age when the use of automobiles is most intensive—will contribute importantly to the rising fuel consumption per average licensed driver.

The vital role played by the automobile in satisfying the transportation needs of the United States is obvious in the following subdivision of the Transportation market according to major end uses.

Transportation market:	*Percent of total fuel use*
Automobiles	53
Trucks and buses	22
Aircraft	13
Agriculture and off-road vehicles	5
Ships and boats	4
Railroads	3
Total	100

As indicated, automobiles consume more energy than all other forms of transportation combined. With the addition of trucks and buses, the consumption of all road vehicles represents as much as three-fourths of the over-all energy needs for transportation purposes. And, clearly, it will be the expanding use of such vehicles that will contribute most to the growth of the Transportation market's

energy requirements. But the other forms of transportation will all have increasing needs too, particularly aircraft. Reflecting the growth of the nation's economy and continued dispersal of economic activity, the business needs for air travel—both commercial and private—are expected to increase strongly between 1970 and 1985. And vacation travel by air should rise too. Barring a major conflict, the fuel requirements of military aircraft are predicted to grow only moderately, however. The fuel consumption of agricultural machinery and other off-road vehicles will increase along with food needs and construction activity. Foreign competition and limited fuel availability are among factors that will hold the expansion of domestic energy requirements for ships to moderate proportions. To the extent that business activities grow within their reach, the tonnages hauled by railroads will rise. But their fuel needs will increase only modestly as they continue to achieve gains in operating efficiency.

With the exception of a fractional amount of coal used by ships operating on the Great Lakes, the Transportation market's energy needs are satisfied entirely with oil. As much as 73 percent is satisfied with gasoline alone and that product is expected to be still satisfying nearly that proportion by 1985. With mounting concern about pollution, various other power systems have been proposed as substitutes for the gasoline fueled internal combustion engine. They all have been tested but none has proven practical from an over-all standpoint. Therefore, internal combustion engines are expected to continue to be the dominant automotive power plant, at least until 1985.

The higher vehicle manufacturing costs associated with efforts to increase safety and lessen pollution may lead to a reduction in the average size of automobiles purchased in the future. In that event, fuel requirements would be reduced somewhat because of lower weight. But, on the other hand, the efforts to limit the polluting emissions of automobile engines are likely to reduce substantially their operating efficiency. And, on balance, the average fuel requirements of automobiles in the years ahead are expected to be higher.

In the following table, the expected growth for each segment of the Transportation market is shown:

	Thousand barrels daily[1]		Change	
	1970	1985	Thousand barrels daily[1]	Percent
For combustion	7,165	10,105	+2,940	+41.0
For raw material	3,392	6,540	+3,148	+92.8
Total	10,557	16,645	+6,088	+57.7

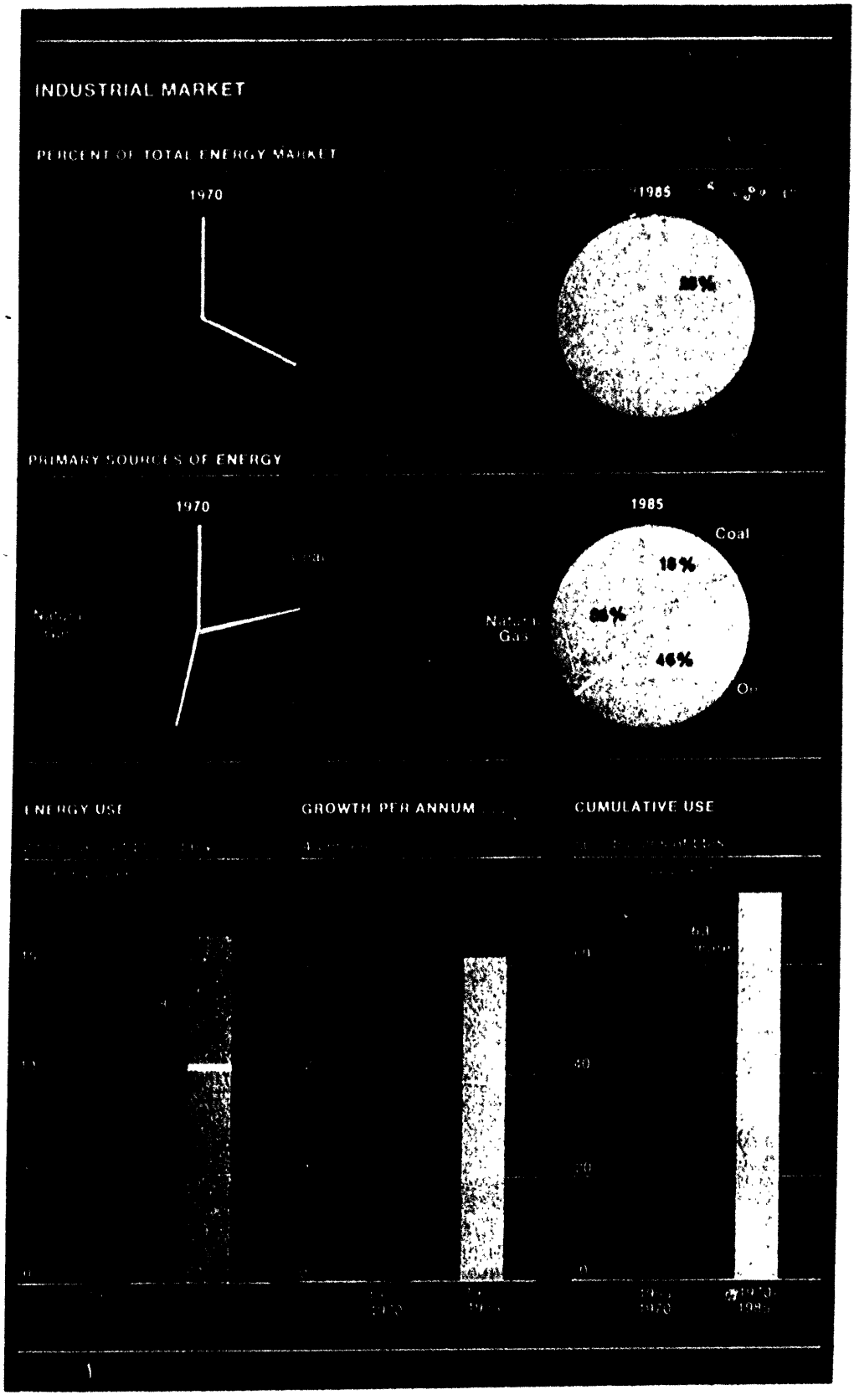
[1] Oil equivalent.

The average annual rate of growth for the 15 year period is 3.0 percent. And the accumulated consumption for the period will be 76 percent greater than in the preceding 15 years.

The Industrial Market

To a major degree, the high standard of living achieved in the United States reflects the nation's productivity. And its enormous output of goods and services could not possibly be accomplished without the use of vast amounts of energy. For that reason, the industrial market for energy has always ranked as the single largest of the five major markets listed earlier in this report. Currently, the industrial needs represent nearly one-third of all primary energy consumption.

Of the total amount of primary energy utilized by industry, somewhat more than two-thirds is for purposes of combustion and the rest is used as a raw material for a wide range of useful products. By 1985, the proportion used as raw material is expected to rise substantially. The increase will occur for a combination of reasons. Between 1970 and 1985, the needs for primary energy as a raw material are expected to nearly double. Much of that growth will reflect the utilization of petroleum as a chemical feedstock—a use that is likely to increase nearly threefold.



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The industrial use of primary energy for combustion purposes will also grow—but at a slower pace. For several years, industry has progressively satisfied its needs with more electricity purchased from utilities rather than with primary energy consumed directly. Currently, purchased electricity represents more than a quarter of industry's overall energy utilization. And, by 1985, it is likely to represent a substantially higher proportion. The increase will occur because, in many cases, industry finds it more expedient to use purchased electricity. And in other cases the severe shortage of natural gas in prospect will force industry to resort in part to electricity as a substitute.

The expected growth of industry's direct needs for primary energy is summarized in the following table:

	Thousand barrels daily		Change	
	1970	1985	Thousand barrels daily	Percent
Automobiles	4,282	7,395	+3,113	+72.7
Trucks and buses	1,741	2,665	+924	+53.1
Aircraft	1,019	2,415	+1,396	+137.0
Agriculture and off-road vehicles	387	525	+138	+35.7
Ships and boats	336	420	+84	+25.0
Railroads	248	295	+47	+19.0
Total	8,013	13,715	+5,702	+71.2

For the 15 year period, the average annual rate of growth is 3.1 percent. And the accumulated consumption will be 63 percent greater than in the preceding 15 years.

Although the figures shown in the table are expressed in terms of oil equivalent, the industrial use of primary energy is by no means limited to oil. Actually, natural gas is industry's single most important source of energy. Of current needs, natural gas satisfies 40 percent, oil 20 percent, and coal 22 percent. In the case of both oil and coal, more than half is used as raw material rather than for purposes of combustion. But, in the case of natural gas, little more than one-tenth is used as raw material.

Because of developing shortages, industry will not be able to increase its use of natural gas to any significant degree. And by 1985, gas as a proportion of industry's over-all supply of primary energy is likely to shrink to little more than one-third. Therefore, industry can be expected to depend upon oil to satisfy much of its expanding needs. As a result, oil use is likely to increase by more than 150 percent between 1970 and 1985. And in the latter year it will represent almost half of the total industrial use of primary energy. The consumption of coal will expand too—but by a much smaller degree. The solid form of coal makes it less attractive from the standpoint of both combustion and storage. And environmental factors also operate against the use of coal. Consumption in 1985 is expected to be about 25 percent greater than in 1970.

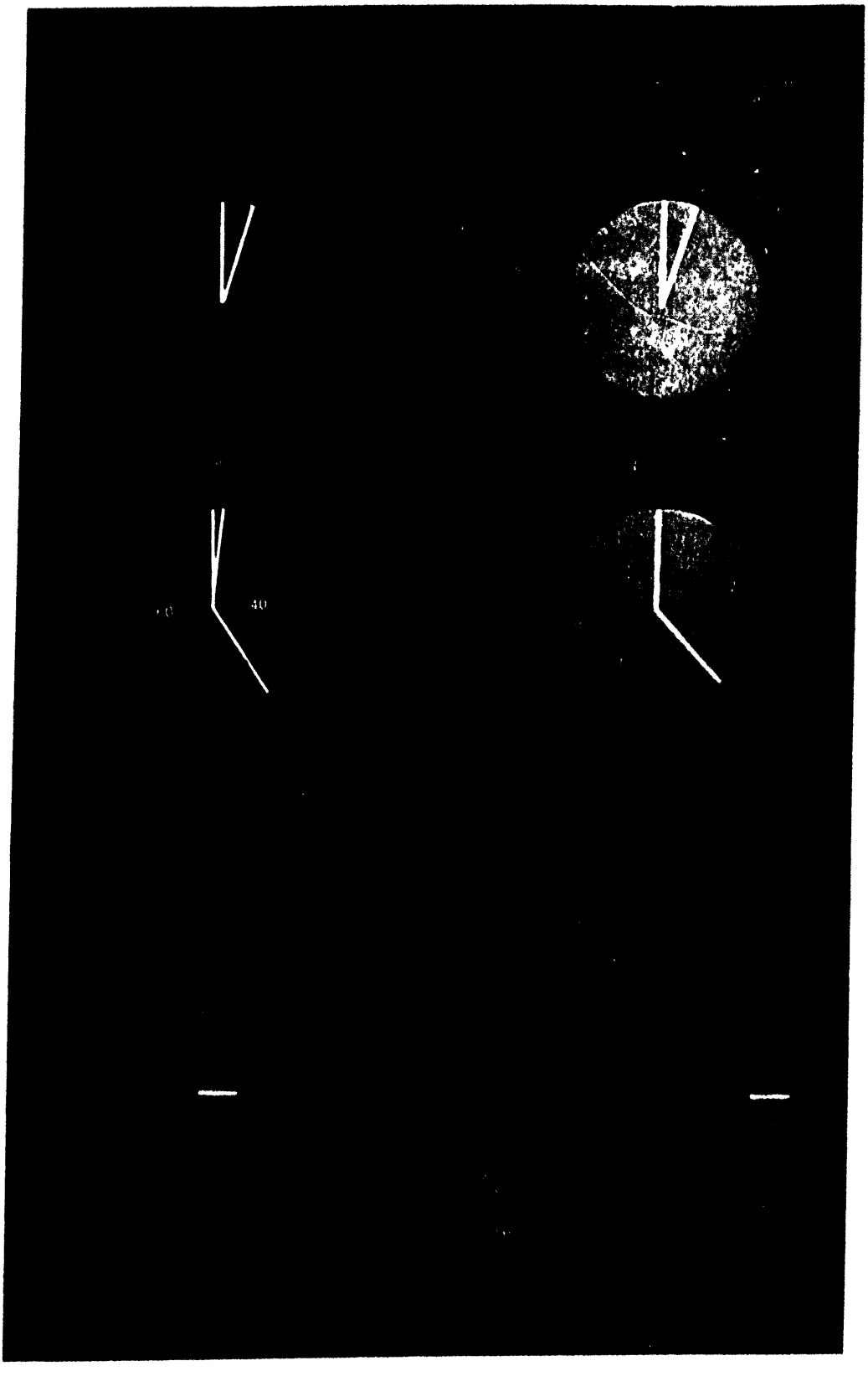
The commercial market

All forms of commercial enterprise—retail establishments, wholesale organizations, office buildings, service activities, hotels, apartment buildings, institutions and so forth comprise another of the major markets for primary energy. Despite its complex structure, however, it is the smallest of the five major markets. In fact, the Commercial market's primary energy needs are not even one-sixth as large as industry's.

For the most part, the primary energy utilized in the Commercial market is for space heating. And most other energy needs are largely satisfied with electricity. Actually, the use of energy in the form of electricity exceeds somewhat the total amount of primary energy consumed.

Two sources of primary energy—natural gas and oil—serve virtually all the requirements of the Commercial market. Of the total current needs, natural gas satisfies about 60 percent and oil most of the rest. Despite the limited supplies of gas, these proportions are not expected to change significantly in the future. Gas used for space heating generally commands a better price than it does in many industrial applications. And, to the extent practical, it is likely to be reserved increasingly for heating purposes.

By 1985, the Commerical market's needs for primary energy are expected to be nearly 75 percent greater than in 1970. And between those years the average annual rate of growth will be 3.7 percent. The accumulated consumption for the 15 years will be more than twice as large as in the preceding 15 year period.



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The residential market

Individual dwelling units of all types comprise the residential market. The bulk of the primary energy utilized is for heating, with lesser amounts required for cooking, water heating, clothes drying, and miscellaneous purposes. In addition to the direct consumption of primary energy, the Residential market also uses large quantities of electricity—more than one-third of its over-all needs for energy is satisfied with electricity.

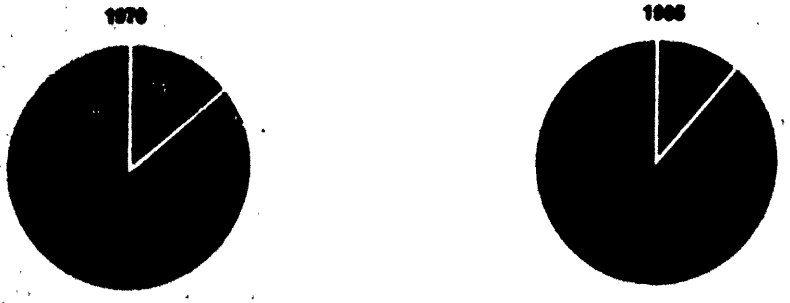
Obviously, as the nation's population expands, the Residential market for primary energy will increase too. The size of the market will also be influenced by other demographic factors. Certain age groups choose to live in apartments and others find their needs are best served with individual dwellings. The 20 to 25 and over 60 age groups generally prefer apartments while individual dwellings are usually the choice of the 25 to 60 group. Buyers of new homes are heavily concentrated in the 25 to 35 age span. Reflecting earlier changes in the birth rate, the number of families preferring individual dwellings will increase much more between 1970 and 1985 than will the number of apartment-prone families. And the bulk of that growth is likely to occur in regions where single family home construction is not limited by congestion and scarcity of land. Because the energy requirements of individual dwellings are greater than the needs of apartments, the per capita use of energy in the Residential market will therefore rise substantially.

The combined effects of 37 million more people, 21 million more households, and a higher proportion of individual dwellings are expected to increase the Residential market's primary energy requirements by nearly 50 percent between 1970 and 1985. The average annual rate of growth for the period will be 2.7 percent and the accumulated consumption will be 47% greater than in the 15 years immediately preceding.

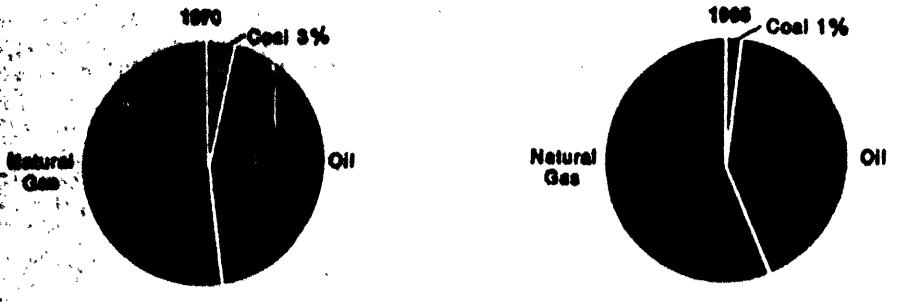
In the beginning, and for a long time thereafter, wood was the single most important source of primary energy for the Residential market. As recently as 1940, wood still satisfied nearly a quarter of the over-all needs. But, by that

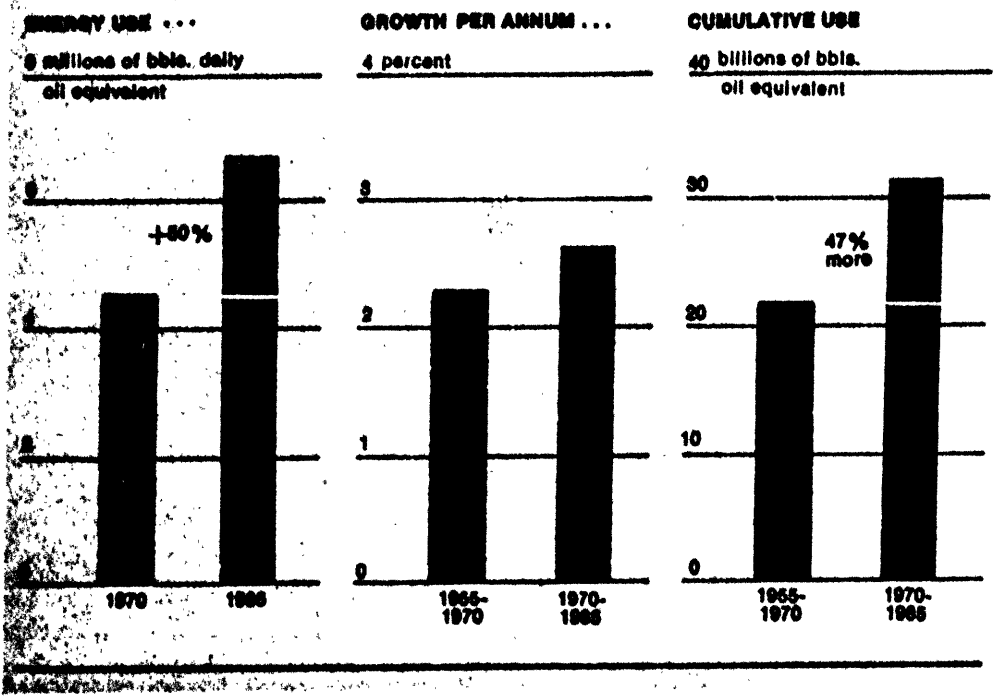
RESIDENTIAL MARKET

PERCENT OF TOTAL ENERGY MARKET



PRIMARY SOURCES OF ENERGY





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time, the superior qualities of coal had become broadly recognized and it was serving well over half of the Residential market's requirements. After World War II, oil briefly took over the lead but the rapidly growing availability of natural gas at bargain prices soon enabled it to move into the forefront. And gas now represents 52 percent of the primary energy used for residential purposes. Oil represents 45 percent and coal only 3 percent.

Because natural gas is widely regarded as a premium fuel for residential use, it is likely to retain its lead position in the years ahead despite limited supplies. For various reasons, it is realistic to expect that residential consumers will be accorded top priority in respect to available supplies. Oil is also expected to hold approximately its present share of the market. But the direct burning of coal as such is likely to cease. Coal will not be eliminated entirely from the market, however, because there is the likelihood that some will be converted to synthetic gas and used in that more attractive form.

The electric utilities market

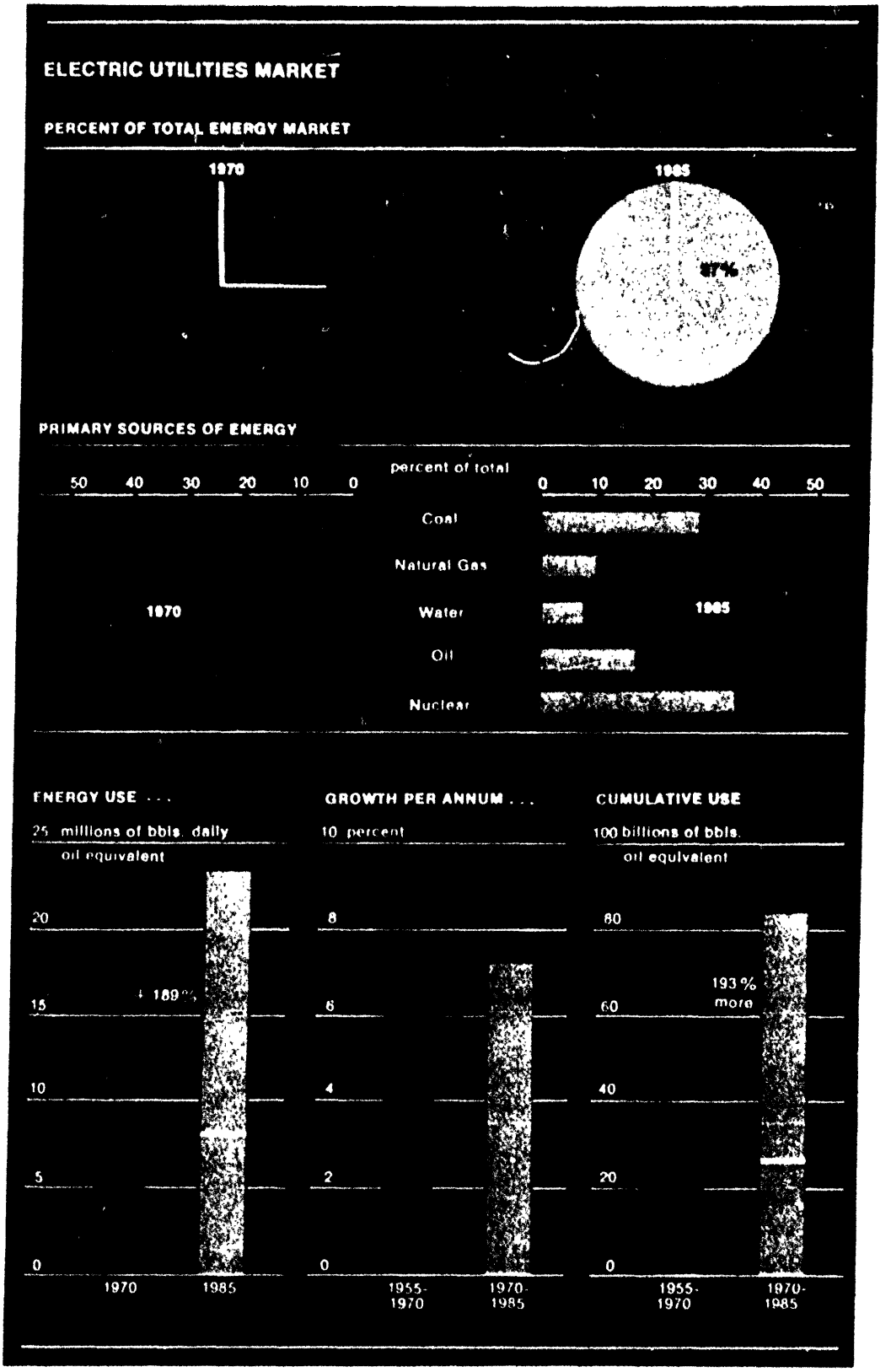
Huge amounts of primary energy are used in the process of generating electricity. And the nation's electric utilities now rank second only to industry as a market for primary energy. They are also the fastest growing market and by 1985 are expected to constitute the largest of all the major markets by a wide margin.

Electricity is the most versatile form of energy. It is used for many purposes by virtually everyone in all walks of life. And the dynamic pace of technological progress continues to develop new uses—in the home and in business. Per capita consumption of electricity more than doubled between 1955 and 1970. And there is the likelihood that it will rise even more than that in the following 15 years.

As indicated in foregoing discussion, the Industrial, Commercial, and Residential markets all require large amounts of electricity in addition to their direct use of primary energy. And their use of electricity is growing faster than their consumption of primary energy. To some degree, the electricity is utilized for purposes that can be satisfied in no other way. But, in other cases, electricity is used instead of primary energy. And, when that happens, the demand for primary energy is transferred from the other major markets to the Electric Utility market. In fact, the over-all demand actually is increased somewhat because the use of energy in the form of electricity for such purposes as heating is less efficient than the direct burning of primary energy.

To some extent, consumers denied a sufficient supply of natural gas will turn to electricity as a substitute. And air pollution restrictions are also likely to necessitate the substitution of electricity for the direct burning of fossil fuels in some geographical areas. Large quantities of electricty will also be required for other environmental purposes such as recycling, waste treatment, and so forth. Huge and rapidly increasing amounts of electricity consumed in the process of enriching uranium fuel for nuclear power plants will constitute another important new use.

The nation's over-all requirements for electricity by 1985 are expected to be more than three times greater than in 1970. And, to accommodate that growth, the electric utilities will also need to increase their consumption of primary energy nearly threefold. The latter increase will represent an average annual growth of 7.3 percent. And the accumulated consumption over the 15 years period will be almost three times greater than in the preceding 15 years.



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The Electric Utility market is the only one that uses all five of the primary sources of energy. Currently, almost half of its total requirements is satisfied with coal and nearly a quarter with natural gas. Water power, oil, and a small amount of nuclear power serve the remainder of its needs. In the years ahead, however, these proportions are destined to change drastically, as inlicated in the following table:

[In percent]

Market share	1970	1985
Coal	49	29
Natural gas	24	11
Water power	15	8
Oil	11	17
Nuclear	1	35
Total	100	100

Electric Utilities have ordered a large number of nuclear powered generating plants scheduled for delivery in the near future. And many additional orders are in the planning stage and likely to be placed soon. By 1985, nuclear power is expected to emerge as the single largest source of primary energy used to generate electricity. And, of the increase in the over-all requirements of the Electric Utility market between 1970 and 1985, nuclear power alone is expected to accommodate more than half.

Although the use of coal is expected to rise by 75 percent, coal's share of the market will decline from half to less than one-third. Environmental factors, affecting both production and consumption, will restrict coal's growth to less than would otherwise be anticipated. Because of supply limitations, the burning of natural gas for generating electricity will expand relatively little. And most of that limited growth will occur in areas near the sources of gas production. As a result, the share of the market now satisfied with gas will be cut more than in half. Oil's share, on the other hand, is likely to increase. In fact, the consumption of oil is expected to expand more than fourfold by 1985. Environmental factors, economic forces, and a lack of natural gas are among the reasons favoring the dynamic growth in prospect for oil. Although water power ranked as the second most important source of primary energy for generating electricity only two decades ago, it will become the least important by 1985. The number of potential dam sites remaining to be developed will limit the expansion of hydroelectric capacity between 1970 and 1985 to less than 50 percent.

All the major markets together

The primary energy requirements of the five major markets in 1970 and their predicted needs by 1985 are compared in the following table:

	Thousand barrels daily[1]		Change	
	1970	1985	Thousand barrels daily[1]	Percent
Transportation	8,013	13,715	+5,702	+71.1
Industrial	10,557	16,645	+6,088	+57.7
Commercial	1,689	2,930	+1,241	+73.5
Residential	4,567	6,845	+2,278	+49.9
Electric utilities	8,154	23,580	+15,426	+189.2
Total	32,980	63,715	+30,735	+93.2

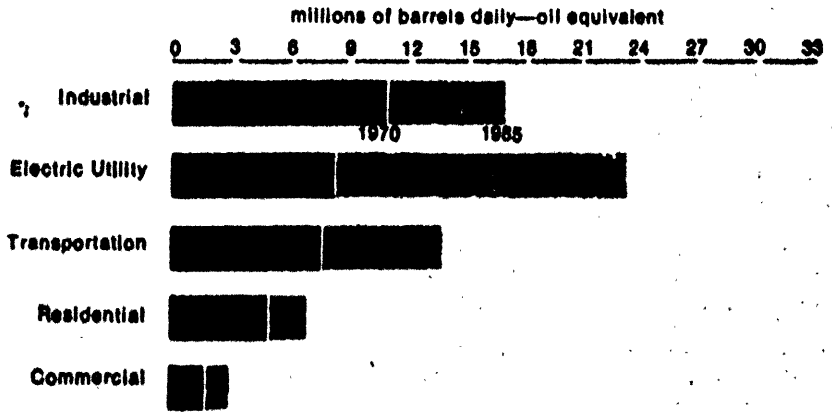
[1] Oil equivalent.

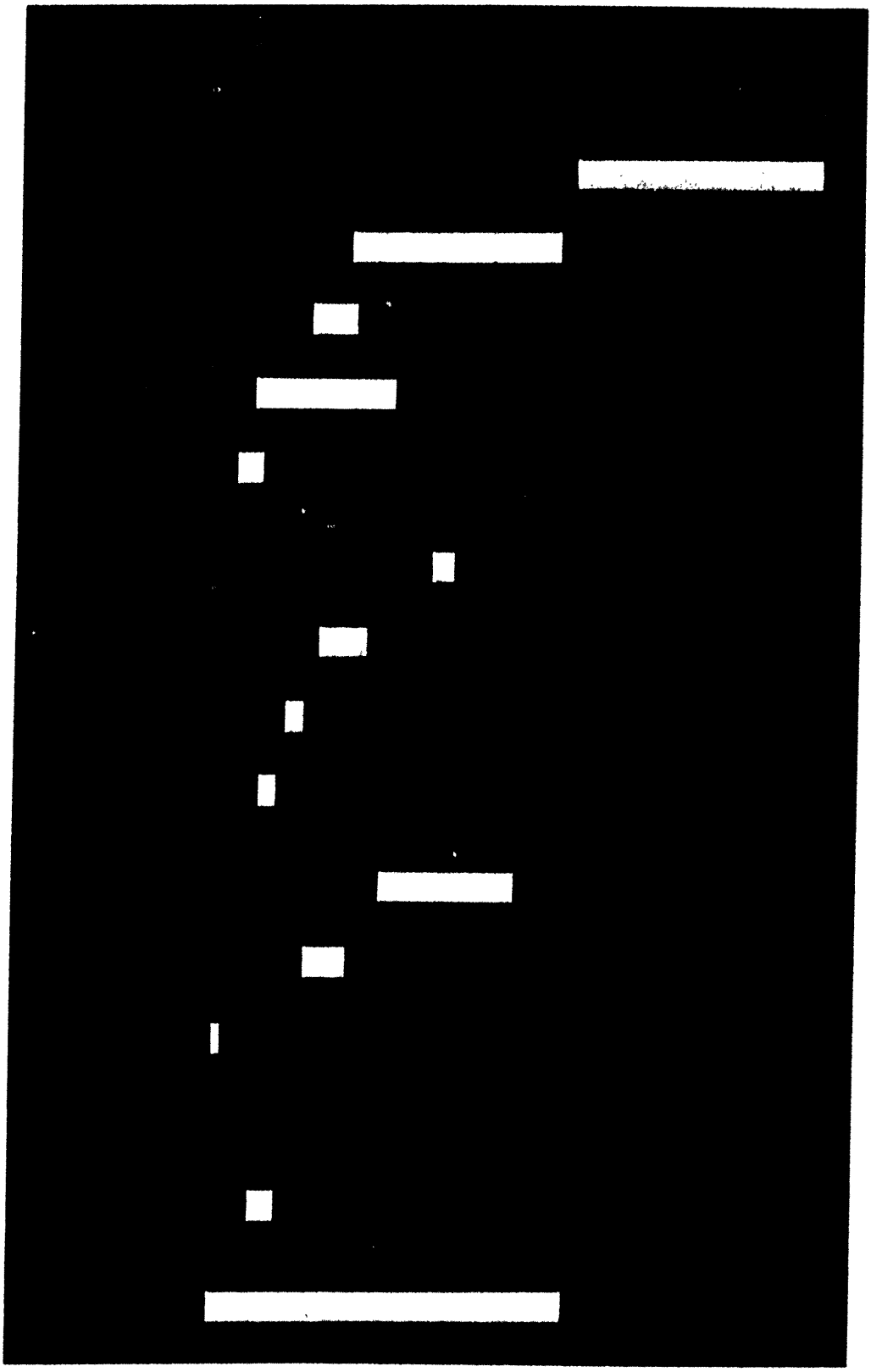
As the table reveals, the nation's over-all requirements for primary energy, are likely to be almost twice as large in 1985 as in 1970. The average annual rate of growth for the 15 year period will be 4.5 percent. And the accumulated consumption will be nearly twice as great as in the preceding 15 years.

Clearly evident are the enormous future needs of the nation's electric utilities. Their requirements alone will represent more than one-third of all energy needs by 1985. And the expansion of their requirements between 1970 and 1985 will be equal to as much as half of the combined growth of all five of the major markets. As discussed earlier, the exceptionally large growth in prospect for the Electric Utilities market reflects not only the rapidly developing new uses for electricity but also the large scale substitution of electricity for the use of primary energy in the Industrial, Commercial, and Residential markets.

Although the five major markets vary substantially in size, no single one can be considered more important than the others. All are essential. And none can be denied a fully adequate supply of energy without impairing the nation's economy and its standard of living.

ENERGY USE — By Markets





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All the primary sources of energy together

In the following table, the actual consumption of the five sources of primary energy in 1970 is compared with their predicted use in 1985:

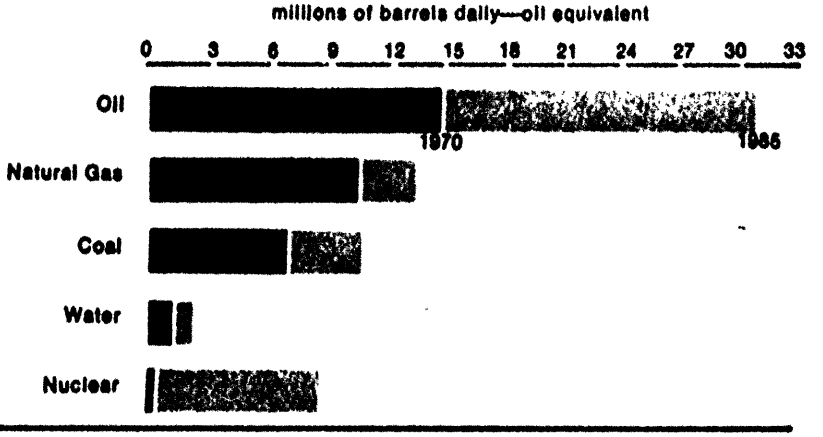
	Thousand barrels daily[1]		Change	
	1970	1985	Thousand barrels daily[1]	Percent
Oil	14,709	30,170	+15,461	+105.1
Natural gas	10,417	12,830	+2,413	+23.2
Coal	6,497	10,555	+4,058	+62.4
Water power	1,247	1,805	+558	+44.7
Nuclear	110	8,355	+8,245	+659.5
Total	32,980	63,715	+30,735	+93.2

[1] Oil equivalent.

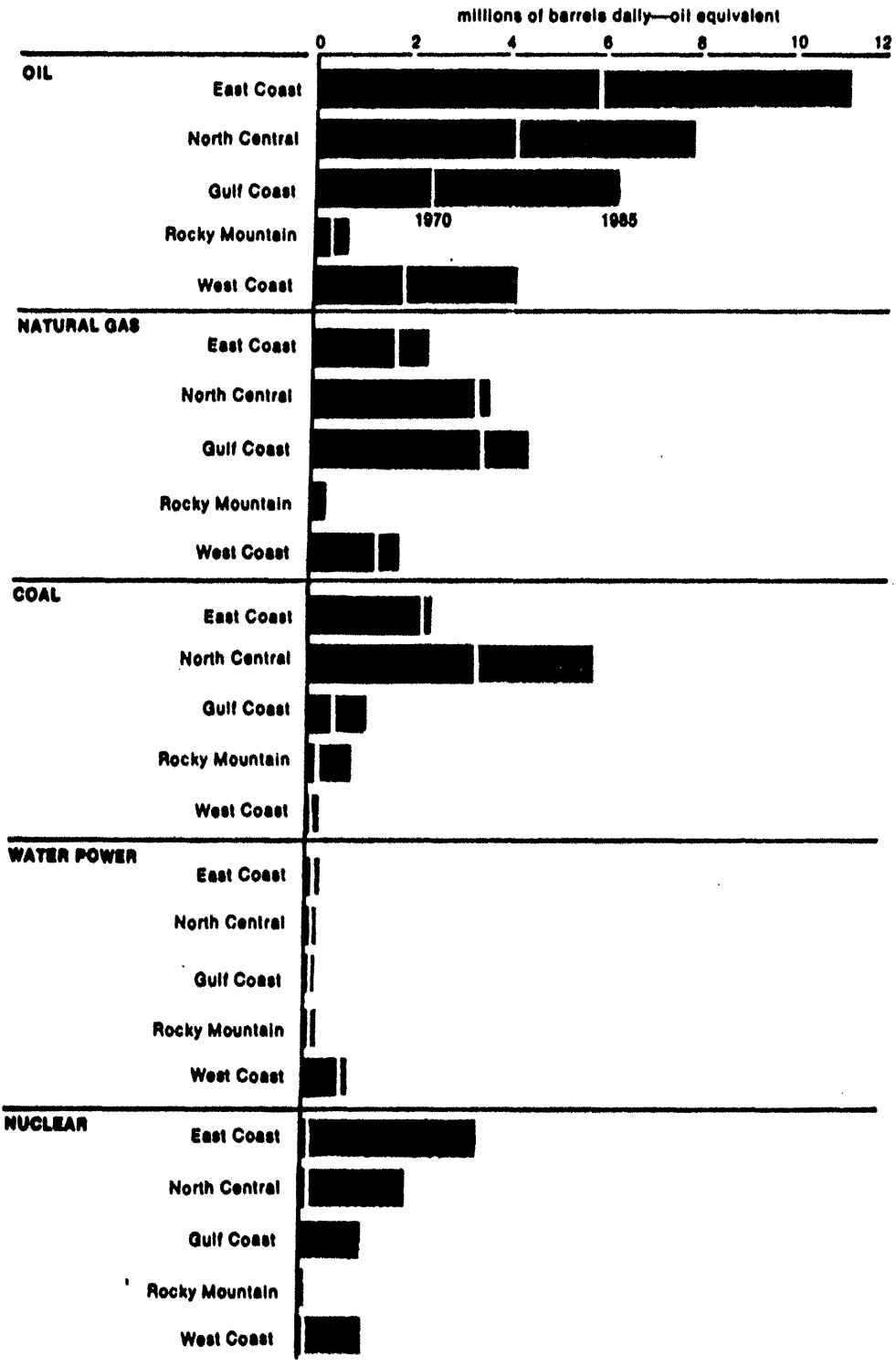
Oil was the largest source of primary energy in 1970, and will continue to be in 1985, because it is so versatile. Among the sources of primary energy, oil is the only one that is used in all five of the major markets. And it is virtually the only source that can serve the Transportation market's needs. Conceivably, coal might also be utilized as a fuel for transportation purposes—but it would have to be converted to a liquid first.

Of the over-all growth of the nation's energy needs between 1970 and 1985, oil alone is expected to accommodate half. To a significant degree, the exceptionally

ENERGY USE — By Sources



PRIMARY ENERGY USE BY REGIONS



strong increase in the demand for oil reflects the rapidly developing shortage of natural gas. If there were no supply limitations, the potential demand for gas in 1985 would be nearly 50 percent greater than indicated in the foregoing table. Natural gas is truly a premium fuel and is much preferred by a wide range of customers. But, under no realistic circumstances, can the supply of gas be expected to be adequate for the full potential demand. And consumers, therefore, will be forced to substitute other sources of primary energy. An end-use analysis indicates they are likely to fill nearly two-thirds of the gas deficit with oil and the rest with coal. As a result, the demand for oil in 1985 will be 15 percent larger than might normally be expected and the demand for coal will be nearly a third greater. For the most part, the additional oil and coal will be used as such. But, to some degree, both are likely to be converted to a synthetic gas and burned in that form.

The five regions

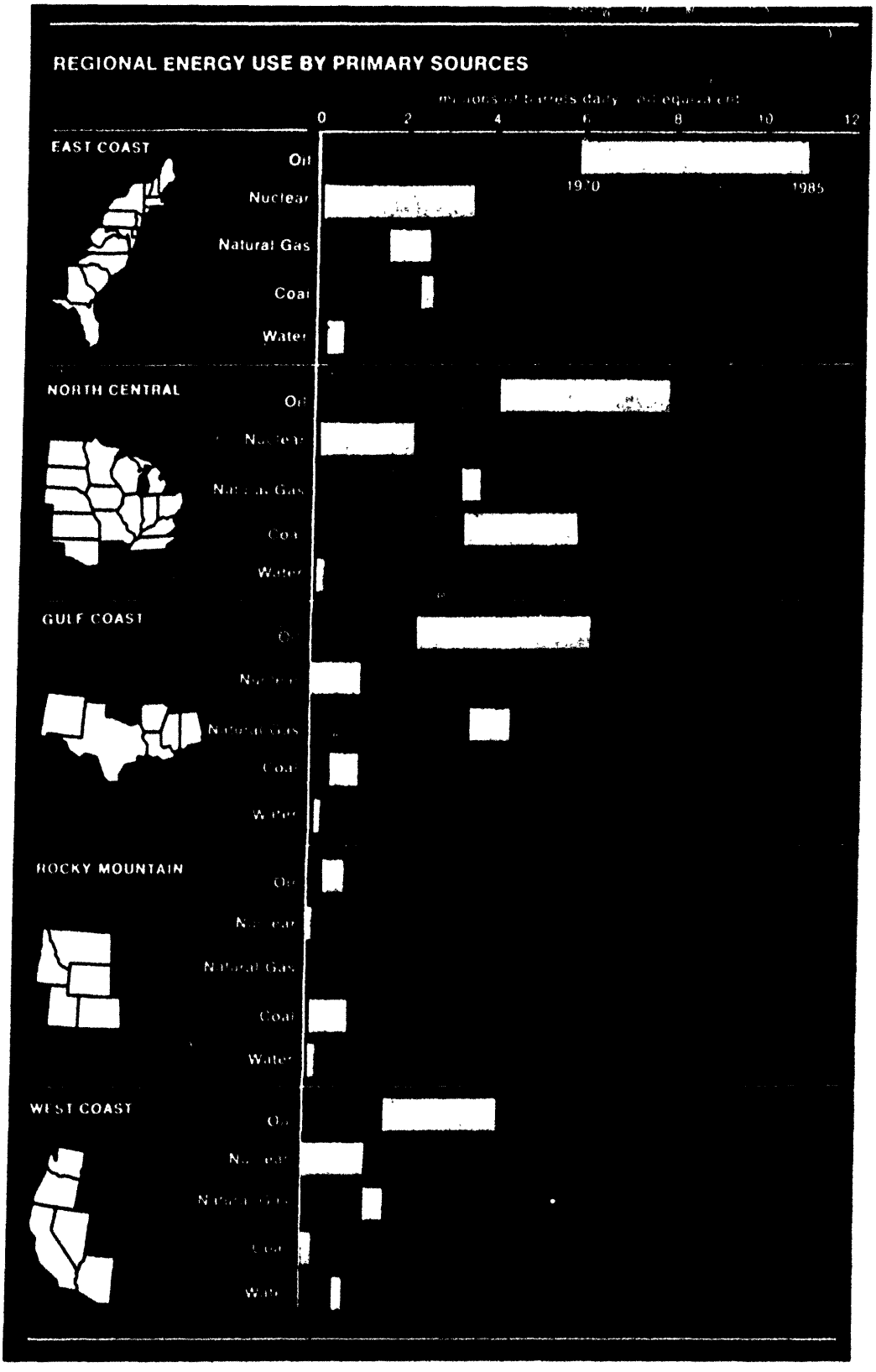
Because the United States is so large in area, with widely varying geographic conditions, population concentrations, and economic activities, the requirements for energy are by no means uniform throughout the nation. The nature of energy end-use, the sources of energy utilized, and per capita use all vary substantially from region to region. It is necessary, therefore, to study regional needs on a detailed basis in the process of determining the future energy requirements for the nation as a whole. For the purposes of this report, the United States is divided into five major geographical regions. They are listed in the following table along with related population and energy data for 1970:

Region	Percent of total United States		Per capita use,[1] barrels per year[1]
	Population	Energy use	
East coast	39	31	47
North central	33	34	61
Gulf coast	12	20	101
Rocky Mountain	2	3	69
West coast[2]	14	12	51
Total United States	100	100	59

[1] Oil equivalent.
[2] Includes Alaska and Hawaii.

Although the East Coast has the largest share of the nation's population, it does not account for the largest proportion of over-all energy use. In fact, it has the smallest per capita consumption of the five regions. But the Gulf Coast, with little more than an eighth of the nation's population, nevertheless accounts for a fifth of the total energy use and has by far the highest per capita rate of consumption.

The differences in per capita use indicated in the table reflect the regional distribution of the five major markets for primary energy. As indicated earlier, the industrial market is the largest of the five. And more than one-third of that entire market is located on the Gulf Coast. Almost another third is located in the North Central region, but less than a quarter exists on the East Coast. Of the total Electric Utilities market more than a third is in the North Central region with almost another third on the East Coast. Although the single largest segment of the Transportation market—about one-third—exists on the East Coast, the per capita use of energy for transportation purposes is smallest in that region. Nearly another third is located in the North Central region. Because the primary energy needs of both the Residential and the Commercial markets are mainly for space heating purposes, those markets are largest in the colder regions.



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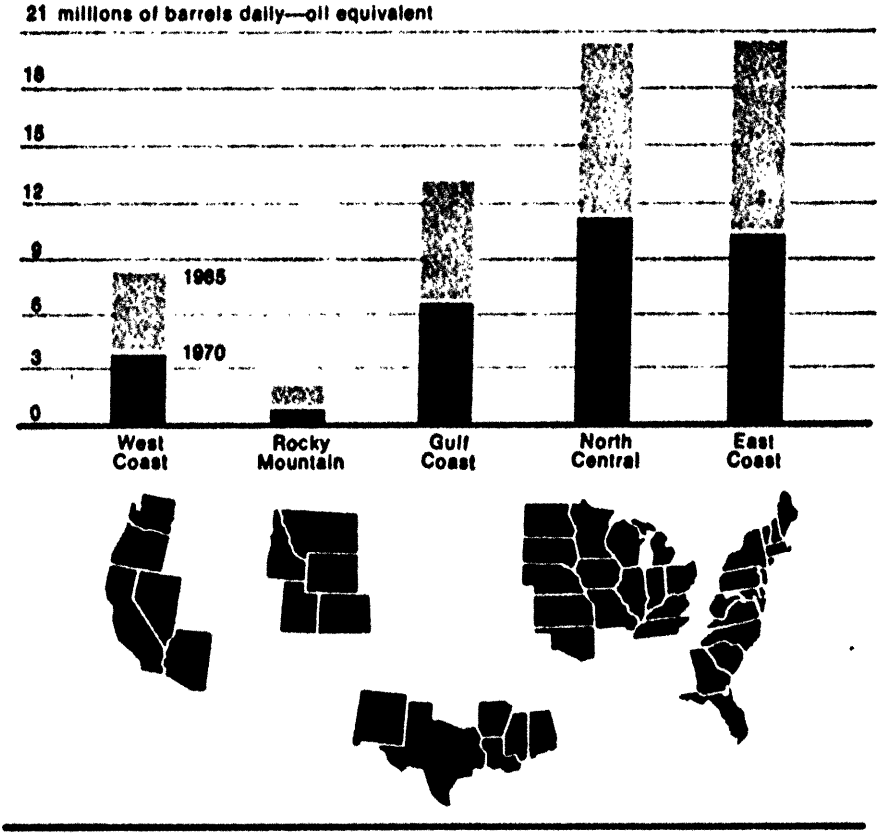
The North Central region is the largest Residential market and the East Coast is the next largest. But, in respect to the Commercial market, their positions are reversed.

The regional use of the five primary sources of energy also varies substantially, as indicated in the following table:

	Percent of total energy used—				
	East coast	North central	Gulf coast	Rocky Mountain	West coast
Oil	57	36	37	40	48
Natural gas	17	31	55	34	33
Coal	23	31	7	16	1
Water power	2	1	1	10	18
Nuclear	1	1			
Total	100	100	100	100	100

Obvious is the East Coast's heavy dependence upon oil. In fact, the East Coast is the single largest regional market for oil, accounting for as much as 40 percent of the nationwide consumption. The North Central region ranks second

TOTAL ENERGY MARKET BY REGIONS



with 28 percent. For natural gas, the Gulf Coast is the largest market and the North Central region is almost as large. Together, they account for two-thirds of the total consumption of gas. More than half of all coal consumption occurs in the North Central region alone and more than one-third on the East Coast. Relatively little is utilized elsewhere. The mountains on the West Coast are

the source of as much as 30 percent of the nation's water power, with much smaller proportions located in the other four regions. Thus far, very little nuclear power is utilized, and most of that is in the East Coast and North Central regions.

For numerous reasons, the nation's regional energy needs are expected to undergo progressive change between 1970 and 1985. Several factors are likely to motivate economic migration. Oppressive taxation will continue to cause economic activities to take flight and so will labor strife. The relative availability and cost of qualified labor is another cause. Congestion and all its associated costs constitute an additional reason. Another factor, closely related to congestion, is inadequate and unreliable local transportation. Pollution, a product of congestion, will have an impact in various forms—there will be efforts to escape pollution by leaving it behind, there will be attempts to minimize it by dispersal, and overly restrictive controls will force the relocation of economic activity. Water shortages and climatic conditions represent still another reason for movement. And changing market conditions and marketing practice are a force of growing importance. As discussed earlier, the development of the nation's transportation system has had a major influence on the economy of the United States. And it will surely continue to do so. The much improved transportation possibilities provided by the Interstate Highway System and jet aircraft can be expected to promote and facilitate continued dispersal of the nation's economic activities over broader geographical areas.

One more factor of major importance is the availability of energy. Because the availability of primary energy is so vital, not only to future growth but also continued existence, it is certain to play a rapidly increasing role in the determination of where economic activities are located. And intensified competition for available energy supply—particularly in the preferred form—can be expected in the years ahead. The East Coast and the North Central regions are deficit areas in respect to primary energy—they both consume far more than they produce within their borders. And they are, therefore, relatively more vulnerable in the event of energy shortages. Although not widely recognized at present, that is a fact certain to become increasingly apparent to consumers as time goes on. And reactions can be expected.

For the reasons cited above, along with others, the demand for primary energy in the 1970–85 period is expected to grow at a faster rate in the southern half of the nation than in the northern half. There will also be changes in the proportions of the primary sources of energy utilized in the five regions. The progressive development of nuclear power as an important source of primary energy will be one factor. And the evolving shortage of natural gas will be another. By 1985, gas will represent a much smaller proportion of the total energy utilization in all regions.

The Supply of Energy

Because energy is absolutely essential to the welfare of the United States, the continuing availability of an adequate supply is a matter of vital importance. Properly, all consumers—business and private, large and small—should be concerned. And surely it is the obligation of government to accord no less than the highest priority to the matter of energy supply.

In actual fact, however, the subject of energy supply is treated with complacency. Most consumers take for granted the continuing availability of all they require. And government has exhibited only sporadic and superficial interest. Even worse, government has taken actions that have proven highly detrimental to the supply of energy.

Petroleum

Petroleum—oil and natural gas together—is the nation's foremost source of primary energy. It satisfies as much as three-fourths of the energy requirements for all purposes. Unfortunately, both oil and natural gas are now in short supply. Domestic production is not sufficient to meet current needs—and the deficit is certain to become progressively worse in the years ahead.

The shortage of petroleum is the ultimate result of a series of interrelated developments precipitated by governmental price controls. For a long period of time, the Federal government has controlled the wellhead price of all natural gas moving in interstate commerce. Reflecting political motivations and insufficient

regard for the damaging consequences of its actions, the government has consistently held the wellhead price of gas at an incredibly low level. And, in so doing, it has severely restricted the petroleum industry's ability to generate the capital funds required to finance a continuing search for oil and natural gas of the magnitude necessary to keep pace with the nation's expanding needs. In addition, the price regulation badly damaged the incentive to reinvest funds that actually were available. There is clear-cut evidence that the price controls caused capital funds to be diverted instead to other areas of investment, particularly on the part of smaller independent producers.

As a result of the severe controls imposed at the well, natural gas became available in the various energy markets for prices much below the levels at which other forms of energy could effectively compete. Consequently, for a long period of years while accumulated gas supplies remained abundantly available, both oil and coal were excluded from markets. Not only did gas capture most of the over-all energy market growth, but it also displaced oil and coal in existing markets. The impact on the oil and coal industries was both devastating and demoralizing. And it was a major factor contributing to the current shortages.

Quite logically, the amount of petroleum discovered reflects the degree of physical effort to find it. More oil and natural gas will be found if the petroleum industry drills 50 thousand wells in a year instead of 25 thousand. And still more will be found if it drills 100 thousand. It is also logical that there is a relationship between the discovery of petroleum and the amount of money applied to the search. The drilling of wells and all of the associated activities are expensive operations. And often they are unsuccessful. If the market requirements for oil and gas indicate the need to drill 100 thousand wells per year but the petroleum industry has only enough money available to drill 25 thousand, the amount of petroleum found obviously will be much too little.

The amount of money that can be devoted to the search for petroleum depends to a major degree upon the price the petroleum industry receives for crude oil, for natural gas, and for all the refined products it sells. Clearly, if the price of gas had been allowed to reflect its true market value in the past, the petroleum industry would have been able to generate more money from the sale of both natural gas and oil and consequently more could have been devoted to the exploratory and drilling effort. And in that event much more oil and gas doubtless would have been found. The petroleum industry's inability to finance a fully adequate search first became apparent about a decade and a half ago and since that time its annual rates of spending and drilling have fallen progressively farther behind indicated needs. And as a result so has the discovery of both oil and gas.

In the fifteen years ranging from 1955 to 1970, the domestic petroleum industry spent a total of 68 billion dollars on its efforts to find more petroleum. And it drilled a total of 653 thousand wells. For its efforts, the industry found 50 billion barrels of crude oil, 10 billion barrels of other petroleum liquids, and 206 trillion cubic feet of natural gas. In terms of energy value, the gas discovered was the equivalent of 88 percent of the amount of oil found. To have discovered enough oil and gas to satisfy all of the nation's needs during the period and also maintain a realistic inventory of proved reserves, the industry would have had to increase its drilling effort by 75 percent and spend an additional 50 billion dollars. But there is no realistic basis for believing that an expanded effort of such magnitude would have been possible with the existing price structure.

As revealed earlier in this report, the nation's needs for oil and natural gas in the 1970–1985 period will be very much greater than in the preceding fifteen years. And the task of satisfying those needs will be enormous. If they were to be satisfied from domestic sources without any proportional increase in the dependence upon foreign supplies, the petroleum industry would have to carry on a drilling effort more than twice as great as in the preceding fifteen years. And the probable cost of such an effort, including all related activities, would be at least 140 billion dollars—measured in dollars of current value. With continuing inflation, the required outlay would involve a greater number of dollars, of course. Within the existing economic framework, however, there is no likelihood that the industry would be able to finance a search of the required magnitude. The need for capital funds is by no means limited to the amount of money that would have to be devoted to the search for oil and natural gas. As the nation's requirements for petroleum grow, the industry will also have to invest large and steadily increasing amounts for additional transportation, refining,

and marketing facilities. It must also pay all operating and capital costs, of course. And the proportions of internally generated funds and borrowed capital must be kept in realistic balance. Considering all the factors involved and the existing economic circumstances, it would not be realistic to expect the petroleum industry to apply more than 85 million dollars to the search for new sources of petroleum within the 1970–1985 period.

Natural gas supply

With the financial input limited to 85 billion dollars, there would be no realistic basis for believing a fully adequate search could be conducted. And the discovery of both oil and natural gas, therefore, would fall far short of indicated needs. Based upon the amount of gas that logically could be expected to be found, the nation's maximum productive capability in 1985 is related to the potential demand in the following table:

[In billion cubic feet per day]

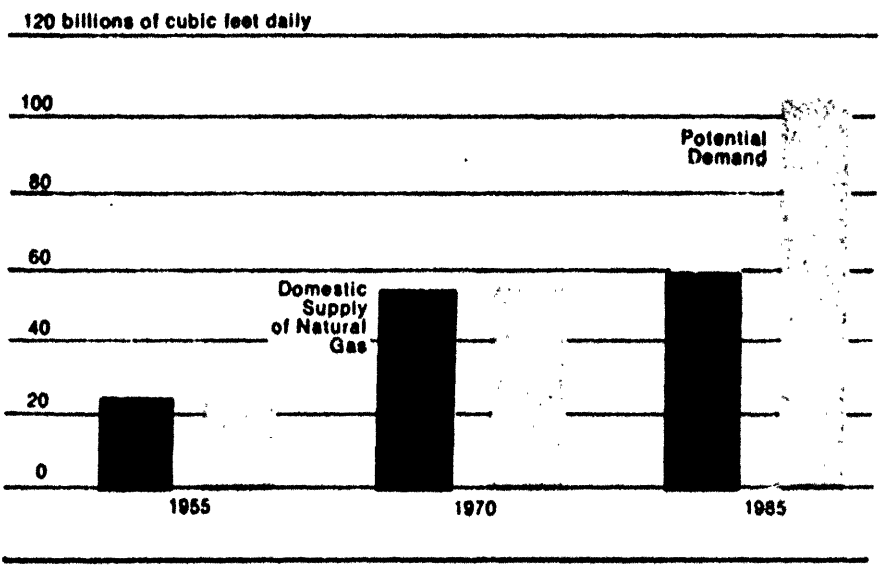
Natural gas	1970	1985	Change
Potential demand	59.5	107.0	+47.5
Domestic supply	56.5	60.0	+3.5
Deficit	3.0	47.0	+44.0

As indicated, the nation's self-sufficiency—*even with the production of far away Alaska included*—is not likely to be much over 50 percent. And, obviously, there will be a great need for alternate sources of supply. Of the current over-all supply, gas imported from Canada represents 4 percent. Although the amount of gas brought in from Canada is likely to increase substantially in the years ahead, it will not represent a significantly larger proportion of the total required supply. As in the United States, the future discoveries of natural gas in Canada will reflect both the physical effort to find it and the money available to pay the costs of that effort. In the past, American companies have been responsible for a major part of the expenditures devoted to the search for petroleum in Canada. And the economic forces that determine the availability of funds in the United States also apply in Canada. Based upon existing reserves, a realistic projection of future discoveries, and Canada's internal needs, it is not likely that more than 5.5 billion cubic feet a day of Canadian gas could be imported by 1985. That amount compares with approximately 2 billion cubic feet a day in 1970.

Normally, natural gas is transported by pipeline. And the gas imported from Canada is moved by that means. It is, however, possible to convert natural gas to a liquid form by lowering its temperature and, in that form, it can be transported in specially built tankers. If that method of transportation is utilized, natural gas can be imported from several foreign sources. However, because of the exceptionally high costs of the tankers and other necessary facilities, it is a very expensive means of transportation. And the delivered cost of foreign gas to United States markets would therefore be much greater than the current cost of domestic natural gas. As a result of their long history of instability, some of the potential sources of gas supply are widely regarded as unreliable. For that reason and others of a political nature, capital investment tends to be discouraged. And the availability of capital, of course, will be a major factor in the determination of how much liquefied gas will be imported in the future. Some projects are now in the preliminary stage and others may develop in the future. Considering all the factors involved, the imports of liquid natural gas conceivably could reach a total of 6.5 billion cubic feet per day by 1985.

The production of synthetic gas from coal is another potential supplementary source of supply. But, like imported liquefied natural gas, it is a very expensive source. The capital costs of a gasification plant are exceedingly high relative to the output of gas. And, at best, the price of the gas at the plant would be several times greater than the current average price of natural gas at the wellhead. Very large scale coal mining operations are required to satisfy the needs of even the smallest economically feasible plant. And the labor requirements are also high, for both the mining and plant operations. In addition, vast quantities of water are needed. Major environmental problems must be resolved in the mining operations and also at the plant. Moreover, approximately one-third of the energy

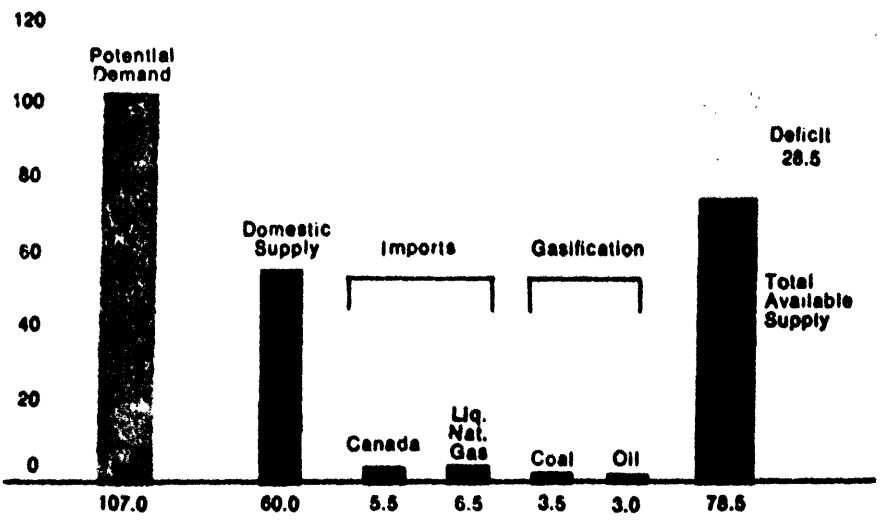
U.S. GAS SUPPLY AND DEMAND



content of the coal is lost in the gasification process. All of the foregoing factors add to the price of synthetic gas, of course. A few plants are currently under consideration for possible construction within the next several years. And research directed toward the development of more advanced gasification technology is being carried on. By 1985, it is possible that 3.5 billion cubic feet per day of synthetic gas produced from coal may be available.

Synthetic gas can also be produced from oil. Although the initial capital investment required is smaller than for liquefied natural gas or for coal gasification, the price of the gas nevertheless is higher. To a major degree, the price

1985—U.S. GAS SUPPLY AND DEMAND



reflects the cost of the feedstock and it is therefore highly sensitive to changes in that cost. For the most part, current technology involves the use of naphtha as a feedstock. And, reflecting supply and demand forces, the price of naphtha is increasing sharply. Naphtha is also used as a feedstock in the production of chemicals and increasing competition for available supplies is likely. Additional price advances, therefore, are in prospect. Other light liquids can also be used for gasification purposes, but availability will be limited. In time, a gasification process utilizing crude oil may be developed. But, with domestic supplies becoming increasingly short, the crude oil would have to be imported. Because of a relatively short plant construction time, the gasification of naphtha is the earliest available supplementary source of supply. And, despite the high price of the gas, a number of plants have been announced and others are in the planning stage. By 1985, the total output of such plants is expected to reach 3 billion cubic feet per day.

All of the possible sources of gas supply in 1985 are listed in the following table and their total is compared with the potential demand:

	Billion cubic feet per day
Domestic production	60.0
Imports from Canada	5.5
Imports of liquid natural gas	6.5
Coal gasification	3.5
Oil gasification	3.0
Total gas supply	78.5
Potential demand	107.0
Supply deficit	28.5

As the table reveals, the maximum amount of gas—both natural and synthetic—that can realistically be expected to be available by 1985 will fall very much short of indicated market needs. And, unless economic circumstances improve sufficiently to stimulate a much expanded search for new reserves of domestic natural gas, more than a quarter of the market must go unsatisfied. That portion of the market, therefore, will be forced to resort to other sources of primary energy. As discussed earlier in the demand section of this report, oil and coal are the sources likely to be utilized as direct substitutes. That dependence upon oil and coal will be in addition, of course, to the amounts used for gasification, as shown in the foregoing table.

Oil supply

If there were no limitations upon the future supply of natural gas, the demand for oil would be expected to grow from 14.7 million barrels per day in 1970 to 26.3 million a day in 1985. But, as a result of the shortage of gas and the need to use oil as a substitute, the demand for oil is expected to reach 30.2 million barrels per day in 1985—nearly 4 million a day more than would normally be in prospect. If the domestic petroleum industry's ability to conduct a search for new sources of petroleum continues to be restricted by a lack of capital funds and other unfavorable economic and political factors, it will become progressively less able to satisfy the nation's needs for oil as well as for natural gas. Based upon the amount of oil that logically could be expected to be found as a result of an 85 billion dollar investment, the nation's productive capability in 1985 is related to the expected demand in the following table:

[Million barrels per day]

Oil	1970	1985	Change
Demand	14.7	30.2	+15.5
Domestic supply[1]	11.6	15.0	+3.4
Deficit	3.1	15.2	+12.1

[1] Includes net processing gain.

The information conveyed by the table is truly cause for alarm. Clearly evident is a sharp decline in the self-sufficiency of the United States in respect to its supply of oil. In 1970, the nation was capable of satisfying nearly 80 percent of

its needs from domestic sources. But, by 1985, it is not likely to be able to satisfy as much as half—*even with the production in Alaska included.* If the market needs are to be fully satisfied in the future, the United States necessarily must become progressively more dependent upon foreign sources of supply. The most likely sources of imported oil in 1985 are shown in the following table:

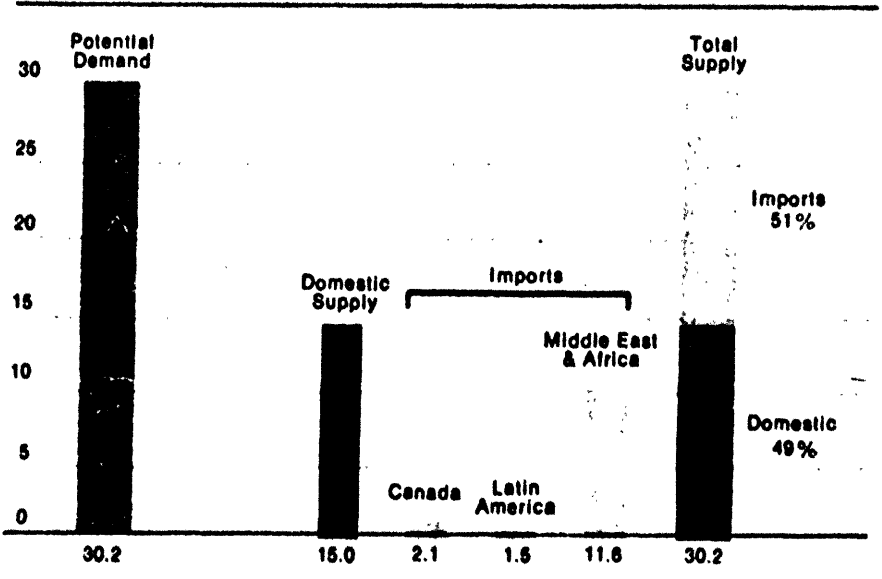
	Million barrels per day
Latin America	1.5
Canada	2.1
Middle East & Africa *	11.6
Total	15.2

*Includes a fractional amount from the Far East.

Neither Latin America nor Canada will have unlimited amounts of oil to export to the United States. Based upon their existing reserves, realistic projections of future discoveries, and expanding internal needs, the amounts shown in the table represent the maximum likely to be available. Therefore, the great bulk of the imported oil in 1985 will have to be obtained from the Middle East and Africa. The indicated amount from those regions would represent more than three-fourths of all imports and nearly 40 percent of the nation's total supply of oil from all sources.

As demonstrated in earlier discussion, the United States is more dependent upon oil than any other primary source of energy. And it cannot tolerate a prolonged shortage of supply. Even a brief interruption can have a severely damaging impact. As the dependence upon foreign sources of supply increases, so will the potential for supply shortages. And, by 1985, when the nation may have to import more than half of its supply, will be in a highly vulnerable position. Many of the foreign producing areas have long been the scene of strife and turmoil. And, as past experience teaches, there is the continuing possibility that the movement of oil to market may be halted by governmental action. Threats to cut off or reduce the flow are heard frequently. Because operating facilities are so highly concentrated in these areas, they are exceedingly vulnerable to both sabotage and military action. And there actually have been frequent incidents in the past that have stopped or reduced the movement of oil to market. In the unfortunate event of a large scale armed conflict between nations, the entire production of the Middle East and Africa conceivably could be halted.

1985—U.S. OIL SUPPLY AND DEMAND

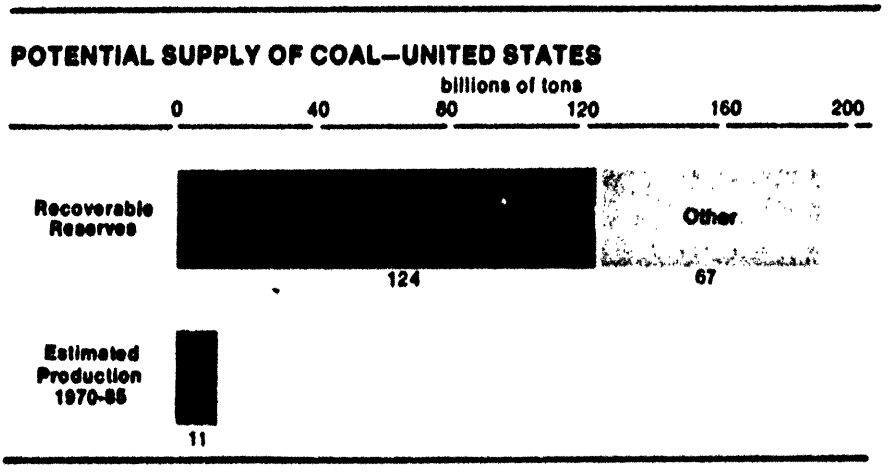


As noted earlier, the great bulk of the supply of both rubber and organic chemicals is derived from petroleum. And, as the nation's self-sufficiency in respect to petroleum progressively declines in the fuutre, so will its self-sufficiency in rubber and chemicals.

Coal

Without any limitations upon the future supply of natural gas, the nation's needs for coal would be expected to grow from 525 million tons in 1970 to 715 million tons in 1985. But, as a result of the shortage of gas and the need to use coal as a substitute, the demand for coal is expected to reach 960 million tons in 1985—about one-third more than would normally be in prospect. The accumulated needs over the 15 year period are expected to be nearly 11 billion tons.

From the standpoint of coal resources, there is positively no question about the adequacy of supply. The total potential resource base is nearly 800 billion tons—enough to last 1,500 years at the current rate of consumption. Although it would not be possible to recover all of this coal with current mining technology and economic conditions, much of it would be available given the proper circumstances. With existing technology, approximately one-fourth of the total potential resource is accessible. And even that amount would last for several hundred years at the current rate of consumption.



Despite the abundance of potentially available coal, the nation is nevertheless on the threshold of a developing shortage. Numerous factors are involved—some economic and some political. Together, they have created for the coal industry a shortage of capital funds similar to that experienced by the petroleum industry. Following World War II, the coal industry suffered a severe loss of market as the nation's railroads progressively converted from coal fired steam locomotives to the more efficient diesel engines. On the heels of that development, the coal industry was dealt an even more devastating blow by the rapidly expanding invasion of its other markets by exceedingly low priced natural gas. As noted earlier, the gas was available at an unrealistically small cost because of the price controls imposed at the well. Unable to compete in terms of price, the coal industry experienced a large scale loss of markets.

With declining markets and a very low price received for the coal it was still able to sell, the industry had neither the financial means nor the incentive to develop additional productive capacity. Indeed, it was not even able to maintain existing capacity, as it continued to encounter rising costs of operation. Only the most efficient operations could be sustained. In the mid-Sixties, the industry's outlook was rendered even more bleak when electric utilities began to place a large number of orders for nuclear powered generating stations. And more recently, the use of coal by electric utilities and industrial consumers has been restricted for environmental reasons. Considering all the circumstances of the past 25 years, it is little wonder that the United States is faced with a shortage of coal in the midst of plenty.

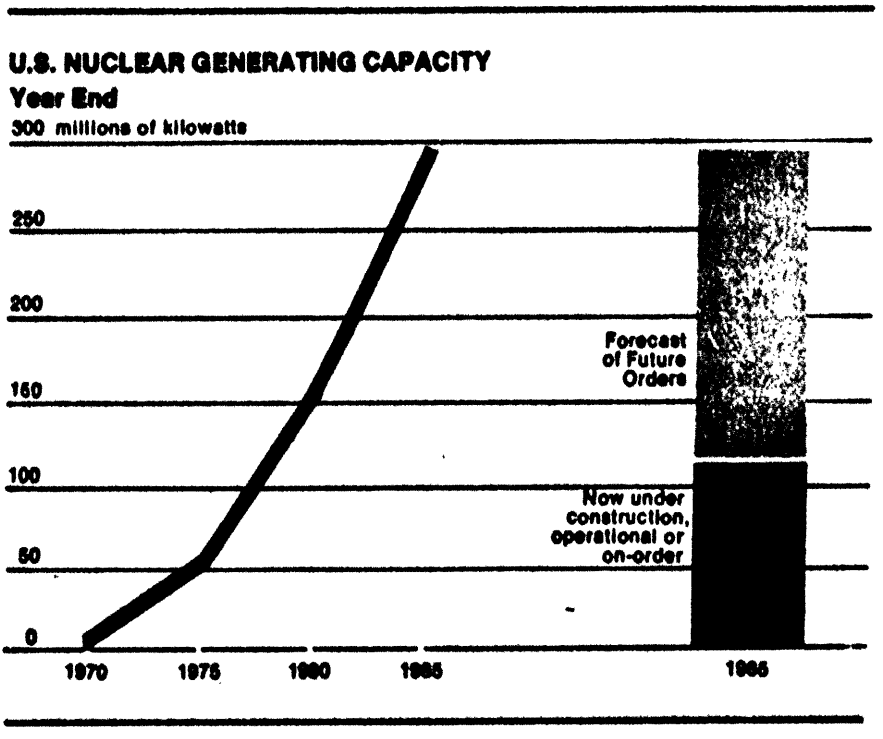
If the coal industry is to satisfy all of the expected demand between 1970 and 1985, it must progressively enlarge its productive capacity to nearly double

what it is at present. Much of the increase will be needed in the latter part of the 15 year period, when the shortage of natural gas becomes more acute. The need to conform to stringent environmental standards will constitute a major problem for the coal industry. About one-third of the recoverable coal reserves has a sulphur content too high to meet current standards. And, if that coal is to be utilized, the sulphur will have to be removed at a substantial cost when the coal is burned. The coal reserves with a low sulphur content are located largely in the western part of the nation and high transportation costs would be involved in moving the coal to the major markets in the East. To a growing degree, the coal industry will also need to depend upon strip mining, if it is to increase its productive capacity. And the associated costs of land restoration will be high.

Clearly, the capital costs of expanding the nation's coal production will be very large. And, if the required funds are to be generated, the price of coal necessarily will have to be substantially higher than it has been in the past.

Nuclear energy

Unfortunately, a rather widespread misconception exists in respect to the use of nuclear power. To a surprising degree, there is a tendency to believe that it can be freely substituted for other forms of primary energy. But, in actual fact, that is not possible. The use of nuclear power is virtually limited to the generation of electricity by electric utilities—it is not practical to utilize it directly for industrial, commercial, transportation, and residental purposes. Only to the extent that those markets can readily substitute electricity purchased from utilities for the direct use of primary energy can their needs be satisfied with nuclear power. And there are practical limits to the degree of such substitution.



As noted earlier, the use of nuclear energy to generate electricity is expected to grow at an exceptionally fast rate in the 1970–1985 period. And by 1985, nuclear power is likely to be the foremost form of primary energy utilized to produce electricity, representing as much as 35 percent of the total consumption of the electric utilities. Despite the rapid growth in prospect, nuclear power is not likely to constitute more than 18 percent of the total supply of primary energy required for all purposes. And there is no realistic basis for thinking that it could possibly be a higher proportion. After a nuclear generating plant is ordered, a 7 to 8 year period is required for construction and other details. And there is

little likelihood that any plant orders in addition to those already projected could possibly be operational by 1985.

At present, there is a substantial degree of objection to nuclear power plants on environmental grounds. And the start up of a number of plants has been delayed as a result. Conceivably, such objections could limit the growth of nuclear energy to less than the expected amount. But, it is necessary to be mindful that there are also environmental restrictions on the use of coal and, if the electric utilities were denied sufficient supplies of both nuclear energy and coal, they could not possibly satisfy the nation's needs for electricity. In that event, a direct conflict between consumers and environmentalists would be inevitable.

As a result of a vigorous exploratory effort both in the United States and abroad, there have been significant additions to uranium reserves. And the outlook for the basic raw material used in the production of enriched nuclear fuel has improved. Also, joint private and government sponsored research effort to develop a practical breeder reactor is being accelerated. When perfected, such a unit would have the eventual capability of producing more nuclear fuel than was originally needed to start the plant's operations. And the dependence upon natural uranium reserves would therefore be reduced. It is unlikely, however, that a significant number of such plants could possibly be operating commercially by 1985.

Water power

Of all the electricity produced in the United States in 1970, approximately 15 percent was generated with water power. In the mountainous areas of the West, where more than half of the nation's hydroelectric capacity is located, water power alone was responsible for nearly sixty percent of the total output of electricity.

Conventional hydroelectric projects involve the control of the water flow of rivers through a system of dams to spin turbines and thus generate electricity. Capital costs are high but operating costs are low. There is no air pollution but environmentalists often object to the construction of dams on other ecological grounds. Another form of water power, developed in recent years, is the pumped storage system. That method involves the pumping of water to an elevated reservoir at a time when the demand for electricity is slack. The water is allowed to flow down through turbines when the demand is at a peak. Although more electricity is required for the pumping process than is generated when the water flows down, greater efficiency is achieved in terms of serving consumer needs. Geothermal energy is still another form of water power. In a few areas in the West, steam rising from hot water trapped deep in the earth is used to produce electricity. The amount that can be thus utilized, however, represents only a tiny fraction of the water power used.

Based upon the relatively few remaining hydroelectric sites that can be developed and effectively utilized, the amount of electricity generated with water power, is not likely to increase by more than 45 percent between 1970 and 1985. By 1985, the electricity thus produced will represent no more than 8 percent of the total amount of electricity generated. And, as a proportion of the over-all supply of primary energy needed, water power is likely to constitute less than 3 percent.

Conclusions

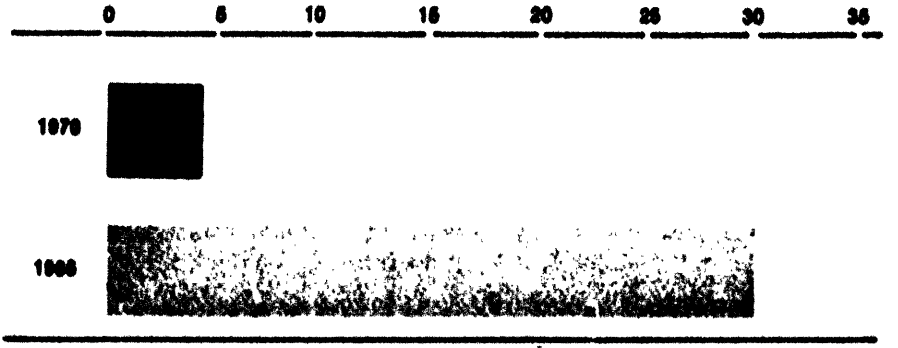
Unfortunately, none of the five domestic sources of primary energy is now adequate to meet the nation's needs. And, for a period of time, the shortage is certain to become progressively greater. Clearly, the situation is very serious and demands immediate corrective steps. But even if such actions were taken, the shortage would still worsen for several years because of the time that necessarily must elapse before the corrections could possibly become effective and the nation's rapidly growing energy requirements in the meantime.

As indicated in foregoing discussion, the United States depends upon petroleum to satisfy as much as three-fourths of its over-all energy needs. And petroleum is the source of energy in shortest supply. In the opinion of some, the domestic shortage is not a reason for concern because, it is claimed, the United States can import all it needs. Under no logical circumstances, however, could nearly enough natural gas be imported. And, even though a sufficient amount of foreign oil conceivably might be brought in, the nation would be taking a grave risk in

doing so. To depend upon uncertain foreign sources for such a high proportion of its oil supply would make no more sense than to expect foreign countries to provide for this nation's defense.

Not only would the United States be in a position of constant weakness, always vulnerable to having a major portion of its oil supply cut off, but it would also suffer from a monumental balance of payments deficit. Currently, the cost of imported petroleum amounts to approximately 4 billion dollars per year. That outflow is more than offset by the repatriated earnings of American petroleum companies operating abroad and the funds derived from the export of related technology and equipment. If the United States is forced to import the amounts of oil and natural gas indicated earlier in this report, the necessary outflow by 1985 is likely to be in excess of 30 billion dollars per year. In no sense would it be realistic to expect that the outflow of dollars would be offset by a corresponding inflow. Indeed, the annual balance of payments deficit for petroleum alone could be as much as 25 billion dollars—a deficit the nation could not tolerate. It could possibly be even greater if foreign producing countries raise their prices more than presently estimated. As a major importer of necessity and with no ready alternatives, the United States would have virtually no bargaining power and would be forced to pay almost any price demanded by the producing countries.

BALANCE OF PAYMENTS—GROSS OUTFLOW FOR IMPORTED PETROLEUM



It has been recommended in some quarters that the United States should curb its use of energy as a means of alleviating the shortage of supply. However, an analysis of the uses of energy reveals little scope for major reductions without harm to the nation's economy and its standard of living. The great bulk of the energy is utilized for essential purposes—as much as two-thirds is for business related reasons. And most of the remaining third serves essential private needs. Conceivably, the use of energy for such recreational purposes as vacation travel and the viewing of television might be reduced—but not without widespread economic and political repercussions. There are some minor uses of energy that could be regarded as strictly nonessential—but their elimination would not permit any significant savings. In an emergency, of course, there would be no alternative to a reduction in the use of energy. But, curbing consumption at other times would represent no more than a temporary expediency that would have the unwanted effect of lessening the incentive to find a lasting solution to the problem of an adequate energy supply. And a lasting solution must be found. The United States was able to become the great nation it is because, until recently, it possessed all the energy needed to sustain its enormous productive capacity. But, without enough energy in the future, the nation could not possibly retain its foremost rank.

There is no basis for thinking a lasting solution is impossible. Actually, there are sound reasons for believing that the United States has within reach vast energy resources. Although the proved reserves of petroleum—both oil and natural gas—are small relative to future needs, geologists believe there is a potential

for finding a great deal more, particularly in offshore areas. How much more actually remains to be found, no one really knows. And the answer cannot be known without a truly exhaustive search. Geologic knowledge has increased enormously since the first discovery of oil 113 years ago. And so has the petroleum industry's technical ability to conduct a thorough search. Because of these developments, petroleum is now found in areas once considered barren or beyond reach. And continuing progress of this nature can be expected. In addition to the potential for finding petroleum by conventional means, huge amounts can be extracted from the oil bearing shale deposits located in the Rocky Mountains. And it is also potentially possible to produce large quantities of synthetic oil and gas from coal in addition to the use of coal in its original form.

But much of the energy resources of the United States is not accessible within the current economic framework. To find, develop, and make available the energy the nation requires, will necessitate the use of vast amounts of private capital. And if the capital funds are to be available, the price structure will have to be adequate. Moreover, it must be flexible—free to change whenever warranted by economic conditions. As a result of the unnatural market conditions created by the price controls imposed on natural gas at the well, the consumers of all forms of energy have been living in a fool's paradise. But time has now run out. And, if they are to have enough energy in the future, they will have to pay prices that are economically sound. Even though such prices will be substantially more than they have been accustomed to paying, the cost of energy nevertheless will remain modest relative to the cost of the other essentials of life. Currently, less than 5 percent of the average family's annual income is devoted to energy—much smaller than the proportions used for food or housing or clothing or taxes.

Clearly, it is vitally important that the United States maintain the highest possible level of self-sufficiency in respect to its energy supply. And, if that goal is to be achieved, major changes are essential—there is no hope that it can be won as long as existing conditions persist. The restrictions that have stifled both the generation of capital and the incentive to invest must be removed at once. From the beginning, there was never any logical basis for thinking that the price of natural gas could be regulated without an adverse impact on all forms of energy. And no reasonable excuse can be offered for the failure to take corrective actions in the face of mounting evidence over the past decade and a half of the damage being done. The idea that the consumer was being protected by the regulation has been proven false—instead, by creating an energy shortage, the controls have done the consumer and the nation a great disservice. Therefore, the controls should be removed—not merely modified, but removed completely and quickly. And the prices of all forms of primary energy should be allowed to respond to natural economic forces and move to whatever levels may be necessary to assure an adequate supply.

In addition, there is an urgent need for an understanding by government of the importance of the role played by the provisions for capital recovery. They rank almost equally with net income as a source of capital funds. Together, the provisions for capital recovery and net income provide the great bulk of the money utilized to finance the search for more petroleum and the construction of additional refineries, tankers, pipelines, and marketing facilities needed to serve the nation's petroleum requirements. The lack of a sufficient understanding by government was demonstrated in the Tax Reform Act of 1969. By that legislation, the domestic petroleum industry was deprived of several hundred million dollars of capital funds annually. Based upon past results, the amount of capital lost since the legislation became effective was potentially capable of finding 1 billion barrels of oil and 5 trillion cubic feet of natural gas—enough to satisfy 10 percent of the nation's needs in that period. And now, in the case of a worsening shortage of petroleum, there are actually efforts to reduce the capital recovery provisions even further. The United States can no longer afford politically inspired actions of that nature—the potential harm to the nation is much too great. And the other energy industries, of course, also have a need for realistic capital recovery.

The United States cannot hope to achieve a safe degree of energy self-sufficiency unless a more realistic approach to the solution of environmental problems is also adopted. Improvement of our environment surely is a worthy objective—but not at any cost. To achieve a better environment at the expense of a greater shortage of energy would prove to be a hollow victory, indeed—one

the nation simply cannot afford to win. Many actions taken thus far by government and private organizations have limited the current availability of energy and restricted efforts to provide for future needs. And some actions have actually led to a waste of both energy and capital resources. There is a compelling need for all involved to consider with utmost care the ultimate consequences of their actions before further harm is done. Otherwise, a backlash leading to an ugly conflict between the consumers of energy and environmentalists is a likely consequence. And, considering the vastly superior number of consumers, there can be no doubt about the outcome of such an encounter. With a sincere, well conceived, and coordinated effort, the nation can realize environmental gains without sacrificing its supply of energy. But such an effort must be free of political motivations and the influence of special interests, if it is to succeed.

Finally, it must be understood that the energy industries will not be able to serve the nation's needs to the fullest without support and cooperation. Rather than working in harmony for the good of the nation as a whole, government often chooses to play the shortsighted role of adversary instead. Sometimes, these actions of governmental hindrance reflect a lack of knowledge and understanding. But many also leave the clear impression that they are politically motivated. As a nation, we cannot embrace the free enterprise system with one arm and simultaneously reject it with the other. If our chosen system is to function effectively, there must exist a far better understanding of the vital role played by private capital. Like energy, capital is a resource—and it is also in short supply. The current shortage of energy reflects a prolonged shortage of capital—not the lack of an energy resource base. And that is a condition that must be corrected. If it is not, and the energy deficit becomes critical, we have only ourselves to blame.

1972

Energy Economics Division August, 1973

Annual Financial Analysis of a Group of Petroleum Companies

by Richard C. Sperling
Norma J. Anderson
Richard S. Dobias

with John G. Winger

THE CHASE MANHATTAN BANK, N.A.

Companies Included in Study

Amerada Hess Corporation
Apco Oil Corporation
Ashland Oil, Inc.
Atlantic Richfield Company
The British Petroleum Company Limited
Champlin Petroleum Company
Cities Service Company
Clark Oil & Refining Corporation
Compagnie Francaise des Petroles
Continental Oil Company
Exxon Corporation
Getty Oil Company
Gulf Oil Company
The Louisiana Land and Exploration Company
Marathon Oil Company
Mobil Oil Corporation
Murphy Oil Corporation
The Oil Shale Corporation
Petrofina Societe Anonyme
Phillips Petroleum Company
Royal Dutch/Shell Group of Companies
The Signal Companies, Inc.
Skelly Oil Company
Standard Oil Company of California
Standard Oil Company (Indiana)
The Standard Oil Company (Ohio)
Sun Oil Company
The Superior Oil Company
Texaco Inc.
Union Oil Company of California

This study is based on data secured from annual reports to stockholders and to the Securities and Exchange Commission and on information developed from other sources. The Energy Economics Division of The Chase Manhattan Bank wishes to thank the companies and individuals who have cooperated in supplying special information and material used in this survey.

Additional Copies may be obtained from:
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Foreword

For many years The Chase Manhattan Bank has conducted a detailed study of the financial performance of a large number of petroleum companies. Because the combined operations of these companies constitute a major proportion of the worldwide activities of the petroleum industry, their combined financial performance provides a valuable basis for determining the probable experience of the over-all industry.

As a service to the petroleum industry, and all others with a related interest, the Bank has published annually since 1945 the summarized results of this study.

The companies included in this study are the 30 organizations listed on the adjoining page. Throughout the report they are referred to collectively as "The Group." Over the years the number of companies comprising The Group has changed as a result of additions or mergers. Data for earlier years have been adjusted to reflect major additions and thereby permit valid comparisons of current developments with those of the past.

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Introduction

The United States is now in the early stages of an economic impact that is the natural result of an inadequate supply of energy. It is a situation destined by existing circumstances to become much more severe in the years immediately ahead. And it is one that eventually could extend far beyond the borders of the United States if corrective forces are not soon brought into play.

An energy shortage in the United States at this time was not inevitable. It did not have to happen The shortage is a product of man's own making—the consequence of a prolonged failure to recognize this basic economic fact of life: the supply of energy is directly related to the expenditures made to provide that supply. That principle applies to all forms of energy—fossil fuels, water power, nuclear power, and the various exotic forms not yet in use. If the expenditures required to find, develop, or otherwise make available a supply of energy are insufficient, a shortage will surely develop no matter how abundant the basic energy resources.

The United States does not lack basic energy resources—an enormous additional supply of energy could be made available if only the necessary expenditures were possible. But faulty policies of government have operated for more than three decades to prevent the required expenditures. And the current energy shortage is the harvest those policies have reaped. As they begin to encounter first hand the adverse effects of the energy shortage, consumers in rapidly increasing numbers are asking why their government has been so insensitive to the problem, why it has continued to foster for such a long time the policies that have led to the shortage.

Although there are several facets to a complete answer to such questions, a lack of comprehension obviously is an important factor. By their words and deeds many representatives of government demonstrate an insufficient understanding of all that is involved. And that inadequacy can be

traced in part to a lack of effective communications. The energy industries have not explained to government and the public at large nearly as well as they might the nature and vital importance of their business activities.

For the most part, information relating to the petroleum industry is conveyed in the reports of individual companies to shareholders. Although these reports are fairly comprehensive, they emphasize the items of greatest interest to stockholders and pay only scant attention to other features of vital importance. Earnings, earnings per share, and dividends are stressed in the most prominent part of such reports, but a review of capital expenditures and return on investment are usually relegated to the back pages. Whenever possible, shareholders are told that earnings are at a record level, but rarely do they learn that capital expenditures are also at a record high and that the growth of earnings is far short of the need for new investment.

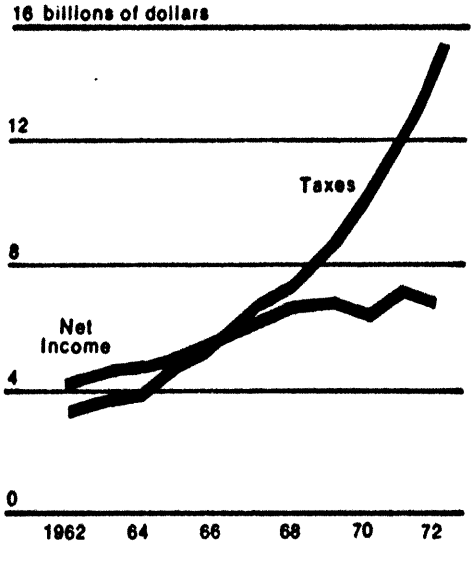
Press releases to the news media are usually patterned after reports to stockholders. And the media therefore receive and pass on to the public distorted impressions of the petroleum industry. Under such circumstances the industry's image is not likely to be good. And it is understandable why government so often behaves as it does. It might be argued with reason that government has a moral obligation to be fully and correctly informed on its own initiative before it acts. But, since the legal requirements for holding elective or appointive office are not nearly so demanding, government often operates on the basis of only limited information and understanding. Therefore, it is not surprising that government implements policies of the kind that have led to a shortage of petroleum and other forms of energy as well.

Even in the face of a progressively worsening shortage of petroleum, government continues to exhibit little evidence of understanding the industry's essential need for adequate financial resources. Obviously, taxes are a major cost of doing business. And whenever that cost increases, there is a need for a corresponding rise in revenue, of course. If the expansion of revenue is restricted, however, the growth of

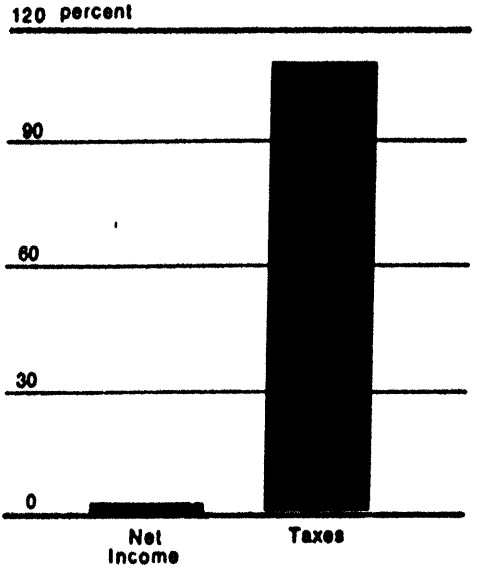
earnings cannot keep pace with the increasing need for new capital investment. And, as noted earlier, a shortage of petroleum is the direct consequence of inadequate capital spending. These elementary facts ought to be clear to all. But they are not, unfortunately. Government continuously displays an active interest in ways and means of extracting additional tax revenue, but is unconcerned about the adequacy of the funds remaining after taxes. The lack of concern is made abundantly clear when government prevents the generation of the capital funds needed to provide additional petroleum supplies by imposing artificial restraints on petroleum prices.

The devastating impact of governmental policies is clearly evident in the experience of the companies under study here. The Group represents a major part—more than three-fourths—of the entire petroleum industry throughout the non-Communist world. And its experience closely parallels that of the industry as a whole. Over the past four years the taxes paid by The Group increased by as much as 112 percent. But the combined net earnings of the companies increased by only 2.9 percent—an average growth of not even

NET INCOME IN RELATION TO TAXES



CHANGE OVER PAST FOUR YEARS



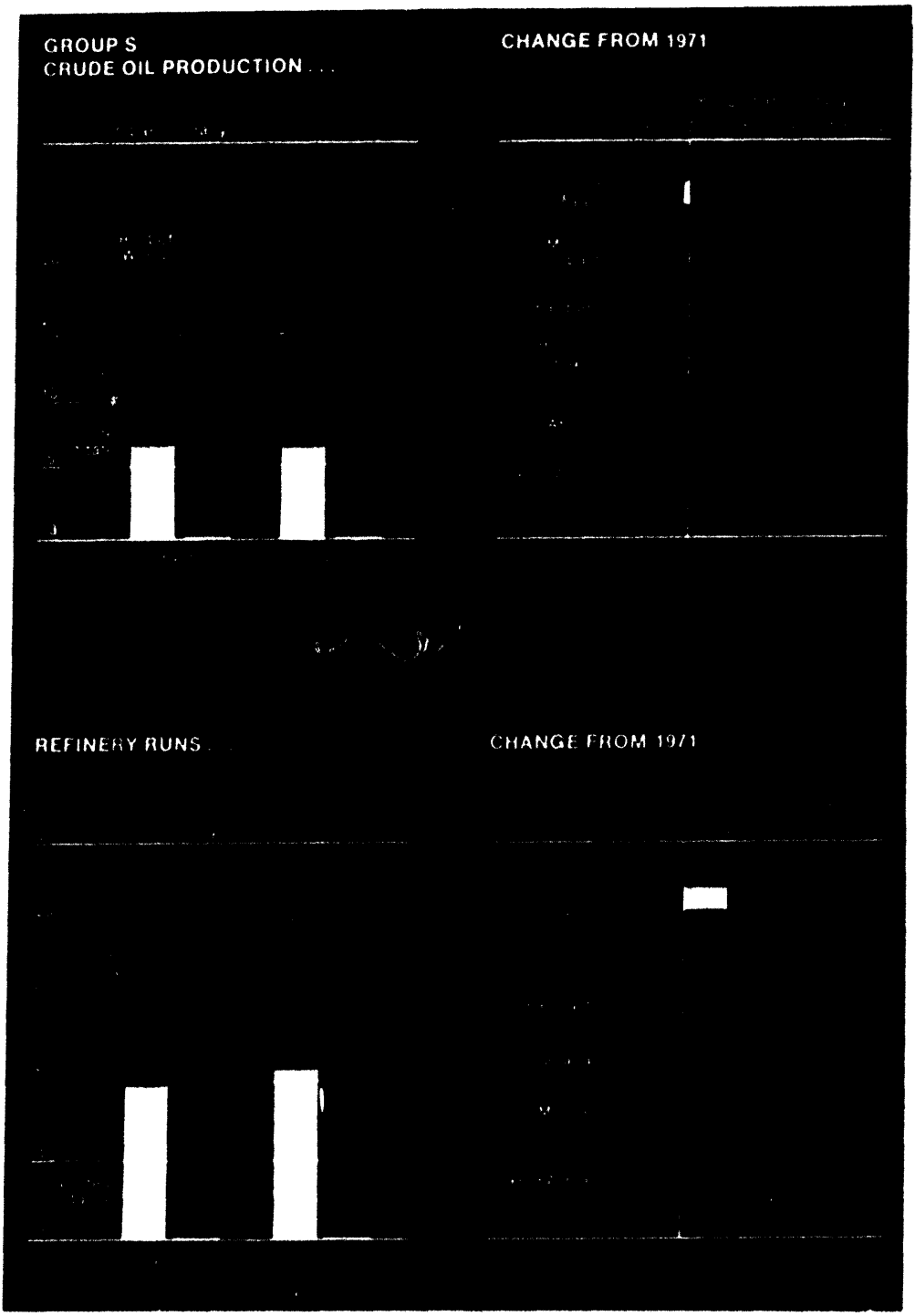
1 percent a year. Because of its inability to obtain from earnings enough money to satisfy its growing capital needs, The Group was forced to borrow much more heavily. As a consequence, its interest expense nearly doubled in only the last four years. Despite the much greater use of borrowed capital, The Group was unable to maintain an adequate level of capital spending. Over the four year period capital expenditures rose by no more than 16.6 percent—far less than the amount necessary to keep pace with the expanding needs for petroleum. No wonder petroleum is in short supply.

The Group's financial experience is cause for great concern. Clearly, the trends of recent years cannot continue without leading to much more widespread and severe shortages of petroleum. And the economies of all nations experiencing a shortage will surely suffer as a consequence. There is, therefore, an urgent need to bring corrective forces into play. And if that objective is to be achieved, there must be a much greater public awareness of the situation than now exists. The petroleum industry, and the other energy industries too, need to make a truly massive effort to bring the true facts before the public. Every possible means should be employed to explain the situation as soon and as extensively as possible in a simple and straightforward manner. A well informed public is much more likely to be reasonable and understanding. And when the public knows the facts, the attitude of government can be expected to be more realistic simply because it would be politically expedient.

Operations

The Group's crude oil production in 1972 averaged 33.3 million barrels per day—four-fifths of all the oil produced throughout the non-Communist world. Compared with 1971, output was 1.7 million barrels per day higher—a gain of 5.3 percent.

Once again, the largest portion of The Group's production gain was achieved in the Middle East. After an increase of 1.6 million barrels per day, the output in that area alone was equal to as much as half of The Group's worldwide total.

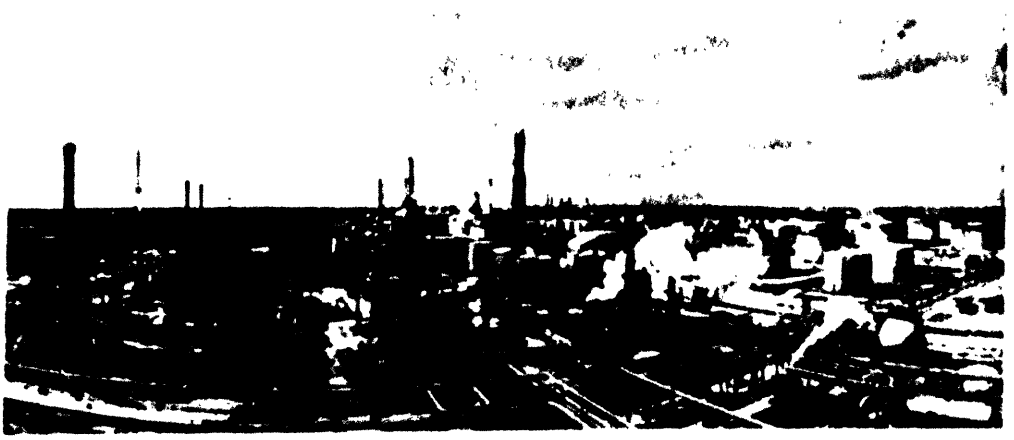


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The largest percentage increase, however, was achieved in the Far East. Production in that part of the world was raised by 213 thousand barrels a day to reach an annual average total of 1.4 million daily. Canada also was the scene of a large percentage increase. Up by 170 thousand barrels per day, the production for the year averaged 1.2 million daily. Although the annual production of 218 thousand barrels per day in Western Europe was still relatively small, a significant gain of 47 thousand a day was made in that area.

The Group was not able to increase its production in all parts of the world, however. A sharp reduction of 336 thousand barrels per day brought the output in Venezuela down to an annual rate of 3.2 million a day. And in Africa governmental restraints caused production to fall by 80 thousand barrels a day to an annual level of 3.6 million. Because the lack of transportation facilities continues to prevent the use of oil discovered several years ago in northern Alaska, production in the United States declined by 17 thousand barrels per day to an annual rate of 6.7 million daily.

Of all the oil refined throughout the non-Communist world in 1972, The Group was responsible for three-fourths. Its refinery runs averaged 28.5 million barrels per day—1.2 million more than in 1971. The increase occurred in three major geographical areas. A substantial gain of 482 thousand barrels per day brought refinery runs up to 10.4 million daily in the United States. And a similar rise of 516 thousand barrels per day raised the throughput in Western Europe to 9.3 million a day. In the Far East an increase of 237 thousand daily resulted in an annual rate of 2.5 million per day. There were declines of 113 thousand barrels daily in the Middle East and 127 thousand in Venezuela.



Income Statement

Revenue

As a result of The Group's expanded activities in response to the continued growth of worldwide demand for petroleum, its gross operating revenue rose by 9.5 percent to reach a level of 104.2 billion dollars. Non-operating revenue, however, declined in 1972. It amounted to 2.1 billion dollars—637 million less than in the year before.

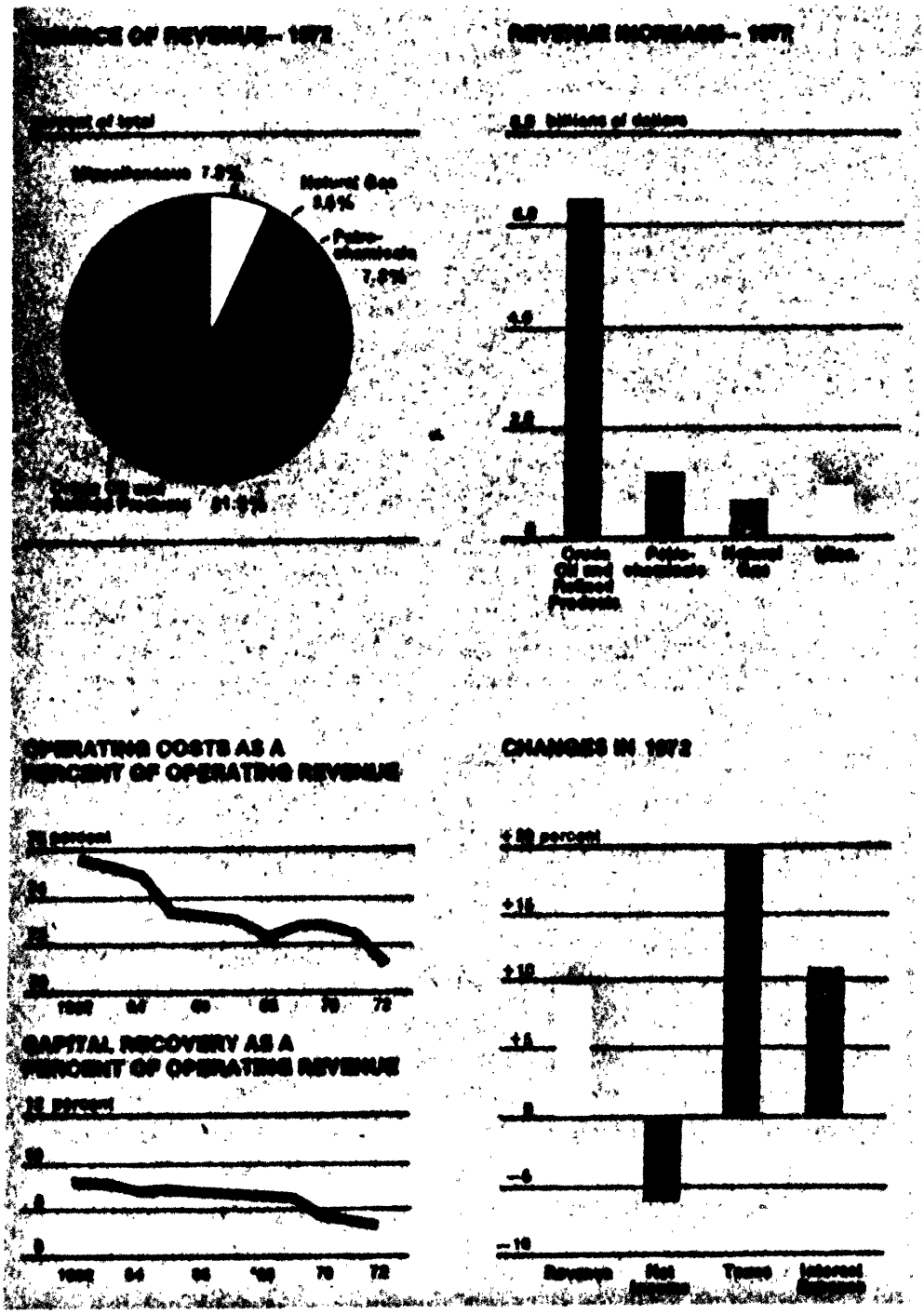
The sale of crude oil and refined products generated 85.3 billion dollars—81.9 percent of all operating revenue. Chemical product sales were the source of 7.5 billion dollars—7.2 percent of operating revenue. Although the natural gas sold by The Group represented an enormous amount of petroleum energy, no more than 3.7 billion dollars was thus derived—only 3.6 percent of its total operating revenue. Governmental price regulation prevented a more realistic yield. From various miscellaneous sources The Group obtained 7.7 billion dollars—7.3 percent of its over-all operating revenue.

Charges Against Revenue

The great bulk of all the money The Group took in was utilized to pay the day to day costs of doing business. Operating costs rose in 1972 by 8.2 percent to a total of 74.4 billion dollars. At that level, they absorbed 70 percent of The Group's total revenue—approximately the same proportion as in the year before.

In conformance with depreciation and other capital recovery provisions, 7.5 billion dollars were set aside for the replacement of worn out and depleted capital. The funds thus earmarked were 6.1 percent more than in 1971.

Reflecting a growing dependence on borrowed capital, The Group's interest expense again increased sharply. It paid out 1.8 billion dollars for that purpose in 1972—11 percent more than in the previous year. As noted earlier, the amount of money required to pay the interest charges on



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borrowed funds has risen by as much as 98 percent within the brief span of only four years.

The day to day operating costs, capital recovery charges and interest expense totaled 83.7 billion dollars and together they absorbed 79 percent of The Group's gross revenue. After these financial needs had been accommodated, there were 22.6 billion dollars remaining. But as much as 68 percent of that amount was needed to pay The Group's tax bills. The direct taxes paid in 1972 totaled 15.4 billion dollars—20 percent more than in the year before and, as noted earlier, 112 percent more than only four years before. Income taxes, amounting to 10.3 billion dollars, were 22.5 percent higher than in 1971. And other taxes increased by 16.4 percent to a level of 5.1 billion dollars.

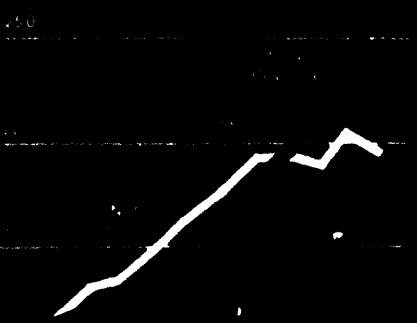
In addition to the direct taxes paid, The Group collected and passed on to governments 22.4 billion dollars in the form of sales and excise taxes. Thus, as a result of The Group's activities, governments received a total of 37.8 billion dollars of tax revenue in 1972—14.3 percent more than in 1971. And, if it can be presumed that governments utilized this money wisely and efficiently, the general public therefore benefited indirectly to a major degree.

Net Income

After meeting all the essential expenses and other charges associated with its business activities, The Group had remaining 6.9 billion dollars of net income. Thus, of the 106.3 billion dollars of gross revenue taken in, only 6.5 percent remained as net earnings. Never before was the earnings proportion so low. It was 7.4 percent a year earlier and 9.2 percent four years ago. In sharp contrast was the much larger 14.5 percent of gross revenue taken by taxes in 1972.

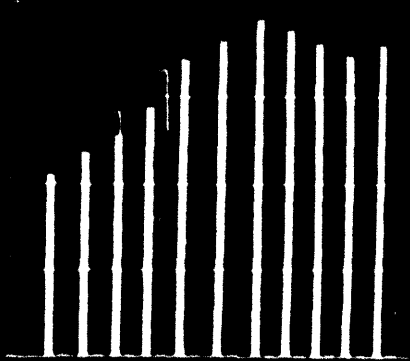
The 6.9 billion dollars of net income generated in 1972 was 5.6 percent less than in 1971. And, as cited earlier, it was only 2.9 percent more than four years ago. Again, The Group's earnings performance stands in sharp contrast with its tax payments which were up 20 percent in 1972 and 112 percent more than four years ago. Between 1968 and 1972, The Group's net income increased by 196 million dollars and

NET INCOME RELATED TO TOTAL REVENUE



NET INCOME AS A PERCENT OF TOTAL REVENUE

NET INCOME



UNITED STATES AS A PERCENT OF TOTAL

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its tax payments rose by 8,163 million dollars. Thus, for every dollar of additional net earnings, taxes increased by 42 dollars.

The table below indicates the proportions of The Group's net earnings generated in the United States and in the Foreign Sector:

	1972	1971	Change	
	Million Dollars		Mill.$	Percent
United States	3,656	3,490	+166	+ 4.8
Rest of World	3,204	3,779	−575	−15.2
Total	6,860	7,269	−409	− 5.6

The gain achieved in the United States reflected an exceptionally strong demand for oil. That strength, in turn, reflected in part both the lack of other forms of energy and also the inability to use other forms of energy more extensively because of environmental restraints. Although the amount of money earned in the United States was 4.8 percent higher than in 1971, it was, nevertheless, 7 percent lower than the earnings level of four years ago. The decline in the Foreign Sector was the result of various governmental actions, devaluation of the dollar, and higher taxes.

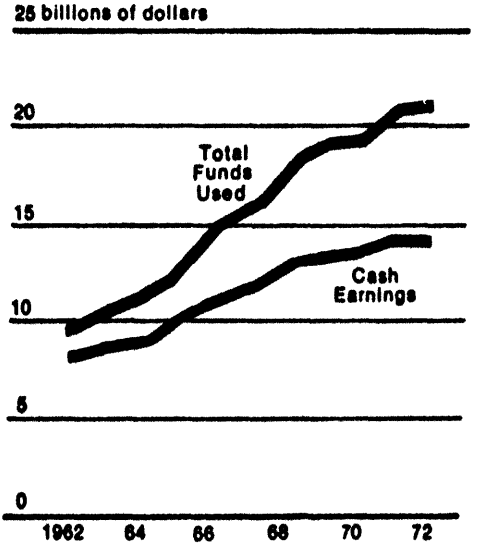
Rate of Return

As a result of the reduced level of earnings, The Group's rate of return on average invested capital fell sharply to 9.7 percent from 10.7 percent the year before. It was the lowest rate since 1958—a year marked by a general business recession.

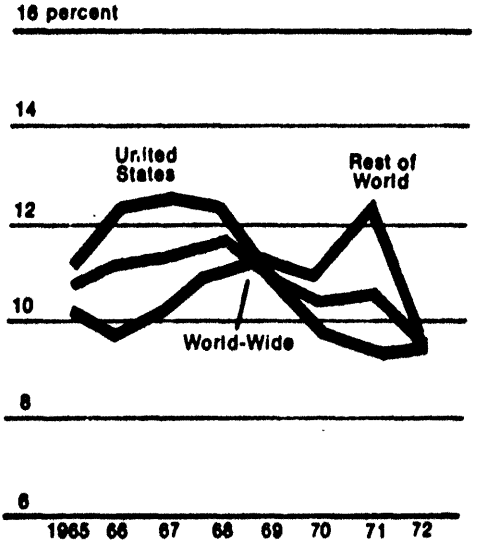
The decline can be attributed entirely to the fall of earnings outside the United States. In that part of the world the rate of return plunged from 12.5 percent the year before to 9.9 percent in 1972. Within the United States the return recovered slightly from the very low level of 9.3 percent the year before to 9.6 percent in 1972. At that level it was well below the 11.1 percent average return for all manufacturing industries.

The developments in 1972 are sobering indeed for they represent the continuation of a long lasting unfavorable

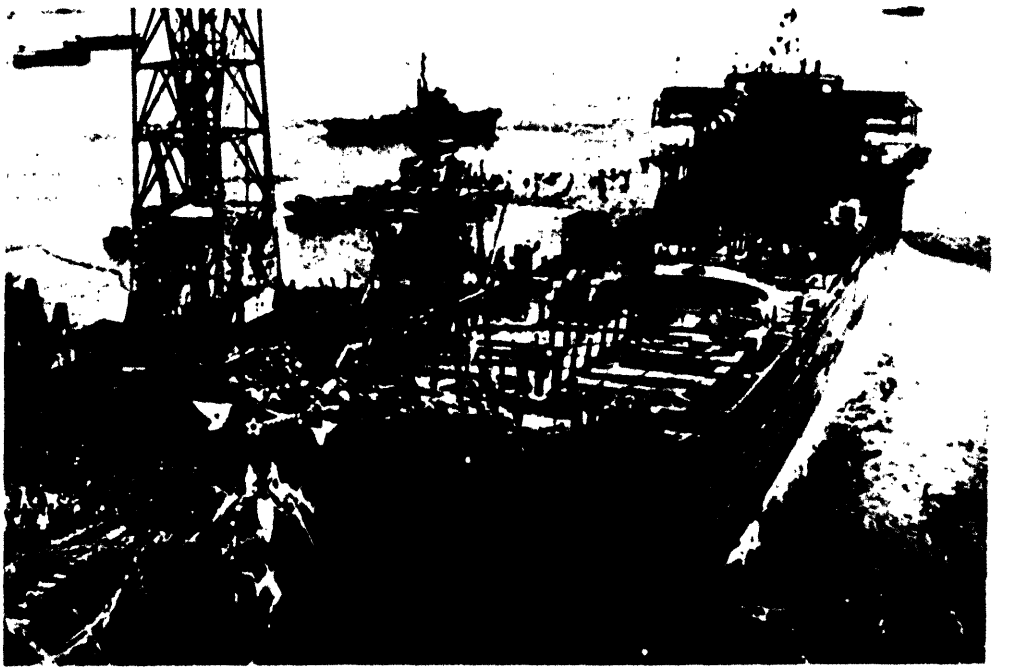
CASH EARNINGS COMPARED TO TOTAL FUNDS USED



RETURN ON AVERAGE INVESTED CAPITAL



trend. Not only in 1972 but for many years before, the rate of return has been much too inadequate relative to The Group's enormous capital needs. And, as long as that condition persists, the prospects for a greater and more widespread shortage of petroleum become more and more certain.



Source and Use of Funds

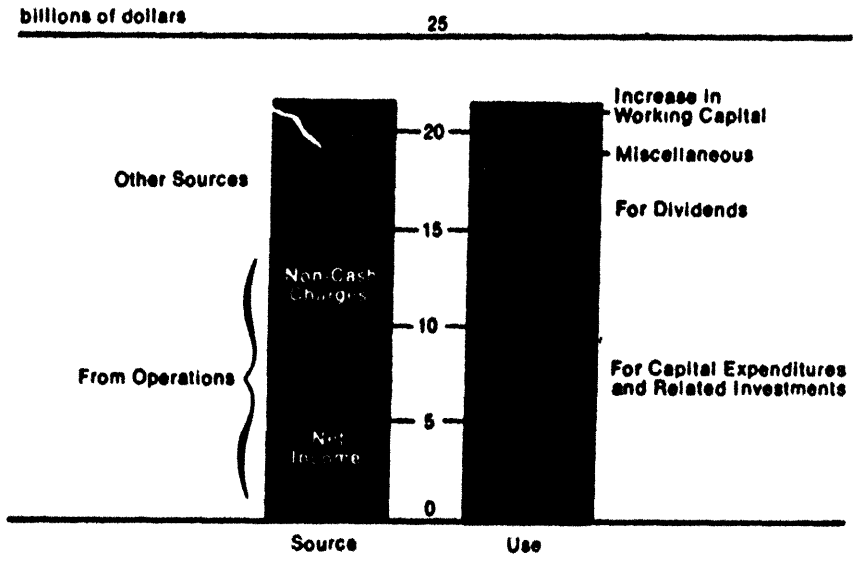
Sources

In 1972 The Group had available for new investment, repayment of debt, additional working capital, and dividends a total of 21.4 billion dollars. That amount was 2.6 percent more than in 1971.

Normally, net income should be the most important source of the funds needed for these purposes. But, as a result of their continuing weak performance, earnings provided no more than 32 percent of the money available in 1972. They provided 35 percent the year before and several years ago they were the source of nearly 50 percent.

Depreciation and other provisions for capital recovery provided 35 percent of the available funds in 1972—about the same proportion as the year before. Another 2 percent was made available from miscellaneous sources.

SOURCE AND USE OF FUNDS IN 1972



Altogether, The Group generated from internal sources 69 percent of the funds utilized compared with 71 percent the year before. Another 9 percent was derived from the sale of assets and other transactions. The rest of the money used was obtained from the capital markets—4.4 billion dollars was borrowed and 250 million more was received from the sale of stock. Compared with the year before, The Group reduced its demand upon the capital markets by 9 percent.

Uses

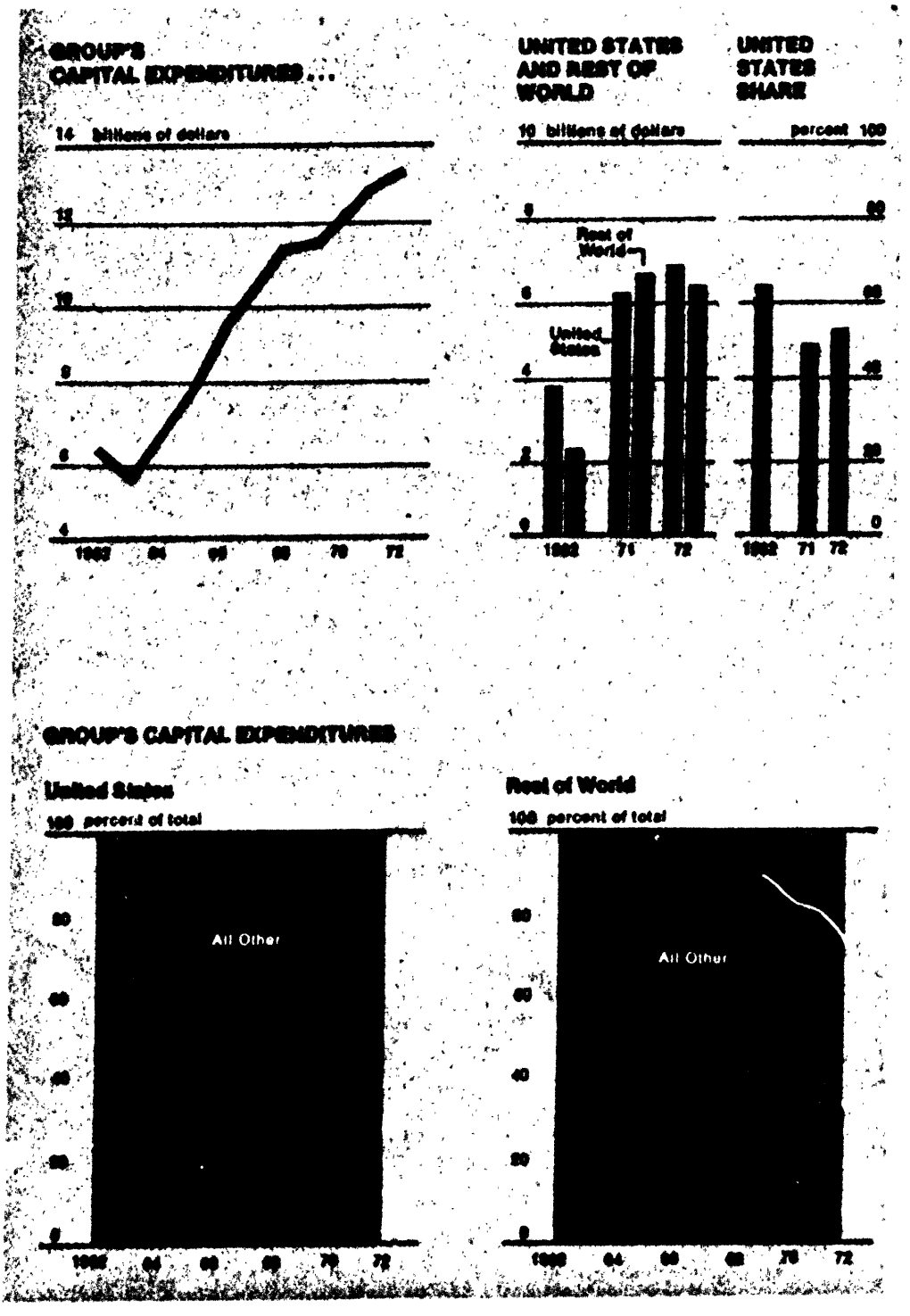
The Group's capital expenditures reached a record level in 1972—but they exceeded the previous year's outlay by only a small margin as indicated in the following table:

	1972	1971	Change	
Expenditures	Million Dollars		Mill.$	Percent
United States	6,811	6,265	+546	+8.7
Rest of World	6,379	6,656	−277	−4.2
Total	13,190	12,921	+269	+2.1

As the table reveals, all of the increased spending occurred in the United States while the rest of the world was the scene of a reduced outlay. The next table reveals further that the increased spending in the United States was devoted entirely to production purposes and expenditures for all other reasons were cut back:

United States	1972	1971	Change	
Expenditures	Million Dollars		Mill.$	Percent
Production	3,957	2,666	+1,291	+48.4
Transportation	304	448	− 144	−32.1
Refineries and Chemical Plants	1,212	1,430	− 218	−15.2
Marketing	1,001	1,322	− 321	−24.3
Other	337	399	− 62	−15.5
Total	6,811	6,265	+ 546	+ 8.7

All of the increased capital spending in the production area can be attributed to a single cause. The Federal Government in the United States conducted two major lease sales in 1972 and thereby diverted a great deal of money



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away from other areas where spending otherwise would have occurred. There was no increase in spending for any other production purpose.

The higher level of capital spending in 1972 represented the first increase in the past four years. But, at 6.8 billion dollars, the outlay still failed to equal the expenditure made four years earlier.

Although the outlays for production and transportation were moderately higher outside the United States, the gains were more than offset by reduced spending for other functional purposes. The details are illustrated in the following table:

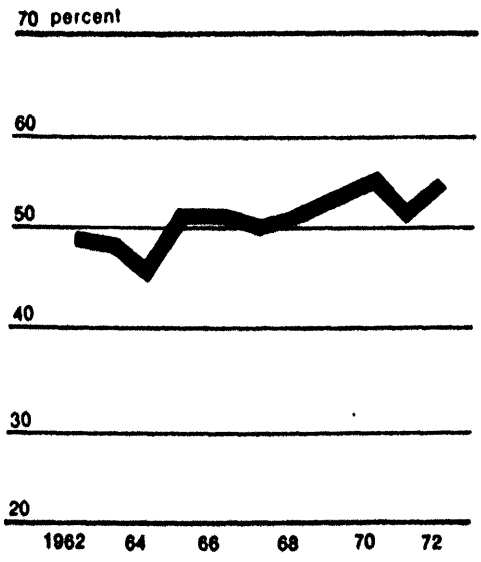
Rest of World Expenditures	1972	1971	Change	
	Million Dollars		Mill.$	Percent
Production	2,202	2,092	+110	+ 5.3
Transportation	950	893	+ 57	+ 6.4
Refineries and Chemical Plants	1,819	2,180	−361	−16.6
Marketing	1,222	1,348	−126	− 9.3
Other	186	143	+ 43	+30.1
Total	6,379	6,656	−277	− 4.2

Relative to the new investment required to keep pace with the world's expanding needs for petroleum, The Group's capital expenditures have been inadequate for many years—particularly the last four. But, without sufficient net earnings, The Group could not possibly have spent more. In the early part of 1973 earnings have improved. But, despite the large percentage gains over a year earlier, the actual dollar amount of net income is still much too small to permit a fully adequate level of capital spending.

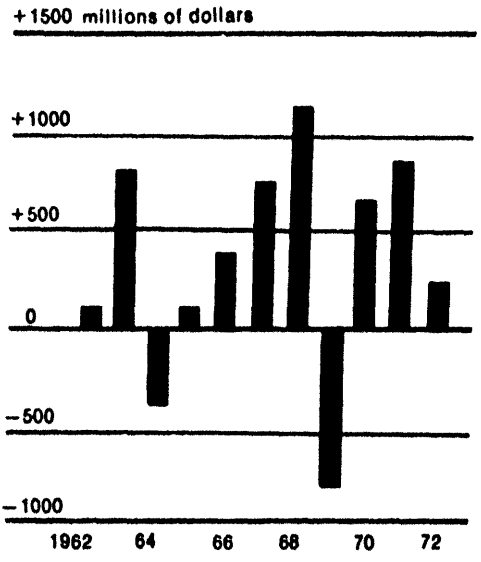
Dividends

Because of governmental restrictions and internal needs, The Group's cash dividends to shareholders remained virtually unchanged at 3.7 billion dollars. At that level dividends were equal to 54.5 percent of net income compared with 51.5 percent the year before. The increase reflected the decline in earnings. As a proportion of The Group's gross

DIVIDENDS
AS A PERCENT OF NET INCOME



CHANGE IN WORKING CAPITAL



revenue, dividends fell from 3.8 percent in 1971 to only 3.5 percent—the lowest proportion on record. Of all the money taken in as a result of The Group's operations, the 3.5 percent remaining for shareholders was far smaller than the 14.5 percent paid to governments.

Other Uses

As a consequence of its growing reliance upon borrowed capital, the money required for the repayment of long-term debt rose again in 1972. The 3.2 billion dollars utilized for that purpose was 62.4 percent more than in the year before. Investments and advances to affiliates amounted to 763 million dollars and 123 million dollars was utilized for stock retirement. Additions to working capital amounted to 216 million dollars.

Balance Sheet

Working Capital

The Group's current assets increased by 3.1 billion dollars to reach a level of 42.7 billion. After rising by 2 billion dollars, accounts receivable amounted to 21.6 billion. Cash and marketable securities moved up by 764 thousand dollars to a total of 8.9 billion. And inventories remained virtually unchanged at 11.4 billion dollars. As a proportion of current assets, accounts receivable represented 50.7 percent; cash and marketable securities, 20.9 percent; inventories, 26.7 percent.

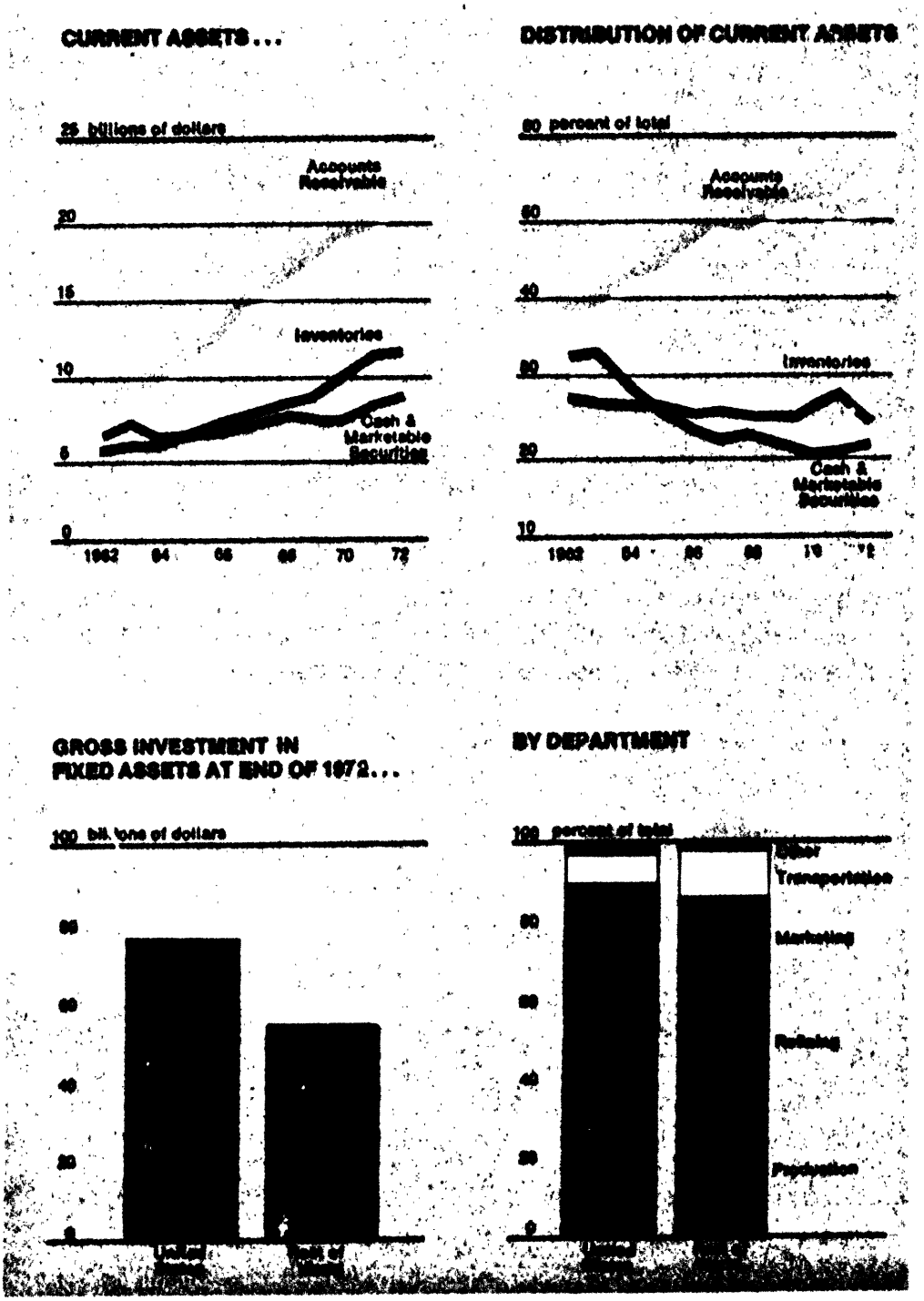
Current liabilities amounted to 28.5 billion dollars following an increase of 2.9 billion. One-third of the increase was concentrated in accounts payable. The ratio of current assets to current liabilities was 1.5—the same as a year earlier and the lowest on record.

Capital Employed

Although the capital employed by The Group increased in 1972, the rise was less than half as large as in recent years. The details are shown in the following table:

	1972	1971	Change	
	Million Dollars		Mill.$	Percent
Long-Term Debt	21,858	20,523	+1,335	+6.5
Minority Interest	3,031	2,941	+ 90	+3.1
Invested Capital	71,756	69,897	+1,859	−2.7
Total Capital Employed	96,645	93,361	+3,284	+3.5

The decline in earnings, currency adjustments, certain extraordinary charges, and the restricted increase in capital expenditures all contributed to the relatively small change in capital employed.



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In addition to the amount shown on the balance sheet, large sums of money were made available by long-term lease arrangements and production payments. If these funds were regarded as debt, The Group's debt would be equal to 32 percent of capital employed.



Statistical Tables

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Photographs used in this study were furnished through the courtesy of Continental Oil Company, Exxon Corporation and Mobil Oil Corporation.

1 Gross Crude Oil Production

	1972	1971	Change TBD	Change Percent
	Thousand Barrels Per Day			
United States	6,730	6,747	– 17	– 0.2
Canada	1,239	1,069	+ 170	+15.9
Venezuela	3,163	3,499	– 336	– 9.6
Other Western Hemisphere	403	352	+ 51	+14.5
Western Hemisphere	11,535	11,667	– 132	– 1.1
Western Europe	218	171	+ 47	+27.5
Africa	3,613	3,693	– 80	– 2.2
Middle East	16,586	14,961	+1,625	+10.9
Far East	1,368	1,155	+ 213	+18.4
Eastern Hemisphere	21,785	19,980	+1,805	+ 9.0
Total World-wide (a)	33,320	31,647	+1,673	+ 5.3

Note: The above figures include 100% of operations of companies and consolidated subsidiaries and equity in foreign operations of non-consolidated affiliates based on percentage of stock ownership.

(a) Figures expressed in million barrels are as follows:

	1972	1971
United States	2,463	2,463
Other Countries	9,732	9,088
Total	12,195	11,551

2 Crude Runs To Stills

	1972	1971	Change TBD	Change Percent
	Thousand Barrels Per Day			
United States	10,386	9,904	+ 482	+ 4.9
Canada	1,343	1,275	+ 68	+ 5.3
Venezuela	1,100	1,227	– 127	–10.3
Other Western Hemisphere	1,995	1,902	+ 93	+ 4.9
Western Hemisphere	14,824	14,308	+ 516	+ 3.6
Western Europe	9,341	8,825	+ 516	+ 5.9
Africa	375	342	+ 33	+ 9.7
Middle East	1,456	1,569	– 113	– 7.2
Far East	2,472	2,235	+ 237	+10.6
Eastern Hemisphere	13,644	12,971	+ 673	+ 5.2
Total World-wide (a)	28,468	27,279	+1 189	+ 4.4

Note: The above figures include 100% of operations of companies and consolidated subsidiaries and equity in foreign operations of non-consolidated affiliates based on percentage of stock ownership.

(a) Figures expressed in million barrels are as follows:

	1972	1971
United States	3,801	3,615
Other Countries	6,618	6,342
Total	10,419	9,957

3 Income Statement

	1972	1971	Percent Change
	Million Dollars		
Gross Operating Revenue	104,159	95,104	+ 9.5
Non-Operating Revenue	2,119	2,756	−23.1
Total Revenue	106,278	97,860	+ 8.6
Operating Costs and Expenses	74,413	68,805	+ 8.2
Taxes – Other than Income Taxes (a)	5,138	4,413	+16.4
Write-offs	7,514	7,079	+ 6.1
Interest Expense	1,774	1,597	+11.1
Other Charges	22	23	− 4.3
Total Deductions	88,861	81,917	+ 8.5
Net Income before Income Taxes	17,417	15,943	+ 9.3
Estimated Income Taxes	10,301	8,409	+22.5
Income Applicable to Minority Interests	256	265	− 3.4
Net Income (c)	6,860(b)	7,269	− 5.6

(a) Excludes $22,362 million in 1972 and $20,246 million in 1971 representing sales and excise taxes on gasoline and other refined products, which are collected from customers and accounted for to United States federal, state and city authorities, and to other governments. Such taxes are deducted before arriving at gross operating revenue.

(b) Excludes $311 million of extraordinary losses basically from disposal of assets.

(c) Includes earnings from operations outside U.S.: 1972–$3,204 million and 1971–$3,779 million.

4 Distribution of Total Revenue Dollar

	1972	1971
	Cents	
Operating Costs and Expenses	70.0	70.3
Write-offs	7.1	7.3
Interest	1.7	1.6
All Taxes	14.5	13.1
Income Applicable to Minority Interests	0.2	0.3
Dividends to Stockholders	3.5	3.8
Reinvested in Business	3.0	3.6
Total Revenue	100.0	100.0

5 Rates of Return

	1972	1971
	Million Dollars	
Average Borrowed and Invested Capital (a)	94,912	89,912
Earnings (b)	8,889	9,086
Return	9.4%	10.1%
Average Invested Capital (c)	71,730	67,849
Earnings (d)	6,860	7,269
Return	9.7%	10.7%
Average Total Assets	128,552	119,962
Earnings (e)	7,116	7,534
Return	5.5%	6.3%
Average Gross Fixed Assets	132,545	126,109
Gross Operating Profit (f)	24,608	21,885
Return	18.6%	17.4%

(a) Includes long-term debt, preferred stock, common stock, surplus and equity of minority interests.

(b) Represents net income plus interest charges and income applicable to minority interests.

(c) Includes preferred stock, common stock and surplus.

(d) Represents net income.

(e) Represents net income plus income applicable to minority interests.

(f) Represents gross operating revenue less operating costs and expenses and taxes — other than income taxes.

6 Source and Use of Working Capital Year 1972

	Million Dollars	Percent Distribution
Funds Available From:		
Cash Earnings (a)	14,801	69.3
Long-Term Debt Issued	4,448	20.8
Preferred and Common Stock Issued	250	1.2
Sales of Assets and Other Transactions	1,860	8.7
Total	21,359	100.0
Funds Used For:		
Capital Expenditures	13,190	61.7
Investments and Advances	763	3.6
Dividends to Companies' Shareholders	3,741	17.5
Dividends to Minority Interests	119	0.6
Long-Term Debt Repaid	3,207	15.0
Preferred and Common Stock Retired	123	0.6
Total	21,143	99.0
Change in Working Capital	+ 216	1.0

(a) Represents:

	Million Dollars
Net Income	6,860
Write-offs	7,514
Other Non-Cash Charges (net)	427
Cash Earnings	14,801

7 Expenditures for Fixed Assets Year 1972

By Function –	United States	Other Countries	Combined
	Million Dollars		
Production:			
Crude Oil and Natural Gas (a)	3,842	2,088	5,930
Gasoline and Cycling Plants	115	114	229
Total	3,957	2,202	6,159
Transportation:			
Pipe Lines	193	118	311
Marine	58	826	884
Other	53	6	59
Total	304	950	1,254
Refineries and Chemical Plants	1,212	1,819	3,031
Marketing	1,001	1,222	2,223
Others	337	186	523
Total	6,811	6,379	13,190

(a) Excludes exploration expenses and lease rentals charged to income account.

By Area –	1972	1971	1970	1969
	Million Dollars			
United States	6,811	6,265	6,637	6,774
Canada	854	796	760	713
Venezuela	162	233	259	317
Other Countries	560	747	476	436
Western Hemisphere	8,387	8,041	8,132	8,240
Western Europe	3,181	3,230	2,514	1,985
Africa	468	522	525	544
Middle East	245	241	166	173
Far East	909	887	688	632
Eastern Hemisphere	4,803	4,880	3,893	3,334
Total	13,190	12,921	12,025	11,574

8 Capital and Exploration Expenditures Year 1972

	United States	Other Countries	Combined
	Million Dollars		
Production Expenditures*	3,454	1,655	5,109
Dry Holes	388	433	821
Total	3,842	2,088	5,930
Geological and Geophysical Expenses and Lease Rentals	494	483	977
Total Production and Exploration Cost	4,336	2,571	6,907
Other Capital Expenditures	2,854	4,177	7,031
Capital and Exploration Expenditures	7,190	6,748	13,938

*Excludes expenditures for Natural Gasoline Plants.

9 Balance Sheet

Assets	12/31/72	12/31/71	12/31/72	12/31/71
	Million Dollars		Percent Distribution	
Current Assets	42,686	39,586	32.3	31.7
Investments and Advances	10,266	9,900	7.8	7.9
Property, Plant and Equipment (a)	75,097	71,740	56.8	57.4
Other Assets	4,134	3,673	3.1	3.0
Total Assets	132,183	124,899	100.0	100.0
Liabilities and Net Worth				
Current Liabilities	28,540	25,656	21.6	20.5
Long-Term Debt	21,858	20,523	16.5	16.4
Deferred Credits	4,587	3,804	3.5	3.0
Other Reserves	2,411	2,078	1.8	1.7
Minority Interests	3,031	2,941	2.3	2.4
Net Worth:				
Preferred Stock	404	429	0.3	0.3
Common Stock	10,511	10,530	7.9	8.4
Capital Surplus	9,061	8,800	6.9	7.1
Earnings Reinvested in Business	51,780	50,138	39.2	40.2
Shareholders' Equity	71,756	69,897	54.3	56.0
Total Liabilities and Net Worth	132,183	124,899	100.0	100.0

(a) After deducting accumulated reserves of $60,530 million in 1972 and $58,562 million in 1971.

10 Earnings Reinvested and Employed

	Million Dollars
Balance at December 31, 1971	50,138
Add: Net Income	6,860
	56,998
Less: Cash Dividends	3,741
Stock Dividends	102
Other Charges	1,375
Balance at December 31, 1972	51,780

11 Net Assets Year 1972

	United States	Other Countries	Combined
	Million Dollars		
Working Capital	8,466	5,680	14,146
Investments and Advances	2,516	7,750	10,266
Property, Plant and Equipment (a)	42,254	32,843	75,097
Other Assets	1,752	2,382	4,134
	54,988	48,655	103,643
Less: Long-Term Debt	11,751	10,107	21,858
Other Reserves and Credits	3,578	3,420	6,998
Minority Interests	1,002	2,029	3,031
Preferred Stock	345	59	404
Total Net Assets	38,312	33,040 (b)	71,352
Percent Distribution	53.7	46.3	100.0

(a) After deducting accumulated reserves of $35,869 million for United States facilities and $24,661 million for facilities of other countries.

(b) Distribution by areas:

	Million Dollars	Percent of Total
Western Hemisphere	9,250	28.0
Eastern Hemisphere	23,790	72.0
Total	33,040	100.0

12 Working Capital

	12/31/72	12/31/71	Change	12/31/72 Percent Distribution	12/31/71 Percent Distribution
	Million Dollars				
Cash	4,252	4,206	+ 46	10.0	10.6
Marketable Securities	4,653	3,935	+ 718	10.9	10.0
Accounts and Notes Receivable (net)	21,626	19,566	+2,060	50.7	49.4
Inventories:					
Crude Oil, Refined Products and Other Merchandise	10,039	9,506	+ 533	23.5	24.0
Materials and Supplies	1,337	1,830	— 493	3.1	4.6
All Other	779	543	+ 236	1.8	1.4
Total Current Assets	42,686	39,586	+3,100	100.0	100.0
Accounts Payable	13,052	12,053	+ 999	45.7	47.0
Notes and Loans Payable	6,891	5,837	+1,054	24.1	22.8
Income and Other Taxes	5,155	4,861	+ 294	18.1	18.9
All Other	3,442	2,905	+ 537	12.1	11.3
Total Current Liabilities	28,540	25,656	+2,884	100.0	100.0
Working Capital	14,146	13,930	+ 216	—	—
Ratio of C.A. to C.L.	1.5	1.5	—	—	—

13 Investment in Fixed Assets December 31, 1972

By Function —	Gross			Net		
	United States	Other Countries	Combined	United States	Other Countries	Combined
	Million Dollars			Million Dollars		
Production:						
Crude Oil and Natural Gas	36,913	16,497	53,410	18,276	8,356	26,632
Gasoline and Cycling Plants	2,546	1,323	3,869	1,327	979	2,306
Total	39,459	17,820	57,279	19,603	9,335	28,938
Transportation:						
Pipe Lines	3,596	1,263	4,859	1,816	742	2,558
Marine	775	5,654	6,429	382	3,604	3,986
Other	909	52	961	495	28	523
Total	5,280	6,969	12,249	2,693	4,374	7,067
Refineries and Chemical Plants	18,419	18,005	36,424	9,610	10,182	19,792
Marketing	11,913	13,061	24,974	8,301	7,904	16,205
Others	3,052	1,649	4,701	2,047	1,048	3,095
Total	78,123	57,504	135,627	42,254	32,843	75,097

By Area —	12/31/72		12/31/71	
	Gross	Net	Gross	Net
	Million Dollars		Million Dollars	
United States	78,123	42,254	76,122	40,884
Canada	8,910	5,480	8,490	5,231
Venezuela	6,054	1,640	6,176	1,830
Other Countries	4,757	2,894	4,625	2,793
Western Hemisphere	97,844	52,268	95,413	50,738
Western Europe	25,642	15,566	23,422	14,130
Africa	4,402	2,521	4,014	2,351
Middle East	2,210	1,200	2,129	1,118
Far East	5,529	3,542	5,324	3,403
Eastern Hemisphere	37,783	22,829	34,889	21,002
Total	135,627	75,097	130,302	71,740

CAPITAL INVESTMENTS OF THE WORLD PETROLEUM INDUSTRY 1971

by
Richard C. Sparling
Norma J. Anderson
with
John G. Winger

Foreword

For many years the Energy Division of The Chase Manhattan Bank has conducted a continuous and detailed study of the financial performance of a large number of petroleum companies. The combined operations of these organizations constitute a major proportion of the worldwide activities of the petroleum industry, and their financial performance, therefore, is a significant indication of the probable experience of the over-all industry.

Additional data have been obtained from surveys of a great many other operating entities, and the sum of all the information gained has provided a base from which we have derived a reliable estimate of the worldwide capital investments of the petroleum industry.

December, 1972



THE CHASE MANHATTAN BANK, N.A.

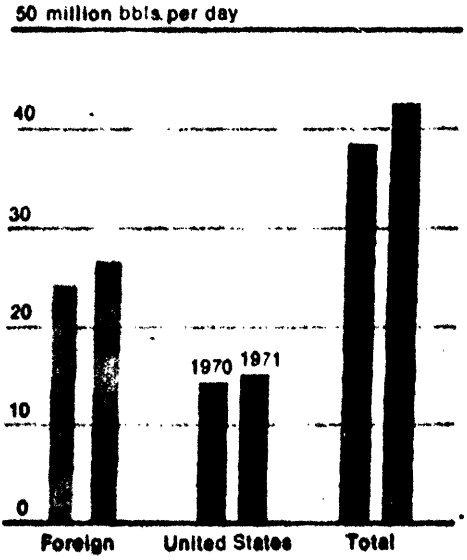
INTRODUCTION

All over the world people have needs for goods and services. And everywhere these needs are increasing. With much of the world experiencing continuous population growth, the number of people having such needs becomes larger year after year. And all people naturally hope to increase their standard of living with more goods and services.

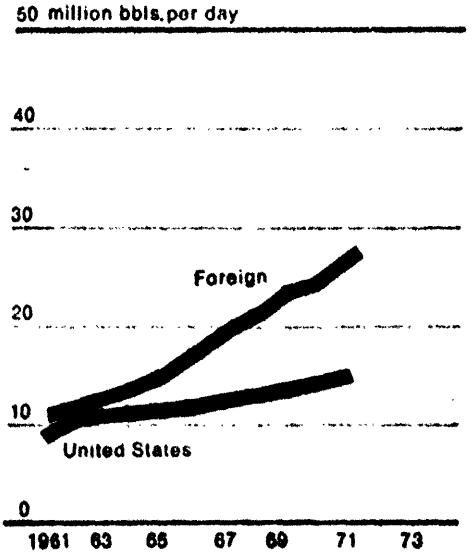
Because the satisfaction of virtually every human need for goods and services involves the use of energy, the world's energy requirements continue to grow at a vigorous pace. Even assuming more efficient energy utilization, these requirements are certain to become vastly greater in the years ahead.

Of the various sources of primary energy available to serve man's needs, petroleum is the most important. Oil is more versatile than other sources and can be applied to a much broader range of uses. Therefore, petroleum will be called upon to serve the great bulk of the world's energy requirements in coming years. In the fifteen year period ranging from 1970 to 1985 the worldwide needs for oil, excluding those of the communist nations, are expected to be more than twice as great as in the preceding fifteen years. The requirements for natural gas, too, will be more than double in size.

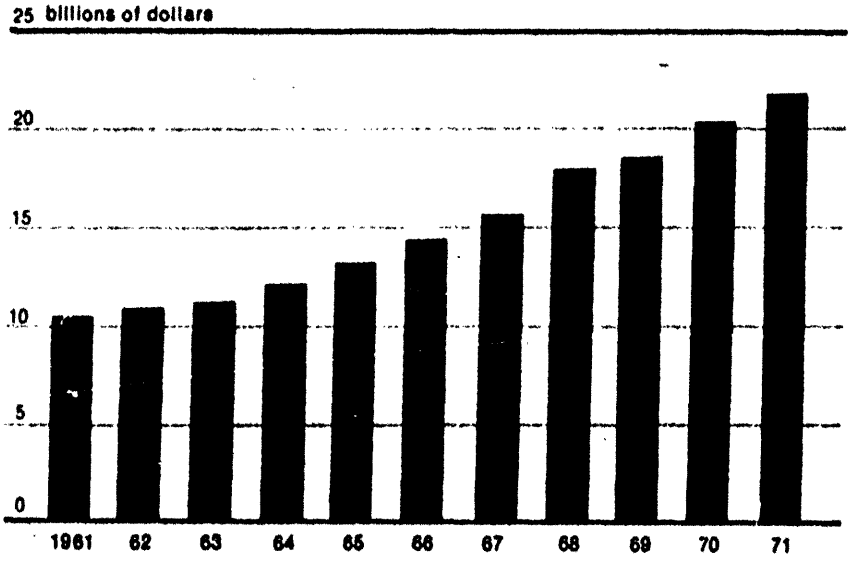
LIQUID PETROLEUM CONSUMPTION



TEN YEAR TREND



CAPITAL EXPENDITURES – WORLDWIDE



Much of the oil and natural gas that will be needed in the 1970-1985 period has not yet been found. Therefore, a continuously expanding search is absolutely necessary. And, obviously, the capital investment required to sustain such a search must also grow. To a major degree, the search will have to be conducted deeper in the earth, in more remote regions, and in offshore areas. In each case, the investment required will be much greater than the amount needed for the smaller scale efforts of the past.

As the world's needs for oil expand, refining and other processing capacity must also increase. A great many new refineries will have to be built in numerous countries around the world. In addition, existing plants must be enlarged and modernized. Obviously, the capital investment involved will be enormous.

Transportation facilities, too, will have to keep pace with the growth of oil demand. For geographical reasons, a major proportion of the world's markets necessarily must be served with oil transported over water. And, for the most part, the distances between the producing and consuming areas are very long. Therefore, the required carrying capacity of oil tankers will increase rapidly in the future. There will also be a sharp rise in the need for the highly specialized and exceedingly costly tankers used for transporting liquefied natural gas. In many parts of the world extensive new

pipeline systems must be constructed and in other areas existing facilities will have to be enlarged. For all modes of transportation the capital expenditures required will be huge.

Another large and expanding investment must be made to provide all the marketing facilities required to deliver petroleum to consumers throughout the world. Market growth will necessitate additional facilities and older equipment will have to be modernized or replaced.

In addition to the investment required in connection with all its normal activities, the petroleum industry must also invest huge amounts of money for environmental purposes. The need to spend for such reasons will apply to all of the industry's major operations — production, refining, transportation, and marketing.

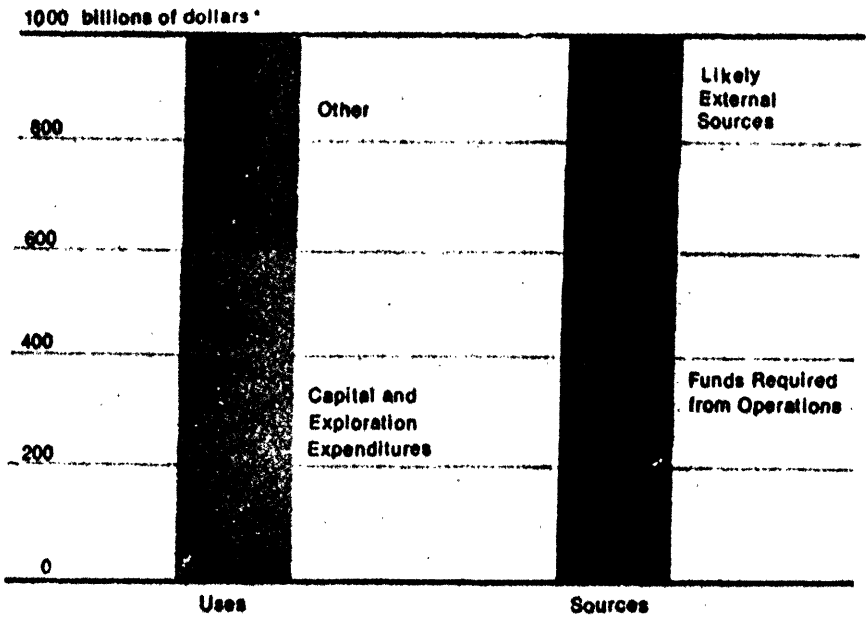
If the petroleum industry is to satisfy all the indicated needs for oil and natural gas between 1970 and 1985, it will have to make a capital investment of approximately 565 billion dollars. Another 35 billion dollars must be used to pay geological, geophysical, and leasing expenses. Of the total 600 billion dollar outlay, 265 billion will have to be spent on the search for oil and natural gas, 135 billion for processing, 80 billion for transportation, 65 billion for marketing, and 55 billion for all other purposes. To an important degree, the last category of investment represents the expenditures required for environmental reasons.

In addition to the necessary outlays listed above, the petroleum industry will have other financial needs for purposes that are absolutely essential to a viable operation. The funds it will require for debt service, working capital, and dividends are expected to amount to 400 billion dollars. Therefore, the petroleum industry will have to utilize altogether approximately one trillion dollars in the process of filling the petroleum needs of the non-Communist portion of the world between 1970 and 1985. To some extent, the calculation of that figure reflects the expectation of continued inflation, but there are plausible reasons for believing the allowance may prove too conservative. In that event, the financial needs of the petroleum industry will be greater than indicated, of course.*

To assume arbitrarily that the petroleum industry will be able to acquire all the money needed to conduct its operations in a fully satisfactory manner would be unrealistic. Indeed, there are strong indications that it may be

*$1,000,000,000,000

WORLDWIDE FINANCIAL NEEDS 1970—1985



*1 billion=$1,000,000,000

unable to assemble nearly enough money from all available sources. Because of a relatively high degree of risk associated with many of its operations, the petroleum industry has depended, until recent years, upon funds generated primarily from operations. And its reliance upon borrowed capital has been proportionately smaller than that of most other large industries.

Of the petroleum industry's internally generated funds, net income constitutes almost half and the rest is derived from various provisions for capital recovery. In the fifteen year period ranging from 1955 to 1970 the industry's net income grew at an average rate of approximately 8 percent per year. If that same rate of growth could be achieved between 1970 and 1985, the industry's accumulated net earnings would amount to 265 billion dollars. And, if there were no changes in the provisions for capital recovery, another 335 billion dollars could be obtained from such sources. Under these assumed circumstances, the total internal generation of funds would be 600 billion dollars, leaving another 400 billion to be obtained from the capital markets.

If the industry obtained that amount of money from external sources, its dependence upon borrowed capital would

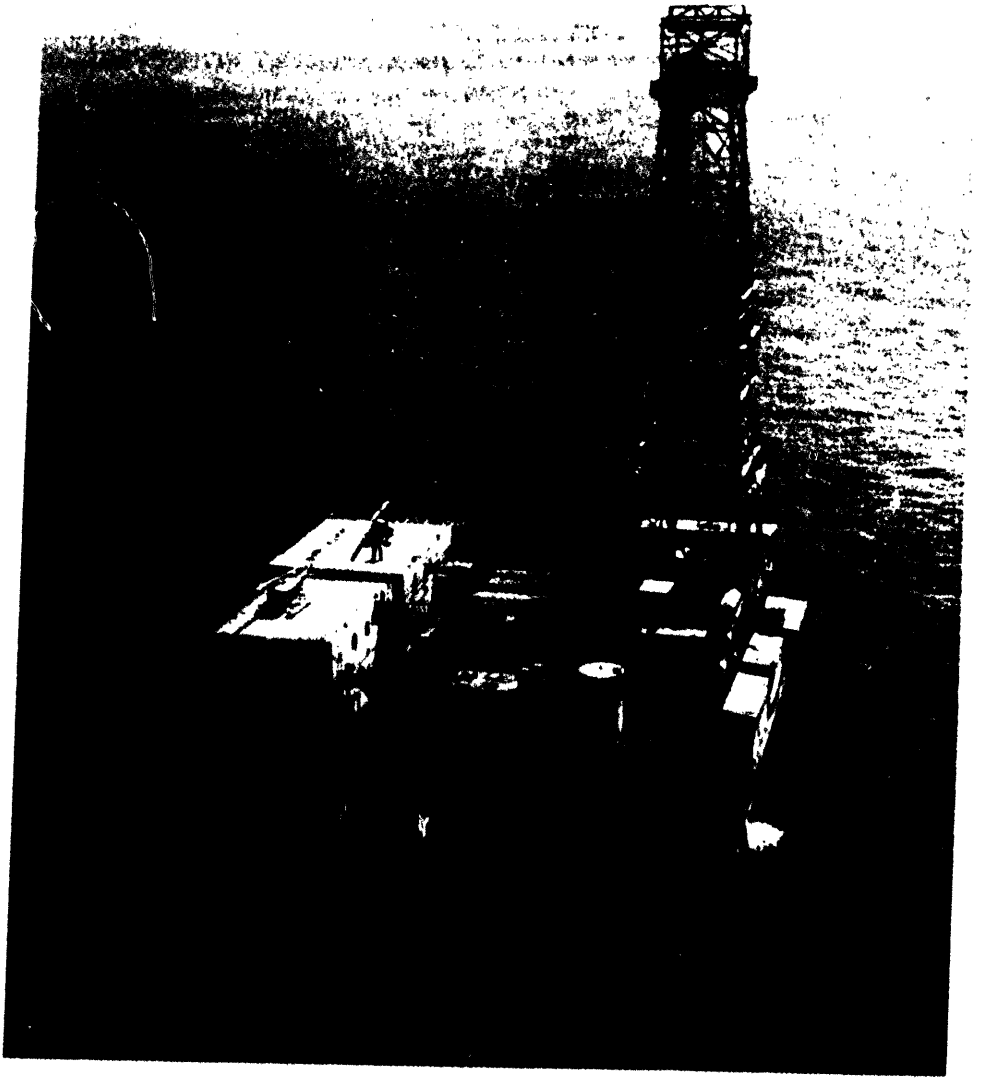
be nearly eight times greater than it actually was in the preceding fifteen year period. That the petroleum industry could obtain so much money from the capital markets in competition with all other segments of the worldwide economy is by no means certain. Indeed, it is highly doubtful. And it is equally doubtful that prudent industry management would be willing to incur so much debt, even if the funds were available.

Obviously, if the petroleum industry is to secure all the money it will need, it must generate much more than 600 billion dollars from internal sources. The prospects, however, for obtaining more in the form of capital recovery are dim. In fact, there is a likelihood that the flow of such funds may instead be reduced by governmental action. It appears likely, therefore, that the industry will have to rely entirely upon the growth of net income to provide the additional money required. In that case, the growth of net income will have to be substantially higher than the 8 percent annual rate cited above — indeed, it must grow at nearly double that rate.

Recent experience, however, leads to doubts that the necessary growth can be achieved. The expansion of net earnings over the past four years was not even one-fourth as large as the indicated need. If the growth rate is to be accelerated sufficiently, it can be accomplished only with higher prices for petroleum, of course. But governmental restraints of various forms are likely to constitute a major roadblock to price advances of the required magnitude. And intensely competitive market conditions may have a similar effect.

Within the framework of existing economic and political circumstances, there is no basis for believing the petroleum industry can possibly generate from all potential sources the one trillion dollars it apparently will need between 1970 and 1985. And, in that event, it would be unable to provide all the petroleum the world's markets will require. Without enough petroleum, the economy and living standard of any nation would suffer, of course. To think that other sources of energy could be substituted is unrealistic because their expansion, too, is limited by a similar lack of necessary financial resources.

Because a sufficient supply of petroleum is so highly essential to all nations, there is an urgent need for a better and broader understanding of the petroleum industry's



capital requirements. A lack of understanding has led the United States to a severe shortage of petroleum and all other forms of energy as well. And it can also lead to the same predicament in other parts of the world.

Photographs used in this study were furnished through the courtesy of Mobil Oil Corporation and Cities Service Company.

CAPITAL EXPENDITURES

WORLDWIDE — BY FUNCTION

The world's requirements for oil in 1971—excluding those of the Communist nations—reached a record level of 42.3 million barrels per day. At that level they were 7 percent larger than in the preceding year.

Reflecting the continuing expansion of the world's needs, the petroleum industry invested more money in 1971 than ever before. Its total capital outlay was 21.8 billion dollars—1.7 billion, or 8.3 percent, more than in the year before. Huge as that investment was, it can nevertheless be termed inadequate in the light of the world's future requirements for petroleum.

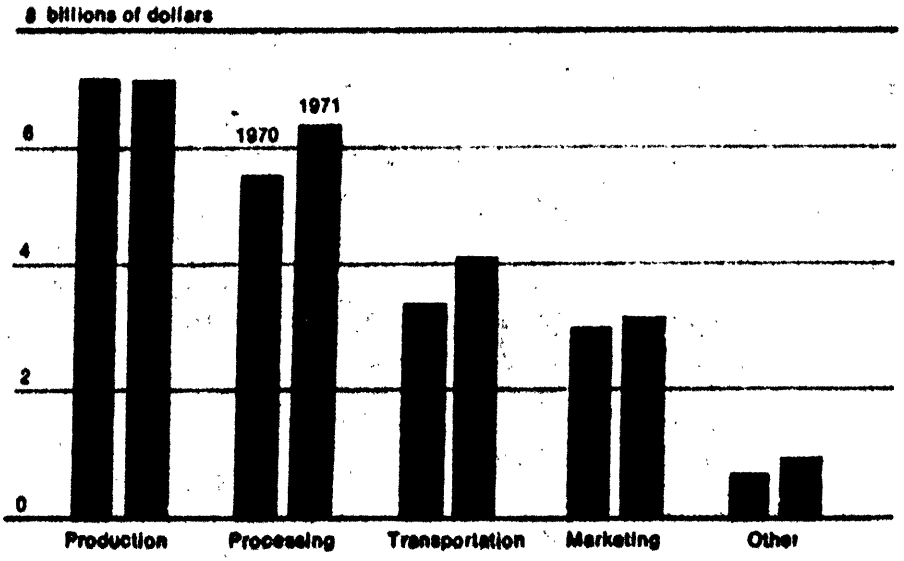
Production

Despite the obvious need to accelerate the search for new reserves of petroleum, the industry actually spent somewhat less on that effort in 1971. Its investment amounted to 7.2 billion dollars, down 15 million from the year before. The failure to spend more was not the industry's own choice. A lack of offshore leasing activities by government, restraining actions by environmentalists, and insufficient capital funds all prevented a more vigorous effort on the part of the industry.

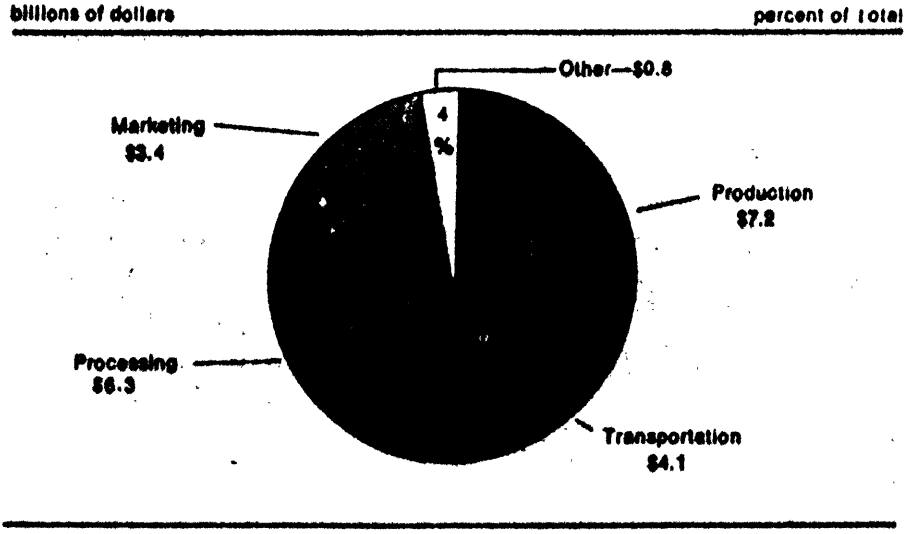
Of the industry's over-all capital investment, the expenditure devoted to the search for more petroleum represented 33 percent . It was the smallest proportion on record—down from 36 percent in 1970 and 52 percent a decade earlier. The downtrend, which has been in progress since the mid-fifties, is cause for much concern for it is a clear manifestation of the petroleum industry's growing inability to generate sufficient capital funds and also the other restraints that prevent or discourage the use of capital.

In addition to capital investment, the search for petroleum also necessitates large expenditures for geological, geophysical, and leasing purposes. Such outlays in 1971 amounted to 1.4 billion dollars—55 million more than in 1970.

WORLDWIDE CAPITAL EXPENDITURES



BREAKDOWN OF CAPITAL SPENDING BY FUNCTION—1971



Processing

To provide all the facilities needed to convert crude oil and other petroleum liquids into useful products the industry invested 6.3 billion dollars in 1971. The expenditure was 765 million dollars larger than in the previous year. All but 10 million of that increase was applied to refineries. Of the total expenditure for processing facilities, three-fourths was for refineries and the rest for petrochemical plants.

The capital expenditures devoted to processing represented 29 percent of the industry's over-all investment—almost as large as the proportion allocated to the quest for new petroleum reserves.

Transportation

In response to the need to deliver a growing volume of oil to market the industry invested 4.1 billion dollars in 1971 for transportation facilities. Of that amount, 2.9 billion was spent for tankers and 1.2 billion was applied to pipelines.

Compared with the preceding year, the transportation outlay was 650 million dollars larger. Somewhat more than half of the increase was devoted to pipelines and most of the rest to tankers.

Marketing

Additional marketing facilities throughout the world required an investment of 3.4 billion dollars. The outlay was 160 million dollars, or 5 percent, more than was spent for such purposes in 1970. It represented approximately 15 percent of the industry's over-all investment.

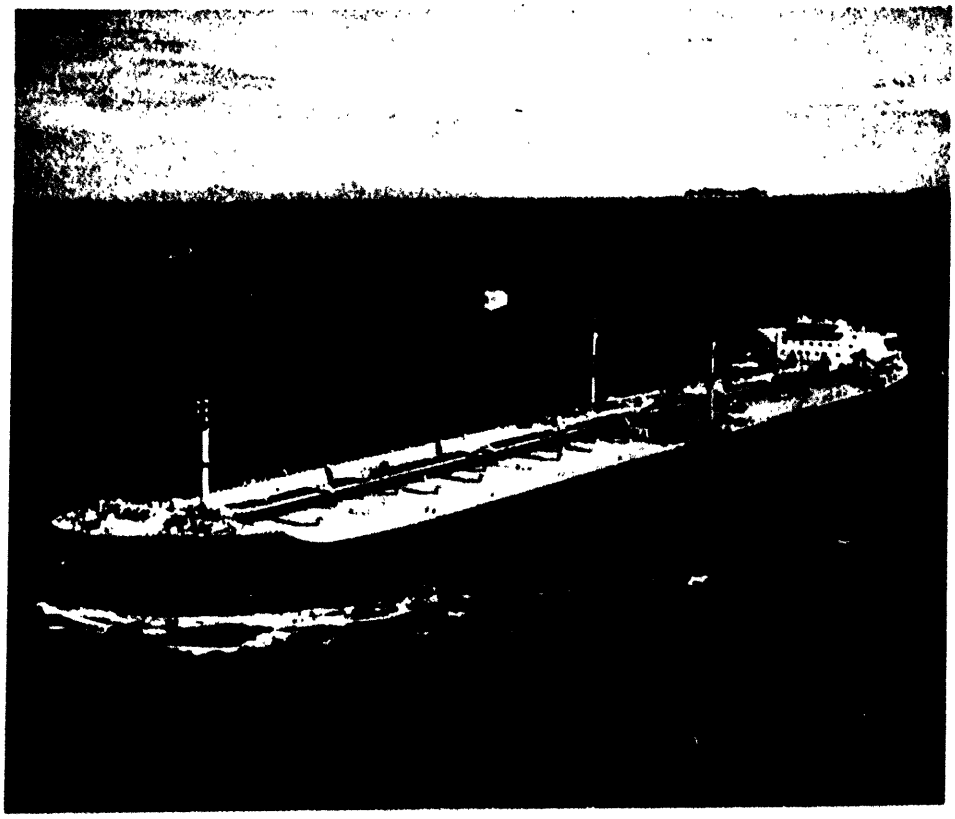
Miscellaneous

Expenditures for administrative buildings and a wide range of other miscellaneous purposes amounted to 840 million dollars—115 million more than in 1970.

Summary

The following table provides a functional breakdown of the industry's capital investment in 1971 and a comparison with the details for the year before.

	1971 Million Dollars	1970 Million Dollars	Change Mill. $	Change Percent
Production	7,215	7,230	- 15	- 0.2
Processing	6,290	5,525	+ 765	+13.8
Transportation	4,075	3,425	+ 650	+19.0
Marketing	3,380	3,220	+ 160	+ 5.0
Miscellaneous	840	725	+ 115	+15.9
Total Capital Expenditures	21,800	20,125	+1,675	+ 8.3
Geological, Geophysical & Lease Expense	1,395	1,340	+ 55	+ 4.1
Total Capital and Exploration Expenditures	23,195	21,465	+1,730	+ 8.1



UNITED STATES AND FOREIGN—BY FUNCTION

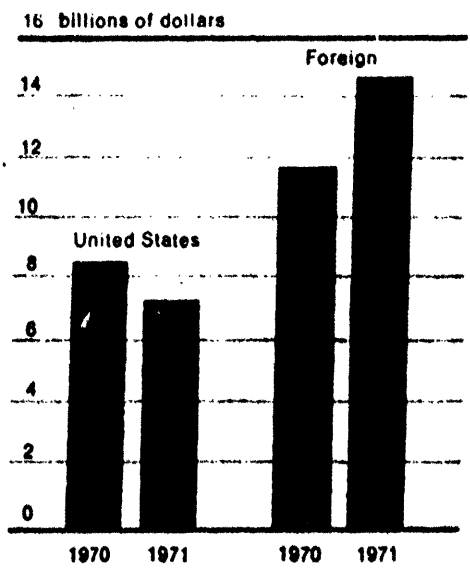
Only five years earlier the petroleum industry's capital investment in the United States equaled the combined outlay in all the rest of the non-Communist world. But, in 1971, the capital expenditures in the United States were no more than half as large as in the Foreign sector.

The industry spent 7.3 billion dollars in the United States—975 million less than in 1970. Its outlay in the Foreign sector was nearly 14.6 billion dollars—2.7 billion more than in the year before.

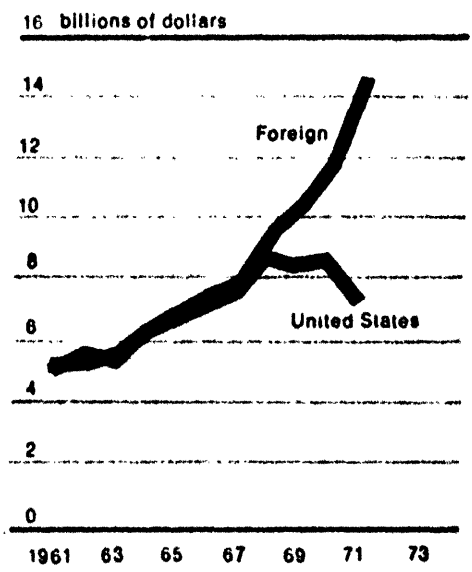
Production

Most of the capital spending cutback in the United States was in the production area. A total of 3.4 billion dollars was devoted to the search for more petroleum—950 million dollars less than in 1970. For the most part, the lower level of spending reflected the lack of major leasing activities by government. A lease sale planned by the Federal Government was prevented by legal actions taken by environmentalists.

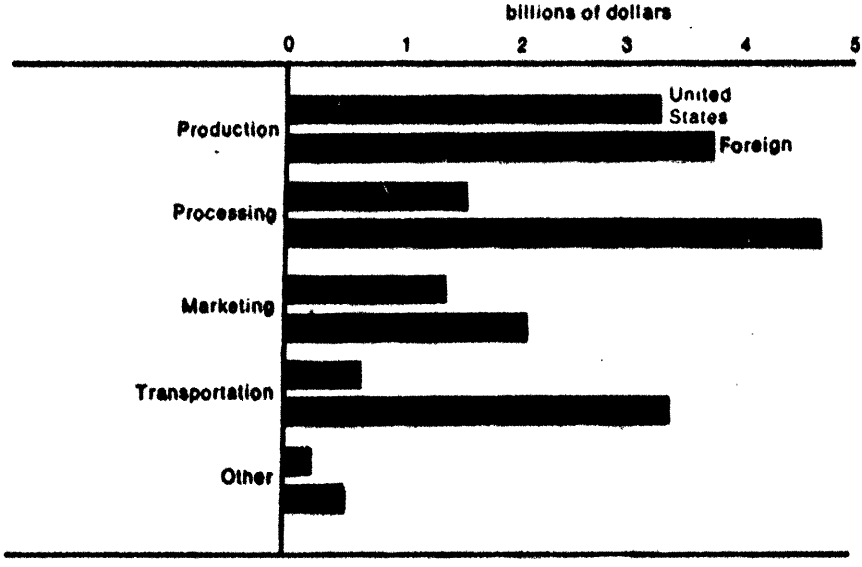
SPENDING BY AREA



TEN YEAR TREND

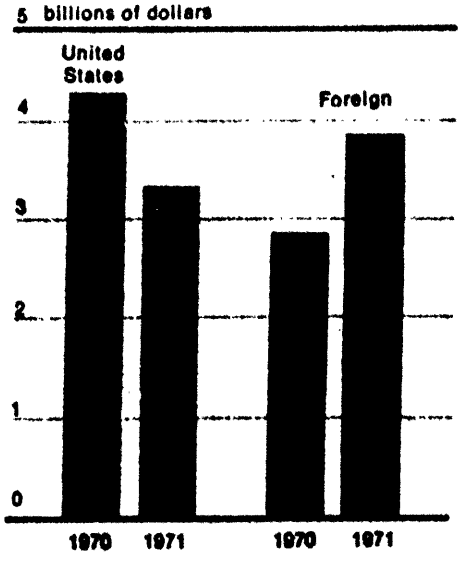


CAPITAL SPENDING BY FUNCTION—1971

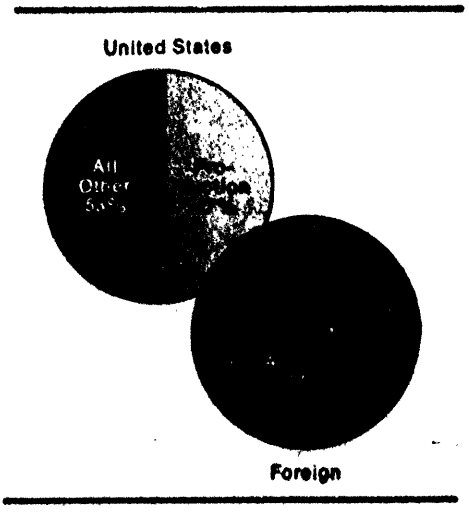


For the first time, the industry spent more money on the search for petroleum outside the United States than within. Its outlay in the Foreign sector amounted to 3.8 billion dollars—935 million more than in the preceding year. The increase almost equaled the reduction in the United States. Of the total increase, the single largest portion—225 million

PRODUCTION EXPENDITURES



SHARE OF AREA TOTAL—1971



dollars—occurred in Europe's North Sea region. The rest was broadly spread among numerous producing areas of the world.

Processing

Because of various environmental restraints, not even a single new refinery is under construction in the United States. Consequently, there was a decline rather than an increase in the capital investment for refining purposes in 1971. To modernize or replace existing facilities, the industry spent 1.1 billion dollars—25 million less than in 1970. For petrochemical plants it spent 500 million dollars—50 million less than in the year before.

The petroleum industry's inability to build new refining capacity at a rate consistent with the expansion of market needs is the major factor contributing to refined product shortages in the United States. And the need to depend increasingly upon imported products adds to the nation's growing trade deficit. These are the unfortunate consequences of ill-conceived and arbitrary attempts to solve environmental problems.

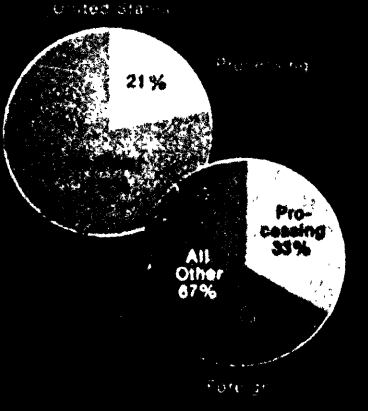
Outside the United States the pattern of spending was much different. The industry invested nearly four times as much for refineries and twice as much for chemical plants. Amounting to 3.7 billion dollars, the outlay for refineries was 780 million more than in the previous year. The investment in chemical plants exceeded a billion dollars—60 million more than in 1970.

Transportation

By far the greatest proportion of the petroleum industry's investment in transportation facilities was made outside the United States. The outlay in the Foreign sector was 3.4 billion dollars compared with only 675 million in the United States. Compared with the year before, the capital expenditure in the Foreign regions was 18.3 percent greater and in the United States it was 22.7 percent larger. More than four-fifths of the Foreign investment was for tankers but in the United States most of the money was spent for pipelines.

PROCESSING EXPENDITURES

SHARE OF AREA TOTAL—1971



PROCESSING BREAKDOWN—1971

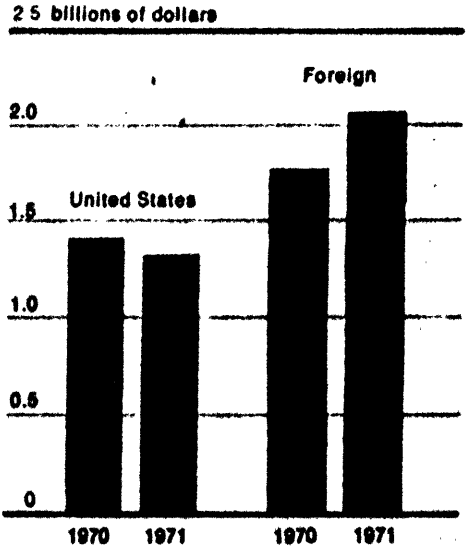
CHANGE FROM 1970

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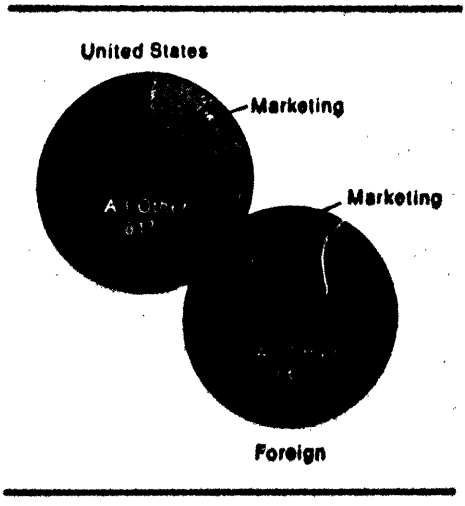


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MARKETING EXPENDITURES



SHARE OF AREA TOTAL—1971



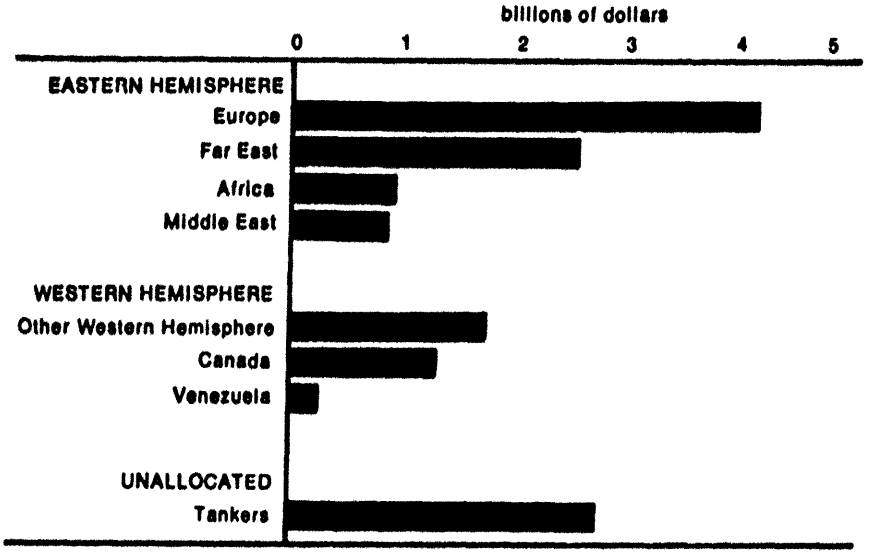
Marketing

The industry invested 1.4 billion dollars for marketing facilities in the United States—100 million less than in 1970. Its outlay in the Foreign sector, however, was increased by 260 million dollars to a level of 2 billion.

Foreign—By Area

Once again Western Europe was the scene of the industry's largest investment in the Foreign sector. Amounting to 4.2 billion dollars, the outlay was 890 million more than in the previous year. In second place, was the Far East where capital spending rose by 450 million dollars to reach a level of 2.5 billion. Except in Venezuela, there was also a substantial rise in spending in the rest of Latin America. The outlay in those countries was 1.7 billion dollars—565 million more than in the previous year.

FOREIGN CAPITAL EXPENDITURES – 1971



UNITED STATES AND FOREIGN INTERESTS

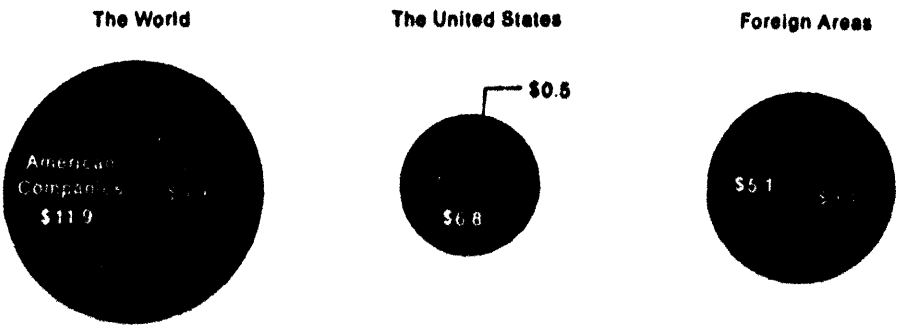
CAPITAL EXPENDITURES

Of the worldwide investment in 1971, American-owned companies accounted for 55 percent—down from 58 percent the year before. The smaller proportion reflected primarily the decline in spending in the United States and also more aggressive investment on the part of Foreign-owned companies. American companies were responsible for 93 percent of the spending in the United States and 35 percent in the Foreign sector.

American companies continued to provide the bulk of the funds applied to the search for new sources of petroleum. They accounted for 93 percent in the United States, 54 percent in the Foreign sector, and 72 percent Worldwide.

WHAT AMERICAN AND FOREIGN COMPANIES SPENT IN . . .

billions of dollars



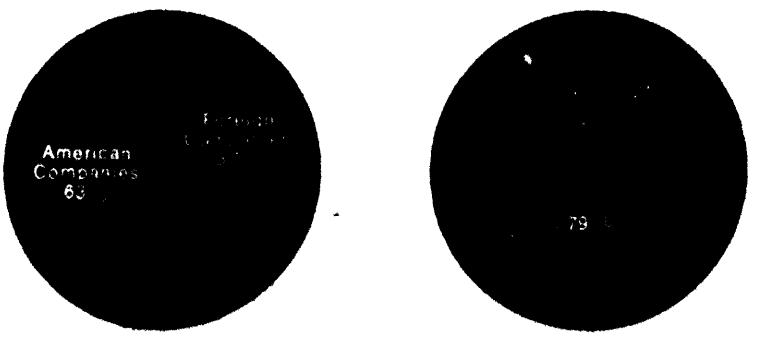
1971

GROSS INVESTMENT

At the end of 1971, the petroleum industry's gross investment in fixed assets totaled 223 billion dollars — up 17 billion from a year earlier. Of the total, 101 billion was located in the United States and 122 billion in the Foreign sector.

GROSS INVESTMENT IN FIXED ASSETS – DECEMBER 31, 1971

percent of worldwide



All Purposes

Production Only

SCHEDULE 1 CAPITAL AND EXPLORATION EXPENDITURES Year 1971

	United States	Canada	Venezuela
	Million Dollars		
Crude Oil and Natural Gas	3,185	725	210
Natural Gas Liquids Plants	200	150	5
Total Production	3,385	875	215
Pipe Lines	550	75	10
Tankers	125	0	0
Refineries	1,050	210	45
Chemical Plants	500	15	0
Marketing	1,350	150	5
Other	290	20	5
Total Capital Expenditures	7,250	1,345	280
Geological and Geophysical Expense & Lease Rentals	715	150	30
CAPITAL & EXPLORATION EXPENDITURES	7,965	1,495	310

SCHEDULE 2 GROSS INVESTMENT IN FIXED ASSETS December 31, 1971

Crude Oil and Natural Gas	52,475	5,750	5,030
Natural Gas Liquids Plants	3,325	855	235
Total Production	55,800	6,605	5,265
Pipe Lines	6,975	940	560
Tankers	1,275	0	0
Refineries	13,550	1,785	905
Chemical Plants	7,150	510	0
Marketing	13,500	1,935	195
Other	3,200	200	75
TOTAL GROSS INVESTMENT	101,450	11,975	7,000

SCHEDULE 3 NET INVESTMENT IN FIXED ASSETS December 31, 1971

Crude Oil and Natural Gas	24,380	4,135	1,195
Natural Gas Liquids Plants	1,695	685	145
Total Production	26,075	4,820	1,340
Pipe Lines	3,725	525	100
Tankers	600	0	0
Refineries	5,875	945	275
Chemical Plants	3,950	315	0
Marketing	8,775	1,160	90
Other	1,825	145	30
TOTAL NET INVESTMENT	50,825	7,910	1,835

Other Western Hemisphere	Western Europe	Africa	Middle East	Far East	Unallocated	World
			Million Dollars			
525	500	525	450	400	0	6,520
5	75	135	25	100	0	695
530	575	660	475	500	0	7,215
220	150	80	65	50	0	1,200
0	0	0	0	0	2,750	2,875
650	1,400	100	125	1,175	0	4,755
75	800	5	40	100	0	1,535
150	1,000	100	25	600	0	3,380
100	225	30	95	75	0	840
1,725	4,150	975	825	2,500	2,750	21,800
75	75	150	50	150	0	1,395
1,800	4,225	1,125	875	2,650	2,750	23,195
4,905	2,025	3,575	3,950	1,675	0	79,385
200	225	510	135	325	0	5,810
5,105	2,250	4,085	4,085	2,000	0	85,195
1,625	1,425	1,285	1,500	385	0	14,695
0	0	0	0	0	23,675	24,950
3,525	13,325	900	1,625	7,500	0	43,115
1,150	4,775	40	190	1,150	0	14,965
1,925	10,175	1,375	500	4,225	0	33,830
495	950	140	600	340	0	6,000
13,825	32,900	7,825	8,500	15,600	23,675	222,750
2,085	1,390	2,410	2,240	750	0	38,585
90	200	430	95	270	0	3,610
2,175	1,590	2,840	2,335	1,020	0	42,195
1,085	1,050	875	620	250	0	8,230
0	0	0	0	0	15,450	16,050
2,350	7,710	555	740	4,980	0	23,430
885	3,595	30	180	830	0	9,785
845	5,400	630	205	2,535	0	19,640
435	830	75	280	310	0	3,930
7,775	20,175	5,005	4,360	9,925	15,450	123,260

SCHEDULE 4 CAPITAL EXPENDITURES BY AMERICAN COMPANIES Year 1971

	United States	Canada	Venezuela
	Million Dollars		
Crude Oil and Natural Gas	2,975	400	130
Natural Gas Liquids Plants	175	120	5
Total Production	3,150	520	135
Pipe Lines	530	40	10
Tankers	125	0	0
Refineries	1,005	100	35
Chemical Plants	460	10	0
Marketing	1,225	95	0
Other	280	10	0
TOTAL	6,775	775	180

SCHEDULE 5 GROSS INVESTMENT OF AMERICAN COMPANIES December 31, 1971

Crude Oil and Natural Gas	49,250	3,680	3,360
Natural Gas Liquids Plants	3,225	655	210
Total Production	52,475	4,335	3,570
Pipe Lines	6,575	440	385
Tankers	1,275	0	0
Refineries	12,285	1,055	525
Chemical Plants	6,385	395	0
Marketing	12,515	1,215	45
Other	3,085	160	35
TOTAL	94,595	7,600	4,560

SCHEDULE 6 NET INVESTMENT OF AMERICAN COMPANIES December 31, 1971

Crude Oil and Natural Gas	22,775	2,700	810
Natural Gas Liquids Plants	1,645	510	120
Total Production	24,420	3,210	930
Pipe Lines	3,550	250	60
Tankers	600	0	0
Refineries	5,085	410	155
Chemical Plants	3,555	270	0
Marketing	8,045	680	25
Other	1,745	100	20
TOTAL	47,000	4,920	1,190

Other Western Hemisphere	Western Europe	Africa	Middle East	Far East	Foreign Flag Tankers	Foreign
			Million Dollars			
250	275	375	175	250	0	1,855
5	50	10	5	15	0	210
255	325	385	180	265	0	2,065
100	50	5	25	10	0	240
0	0	0	0	0	600	600
300	500	15	25	200	0	1,175
10	75	0	0	20	0	115
60	425	40	5	175	0	800
15	55	5	15	30	0	130
740	1,430	450	250	700	600	5,125
1,230	725	1,790	1,595	680	0	13,060
150	150	200	40	140	0	1,545
1,380	875	1,990	1,635	820	0	14,605
325	480	335	650	80	0	2,695
0	0	0	0	0	7,375	7,375
1,345	4,050	170	600	1,730	0	9,475
295	1,170	10	40	380	0	2,290
680	3,605	445	105	1,380	0	7,475
40	280	25	410	150	0	1,100
4,065	10,460	2,975	3,440	4,540	7,375	45,015
630	525	1,220	845	345	0	7,075
70	140	175	35	115	0	1,165
700	665	1,395	880	460	0	8,240
225	360	250	185	55	0	1,385
0	0	0	0	0	4,690	4,690
870	2,640	110	200	1,045	0	5,430
240	910	10	40	305	0	1,775
405	2,255	240	45	800	0	4,450
25	225	25	120	125	0	640
2,465	7,055	2,030	1,470	2,790	4,690	26,610

SCHEDULE 7 CAPITAL AND EXPLORATION EXPENDITURES

	1961	1962	1963	1964	1965
	Million Dollars				
WORLD					
Crude Oil and Natural Gas	5,205	5,430	4,965	5,350	5,550
Natural Gas Liquids Plants	175	235	205	215	235
Pipe Lines	475	640	625	555	550
Tankers	875	880	940	1,340	1,215
Refineries	1,295	1,425	1,735	1,565	1,865
Chemical Plants	655	650	630	625	925
Marketing	1,455	1,585	1,735	2,190	2,430
Other	290	255	315	435	405
Total Capital Expenditures	10,425	11,100	11,150	12,275	13,175
Geological and Geophysical Expense & Lease Rentals	1,020	1,000	1,050	1,130	1,180
COMBINED	11,445	12,100	12,200	13,405	14,355
UNITED STATES					
Crude Oil and Natural Gas	3,400	3,850	3,525	3,800	3,600
Natural Gas Liquids Plants	125	150	125	160	160
Pipe Lines	165	300	375	275	225
Tankers	65	40	40	65	40
Refineries	360	350	325	350	600
Chemical Plants	325	310	275	325	525
Marketing	525	600	650	850	1,000
Other	135	125	160	275	225
Total Capital Expenditures	5,100	5,725	5,475	6,100	6,375
Geological and Geophysical Expense & Lease Rentals	600	575	600	650	610
COMBINED	5,700	6,300	6,075	6,750	6,985
FOREIGN					
Crude Oil and Natural Gas	1,805	1,580	1,440	1,550	1,950
Natural Gas Liquids Plants	50	85	80	55	75
Pipe Lines	310	340	250	280	325
Tankers	810	840	900	1,275	1,175
Refineries	935	1,075	1,410	1,215	1,265
Chemical Plants	330	340	355	300	400
Marketing	930	985	1,085	1,340	1,430
Other	155	130	155	160	180
Total Capital Expenditures	5,325	5,375	5,675	6,175	6,800
Geological and Geophysical Expense & Lease Rentals	420	425	450	480	570
COMBINED	5,745	5,800	6,125	6,655	7,370

1966	1967	1968	1969	1970	1971	1970-1985
			Million Dollars			
5,400	5,595	6,875	7,075	6,650	6,520	230,000
240	405	585	465	580	695	14,750
760	860	1,080	910	850	1,200	33,500
1,290	1,255	1,650	2,050	2,575	2,875	47,000
2,670	2,585	2,950	3,210	4,000	4,755	101,500
1,340	1,565	1,480	1,310	1,525	1,535	33,500
2,410	2,705	2,665	2,805	3,220	3,380	64,500
565	605	615	550	725	840	40,250
14,675	15,575	17,900	18,375	20,125	21,800	565,000
1,110	1,190	1,330	1,380	1,340	1,395	35,000
15,785	16,765	19,230	19,755	21,465	23,195	600,000
3,600	3,750	4,675	4,525	4,110	3,185	120,000
170	275	250	225	225	200	5,000
275	360	425	300	450	550	13,000
25	40	50	100	100	125	7,000
775	775	800	950	1,075	1,050	25,000
800	825	650	575	550	500	10,000
1,100	1,250	1,150	1,250	1,450	1,350	25,000
380	375	350	250	265	290	15,000
7,125	7,650	8,350	8,175	8,225	7,250	220,000
650	615	715	725	665	715	20,000
7,775	8,265	9,065	8,900	8,890	7,965	240,000
1,800	1,845	2,200	2,550	2,540	3,335	110,000
70	130	335	240	355	495	9,750
485	500	655	610	400	650	20,500
1,265	1,215	1,600	1,950	2,475	2,750	40,000
1,895	1,810	2,150	2,260	2,925	3,705	76,500
540	740	830	735	975	1,035	23,500
1,310	1,455	1,515	1,555	1,770	2,030	39,500
185	230	265	300	460	550	25,250
7,550	7,925	9,550	10,200	11,900	14,550	345,000
460	575	615	655	675	680	15,000
8,010	8,500	10,165	10,855	12,575	15,230	360,000

SCHEDULE 7 CAPITAL AND EXPLORATION EXPENDITURES *(Continued)*

	1961	1962	1963	1964	1965
	Million Dollars				
CANADA					
Crude Oil and Natural Gas	350	280	340	375	500
Natural Gas Liquids Plants	40	20	45	50	50
Pipe Lines	25	25	45	30	30
Refineries	40	65	45	40	35
Chemical Plants	15	10	15	25	25
Marketing	75	100	100	100	100
Other	5	10	10	30	10
Total Capital Expenditures	550	510	600	650	750
Geological and Geophysical Expense & Lease Rentals	95	110	120	100	125
COMBINED	645	620	720	750	875
VENEZUELA					
Crude Oil and Natural Gas	165	160	170	155	175
Natural Gas Liquids Plants	0	0	0	0	0
Pipe Lines	5	5	5	5	5
Refineries	10	10	10	15	10
Chemical Plants	0	0	0	0	0
Marketing	15	10	10	20	10
Other	5	5	5	5	0
Total Capital Expenditures	200	190	200	200	200
Geological and Geophysical Expense & Lease Rentals	20	15	10	10	10
COMBINED	220	205	210	210	210
OTHER WESTERN HEMISPHERE					
Crude Oil and Natural Gas	475	415	325	265	245
Natural Gas Liquids Plants	5	10	5	5	10
Pipe Lines	40	50	25	20	25
Refineries	160	100	125	150	125
Chemical Plants	10	25	75	50	100
Marketing	175	100	75	75	75
Other	35	20	45	10	20
Total Capital Expenditures	900	720	675	575	600
Geological and Geophysical Expense & Lease Rentals	65	75	75	60	60
COMBINED	965	795	750	635	660

1966	1967	1968	1969	1970	1971	1970-1985
			Million Dollars			
550	525	500	675	650	725	22,000
50	60	75	75	165	150	2,000
30	90	85	50	35	75	9,000
55	90	145	150	240	210	2,500
40	30	50	50	25	15	1,000
125	150	150	150	160	150	3,000
25	30	20	25	25	20	1,500
875	975	1,025	1,175	1,300	1,345	41,000
150	175	175	175	175	150	3,000
1,025	1,150	1,200	1,350	1,475	1,495	44,000
120	120	175	200	205	210	3,000
0	5	10	25	25	5	750
10	5	5	15	20	10	750
5	10	40	95	35	45	1,000
0	0	0	0	0	0	0
10	5	5	5	10	5	250
5	5	5	0	5	5	250
150	150	240	340	300	280	6,000
10	15	15	20	15	30	500
160	165	255	360	315	310	6,500
255	250	350	325	360	525	20,000
5	10	50	10	10	5	500
50	60	200	125	60	220	1,500
300	160	275	400	400	650	21,000
50	125	150	175	100	75	3,000
75	100	100	100	100	150	3,000
25	30	100	65	130	100	3,000
760	735	1,225	1,200	1,160	1,725	52,000
50	60	75	75	85	75	3,000
810	795	1,300	1,275	1,245	1,800	55,000

SCHEDULE 7 CAPITAL AND EXPLORATION EXPENDITURES *(Continued)*

	1961	1962	1963	1964	1965
	Million Dollars				
WESTERN EUROPE					
Crude Oil and Natural Gas	85	100	110	105	175
Natural Gas Liquids Plants	0	0	0	0	0
Pipe Lines	60	140	80	60	75
Refineries	325	500	725	580	710
Chemical Plants	250	200	175	150	175
Marketing	400	450	600	750	850
Other	55	60	60	80	65
Total Capital Expenditures	1,175	1,450	1,750	1,725	2,050
Geological and Geophysical Expense & Lease Rentals	40	25	35	90	150
COMBINED	1,215	1,475	1,785	1,815	2,200
AFRICA					
Crude Oil and Natural Gas	400	285	245	325	330
Natural Gas Liquids Plants	0	50	30	0	10
Pipe Lines	110	75	35	75	100
Refineries	30	55	100	100	85
Chemical Plants	0	0	10	0	0
Marketing	90	100	75	70	75
Other	10	10	5	5	0
Total Capital Expenditures	640	575	500	575	600
Geological and Geophysical Expense & Lease Rentals	125	125	115	115	100
COMBINED	765	700	615	690	700
MIDDLE EAST					
Crude Oil and Natural Gas	275	275	150	175	400
Natural Gas Liquids Plants	0	0	0	0	5
Pipe Lines	45	20	20	25	85
Refineries	70	45	55	30	50
Chemical Plants	5	5	5	0	15
Marketing	25	25	25	25	20
Other	30	10	20	20	50
Total Capital Expenditures	450	380	275	275	625
Geological and Geophysical Expense & Lease Rentals	30	25	30	30	35
COMBINED	480	405	305	305	660

1966	1967	1968	1969	1970	1971	1970-1985
			Million Dollars			
175	220	250	250	300	500	20,000
0	5	25	25	50	75	1,000
225	150	175	75	75	150	5,000
950	1,025	900	850	1,050	1,400	27,000
325	425	350	350	725	800	15,000
750	800	825	825	900	1,000	20,000
75	100	100	105	160	225	14,000
2,500	2,725	2,625	2,480	3,260	4,150	102,000
75	100	125	125	100	75	3,000
2,575	2,825	2,750	2,605	3,360	4,225	105,000
350	325	475	525	450	525	20,000
5	30	100	50	75	135	2,000
65	115	80	110	100	80	2,000
60	50	40	90	85	100	1,500
0	0	25	0	0	5	500
75	75	60	50	75	100	2,500
5	5	5	0	5	30	500
560	600	785	825	790	975	29,000
75	100	75	85	100	150	2,000
635	700	860	910	890	1,125	31,000
250	275	275	325	275	450	15,000
5	15	25	5	5	25	1,000
95	60	85	210	75	65	1,500
175	125	150	100	140	125	2,000
25	10	55	10	25	40	1,000
25	25	25	25	25	25	750
25	40	10	55	20	95	250
600	550	625	730	565	825	21,500
50	50	50	50	50	50	2,000
650	600	675	780	615	875	23,500

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SCHEDULE 7 CAPITAL AND EXPLORATION EXPENDITURES *(Continued)*

	1961	1962	1963	1964	1965
	Million Dollars				
FAR EAST					
Crude Oil and Natural Gas	55	65	100	150	125
Natural Gas Liquids Plants	5	5	0	0	0
Pipe Lines	25	25	40	65	5
Refineries	300	300	350	300	250
Chemical Plants	50	100	75	75	85
Marketing	150	200	200	300	300
Other	15	15	10	10	35
Total Capital Expenditures	600	710	775	900	800
Geological and Geophysical Expense & Lease Rentals	45	50	65	75	90
COMBINED	645	760	840	975	890
FOREIGN FLAG TANKERS	810	840	900	1,275	1,175
WESTERN HEMISPHERE					
Crude Oil and Natural Gas	4,390	4,705	4,360	4,595	4,520
Natural Gas Liquids Plants	170	180	175	215	220
Pipe Lines	235	380	450	330	285
Tankers	65	40	40	65	40
Refineries	570	525	505	555	770
Chemical Plants	350	345	365	400	650
Marketing	790	810	835	1,045	1,185
Other	180	160	220	320	255
Total Capital Expenditures	6,750	7,145	6,950	7,525	7,925
Geological and Geophysical Expense & Lease Rentals	780	775	805	820	805
COMBINED	7,530	7,920	7,755	8,345	8,730
EASTERN HEMISPHERE					
Crude Oil and Natural Gas	815	725	605	755	1,030
Natural Gas Liquids Plants	5	55	30	0	15
Pipe Lines	240	260	175	225	265
Tankers	810	840	900	1,275	1,175
Refineries	725	900	1,230	1,010	1,095
Chemical Plants	305	305	265	225	275
Marketing	665	775	900	1,145	1,245
Other	110	95	95	115	150
Total Capital Expenditures	3,675	3,955	4,200	4,750	5,250
Geological and Geophysical Expense & Lease Rentals	240	225	245	310	375
COMBINED	3,915	4,180	4,445	5,060	5,625

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1966	1967	1968	1969	1970	1971	1970-1985
			Million Dollars			
100	130	175	250	300	400	10,000
5	5	50	50	25	100	2,500
10	20	25	25	35	50	750
350	350	600	575	975	1,175	21,500
100	150	200	150	100	100	3,000
250	300	350	400	500	600	10,000
25	20	25	50	115	75	5,750
840	975	1,425	1,500	2,050	2,500	53,500
50	75	100	125	150	150	1,500
890	1,050	1,525	1,625	2,200	2,650	55,000
1,265	1,215	1,600	1,950	2,475	2,750	40,000
4,525	4,645	5,700	5,725	5,325	4,645	165,000
225	350	385	335	425	360	8,250
365	515	715	490	565	855	24,250
25	40	50	100	100	125	7,000
1,135	1,035	1,260	1,595	1,750	1,955	49,500
890	980	850	800	675	590	14,000
1,310	1,505	1,405	1,505	1,720	1,655	31,250
435	440	475	340	425	415	19,750
8,910	9,510	10,840	10,890	10,985	10,600	319,000
860	865	980	995	940	970	26,500
9,770	10,375	11,820	11,885	11,925	11,570	345,500
875	950	1,175	1,350	1,325	1,875	65,000
15	55	200	130	155	335	6,500
395	345	365	420	285	345	9,250
1,265	1,215	1,600	1,950	2,475	2,750	40,000
1,535	1,550	1,690	1,615	2,250	2,800	52,000
450	585	630	510	850	945	19,500
1,100	1,200	1,260	1,300	1,500	1,725	33,250
130	165	140	210	300	425	20,500
5,765	6,065	7,060	7,485	9,140	11,200	246,000
250	325	350	385	400	425	8,500
6,015	6,390	7,410	7,870	9,540	11,625	254,500

SCHEDULE 8 VOLUMETRIC STATISTICS – 1971

Area	Crude Oil Production	Refinery Runs	Liquid Petroleum Consumption
	Thousand Barrels Per Day		
United States	9,529	11,200	15,210
Foreign			
Canada	1,350	1,392	1,535
Venezuela	3,549	1,225	211
Other Western Hemisphere	1,525	4,079	2,852
Western Europe	357	13,020	13,302
Africa	5,679	631	986
Middle East	16,368	2,290	1,202
Far East	1,594	6,048	6,977
Total	30,422	28,685	27,065
World	39,951	39,885	42,275

SCHEDULE 9 TANKER FACILITIES WORLD – 12/31/71

Flag	Number	Deadweight Tonnage	
		Thousand	% of Total
United States *	251	7,662	4.2
Panama	175	5,863	3.2
Norway	391	23,089	12.6
Greece	229	8,912	4.8
United Kingdom	442	23,112	12.6
Liberia	850	47,928	26.2
Japan	286	22,822	12.5
Others	1,055	43,760	23.9
Total	3,679	183,138	100.0

**Excludes U.S. Government vessels*
Source: Sun Oil Company – Economics Department

SCHEDULE 10 EXPLORATION AND DEVELOPMENT EXPENDITURES – UNITED STATES – 1971

	Million Dollars
Lease Acquisitions	300
Producing Wells	2,095
Dry Holes	790
Total Capitalized	3,185 *
Geological & Geophysical Expense	575
Lease Rentals	140
Total Exploration & Development Expenditures	3,900

**Excludes natural gasoline plants of $200 million.*

Senator GRAVEL. I would like to introduce into the hearing record at this point, numerous documents related to the energy crisis. These are in addition to the many communications received by the committee expressing an interest in these hearings, which will also be printed in these hearings.

[The documents referred to follow. The communications are included in this hearing as appendix B.]

THE ARAB OIL EMBARGO AND ITS IMPACT ON WINTER FUEL SHORTAGES

(By David Lindahl)

I. INTRODUCTION

The United States has been concerned over the possibility of a winter fuel crisis for the past year. Rising demand and falling supply have created a situation in which a shortage was extremely likely. The Arab oil cutoff has made that shortage inevitable and threatens to produce economic dislocations as well as personal inconvenience and discomfort. The factors behind the shortage, its impact on the Nation, and possible corrective measures are complex and subject to extensive analysis. This report, however, is a brief overview which is intended to place these actions and reactions in perspective.

II. DOMESTIC DEMAND

For the past several years, shortages of fuel oil have occurred during the winter months. Part of the recent shortages can be attributed to the appearance of new users who were unable to obtain natural gas because of curtailments starting in 1971 and were not permitted to burn high-sulfur fuels because of air-quality regulations. The shortage was particularly acute during last winter (1972–1973) because demand rose much more rapidly than did supply. The shortage could have been much worse, however, had it not been for the unusually mild weather experienced by many parts of the country.

Fuel oil demand for the winter of 1973–1974 is expected to be higher than for last year. The Department of the Interior has estimated that distillate demand this winter will increase 10.4% over last year (4,048,000 b/d in 1973/1974 compared to 3,668,000 b/d in 1972/1973).[1] If temperatures are colder than normal and increase demand by 3.9%, an extra 120,000 b/d would be required to prevent a shortage.[2] The effect of cold weather on the demand for distillate fuel oil can be seen in Table 1.

TABLE 1.—MONTHLY CONSUMPTION OF DISTILLATE FUEL OIL UNDER DIFFERENT ASSUMPTIONS OF WINTER WEATHER

[In millions of barrels]

	October	November	December	January	February	March
Case A. 6 percent increase over last winter	87.2	102.0	131.3	132.0	115.6	109.7
Case B. Warm winter	75.2	87.0	115.6	118.1	101.1	97.0
Case C. Cold winter	89.9	110.3	148.1	153.7	131.1	119.5
Case D. Warm early/cold late winter	79.6	93.9	126.8	144.4	121.7	113.0
Case E. 10 percent increase over last winter	90.5	105.9	136.3	137.0	120.0	113.8

Source: Winter Heating Outlook, P. K. Verleger, Jr., S. and Haltmaier, DRI Review, Oct. 10, 1973, p. 3.

In addition to the normal growth rate in heating oil demand and the possible effects of unseasonably cold weather, an increase of 130,000 b/d may result from the curtailment of natural gas sales because of shortages.[3] The combined total

[1] The Distillate Fuel Oil Situation, Winter 1973–74, Department of the Interior, Sept. 15, 1973, p. 3.
[2] *Ibid.*, p. 4.
[3] The Distillate Fuel Oil Situation, p. 4.

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of these demand factors indicates a distillate demand of 4,048,000 b/d over last year's figure of 3,668,000 b/d. This increase of 380,000 b/d, shown in Table 2, does not include crude oil or other refined products which would increase the total demand to over 17,000,000 b/d.

The U.S. demand for petroleum products of all types is estimated by the Bureau of Mines at 17,455,000 b/d in 1973. The demand in 1974 is predicted by the Independent Petroleum Association of America (IPAA) to rise to 18,725,000 b/d.[4] Much of this increase can be attributed to the greater use of fuel oil, but demand for other petroleum derivatives is also expected to grow at comparable rates. The requirements for gasoline, propane, and petrochemical feedstocks are unprecedented, and shortages are likely to recur for those products as well as for fuel oil.

TABLE 2.—U.S. DISTILLATE DEMAND BY QUARTERS AND WINTER SEASON 1971 THROUGH 1974

[Millions of barrels daily]

	1971	1972	1973	1974
1st quarter	3.695	3.788	3.885	4.570
2d quarter	2.258	2.406	[1] 2.500	2.630
3d quarter	1.886	2.011	[2] 2.150	2.264
4th quarter	2.955	3.458	3.538	3.680

[1] Estimated.
[2] Forecast thereafter.

Source: The "Distillate Fuel Oil Situation Winter 1973-74," Department of the Interior, Sept. 15, 1973.

Winter season	Millions of barrels daily	Percent increase
1971-72	3.369	3.7
1972-73	3.668	8.9
1973-74	4.048	10.4

III. DOMESTIC SUPPLY

The United States currently produces less than 70% of the petroleum it needs to meet domestic demands. With the exception of the addition of the Alaskan North Slope fields, productive capacity has been dropping as has actual production. During the shortage of last winter, it was apparent that the oil industry no longer had the capability of increasing production to match the peak demand.

This trend is likely to continue indefinitely. Domestic production of petroleum for 1973 has been estimated by the Bureau of Mines to be 10,961,000 b/d, compared to a demand of 17,455,000 b/d. Of the 6,494,000 b/d shortfall between domestic demand and supply, 6,251,000 b/d were expected to be made up by imports, leaving a shortage of 223,000 b/d. The IPAA predicted that domestic production would drop to 10,788,000 b/d, even though demand is likely to rise over 1,000,000 b/d compared to last year.[5] Of the 7,737,000 b/d deficit forecast between supply and demand, 7,435,000 b/d were expected, before the Arab oil cutoff, to be made up with imported oil, leaving a net shortage of 302,000 b/d.

The most immediate supply problem is for fuel oil because of the onset of the heating season. Stocks of distillate fuel in November (203,656,000 bbl) are only slightly higher than they were a year ago (197,750,000 bbl.).[6] The gain in supply (3%) has been more than offset by increased demand (10%) with the net effect being a shortage 7% worse than last year.

The shortage of residual fuel oil, which is used primarily by electric utilities and heavy industry as a boiler fuel, is even more acute. Stocks of residual fuel oil on Oct. 26, 1973 were only 56,891,000 bbl. in contrast with 63,990,000 bbl. a year ago.[7] With greatly increased demand pressures and lower stocks, a serious residual shortage appears inevitable. A futher complication is that most of the

[4] Report of the Supply and Demand Committee, IPAA Houston Meeting, Oct. 21-23, 1973, p. 7.
[5] Report of the Supply and Demand Committee, p. 7.
[6] API Weekly Statistical Bulletin, Oct. 26, 1973, p. 2.
[7] *Ibid.*, p. 2.

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residual fuel oil used in the U.S. is imported, and reductions in foreign production may worsen the supply situation here.

IV. IMPORTS

A. Requirements

As has already been indicated, imports figure prominently in the supply/demand situation for petroleum. U.S. dependence on foreign sources of oil has grown rapidly in recent years, and it would now be impossible to prevent severe shortages without substantial imports. In 1972 imports accounted for 18.8% of the U.S. crude distillate supply (see Table 8).[8] Imports now constitute over one-third of our total petroleum consumption, and the trend is toward even greater dependence on foreign producers. By 1980 the U.S. may be importing over 50% of its oil. Most of that increase was expected to come from the Middle East because of its extensive reserves. The supply of some products such as residual fuel oil is already dependent on foreign production. The demand for residual oil in 1972, for example, was 925,647,000 bbl. Of this, 637,401,000 bbl. was imported, amounting to over two-thirds of the total.[9]

Because of the drop in domestic production and the increase in demand for petroleum products, an estimated 640 million barrels of crude oil will have to be imported during the last quarter of 1973 and the first quarter of 1974 to avert a serious shortage.[10] If available on the world market, this much oil would represent an increase of 50% over 1972 U.S. imports. The Middle East is currently the only producing area in the world that has the proven reserves and productive capacity to meet those increasing requirements. The added cost of the incremental imports over last year's total would depend upon the price per barrel (which is rapidly escalating upward) but would probably be near $8 billion.[11]

TABLE 3.—CRUDE OIL IMPORTS INTO THE UNITED STATES

Country of origin	Annual total for 1972 (In 42-gallon barrels)	Posted price per barrel, Oct. 1, 1973	Posted price per barrel, Oct. 31, 1973	U.S. export embargo (percent)	Middle East monthly production cut (percent)
Canada	312,440,000				
Colombia	1,695,000				
Ecuador	5,331,000	3.600	5.250		
Venezuela	93,300,000	4.610			
Algeria	31,753,000	5.000	7.000	100	10
Egypt	3,091,000			100	5
Libya	40,069,000	4.604	8.925	100	5
Nigeria	88,887,000	5.000	5.000		
United Arab Emirates	26,873,000	3.110	5.538	100	5
Iran	49,700,000	2.995	5.091		
Iraq	1,315,000			100	10
Kuwait	13,205,000	2.884	4.903	100	10
Qatar	1,263,000	3.143	5.343	100	10
Saudi Arabia	63,626,000	2.884	4.903	100	10
Indonesia	59,633,000	5.000	5.000		
Others	18,954,000				
Combined total	811,135,000				

Note: Total does not include indirect imports of refined products made from Middle Eastern crude.

Source: API Annual Statistical Review, April 1973, p. 9-10; Oil and Gas Journal, Oct. 29, 1973, p. 50; Oil Daily, Oct. 26, 1973, p. 6.

The level of imports needed to meet the demand for distillate fuel oil also will be substantial. The Department of Interior has estimated that if domestic refinery capacity is to be used as expected and inventories are to be maintained at a level of 100,000,000 barrels or above, then imports of distillate must average more than 650,000 b/d.[12] If the weather is exceptionally cold, imports of

[8] The Distillate Fuel Oil Situation, p. 4.
[9] API Annual Statistical Review, April 1973, p. 45.
[10] Winter Heating Outlook, P. K. Verleger, Jr., and S. Haltmaier, *DRI Review*, Oct. 10, 1973, p. 6.
[11] *Ibid.*, p. 6.
[12] The Distillate Fuel Oil Situation, p. 1.

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800,000 b/d may be needed during the cold spells. Even in normal circumstances such quantities may not be available for the United States on world markets. During the shortage last winter, for example, distillates were imported at an average rate of 400,000 b/d. Most of that distillate (80 to 85%) came from refineries in the Caribbean, with the remainder imported from Europe. Most of the European distillate and a substantial amount of the Caribbean distillate was made from Middle Eastern crude oil.

It is unlikely that as much distillate fuel oil will be available from Europe as that obtained last winter. Europe imports more distillate than it exports, and was able to provide extra distillate last year only because of mild weather. The largest quantity of distillate that the U.S. could reasonably expect to obtain from Europe this season is 165,000 b/d.[13] A cold winter would reduce that amount considerably.

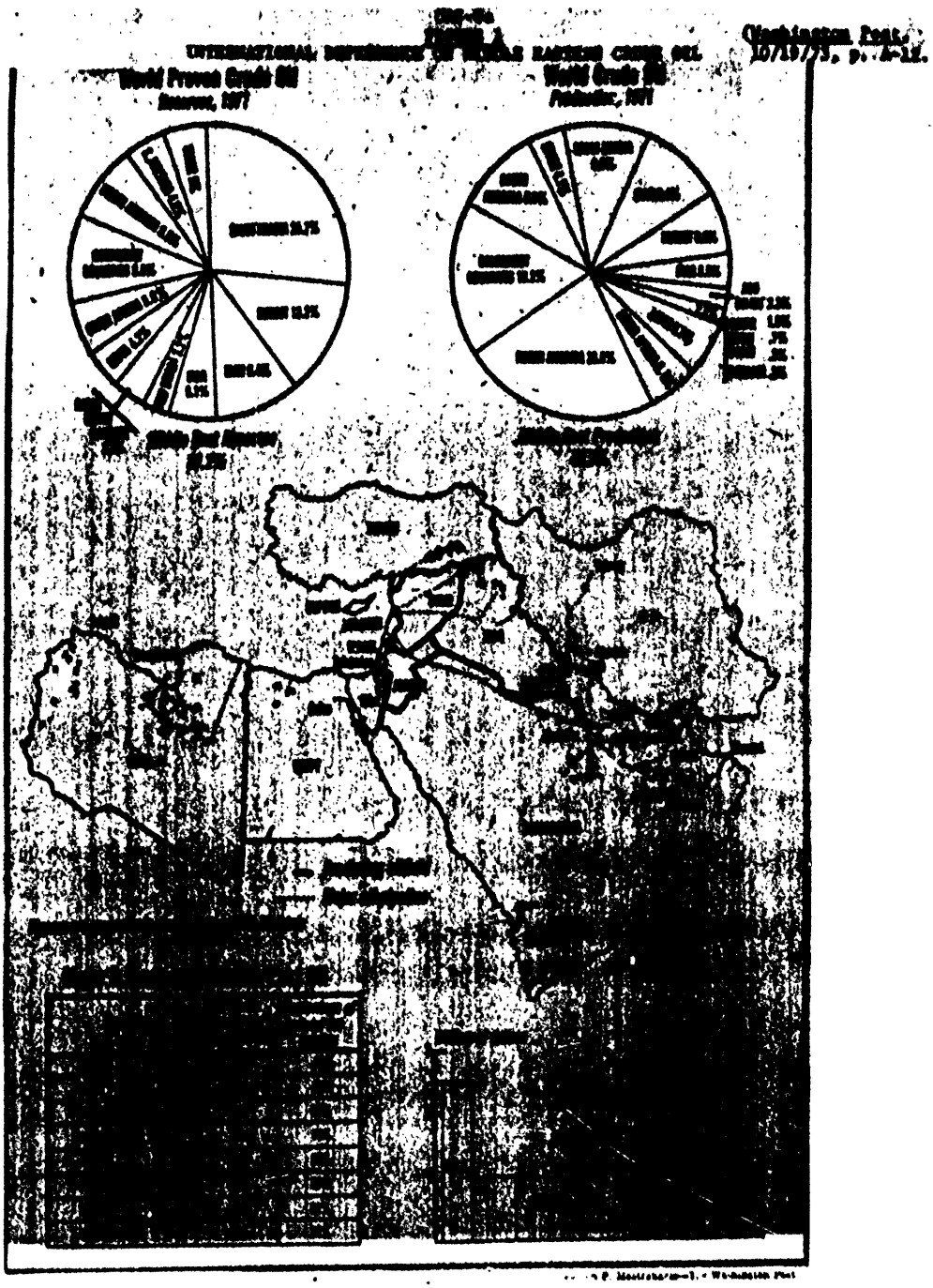
B. The oil producer's boycott

The availability of oil to import into the United States has been drastically reduced as a result of renewed hostilities in the Middle East. The Arab countries that export oil have agreed to boycott the U.S. market in an attempt to influence U.S. policy towards Israel and generally to modify its Middle-Eastern policy. The use of oil as an instrument of diplomacy is not new, but it has never been applied as effectively on as large a scale as at present. The U.S. has been wholly cutoff from Middle Eastern oil, as has the Netherlands, because of its pro-Israeli policies. Canada has also been denied Arab oil for fear that it would send part of it to the U.S. The Arab states have also reduced production 10% initially for European customers and plan to cut it 5–10% each month thereafter. Additional cuts have been threatened and may be implemented. These actions are of vital concern to Europe and Japan where imports from the Middle East comprise 40%–85% of their petroleum supply (Fig. 1).

The Arab oil cutoff is certain to have a serious impact on the Nation's petroleum supply and upon the winter distillate inventories in particular. As Table 4 indicates, the 1972 shipments to the United tSates totaled 687,900 b/d, which was 5% of the U.S. distillate demand of 16,300,000 b/d. The level of imports in 1973, prior to the war, was much higher with Saudi Arabia exporting in July as much crude oil as all the Arab countries combined had exported in July of 1972. As Table 4 shows, imports of Arab crude oil in July were 2½ times the rate a year earlier.

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[13] *Ibid.*, p. 12.



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TABLE 4.—U.S. IMPORTS OF ARAB CRUDE OIL, JULY 1973 VERSUS JUNE 1972

Producing country	Crude shipments to United States, barrels per month	
	June 1972	July 1973
Algeria	2,380,000	4,595,000
Egypt		653,000
Iraq		
Kuwait	1,012,000	482,000
Libya	3,192,000	3,599,000
Qatar		185,000
Saudi Arabia	5,145,000	19,958,000
Tunisia		205,000
United Arab Emirates	1,452,000	3,169,000
Total	13,181,000	32,661,000

Source: Oil and Gas Journal, Oct. 15, 1793, p. 40.

C. Severity of the shortage

When the production cutbacks and cutoffs were announced by the Arab oil-producing states, the initial reaction in the U.S. was that the loss of Mid-East supply was a minor complication that could be easily accommodated. It was reasoned that since only 2½% of our oil consumption in 1972 was met with oil from the Middle East, the impact would not be very great. Those initial assessments, however, appear to be overly optimistic because they did not include several important considerations. First, the direct imports of Arab oil have averaged about 250% more for 1973 than for 1972, and were even higher in the period immediately preceding the cutoff. The direct imports of crude oil from the Middle East in 1973 amount to 1.1 million b/d compared to the estimated U.S. demand of 17.5 million b/d.[14] Second, the United States imports petroleum products, especially residual and distillate fuel oil, which are refined in Western Europe and the Caribbean from Middle Eastern crude oil. If both direct and indirect shipments of Arab oil are affected, the reduction in supply may amount to 3 million b/d or 18% of the U.S. daily demand. Third, Canada, which supplies the U.S. with more than any other country (1.1 million b/d in 1972), traditionally for geographical reasons has imported as much oil as it exported. Because Canada's producing areas are in Western Canada, it was expedient to sell the surplus oil there to the U.S. rather than to transport it to Eastern Canada.

Now that Canada's imports are threatened, it has placed strict controls on oil exports and is planning to redistribute as much of its western production as is necessary to meet the requirements of its eastern provinces. The effect of this will reduce Canadian exports to the United States by a comparable amount (possibly 500,000 b/d), and probably would push the U.S. shortfall over 20%. Fourth, the general production cuts imposed by the Arabs have tightened world supply to the point where competition for the oil of Venezuela, Nigeria, Iran, Indonesia, and others may make it difficult for the U.S. oil industry to buy as much petroleum from those sources as it did last year. If the shortages resulting from normal demand growth, natural gas curtailments, low inventories, and an exceptionally cold winter are added the total shortfall could be as much as 35%. While that is the worst possible case, it is unlikely that even an end to the Arab oil embargo and a relatively mild winter could reduce the shortage to 20% or less. That case, if it occurred, would minimize the gasoline problems that would otherwise develop next summer, but would come too late to prevent shortages this winter. The most likely prospect is for winter fuel oil shortages on the order of 25%.

Worldwide, the cutoff of Middle East oil has reduced world oil supplies by 4.7 million b/d.[15] It is expected that the production loss in November will be about 6 million b/d.[16] The *Oil and Gas Journal* reports that there is no alternate supply readily available to offset a reduction of this magnitude. Most non-Arab

[14] "U.S. Moves to Offset Loss of Arab Oil," *Oil and Gas Journal*, Oct. 29, 1973, p. 53.
[15] "World Shaken by Arab Oil-Export Cuts, Price Hikes," *Oil and Gas Journal*, Oct. 29, 1973, p. 49.
[16] "An Arab Oil Squeeze that Works," *Wall Street Journal*, Nov. 6, 1973.

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producers are already operating near capacity and are not likely to increase exports to the U.S., except for Indonesia which has offered to increase production slightly.

The impact of these shortages is certain to be felt by all consuming nations, but the U.S. and the Netherlands will likely be affected to the greatest extent, assuming that the complete embargo is not extended to other countries. Europe will be adversely affected since it gets approximately 80–85% of its oil from Arab states. The cutoff for Europe is not total, however, and many countries there have strategic reserves of approximately 90 days. The U.S., on the other hand, is now subject to a 100% embargo, has no strategic oil storage system, and expects domestic oil production to decline.

No one can say with certainty just how severe the shortage will be. It was widely predicted that there would be a fuel oil shortage this winter and that now appears to be inevitable. The foreign fuel oil that was imported last year will not be available this year because exporters face possible shortages in their own countries and could be cutoff entirely from Middle East oil if they transship crude oil or petroleum products to the United States.

The real effects of the cutoff have not yet been felt in the United States because oil that was shipped before the embargo is still in transit and the peak demands of the heating season will not be reached until late December. The shortage will be the most severe since World War II and will affect every energy consuming phase of American life. At the worst, some factories, schools, and businesses may have to close or limit operations and many personal activities may have to be curtailed. Many homes may be cold and many electric utilities may have to limit output because of fuel restrictions. If the shortage is severe and protracted, serious strains could develop in the U.S. economy.

The region of the United States that will probably be affected the most will be New England, and to a lesser degree, the upper Midwest. Half of the residual fuel oil imported to the East Coast is made from Arab oil. That oil is used primarily to produce 70% of New England's electricity. If the oil supply is reduced by half, 35% of New England's generating capacity will be cut. Some power systems in New England are totally dependent on Mid-East oil and will have difficulty finding other sources, because residual fuel oil is not yet subject to mandatory allocation. The oil shortage problems of the Northeast and Midwest will be compounded by the fact that winters are usually colder there than in the rest of the country and consequently per-capita heating requirements are higher.

V. POLICY OPTIONS

The increasing U.S. dependence on foreign oil has greatly reduced the alternative courses of action available to the U.S. For the most part, it is unlikely that the two extreme options of total capitulation to Arab demands or of military intervention to restore supply lines would be used. The U.S. can respond in other ways that can be effective to varying degrees over both the short and long term.

A. Increased domestic production

An immediate increase in domestic production is, at best, only a partial solution. Certainly there is insufficient productive capacity, even including Naval Petroleum Reserves, to meet a shortfall of 4 to 4½ million b/d. To the extent that this oil is available, however, the shortage can be reduced accordingly. During the oil shortage last winter, production controls were lifted on many U.S. fields but with only marginal success. It is doubtful that U.S. production for this winter will match last year's total, let alone meet the greater demand of this year. The *Oil and Gas Journal* reported that U.S. oil fields do not have sufficient productive capacity to compensate for an Arab oil cutoff.[17] The *Journal* estimated that only 100,000 b/d of extra domestic production could be made immediately available. After 90 days, the *Journal* predicted, 250,000 b/d could be produced if pipeline capacity were increased, gas and brine-handling facilities were expanded. A maximum of 445,000 b/d could be obtained at the risk of reservoir damage, wasted natural gas through flaring, and pollution. This increase falls far short of the 1,053,600 b/d of crude oil imported from the Middle East in July

[17] "U.S. Fields Unable to Fill Gap If Arab Oil Is Cutoff," *Oil and Gas Journal*, Oct. 15, 1973, p. 39.

1973. It should also be noted that the 445,000 b/d increase is considered optimistic by many. The Texas Railroad Commission, which oversees the production of oil in Texas, has indicated that there is no excess capacity and that production could be increased only by damaging the reservoirs which would reduce even more the eventual production.[18] The major oil companies contend, on the other hand, that increased production is possible and have petitioned for increased allowables. Even the most optimistic estimates, however, predict that the cutoff will result in a substantial shortfall in supply at a time when inventories should be building up for the high demands of winter's heating season.

B. Strict conservation measures

Mandatory allocations of distillate fuel oil and propane were implemented earlier this year to deal with the predicted winter shortage. As the President indicated in his message of November 8, 1973, the Arab oil cutoff may require more extreme measures, and rationing may be necessary. Senator Henry M. Jackson has introduced a bill (S. 2176) which he claims could result in savings or additions to supplies of over 3 million b/d within 5 months.[19] The proposed legislation would require a declaration of national emergency when the shortage exceeds 5%, and would direct the President to issue requirements for rationing and conservation plans to be developed by state and local governments. The goal of the conservation plans would be to reduce energy consumption by 10% within 10 days and by 25% within 4 weeks after implementation.[20] Some of the measures may include maximum speed limits of 50 m.p.h. or less; mandatory tuneups of motor vehicles; a ban on advertising to promote the consumption of energy; mandatory inspection of commercial and industrial heating and air conditioning units; temperature limits of 65° F. in winter and 80° F. in summer for all buildings owned or leased by the Federal Government; and mandatory carpooling. Temporary relaxation of air quality standards might be allowed to permit utilities to burn high-sulfur coal instead of oil, which would then be available for transportation and space heating.

President Nixon, in his November 7th nationwide address on the energy situation, proposed a broad energy conservation plan that would give him the authority to ration gasoline and fuel oil, reduce speed limits, exempt industries from environmental controls, and to impose taxes on excessive energy use. The President asked the Congress to return the United States to permanent daylight saving time and ordered immediate cuts in the use of energy by the Federal Government in addition to the 7% cut ordered earlier. He ordered that Federal offices be heated to no more than 68° F. and that Federal vehicles not travel more than 50 m.p.h. In addition, the Atomic Energy Commission was asked to accelerate the rate at which nuclear power plants are being licensed and built. He directed that industries which presently use coal be prevented from switching to oil and encouraged utilities now using oil to convert to coal utilization. Individuals were asked to lower their thermostats, to form carpools and generally reduce their consumption of energy. He urged that the following steps be taken at the state level: halt unnecessary lighting, stagger working hours, encourage greater use of mass transit, and adopt a 50 m.p.h. speed limit. In the legislation requested by the President was the authority to enable regulatory agencies to adjust the schedules of planes, ships, and other carriers in order to conserve energy.

C. Commitment to energy self-sufficiency

One consequence of the Arab oil cutoff is an intensified interest in developing energy self-sufficiency within the United States. While such a goal would take years to realize, the U.S. does have large quantities of coal, oil shale, and offshore and Alaskan oil that ultimately could reduce dependence on foreign sources of oil. To accomplish a task of such magnitude would require a major commitment by the United States to that goal. As seen by some Members of Congress, most prominently Senator Jackson, attaining this goal would require a coordinated national energy policy fortified with adequate funds and manpower. Such a program would be designed to reduce the economic and technological barriers that stand in the way of large scale use of coal gasification and liquefaction, solar energy, breeder reactors, and fusion reactors.

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[18] *Ibid.*, p. 40.
[19] *Oil and Gas Journal*, p. 53.
[20] *Ibid.*

Even if such a national energy program were initiated and were ultimately successful, it would probably not have much effect on energy supply for at least a decade. In the meantime, the United States may find it expedient to launch large-scale exploration and development operations in promising but politically secure areas of the world. The Orinoco heavy oil reserves of Venezuela may hold close to one trillion barrels of oil. Canada's Athabascan tar sands 300 billion barrels, the Green River oil shale formation 600 billion barrels and the Naval Petroleum Reserve No. 4 in Alaska an undetermined amount.[21] The Atlantic Outer Continental Shelf which has not yet been explored may also contain large oil and gas reserves.

The lead time required to develop these reliable sources would be 8 to 15 years,[22] so they could not be immediately brought to bear on the present situation. A national commitment to these resources, however, would be useful in negotiations with Middle-Eastern producers. This combined with the creation of an organization of oil consuming nations could conceivably reduce the prospect of arbitrary supply interruptions in the future and could promote international cooperation in the search for new sources of energy.

WASHINGTON, D.C., *September 17, 1973.*

FEDERAL POWER COMMISSION NEWS RELEASE NO. 10640

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 pipeline companies amounted to about 565.6 billion cubic feet. For next winter, 14 companies are estimating curtailments of more than 670.7 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

FIRM REQUIREMENTS AND CURTAILMENTS OF MAJOR INTERSTATE PIPELINE COMPANIES

BUREAU OF NATURAL GAS REVISED STAFF REPORT

As a result of the recently completed meetings with various groups of interstate natural gas pipeline 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

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[21] "The Oil Crisis: This Time the Wolf Is Here," James E. Akins, Foreign Affairs, April 1973, p. 489.
[22] *Ibid.*, p. 489.

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 months 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–October, 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 Co., Arkansas-Missouri Power Co., Lone Star Gas Co. and Southwest Gas Corp.

[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.

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Regions by FRC

Schedule IV

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

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Schedule I
(Revised)

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

Interstate Company	1972 - Actual 1/									1972-1973 - Actual 1/		
	APRIL-JULY			AUGUST-OCTOBER			APRIL-OCTOBER			NOVEMBER-MARCH		
	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	43,730,600	320,100	0.7	30,368,600	-0-	0.0	74,099,200	320,100	0.4	85,044,730	8,466,467	1.0
Arkansas Louisiana Gas Company	448,563,000	28,651,259	19.3	121,029,000	32,049,470	26.8	570,592,000	61,131,229	22.7	260,450,000	79,256,832	30.7
Cities Service Gas Company	155,943,000	-0-	0.0	117,106,060	31,300 2/	0.0	273,051,000	31,300 2/	0.0	303,710,000	43,800,000 2/	14.2
Colorado Interstate Gas Company	115,873,300	-0-	0.0	89,040,400	-0-	0.0	205,713,700	-0-	0.0	287,430,300	-0-	0.0
Columbia Gas System, Inc. (Columbia Gas Trans. Corp.)	370,934,000	-0-	0.0	254,523,000	-0-	0.0	625,457,000	-0-	0.0	823,817,000	-0-	0.0
Consolidated Gas Supply Corporation	201,310,000	-0-	0.0	144,457,000	-0-	0.0	345,767,000	-0-	0.0	536,045,000	-0-	0.0
East Tennessee Natural Gas Company	28,961,000	-0-	0.0	22,338,060	-0-	0.0	51,299,000	-0-	0.0	63,443,000	-0-	0.0
Eastern Shore Natural Gas Company	3,744,100	-0-	0.0	2,616,600	-0-	0.0	6,360,700	-0-	0.0	9,080,200	3,302	0.1
El Paso Natural Gas Company	587,652,000	83,103	0.0	440,448,000	470,000	0.1	1,034,073,000	553,103	0.1	829,930,000	66,847,332	8.1
Florida Gas Transmission Company	7,101,000	-0-	0.0	5,122,000	-0-	0.0	12,223,000	-0-	0.0	13,478,000	-0-	0.0
Granite State Gas Transmission, Inc.	1,160,100	-0-	0.0	875,600	-0-	0.0	2,035,500	-0-	0.0	2,386,300	-0-	0.0
Great Lakes Gas Transmission Company	129,552,000	-0-	0.0	98,315,000	-0-	0.0	223,867,000	-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	65,245,000	-0-	0.0
Louisiana-Nevada Transit Company	45,940,636	52,500	0.1	33,933,475	24,200	0.1	79,873,911	76,700	0.1	64,634,992	438,880	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	488,954,000	-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	190,048,300	384,500	0.2
Mid Louisiana Gas Company	11,750,000	-0-	0.0	8,529,000	-0-	0.0	20,285,000	-0-	0.0	17,802,000	-0-	0.0
Mississippi River Transmission Corporation	45,575,000	-0-	0.0	35,793,000	-0-	0.0	81,368,000	-0-	0.0	122,659,000	9,217,953	7.5
Montana-Dakota Utilities Company	6,391,000	-0-	0.0	5,333,000	-0-	0.0	11,724,000	-0-	0.0	23,314,000	-0-	0.0
Mountain Fuel Supply Company	13,619,000	-0-	0.0	8,354,000	-0-	0.0	19,773,000	-0-	0.0	42,730,000	-0-	0.0
Natural Gas Pipeline Company of America	399,640,800	74,552,597	18.7	301,020,500	70,936,861	23.6	700,681,300	145,489,458	20.8	505,197,000	-0-	0.0
Northern Natural Gas Company	263,117,000	-0-	0.0	142,718,000	1,270,957	0.9	455,835,000	1,270,957	0.4	480,490,000	6,769,557	1.2
Pacific Gas Transmission Company	130,620,000	-0-	0.0	100,228,000	-0-	0.0	230,848,000	-0-	0.0	180,181,000	-0-	0.0
Panhandle Eastern Pipeline Company	295,257,600	-0-	0.0	187,498,100	-0-	0.0	482,855,700	-0-	0.0	343,055,700	14,504,737	3.7
South Georgia Natural Gas Company	8,394,399	-0-	0.0	6,309,645	-0-	0.0	14,704,044	-0-	0.0	10,457,588	-0-	0.0
Southern Natural Gas Company	176,753,000	-0-	0.0	134,688,000	-0-	0.0	309,441,000	-0-	0.0	287,445,000	-0-	0.0
Tennessee Gas Pipeline Company	415,296,000	-0-	0.0	311,991,000	-0-	0.0	727,287,000	-0-	0.0	591,524,000	-0-	0.0
Texas Eastern Transmission Corporation	313,306,000	26,781,257	8.5	231,430,000	11,711,606	5.1	544,736,000	38,492,861	7.1	427,532,000	61,663,734	14.4
Texas Gas Transmission Corporation	231,876,000	-0-	0.0	173,254,000	-0-	0.0	405,128,000	-0-	0.0	337,604,000	-0-	0.0
Transcontinental Gas Pipe Line Corporation	344,929,000	25,193,144	6.9	271,756,000	21,566,348	7.9	616,685,000	46,759,492	7.3	449,344,000	30,308,327	6.8
Transwestern Pipeline Company	111,713,700	-0-	0.0	86,783,300	-0-	0.0	198,497,000	-0-	0.0	348,534,900	1,043,770	0.7
Trunkline Gas Company	197,057,000	14,399,638	7.3	148,735,000	33,133,617	8.8	345,792,000	27,533,055	8.0	247,444,000	53,325,552	21.5
United Gas Pipeline Company	504,091,000	120,831,859	24.0	389,759,000	112,189,110	29.0	893,913,000	233,020,969	26.2	672,821,000	195,173,079	27.9
TOTAL	5,680,378,035	290,869,457	5.1	4,242,810,020	484,519,467	8.2	9,922,588,055	555,388,924	5.6	8,937,945,380	565,685,898	6.3
Less Intercompany Transactions		86,617,387 2/			49,039,396 2/			135,656,983 2/			142,666,011 2/	
Net Curtailment		204,252,070			435,479,071			691,731,961			423,137,879	

1/ Firm Requirements as reported in Gas Supply-Requirements Balance. Volume Curtailed (anticipated) 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			APRIL-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	43,865,980	-0-	0.0	32,092,800	6,955,100 2/	21.7	76,958,780	6,955,100	9.3	102,977,200	10,476,600	10.2
Arkansas Louisiana Gas Company	151,223,000	43,687,965	28.9	113,015,000	33,092,000	29.3	264,138,000	76,779,965	29.1	231,610,000	43,098,000	18.6
Cities Service Gas Company 3/	162,128,000	4,836,000	3.0	117,934,000	3,000,000	2.5	280,062,000	7,836,000	2.8	291,102,000	22,080,000	7.6
Colorado Interstate Gas Company	126,165,100	-0-	0.0	87,705,000	-0-	0.0	213,870,900	-0-	0.0	230,256,500	-0-	0.0
Columbia Gas System, Inc. (Columbia Gas Trans. Corp.)	381,755,000	-0-	0.0	276,780,000	-0-	0.0	658,535,000	-0-	0.0	834,038,000	12,576,000	1.4
Consolidated Gas Supply Corporation	200,070,000	-0-	0.0	142,856,000	-0-	0.0	342,926,000	-0-	0.0	586,323,000	-0-	0.0
East Tennessee Natural Gas Company	30,700,000	-0-	0.0	22,701,000	-0-	0.0	53,401,000	-0-	0.0	46,628,000	-0-	0.0
Eastern Shore Natural Gas Company	3,744,100	-0-	0.0	2,616,600	-0-	0.0	6,360,700	-0-	0.0	5,158,200	233,000	4.5
El Paso Natural Gas Company	617,147,000	28,326,627	4.6	462,173,000	33,498,000	7.2	1,079,320,000	61,824,627	5.7	827,427,000	85,650,000	10.4
Florida Gas Transmission Company	7,801,000	-0-	0.0	5,736,000	-0-	0.0	13,537,000	-0-	0.0	19,094,000	-0-	0.0
Granite State Gas Transmission, Inc.	1,248,600	-0-	0.0	939,600	-0-	0.0	2,188,000	-0-	0.0	2,568,700	-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	64,790,000	-0-	0.0
Louisiana-Nevada Transit Company	45,148,395	56,700	0.1	32,567,283	-0-	0.0	77,715,678	56,700	0.1	69,555,456	-0-	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	448,082,000	-0-	0.0
Midwestern Gas Transmission Corporation	114,250,000	-0-	0.0	85,350,000	-0-	0.0	199,600,000	-0-	0.0	150,657,000	-0-	0.0
Mid Louisiana Gas Company	10,245,000	-0-	0.0	6,626,000	-0-	0.0	16,871,000	-0-	0.0	17,458,000	-0-	0.0
Mississippi River Transmission Corporation	48,945,000	175,118	0.4	37,530,000	-0-	0.0	86,475,000	175,118	0.2	122,821,000	7,821,000	6.4
Montana-Dakota Utilities Company	7,040,000	-0-	0.0	5,121,000	-0-	0.0	12,161,000	-0-	0.0	25,398,000	-0-	0.0
Mountain Fuel Supply Company	15,290,000	-0-	0.0	6,877,000	-0-	0.0	22,175,000	-0-	0.0	42,867,000	-0-	0.0
Natural Gas Pipeline Company of America 4/	399,227,000	117,908,178	29.6	299,703,900	110,900,000	37.0	698,930,900	228,868,178	32.7	506,208,100	-0-	0.0
Northern Natural Gas Company 4/	286,678,000	-0-	0.0	202,368,000	5,800,000	2.9	489,046,000	5,800,000	1.2	406,934,000	6,000,000	1.5
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	-0-	0.0
Panhandle Eastern Pipeline Company 4/	250,080,000	1,985,308	0.8	188,759,000	3,100,000	1.6	438,839,000	5,085,308	1.2	386,669,000	31,014,000	8.0
South Georgia Natural Gas Company	8,539,998	-0-	0.0	6,440,000	-0-	0.0	14,979,998	-0-	0.0	10,570,000	-0-	0.0
Southern Natural Gas Company	186,136,000	-0-	0.0	136,915,000	-0-	0.0	323,049,000	-0-	0.0	292,936,000	-0-	0.0
Tennessee Gas Pipeline Company	431,573,000	-0-	0.0	326,713,000	-0-	0.0	758,286,000	-0-	0.0	646,751,000	-0-	0.0
Texas Eastern Transmission Corporation 4/	339,724,000	48,064,788	14.1	251,473,000	49,066,000	19.5	591,197,000	97,130,788	16.4	490,617,000	67,373,000	13.7
Texas Gas Transmission Corporation	234,154,000	-0-	0.0	175,967,000	-0-	0.0	412,121,000	-0-	0.0	347,849,000	-0-	0.0
Transcontinental Gas Pipe Line Corporation 4/	368,758,000	46,118,748	12.5	276,903,000	37,219,000	13.4	645,661,000	83,337,748	12.9	451,491,000	57,681,000	12.8
Transwestern Pipeline Company 4/	137,435,100	421,657	0.4	90,781,700	919,000	1.0	208,216,800	1,340,657	0.6	152,315,200	19,419,300	12.7
Trunkline Gas Company	147,657,000	6,840,649	4.7	148,735,000	35,992,000 7/	24.2	345,792,000	84,628,649 7/	24.5	252,194,000	80,973,000 7/	32.1
United Gas Pipe Line Company 4/	512,838,000	179,125,052	34.9	387,891,000	127,367,000	32.8	900,837,000	306,502,052	34.0	702,339,000	235,435,000 8/	33.5
TOTAL	5,861,293,193	515,.12,370	8.8	-336,284,683	490,908,100	10.4	10,217,497,874	986,320,470	9.5	9,160,720,234	679,767,700	7.4
Less Intercompany Transactions		126,961,729 9/			48,590,040 9/			225,313,729			170,990,000 9/	
Net Curtailment		388,.48,641			127,318,100			260,806,741			508,757,300	

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 Gas 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. [illegible].

8/ United had revised its original estimate to reflect a reduction of 12,255,000 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 12,255,000 Mcf.

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Summary and Overview of Foster Associates Study on the "Impact of Deregulation on Natural Gas Prices"

This report presents information on several subjects bearing on the pending proposals for deregulation of interstate natural gas prices. The principal focus is on the impact of alternative deregulation proposals on field prices for natural gas and on future costs to the residential consumer. Related information is presented on the role of natural gas in consumer budgets and cost of residential gas consumption; the relationship between natural gas field prices and the amount of new natural gas supply; and the cost of finding and developing gas supplies.

A major issue with respect to possible deregulation of interstate natural gas prices is: what impact would deregulation have on natural gas prices, both at the field level and at the burner tip? At the field level, this impact depends on the provisions of gas sales contracts now in existence, on the market prices which develop absent regulation, and on the proportions of "old" and "new" gas deliveries, that is, the volumes to be delivered under existing long-term contracts and under contracts which will be negotiated in the future. The estimates presented here are based on a detailed, comprehensive study made by Foster Associates of the price and price-related provisions of all significant gas sales contracts in effect as of January 1, 1973.

The contracts included in the study account for 70 percent of all interstate natural gas deliveries. Inasmuch as the prices which would be negotiated in an unregulated market cannot be known, the estimates have been prepared using four alternative assumptions of market price levels ranging from 45 to 75 cents per Mcf. The prospective increases in costs to residential consumers were estimated by a flow-through of the increases in field prices under each assumption.

Deregulation of natural gas prices has been urged on the grounds that the "costs" to the Nation would be lower than under the alternative of continued FPC regulation, "costs" in this context referring not only to natural gas field prices but to prices of alternatives to domestic natural gas which will be needed in increased quantities as the natural gas shortage becomes more severe; the costs of unused pipeline capacity; and the costs of possible inability to meet all requirements from any sources.[1] This report estimates future increases in field price levels and the accompanying changes in costs at the burner tip under alternative assumptions concerning deregulation, but it does not attempt to measure the "costs" of a continuation of existing FPC price ceilings for natural gas sales.

In 1972, the average annual gas bill of the residential consumer amounted to $155.73. The study concludes that, with deregulation of gas prices, the cost would increase in the short term by $8.30 using the 55-cent field market-price assumption and by $10.03 at the 65-cent estimate, these increases reflecting both the higher prices for new supplies under future contracts and the projected increases in producer revenues per Mcf for deliveries under existing contracts. Over the period to 1980, the increase in residential consumer costs owing to rising field prices would be 2.8 or 3.4 percent per year at the 55- and 65-cent market-price assumptions.

The report shows the estimated impact of deregulation on field prices separately for natural gas committed under contract prior to 1/1/73 [Appendix A, Tables 1–4] and for all prospective supplies, both "old" and "new" [Tables 6–7]. The estimated increases in consumer costs corresponding to the field price projections are also presented separately for existing sales [Table 8] and for all supplies [Tables 9–10]. Each series of estimates is shown year by year to 1980, using four different assumptions of market price levels—45, 55, 65, and 75 cents per Mcf—and several alternative approaches to deregulation. The principal findings are summarized below.

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[1] See, for example, the address of FPC Commissioner Rush Moody, Jr., to the Executive Conference of the American Gas Association on June 16, 1973.

PROJECTED PRICES AND DELIVERIES UNDER EXISTING CONTRACTS (APPENDIX A, TABLES 1–4, 8)

As of 1/1/73, the average field price for interstate natural gas supplies was 20.5 cents per Mcf. The table which follows shows the estimated future prices, assuming partial or complete deregulation, for natural gas supplies committed under contract prior to 1/1/73 ("existing sales" or "old" gas), based on the contract-by-contract analysis:

ESTIMATED AVERAGE FIELD PRICE, "OLD" SUPPLIES

[In cents per million cubic feet]

	Complete deregulation	Deregulation of terminating contracts only
Assuming $0.55 market price:		
Jan. 1, 1974	26.26	22.35
Jan. 1, 1977	29.87	25.21
Jan. 1, 1980	34.21	30.32
Assuming $0.65 market price:		
Jan. 1, 1974	27.42	22.64
Jan. 1, 1977	31.70	26.03
Jan. 1, 1980	36.87	32.31

It is apparent that the price for all old sales would be substantially lower than the unregulated market level for new supplies. Natural gas is sold under long-term contracts which generally specify the prices to be paid over a period of 20 years. Thus, assuming deregulation, more than 60 percent of sales (in terms of volume) under contracts in force as of 1/1/73 would continue to be made at present prices inasmuch as the sellers are already receiving the contract prices under FPC regulation or are receiving the FPC area rate because the contracts include a so-called "area rate" clause. For about one-fourth of the volume, there would be limited price increases, generally averaging 4–5 cents per Mcf, to the levels specified in the contracts. Only a small proportion of all sales (11.5 percent of volume) would be free to increase by 1/1/74 to whatever might develop in an unregulated market. These would include sales under contracts reaching their expiration dates and contracts with favored-nation clauses or applicable redetermination clauses. Over time, as indicated above, field prices for "old" gas sales would continue to increase gradually as additional contracts reached their expiration dates and were renegotiated at higher prices, as additional scheduled contractual price increases occurred, and as redetermination provisions became effective under additional contracts. However, even as of 1/1/80, nearly half of the volume of "old" gas would flow under sales contracts which would not permit a price higher than the projected FPC ceilings.

The impact on residential consumer costs of the rise in prices for supplies now under contract would be small. At the 55-cent market-price assumption, the rise in residential costs is projected at 1.2 percent per year to 1980, or a total increase of 9.0 percent by 1980. However, deliveries under old contracts are projected to decline sharply by 1980 and presumably will be inadequate to meet all residential requirements in future years. Consequently, the projected increases in consumer costs reflecting field prices for all supplies (rather than for "old" gas alone) provide more comprehensive estimates. These latter projections are discussed below.

PROJECTED PRICES, DELIVERIES UNDER ALL CONTRACTS (APPENDIX A, TABLES 7, 9, 10)

Field prices for all future deliveries to interstate pipeline companies have been projected by combining price estimates for "new" supplies (which assume that

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all such supplies would be committed at each market price estimate) and price estimates for supplies delivered under existing contracts (based on the contract-by-contract analysis) using estimated volumes for each type of delivery.

As of 1/1/73, the average field price for interstate natural gas deliveries was 20.5 cents per Mcf. The estimated future prices in the field for all sales, using the 55- and 65-cent market-level assumptions, are as follows for alternative plans of deregulation:

ESTIMATED AVERAGE FIELD PRICES, ALL SALES

[In cents per million cubic feet]

	Deregulation of all sales	Deregulation of new sales and expiring contracts	Deregulation of new sales only
Assuming 55-cent market price:			
Jan. 1, 1974	26.80	22.96	22.08
Jan. 1, 1977	35.84	32.17	30.11
Jan. 1, 1980	45.66	43.43	39.52
Assuming 65-cent market price:			
Jan. 1, 1974	28.12	23.44	22.27
Jan. 1, 1977	39.41	34.94	32.23
Jan. 1, 1980	51.45	48.84	43.80

The amount of new supply which will be found and developed and which will provide the reserve inventory out of which "new" gas deliveries will be made cannot be predicted. The delivery volumes for new gas used in the estimates, together with the projected old-gas volumes, imply that total production would be fairly stable through 1976, increasing thereafter by approximately two percent annually. Should the new gas volumes be smaller than projected in this report, the increase in field prices for all supplies would be smaller than projected. A larger volume of "new" gas, providing more total supplies to consumers, would result in higher field prices for all supplies.

Assuming that the projected volumes of new gas materialize with deregulation, the major portion of the estimated future increase in field prices for all sales would result, except in the short term, from the higher market prices for deliveries under new contracts. For example, using the 55-cent market price, the projected increase in field prices between January 1, 1973 and January 1, 1980 is 19.04 cents per Mcf if prices for new sales only were deregulated (with sales under existing contracts maintained under present FPC ceilings) and 25.18 cents per Mcf if all natural gas prices were freed from regulatory controls.

In 1972, the average annual gas bill per residential customer amounted to $155.73. Translating the projected rise in field prices to increases in residential consumer costs, the estimated near-term impact of complete deregulation is an increase amounting to 3 to 6 percent of 1972 expenditures, depending on market price levels in the field. At the 55-cent market price, the initial effect would be an increase in the yearly gas bill of $8.30; the total projected increase by 1980 is $33.06. The following table shows projected year-by-year percentage increases in consumer costs at the 55- and 65-cent field market price assumptions for the first five years:

[In percent]

	55-cent market price	65-cent market price
To Jan. 1, 1974	5.3	6.4
Jan. 1, 1974 to Jan. 1, 1975	3.0	3.8
Jan. 1, 1975 to Jan. 1, 1976	2.4	3.0
Jan. 1, 1976 to Jan. 1, 1977	2.2	2.8
Jan. 1, 1977 to Jan. 1, 1978	3.0	3.7

The increases in residential consumer costs would be gradual, averaging 2.8 percent per year to 1980 at the 55-cent price assumption and 3.4 percent at the 65-cent market level. The initial impact, which is the largest of any single year, is 5.3 percent using the 55-cent market price and 6.4 percent using the 65-cent price assumption.

The increase in burner tip prices corresponding to any given increase in field price is relatively small because the prices received by producers represent only a small part of the price paid by the residential consumer, transportation and distribution costs accounting for five-sixths of the consumer expenditures. Thus, currently, the producer receives 20.5 cents per Mcf in the field; the gas pipelines, after incurring transportation costs, receive an average of 48 cents per Mcf; and the gas distributors, after incurring distribution costs, receive an average of $1.19 per Mcf of residential consumption. Moreover, as indicated, field prices for "old" sales are estimated to increase gradually rather than abruptly; the higher prices for new sales which may be expected absent regulation would impact on the total only over a period of years as the volume of deliveries under the new contracts increased.

No estimates have been prepared of future increases in gas costs to residential consumers on the assumption of continued regulation, but a continuation of existing FPC ceiling prices would have its own "costs." In this event, we may anticipate a continued decline in exploration and drilling for new gas supplies and a further dwindling of new supply additions to replace existing depleting reservoirs. Higher consumer costs will be experienced in any case because the "rolled-in" price of all gas supplies purchased by distribution companies will rise with higher field prices for the limited volume of new domestic supplies committed to the interstate market and greater dependence on high-priced alternatives to domestic gas such as liquefied natural gas from overseas, synthetic gas from coal, and other alternative sources. Increases in pipeline transportation costs as smaller volumes were carried would also be borne by the ultimate consumers. To the extent that the alternative supplies could not be developed at a sufficiently rapid rate, the "cost" would also include the effects of a steady deterioration of supply availability and growing physical shortages of gas desired by consumers.

PROCEDURES USED IN THE ESTIMATES

The estimates of impact of deregulation of existing sales (gas under contract as of 1/1/73) are based on a detailed study of 1,461 contracts representing all sales with a 1971 delivery volume of at least two billion cubic feet or, for sales under which deliveries commenced after 12/31/71, with estimated annual volumes of at least two billion cubic feet. The 1971 volume for the contracts included in the study accounts for 70 percent of the total volume sold by producers to interstate pipeline companies in 1971. The study projected for each sale the prices payable in accordance with the contract from 1974 to 1980; the prices payable under existing FPC area rate ceilings; and the delivery volumes. Contract expiration dates were identified as were contractual pricing provisions (favored-nation and redetermination clauses) which might permit the seller to receive the market price. In estimating the unregulated prices, it was assumed that the price would increase to the "market price" wherever the contract provisions would permit, that is, after the contract expiration dates, for sales with favored-nation provisions at all dates, and for sales with redetermination provisions on and after the next scheduled redetermination date. For other sales, it was assumed that prices would increase to the contractual levels at each future date. Volumes were projected for each contract using the "vintage" of the contract as a basis for projection. The estimates derived for the sample contracts were expanded to totals, area by area based on the 1971 relationships.

NATURAL GAS COSTS IN CONSUMER BUDGETS (APPENDIX B)

Information on the role of gas costs in consumer budgets, and in the economy generally, helps to place in context the question of impact on ultimate consumers of any proposed plan of deregulation of prices for interstate gas sales. Natural gas, valued at the wellhead, accounts for only 0.30 percent of the gross national product, approximately the same proportion as in 1961 even though the increase in gas consumption has far outstripped the rise in "real" gross national product. Valued at points of consumption, natural gas accounts for 1.20 percent of the gross national product. Over the last decade, average prices paid per Mcf of gas deliveries, both in the field and at the burner tip, have increased much less rapidly than prices in the economy generally.

The cost of gas for residential use, valued at points of production, represents 15/100ths of one percent of all consumption expenditures. Valued at points of consumption—that is, in terms of dollars paid by residential consumers to gas distribution companies—gas accounted for 0.85 percent of total personal consumption expenditures.

The average annual gas bill for all residential customers amounted in 1972 to $155.73. The cost per million Btu (approximately one Mcf) was 1.19. Average expenditures per residential customer varied in 1972 from $90.57 in the West South Central Area to $205.83 for New England.

Data compiled by the Department of Commerce for total personal consumption expenditures show that expenditures for gas service were about 30 percent as large as for alcoholic beverages and were lower than expenditures for such items as toilet articles, miscellaneous household supplies, or nondurable toys and sport supplies. For the "average" moderate-income family with a total budget of $9,000 annually (including families with and without gas service), expenditures for gas amount to $108 per year, compared with $221 for alcoholic beverages, $189 for tobacco products, and $117 for toilet goods. The "average" moderate-income family using gas spent about 1.7 percent of the family budget on gas service.

THE SUPPLY-PRICE RELATIONSHIP (APPENDIX C)

The shortage of natural gas which has developed under regulatory controls raises several significant issues: (1) whether larger new supplies will be found and developed absent regulation; (2) whether it is possible for the regulatory body to make reliable estimates of the supply of natural gas which will be forthcoming at particular price ceilings; and (3) why FPC prices based on so-called "cost" (including return) have failed to elicit an adequate quantity of new supplies.

The FPC, in fixing price ceilings for natural gas, ideally should be able to estimate both the supply of natural gas at alternative regulated prices and the demand for gas at alternative end-market prices. Although it is widely recognized that gas producers have substantial capability to direct their exploration efforts to the separate search for either gas or oil (that exploration is "directional") and that more new supplies would be found and developed at a higher prospective price than at a lower price, no technique has been developed for making reliable estimates of the amount of new natural gas supplies which would be elicited under alternative pricing policies. The relationship between natural gas prices and supply has been a subject of continuing concern in the proceedings before the FPC, with several major Staff presentations on the issue. The Commission has, however, been forced to conclude that it could not make reliable quantitative estimates of the supply-price relationship.

Reduced to essentials, the determinant of the extent of investment in gas exploration is the prospective profitability of such investment in relation to the anticipated profitability of alternative investment opportunities, giving consideration to differences in risk and to the availability of capital. The prospective profitability of gas exploration investments is a function of the anticipated costs, the anticipated revenues, and of the time-distribution of the expenditure and revenue streams. Although a large number of factors influence the estimates of costs and revenues at any time, other factors being unchanged, a higher price increases the prospective profitability of the exploration prospects under consideration and would be expected to elicit a more extensive exploration effort. Projects which may be rejected at one given price would be undertaken at a higher price because the prospective profitability has been increased. Thus, higher gas prices, other factors unchanged, would induce producers to commit more funds to gas exploration and to undertake a wider range of exploration prospects.

The sharp increase in new gas supplies during the 1950's, as gas prices increased with the development of markets, and the decline in supply additions during the 1960's, when gas prices were severely restrained through regulatory action, confirm the conclusion that the new supply of natural gas is responsive to price. Over the period 1950–1970, on the average, an increase in gas prices of 10 percent was accompanied by an increase in exploratory gas drilling (footage) of 14 percent.

There have been a number of econometric studies of the supply-price relationship (Appendix C). These statistical studies generally attempt to estimate the

elasticity of supply with respect to price or, in other words, to separate the price effect from the influence of other supply-determining variables. A partial list of these "other" variables would include prospective costs of the input factors used in finding and developing gas supplies, the prospective productivity of the exploration effort, the risk in such exploration, the inventory of exploration prospects, the availability of capital, the cost of capital, the availability of resources for exploration activity (e.g., trained geologists, drilling rigs), the level of technology, Governmental policies with respect to regulation, taxation, and ecology, the general economic climate, and alternative investment opportunities. Given the large number of variables which influence investment decision-making, it is not surprising that the research to this date has not yielded reliable measures of the price-elasticity of natural gas supply.

COST OF FINDING AND DEVELOPING GAS SUPPLIES (APPENDIX D)

For over a decade, the Federal Power Commission has relied on estimates of the so-called "current" cost of new non-associated gas as the anchor of its pricing system for "new" (recent-vintage) gas. An elaborate ritual developed for these costing computations with protracted controversy arising with respect to each of the cost components entering into the final estimates. Regulated prices based on the computed costs, including return, have however failed to elicit an adequate exploration effort.

The estimates of "current cost" presented by the various parties in the FPC area rate proceedings varied over a wide range, reflecting in part the uncertainties and limitations of the costing process. Less than 60 percent of the total costs are directly identifiable with gas reservoirs and even these costs must be further allocated between gas and the gas liquids extracted from the gas stream. At least 40 percent of expenditures are joint costs of oil and gas, including the costs of unsuccessful exploration. The cost estimates obtained are thus dependent in considerable degree on wholly discretionary techniques for allocating joint costs.

A second limitation of the cost estimates, and another source of controversy concerning the appropriate cost levels, arises from the time lags involved in the various phases of exploration and development of gas reserves. In computing the cost estimates, the expenditures in a particular recent period are related to the reserves additions reported in a recent period. The unit cost estimates thus reflect the erroneous assumption that the reported reserves additions are in fact properly attributed to the dollar expenditures to which they are related in the computations. Moreover, inasmuch as the results of exploration are not predictable, there is considerable uncertainty regarding the appropriate level of productivity (additions to reserves of nonassociated gas per foot of gas well drilling), a key element in the cost computations.

The most serious limitation of the costing process, where the computed costs are used as a basis for regulating prices, is that the results do not provide a measure of the economic cost, that is, the costs which prospectively will be incurred to elicit an adequate level of new supplies. The prevailing FPC prices have limited the scope of the exploration effort to those prospects which producers believed would be profitable at the FPC price levels. Given the restraints on prices, producers became more selective concerning their exploration ventures. An expansion of the exploratory effort would have the effect that producers would explore and drill a wider range of prospects, including some with a lesser chance of success, some with smaller volumes of anticipated reserves, and some with higher costs. Under these circumstances, it may be anticipated that there would be an increase in unit cost, reflecting higher drilling costs per foot, lower productivity of drilling, or a decline in the success ratio.

The per-foot costs of drilling have increased virtually without interruption. Gas well drilling costs increased from $17.60 in 1961 to $27.03 in 1971, the latest year for which data are reported, or by an average of nearly five percent annually. The continuing rise in drilling costs is the result both of the rise in cost of input factors, reflecting price inflation in the economy generally, and of the change in the drilling "mix" over time—the distribution of drilling between exploratory and development wells, among areas, and among depth classes. Gas-well drilling cost averages about $20.00 per foot for wells drilled at 7,500 to 10,000 feet, but increases sharply for deeper drilling, reaching $75.00 or more

at depths of 17,500 feet or greater. The sharp rise in the relative amount of drilling in the deepest depth classes is a principal explanation of why drilling costs have outpaced the rate of general price inflation in the economy.

For every exploratory well that proves to be productive, more than five dry holes are drilled; in rank wildcatting, over nine dry holes are sunk for every producer brought in. The ratio of dry holes to successful drilling has increased steadily both for wildcat drilling and for total exploratory drilling. As of 1953–1957, 4.0 dry holes were drilled for each exploratory producer; by 1968–1972, 5.1 dry holes were drilled for each success.

Future cost trends of finding and developing gas supplies will of course be dependent in part on changes in price levels in the economy generally. Changes in general price levels aside, however, the trend in the cost of gas in the future is upward because natural gas is a limited resource, and natural gas production is inherently an increasing cost industry.

RESERVES OF CRUDE OIL, NATURAL GAS LIQUIDS, and NATURAL GAS in the UNITED STATES and CANADA and UNITED STATES PRODUCTIVE CAPACITY as of DECEMBER 31, 1972







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TABLE VII

ANNUAL ESTIMATES OF PROVED NATURAL GAS RESERVES IN THE UNITED STATES, 1945 THROUGH 1972
TOTAL ALL TYPES

(Millions of Cubic Feet - 14.73 psia, at 60° F.)

	Changes in Reserves During Year								
Year	Revisions	Extensions	New Field Discoveries	New Reservoir Discoveries in Old Fields	Total of Discoveries, Revisions and Extensions	Net Change in Underground Storage	Production [d]	Proved Reserves at End of Year	Net Change From Previous Year
1945									
1946		[a]		[a]	17,632,864	[a]	4,915,774	146,986,723	
1947	7,529,538		3,391,649		10,921,187	[a]	5,599,235	159,703,813	12,717,090
1948	9,716,426		4,106,664		13,823,090	51,202	5,975,001	165,025,765	5,321,952
1949	8,017,797		4,587,818		12,605,615	82,146	6,211,124	172,925,056	7,899,291
1950	9,123,637		2,861,724		11,985,361	52,935	6,855,244	179,401,693	6,476,637
1951	12,942,930		3,022,878		15,965,808	132,030	7,923,673	184,584,745	5,183,052
1952	8,885,950		5,381,656		14,267,606	197,766	8,592,710	192,758,910	8,174,165
1953	13,298,733		7,043,200		20,341,933	513,629 [b]	9,188,365	198,631,566	5,872,656
1954	4,607,155		4,939,919		9,547,074	90,408	9,375,314	210,298,763	11,667,197
1955	16,209,607		5,688,009		21,897,616	87,164	10,063,167	210,560,931	262,168
1956	19,110,251		5,605,864		24,716,115	133,241	10,848,685	222,482,544	11,921,613
1957	11,057,932		8,950,119		20,008,051	178,761	11,439,890	236,483,215	14,000,671
1958	13,316,100		5,580,624		18,896,724	57,582	11,422,651	245,230,137	8,746,922
1959	14,852,004		5,769,245		20,621,249	160,453	12,373,063	252,761,792	7,531,655
1960	7,293,015		6,600,963		13,893,978	281,273	13,019,356	261,170,431	8,408,639
1961	10,258,692		6,907,729		17,166,421	159,544	13,378,649	262,326,326	1,155,895
1962	13,184,794		6,299,164		19,483,958	159,231	13,637,973	266,273,642	3,947,316
1963	12,586,733		5,577,934		18,164,667	253,733	14,546,025	272,278,858	6,005,216
1964	13,342,838		6,909,301		20,252,139	195,110	15,347,028	276,151,233	3,872,375
1965	14,775,570 [c]		6,543,709 [c]		21,319,279	150,483	16,252,293	281,251,454	5,100,221
1966	4,937,962	9,224,745	2,947,329	3,110,396	20,220,432	134,523	17,491,073	286,468,923	5,217,469
1967	6,570,578	9,538,584	3,170,520	2,524,651	21,804,333	151,403	18,380,838	289,332,805	2,863,882
1968	3,016,146	7,758,821	1,376,429	1,545,612	13,697,008	118,569	19,373,428	292,907,703	3,574,898
1969	(1,238,261)	5,800,489	1,769,557	2,043,219	8,375,004	107,169	20,723,190	287,349,852	(5,557,851)
1970	(99,721)	6,158,168	27,770,223	3,367,689	37,196,359	402,018	21,960,804	275,108,835	(12,241,017)
1971	(1,227,400)	6,374,706	1,317,574	3,360,541	9,825,421	310,301	22,076,512	290,746,408	15,637,573
1972	(1,077,791)	6,153,683	1,462,539	3,096,132	9,634,563	156,563	22,511,898	278,805,618	(11,940,790)
								266,084,846	(12,720,772)

a- Not estimated.

b- All native gas in storage reservoirs formerly classified as proved reserves of natural gas is included in this figure.

c- Separation of revisions from extensions and of new field discoveries from new reservoir discoveries in old fields not available prior to 1966.

d- Preliminary net production.

( ) Denotes negative volume.

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TABLE XIII - 3

ANNUAL ESTIMATES OF PROVED NATURAL GAS AND NATURAL GAS LIQUIDS RESERVES, 1959 THROUGH 1972

Alaska

(Millions of Cubic Feet - 14.73 psia, at 60° F. and Thousands of Barrels of 42 U. S. Gallons)

Year	NATURAL GAS Year-End Reserves				NATURAL GAS LIQUIDS Year-End Reserves		
	Non-Associated	Associated-Dissolved	Underground Storage	Total Gas	Non-Associated	Associated-Dissolved	Total NGL
1959	57,660	0	0	57,660	0	0	0
1960	95,291	11,788	0	107,079	0	0	0
1961	853,576	68,219	0	921,795	0	0	0
1962	1,567,989	66,332	0	1,634,321	0	0	0
1963	1,626,290	64,434	0	1,690,724	0	0	0
1964	1,748,527	82,838	0	1,831,365	0	0	0
1965	1,878,447	106,878	0	1,985,325	0	0	0
1966	2,744,218	202,644	0	2,946,862	0	0	0
1967	3,383,695	251,559	0	3,635,254	0	0	0
1968	4,979,055	273,269	0	5,252,324	0	0	0
1969	4,882,363	319,780	0	5,202,143	0	398	398
1970	4,740,760	26,389,991	0	31,130,751	0	335	335
1971	4,967,920	26,397,920	0	31,365,341	0	454	454
1972	5,056,777	26,398,665	0	31,455,443	0	442	442

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TABLE XVII-1

ULTIMATE RECOVERY OF NATURAL GAS BY YEAR OF DISCOVERY AS ESTIMATED DECEMBER 31, 1972

(Millions of Cubic Feet - 14.73 psia at 60°F.)

	Total United States			Alabama			
Year	Non-Associated	Associated-Dissolved	Total	Year	Non-Associated	Associated-Dissolved	Total
Pre- 1920	68,281,796	19,646,137	87,927,933	Pre- 1920	0	0	0
1920	577,363	1,552,862	2,130,225	1920	0	0	0
1921	809,526	3,676,234	4,485,760	1921	0	0	0
1922	33,692,862	481,290	34,174,152	1922	0	0	0
1923	437,157	1,274,987	1,712,144	1923	0	0	0
1924	1,314,916	1,162,382	2,477,298	1924	0	0	0
1925	387,276	537,366	924,642	1925	0	0	0
1926	2,123,280	2,747,477	4,870,757	1926	0	0	0
1927	9,221,760	1,501,031	10,722,791	1927	0	0	0
1928	2,696,067	6,742,890	9,438,957	1928	0	0	0
1929	2,499,560	12,031,562	14,531,122	1929	0	0	0
1930	2,854,427	7,101,255	9,955,682	1930	0	0	0
1931	2,005,592	3,945,992	5,951,584	1931	0	0	0
1932	2,881,465	977,501	3,858,966	1932	0	0	0
1933	2,049,969	1,923,364	3,973,333	1933	0	0	0
1934	4,973,657	7,638,552	12,612,209	1934	0	0	0
1935	10,576,257	5,772,900	16,349,157	1935	0	0	0
1936	19,015,241	6,737,153	25,752,394	1936	0	0	0
1937	12,278,526	8,428,248	20,706,774	1937	0	0	0
1938	9,136,125	6,287,177	15,423,302	1938	0	0	0
1939	7,451,163	5,289,097	12,740,260	1939	0	0	0
1940	9,057,000	4,462,455	13,519,455	1940	0	0	0
1941	9,390,043	4,082,851	13,472,894	1941	0	0	0
1942	5,250,489	3,888,772	9,139,261	1942	0	0	0
1943	5,658,835	2,596,912	8,255,747	1943	0	0	0
1944	6,742,510	3,559,408	10,301,918	1944	0	1,951	1,951

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1945	8,323,353	6,165,280	14,488,633	1945	0	0	0
1946	4,544,834	3,765,694	8,310,528	1946	0	0	0
1947	9,180,821	3,033,230	12,214,051	1947	0	0	0
1948	6,017,505	2,721,620	8,739,125	1948	0	0	0
1949	17,836,559	5,279,590	23,116,149	1949	0	0	0
1950	8,150,741	5,123,806	13,274,547	1950	0	1,250	1,250
1951	7,694,484	2,393,925	10,088,409	1951	0	0	0
1952	13,680,746	2,449,142	16,129,888	1952	167	6,054	6,221
1953	9,786,085	3,119,739	12,905,824	1953	0	0	0
1954	11,887,973	3,228,488	15,116,461	1954	0	0	0
1955	7,723,612	2,351,514	10,075,126	1955	0	22,691	22,691
1956	14,676,660	3,333,935	18,010,595	1956	0	0	0
1957	17,402,901	4,400,393	21,803,294	1957	277	0	277
1958	15,605,049	2,691,541	18,296,590	1958	0	0	0
1959	10,198,744	1,512,110	11,710,854	1959	0	0	0
1960	10,135,995	2,219,298	12,355,293	1960	0	0	0
1961	10,820,048	990,923	11,810,971	1961	0	0	0
1962	9,629,787	2,315,689	11,945,476	1962	0	0	0
1963	10,938,904	1,419,010	12,357,914	1963	0	0	0
1964	8,057,757	1,937,086	9,994,843	1964	0	0	0
1965	7,655,052	1,377,617	9,032,669	1965	0	0	0
1966	6,833,733	1,024,416	7,858,149	1966	0	0	0
1967	5,287,480	1,284,511	6,571,991	1967	0	0	0
1968	4,428,706	27,219,969	31,648,675	1968	132,300	0	132,300
1969	4,934,291	806,115	5,740,406	1969	0	0	0
1970	2,906,337	699,068	3,605,405	1970	20,400	13,603	34,003
1971	3,810,785	464,112	4,274,897	1971	2,668	2,780	5,448
1972	1,605,791	296,745	1,902,536	1972	75,406	0	75,406
Total	481,117,595	217,670,421	698,788,016	Total	231,218	48,329	279,547

Current year discoveries include all new fields and those new reservoirs which warrant classification as a significant discovery.

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TABLE XVII-2

ULTIMATE RECOVERY OF NATURAL GAS BY YEAR OF DISCOVERY AS ESTIMATED DECEMBER 31, 1972

(Millions of Cubic Feet - 14.73 psia at 60°F.)

	Alaska			Arkansas			
Year	Non-Associated	Associated-Dissolved	Total	Year	Non-Associated	Associated-Dissolved	Total
Pre- 1920	0	0	0	Pre- 1920	109,237	0	109,237
1920	0	0	0	1920	2,660	1,007	3,667
1921	0	0	0	1921	109,363	7,036	116,399
1922	0	0	0	1922	0	1,899	1,899
1923	0	0	0	1923	0	0	0
1924	0	0	0	1924	0	0	0
1925	0	0	0	1925	0	0	0
1926	0	0	0	1926	0	0	0
1927	0	0	0	1927	8,736	18,084	26,820
1928	0	0	0	1928	0	0	0
1929	0	0	0	1929	8,363	318	8,681
1930	0	0	0	1930	16,200	17	16,217
1931	0	0	0	1931	0	0	0
1932	0	0	0	1932	11,456	0	11,456
1933	0	0	0	1933	0	0	0
1934	0	0	0	1934	0	0	0
1935	0	0	0	1935	0	0	0
1936	0	0	0	1936	1,998	0	1,998
1937	0	0	0	1937	6,182	217,972	224,154
1938	0	0	0	1938	0	387,399	387,399
1939	0	0	0	1939	0	119,647	119,647
1940	0	0	0	1940	280,893	126,872	407,765
1941	0	0	0	1941	0	5,728	5,728
1942	0	0	0	1942	19,992	27,008	47,000
1943	0	0	0	1943	222,259	93,464	315,723
1944	0	0	0	1944	0	3,213	3,213
1945	10,000	0	10,000	1945	157	5,489	5,646

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1946	0	0	0	1946	0	143	143
1947	0	0	0	1947	0	0	0
1948	0	0	0	1948	0	5,169	5,169
1949	0	0	0	1949	2,585	1,202	3,787
1950	0	0	0	1950	713,661	3,191	716,852
1951	0	0	0	1951	161,982	3,147	165,129
1952	4,000	0	4,000	1952	0	33	33
1953	0	0	0	1953	15,489	3,978	19,467
1954	0	0	0	1954	147,981	11,827	159,808
1955	0	0	0	1955	43,410	30	43,440
1956	0	0	0	1956	481,414	3,369	484,783
1957	0	73,000	73,000	1957	0	2,087	2,087
1958	0	0	0	1958	568,646	2	568,648
1959	3,000,000	0	3,000,000	1959	218,158	13	218,171
1960	3,000	0	3,000	1960	141,176	85	141,261
1961	41,775	0	41,775	1961	6,445	0	6,445
1962	605,000	0	605,000	1962	279,438	6,692	286,130
1963	0	74,200	74,200	1963	13,033	0	13,033
1964	1,200,000	0	1,200,000	1964	91,378	210	91,588
1965	27,030	263,500	290,530	1965	59,334	14	59,348
1966	30,000	1,325	31,325	1966	13,282	338	13,620
1967	225,000	4,875	229,875	1967	2,079	0	2,079
1968	522,000	26,000,000	26,522,000	1968	2,133	102,100	104,233
1969	0	0	0	1969	52,352	0	52,352
1970	0	0	0	1970	72,743	0	72,743
1971	0	0	0	1971	25,152	15,290	40,442
1972	0	0	0	1972	0	0	0
Total	5,667,805	26,416,900	32,084,705	Total	3,909,367	1,174,073	5,083,440

Current year discoveries include all new fields and those new reservoirs which warrant classification as a significant discovery.

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U.S. Petrochemical Industry Impact Analysis

A REPORT TO THE PETROCHEMICAL ENERGY GROUP

(By Arthur D. Little, Inc.)

I. SUMMARY

The current shortages of oil and gas in the United States have forced the Federal Government to implement a Mandatory Fuel Allocation Program, a Mandatory Allocation Program for Propane, and to supervise an expanding level of curtailments in natural gas supplies to interstate pipelines. These shortages will have a significant impact on the whole economy and the petrochemical industry as a major consumer of oil and gas hydrocarbons will be directly affected. However, the impact on this industry and its customers will be significantly greater than on other industries because these hydrocarbons are used not only as fuel but also as the primary raw materials or feedstocks for this business.

As a result of the current shortages, it is not unrealistic to expect that petrochemical production will decline in the near future. To assess the impact of a decline in petrochemical production on the nation's economy as a whole, the Petrochemical Energy Group (PEG) asked Arthur D. Little, Inc. (ADL) to develop an estimate of the effect of a 15% decline in the organic chemicals industry on consuming industries. Through the use of input-output economic analysis, ADL estimates that a sustained 15% reduction in the output of the organic chemicals industry could result in a loss of 1.6 to 1.8 million jobs in consuming industries and a loss of domestic production value of $65–70 billion annually.

While our analysis assumes a decline in production of 15%, it is difficult at this time to anticipate just how extensive a decline will actually result from the current allocation and curtailment programs. Should these programs not provide for the feedstock and process fuel needs of the petrochemical industry, its output will be reduced with the effects cascading throughout the economy.

II. INDUSTRY IMPACT ANALYSIS

To evaluate how a sustained 15% reduction in the output of the U.S. organic chemicals industry will impact on the U.S. economy requires an analytical framework that is a balanced, internally consistent model of the U.S. economy which identifies this sector of the chemical industry and defines its relationship to primary, secondary, and final demand markets. Input/Output economic models have this capability and Arthur D. Little, Inc., uses this type of model in its economic forecasting and regional impact analysis work. The effects developed in this report reflect the current relationships that exist within the ADL Input/Output model based on the Input/Output table originally developed by the U.S. Office of Business Economics for 1963 which has been revised, expanded, and updated by ADL.

A. Background on input/output models

Input/Output analysis focuses on the interaction of all industries in producing our gross national product. Each row of an Input/Output table identifies the interindustry sales structure of the economy by depicting the sales of a particular industry to each of its industrial customers, as well as to final markets.

Although Input/Output analysis has a variety of applications, its major contribution is that it permits measurement of the industrial repercussions of changes in demand levels or production activities. For example, the Input/Output technique allows one to estimate the total impact upon various sectors of the economy of an increase in the demand for passenger cars. This increase in demand will lead to an increase in the output of the automobile industry. However, there will be further impacts. The automobile industry will demand more upholstery fabrics and the increased production of these fabrics will require more synthetic fibers and more plastics. The use of Input/Output techniques allows one to quantify the magnitudes of the increased production in all affected industries.

In like fashion, the Input/Output methodology can be used to identify the impact of a reduction in the output levels of particular raw material suppliers on the level of production in related final end-use markets. By transforming the Input/Output matrix, one can obtain production multipliers which indicate how

a change in demand in a final user market will impact upon all industries in the economy. By identifying the ultimate end-use markets for a particular raw material, one can utilize these production multipliers to estimate the resultant impact upon the economy from a cutback in the production in a given sector.

B. Impact of the petrochemical industry

The U.S. petrochemical industry takes certain petroleum fractions, natural gas, and natural gas liquids, and transforms them into a wide variety of man-made materials. The production of the basic chemicals and many intermediate products is typically classified in government statistics within the Standard Industrial Classification for Organic Chemicals (SIC 2818). These intermediates are then sold to other sectors of the Chemicals and Allied Products industry for conversion to such products as synthetic fibers, plastics, synthetic rubber, detergents, and paints. In turn, the fibers, plastics and rubbers are fabricated into end products used in thousands of consumer products.

Although other hydrocarbon source raw materials have been used by the Organic Chemicals industry, this industry today is more than 95% dependent on hydrocarbons from petroleum and natural gas. Thus, a reduction in the amount of feedstocks available to the industry will be translated directly to a loss in physical output of the industry.

For the purposes of this analysis we have assumed that a reduction in feedstocks and fuel supplies will be distributed evenly throughout the industry affecting the output of all products equally.

If petrochemical output is reduced by no more than about 5%, imports of primary and intermediate organic chemicals might mitigate the effects of a decline in the output of primary petrochemicals. However, this would reduce or eliminate the favorable $1.3 billion annual balance of trade in petrochemicals. If industry output were reduced by more than 5%, the current worldwide shortage of primary petrochemicals and intermediates would limit the ability of consuming industries to secure supplies abroad. The use of substitute materials might also mitigate the effects on lost production and employment. However, given the current tightness of supplies for most basic commodities, it is unlikely that adequate quantities of substitute materials will be available.

Every effort has been made in this analysis to eliminate double-counting which could result from two industry sectors supplying the same final market. For example, plastics, fabrics, and tires supplied to the automotive industry are all derived from petrochemicals and the full impact could be attributed to any one of these primary market sectors. In this case the impact was determined in the plastics sector and not included in the synthetic fiber and synthetic rubber calculation.

The results of our basic impact analysis are summarized in Table 1. A review of the results of our basic impact analysis (Tables 2–6) indicated that there were several special factors that must be taken into account in reaching a conclusion regarding the magnitude of the impact of a 15% decline in the production of organic chemicals. These factors include:

TABLE 1.—SUMMARY, IMPACT OF A 15-PERCENT DECLINE IN PRODUCTION OF ORGANIC CHEMICALS

Item	Loss in production value (millions)	Loss in employment (thousands)
A. Basic analysis:		
1. Organic chemicals	$1,100	15
2. Primary markets for organic chemicals	3,910	71
3. Final market for organic chemicals	67,270	1,804
B. Special factors:		
4. Inflation (1970–73)	+8,750	
5. Incomplete coverage (plastics, fibers, rubbers)	+7,030	+175
6. Nonlinearity effects	−13,200	−330
7. Net effect	+2,580	−155
Adjusted total	[1] 69,850	[2] 1,735
C. Probable range of impact	65,000–70,000	1,600–1,800

[1] Sum of 3 and 7.
[2] Sum of 1, 2, 3, and 7.

Sources: 1970 annual survey of manufactures; 1963 input-output table; ADL input-output model.

Inflation.—In our basic analysis, the data on value shipments and employment has been taken from the 1970 Annual Survey of Manufactures. Our analysis did

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not include an upward adjustment in the value of lost production to account for price movements in each of the industries included for the 1971–1973 period. Based upon an annual average rate of increase in the GNP-deflator of 4.8% during this period, the value of lost production would need to be increased more than $8.7 billion to reflect current (1973) price conditions.

Incomplete coverage.—Our basic analysis concentrated upon estimating the impact upon major end-use markets. This procedure omits, therefore, consideration of the impact on several relatively smaller markets such as the paper and non-ferrous wire coating industries for plastics, the rug industry for synthetic fibers, and non-automotive rubber products for synthetic rubber. A more detailed review of these other markets indicates the impact of lost production would increase by another $7.0 billion and an additional 175,000 jobs would be lost.

Nonlinear Effects.—The Input/Output methodology employed in our analysis implicitly assumes linear relationships between inputs of particular commodities and production in consuming industries. For most industries in the U.S. economy, such an assumption is acceptable since many production functions are approximately linear with respect to material inputs. However, in the case of crop production, this linearity assumption is not valid regarding crop yield in response to fertilizer and pesticide inputs.

At current levels of usage in the U.S., a reduction in the level of application of nitrogen fertilizers would not result in a directly proportional reduction in crop yield. A similar situation would also apply to the reduction in the use of insecticides and herbicides. We estimate that a reduction of 15% in the use of nitrogen fertilizers and pesticides would probably result in a reduction of agricultural output of approximately 5%. This relationship is generally supported by statistical data on increases in yield, and in total agricultural output of the major crops, and usage of nitrogen fertilizer.

To adjust for this non-linear relationship, we have reduced our estimate of the impact upon production in the food processing industry by two-thirds. This adjustment has the effect of reducing the lost production value in our basic analysis by more than $13.0 billion.

On balance, these special factors add $2.5 billion of additional lost production to our basic impact analysis or less than a 5% upward adjustment. As a result, we conclude the probable range of the total economic impact of a sustained 15% reduction in the production of organic chemicals will be an annual loss in production of $65–70 billion and a loss of 1.6–1.8 million jobs.

TABLE 2.—IMPACT ANALYSIS—SUMMARY, 15 PERCENT DECLINE IN PRODUCTION OF ORGANIC CHEMICALS

[Dollar amounts in millions]

Market	Annual loss in production value			Loss in employment (thousands)
	Primary market	Secondary market	Final market	
Plastics	$645			11
Fabricated plastics		$1,050		43
Final markets			$28,250	700
Synthetic fibers	425			10
Fabrics and yarns		2,675		70
Final markets			4,390	110
Synthetic rubber	150			2
Tires		660		15
Final markets			580	15
Agricultural chemicals	130			2
Final markets			19,775	495
Medicinals and pharmaceuticals	980			18
Final markets			1,130	28
Soaps and detergents	450			5
Final markets			515	13
Paint	510			11
Final markets			6,000	150
Toilet preparations	520			8
Final markets			600	15
Cellulosic fibers	100			4
Final markets			6,030	150
Subtotal	3,910		67,270	1,875
Organic chemicals	1,016			15
Total, final market impact			67,270	1,890

Note: Every effort has been made to avoid double-counting by including the impact upon a particular final market only once in our estimates, although a final market may purchase materials from more than 1 sector. For example, plastics, fibers, and rubbers all are used in automobiles, but the impact on the auto industry has been included only once under the plastics sector.

Sources: 1970 annual survey of manufactures; 1963 input-output table; and ADL input-output model.

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TABLE 3.—IMPACT ANALYSIS, 15 PERCENT DECLINE IN PRODUCTION OF ORGANIC CHEMICALS

[Dollar amounts in millions]

1. 1970 value of shipments—organic chemicals (SIC 2818)	$7,373
2. 15 percent reduction in (1)	1,106
3. Distrietjion of organic chemical sales:	

Market	Percent of organic chemical sales	Decline in consumption of organic chemicals
(a) Plastics	30	$332
(b) Organic fibers	14	155
(c) Agricultural chemicals and food processing	8	88
(d) Medicinals and pharmaceuticals	4	44
(e) Soaps and detergents	4	44
(f) Synthetic rubber and tires	6	66
(g) Paint	3	33
(h) Toilet preparations	2	22
(i) Cellulose fibers	2	22
Total	73	806

4. Impact of Above Declines in Organic Chemical Production on:

	Factor	Annual loss in production	Loss in employment (thousands)
(a) Plastic resins—final markefs (see table 4)		$28,250	700
(b) Synthetic fibers—final markets (see table 5)		4,390	110
(c) Agricultural chemicals and food processing:			
1. 1970 value of shipments—agricultural chemicals (SIC 2879)		858	
2. 15 percent reduction in (1)		128	2
3. 15 percent reduction in food processing (SIC 20)		14,647	
4. Output multiplier for food processing	1.35		
5. Decline in shipments in all other sectors		19,773	495
(d) Medicinals and pharmaceuticals:			
1. 1970 value of shipments—medicinals and pharmaceuticles (SIC 2833, 2834)		6,556	
2. 15 percent reduction in (1)		983	18
3. Output multiplier for medicinals and pharmaceuticals	1.15		
4. Decline in shipment in all other sectiors		1,130	28
(e) Soaps and detergents:			
1. 1970 value of shipments—soaps and detergents (SIC 2841)		2,989	
2. 15 percent reduction in (1)		448	5
3. Output multiplier for soaps and detergents	1.15		
4. Decline in shipments in all other sectors		515	13
(f) Synthetic rubber and tires (see table 6)		583	15
(g) Paint:			
1. 1970 value of shipments—paint (SIC 2851)		3,408	
2. 15 percent reduction in (1)		511	11
3. 15 percent reduction in maintenance		7,500	
4. Output multiplier for maintenance	.8		
5. Decline in shipments in all other sectors		6,000	150
(h) Toilet preparations:			
1. 1970 value of shipments—toilet preparations (SIC 2844)		3,461	
2. 15 percent reuction in (1)		519	8
3. Output multiplier for toilet preparations	1.15		
4. Decline in shipments in all other sectors		597	15
(i) Cellulose fibers:			
1. 1970 value of shipments—cellulose fibers (SIC 2823)		685	
2. 15 percent reduction in (1)		103	4
3. 15 percent reduction in rugs, tire cord, etc		3,350	
4. Output multiplier for rugs, tire cord, etc	1.8		
5. Decline in shipments in all other sectors		6,030	150

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Total impact	Annual loss in production value	Loss in employment (thousands)
Organic chemicals	$1,106	15
Primary markets	3,910	71
Secondary markets in fibers, rubbers, and plastics	4,415	128
Final markets for organic chemicals	67,270	1,676
Total		1,890

Note: Every effort has been made to avoid double-counting by including the impact upon a particular final market only once in our estimates.

Sources: 1970 annual survey of manufactures; 1962 input-output table; and ADL input-output model.

TABLE 4.—IMPACT ANALYSIS, 15 PERCENT DECLINE IN PRODUCTION OF PLASTIC RESINS

	Factor	Amount (millions)
1. 1970 value of shipments, plastic resins (SIC 2821)		$4,286
2. 15 percent reduction in (1)		643
3. Percent of plastic resin shipments to nonintegrated plastic fabrication (SIC-3079)	41	
4. Reduction in plastic resin sales to plastic fabrication: (2)X(3)		264
5. 1970 value of shipments, plastic fabrication		6,993
6. Value of plastic resin consumed by plastic fabrication: (3)X(1)		1,757
7. Less reduction in plastic resin availability: (4)		264
8. Net shipment of plastic resin to plastic fabrication: (6)−(7)		1,494
9. Therefore value of shipments, plastic fabrication: (5)X(8)−(6)		5,944
10. Net decline in shipments of plastic fabrication: (5)−(9)		1,049
11. Major end-use markets for plastic fabrication:		

Percent of shipments	Factor	Shipments (millions)	Annual loss in production value (millions)
2.5 percent, upholstery:			
1. 1970 value of shipments		$5,080	
2. 15 percent reduction in (12)		762	
3. Output multiplier	1.5		
4. Decline in shipments in all other sectors			$1,143
8.4 percent, furniture:			
1. 1970 value of shipments		8,967	
2. 15 percent reduction ih (14)		1,345	
3. Output multiplier	1.6		
4. Decline in shipments in all other sectors			2,152
8.4 percent, motor vehicles:			
1. 1970 value of shipmentc		45,692	
2. 15 percent reduction in (16)		6,854	
3. Output multiplier	1.4		
4. Decline in shipments in all other sectors			9,595
7.4 percent, construction:			
1. 1970 value of production		77,255	
2. 15 percent reduction in (18)		11,588	
3. Output multiplier		.8	
4 Decline in shipments in all other sectors			9,270
8.3 percent, packaging:			
1. 1970 value of shipments		41,600	
2. 15 percent reduction in (20)		6,273	
3. Output multiplier	1.0		
4. Decline in shipments in all other sectors			6,237
7.2 percent, miscellaneous manufacturing:			
1. 1970 value of shipments		9,767	
2. 15 reduction in (22)		1,465	
3. Output multiplier	.9		
4. Decline in shipments in all other sectors			1,319

Total impact	Annual loss in production (millions)	Loss in employment (thousands)
Plastic resins	$643	11
Fabricated poastics	1,049	43
All others industries	28,251	700
Total		754

Note: Every effort has been made to avoid double-counting by including the impact upon a particular final market only once in our estimates.

Sources: 1970 annual survey of manufacturers; 1963 input-output table; and ADL input-output model.

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TABLE 5.—IMPACT ANALYSIS, 15 PERCENT DECLINE IN PRODUCTION OF SYNTHETIC FIBERS

	Factor	Millions
1. 1970 value of shipments, synthetic fibers (SIC-2824)		$2,822
2. 15 percent reduction in (1)		423
3. Percent of synthetic fibers shipments made to fabrics/yarn industry (SIC 221, 222, 223, 224, 226, 228)	60	
4. Reduction in synthetic fiber sales to fabrics/yarn industry: (2)×(3)		254
5. 1970 value of shipments, fabrics/yarn		17,699
6. Value of synthetic fibers consumed by fabrics/yarn industry: (3)×(1)		1,681
7. Less reduction in synthetic fiber availability: (4)		254
8. Net shipment of synthetic fiber to fabrics/yarn: (6)−(7)		1,427
9. Therefore value of shipments, fabrics/yarn: (5)×(8)+(6)		15,025
10. Net decline in shipments, fabrics/yarn: (5)−(9)		2,674
11. Output multiplier for fabrics/yarn (net)	1.8	
12. Decline in shipments in all other sectors: (10)×(11)		4,815
13. Net decline in shipments in all other sectors: (12)−(2)		4,392

Total impact	Annual loss in production (millions)	Loss in employment (thousands)
Synthetic fibers	$423	10
Fabrics/yarn	2,674	70
All other industries	4,392	110
Total		190

Note: Every effort has been made to avoid double-counting by including the impact upon a particular final market only once in our estimates. For example, synthetic fiber sales to upholstery or tire manufacturers have been excluded because the impact for these industries has been calculated elsewhere in this analysis.

Sources: 1970 annual survey of manufactures; 1963 input-output table; and ADL input-output model.

TABLE 6.—IMPACT ANALYSIS, 15 PERCENT DECLINE IN PRODUCTION OF SYNTHETIC RUBBER

	Factor	Millions
1. 1970 value of shipments, synthetic rubber (SIC 2822)		$992
2. 15 percent decline in (1)		149
3. Percent of synthetic rubber shipments made to tire industry	45	
4. Reduction in synthetic rubber sales to tire industry: (2)×(3)		67
5. 1970 value of shipments, tires (SIC 3011)		4,587
6. Value of synthetic rubber consumed by tire industry: (3)×(1)		445
7. Less reduction in synthetic rubber availability: (4)		67
8. Net shipments of synthetic rubber to tire industry: (6)−(7)		378
9. Therefore value of shipments of tire industry: (5)×(8)+(6)		3,896
10. Net decline in shipments of tires: (5)−(9)		690
11. Output multiplier for tires (net)	1.06	
12. Decline in shipments in all other sectors: (10)×(11)		731
13. Net decline in shipments in all other sectors: (12)−(2)		583

Total impact	Annual loss in production (millions)	Loss in employment (thousands)
Synthetic rubber	$149	2
Tire shipments	690	15
All other industries	583	15
Total		32

Note: Every effort has been made to avoid double-counting by including the impact upon a particular final market only once in our estimates. For example, tire sales to the auto industry are excluded because the impact for the auto industry has been calculated elsewhere in this analysis.

Sources: 1970 annual survey of manufactures; 1963 input-output table; and ADL Input-Output Model.

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The Oil Crisis: This Time the Wolf Is Here

(By James E. Akins)

Oil experts, economists and government officials who have attempted in recent years to predict future demand and prices for oil have had only marginally better success than those who foretell the advent of earthquakes or the second coming of the Messiah. The recent records of those who have told us we were running out of petroleum and gas are an example. Oil shortages were predicted in the 1920s, again in the late thirties, and after the Second World War. None occurred, and supply forecasters went to the other extreme: past predictions of shortages had been wrong, they reasoned, therefore all such future predictions must be wrong and we could count on an ample supply of oil for as long as we would need it.

It was the popular, almost universal theory of the 1960s—still vigorously defended today by a few of its early proponents—that this abundant supply of oil, whose cost of production was very low, and which was found in all corners of the earth, would soon be sold at its "proper" economic price—apparently $1.00 per barrel or less—and for some time it was confidently predicted that this price would prevail in the Persian Gulf by 1970.

As late as February 1970, President Nixon's Task Force on Oil Imports assumed that world price rises would be modest and that the United States could remain essentially self-sufficient in oil. It projected a demand in the United States in 1980 of around 18.5 million barrels per day of oil; of this only five million barrels per day would need to be imported, and most of this could come from the Western Hemisphere. The Task Force did not favor a complete freeing of imports, but thought that the quota system for imports was inefficient and should be replaced by tariffs (a recommendation eventually rejected by the President). Most important, recognizing the danger of importing large quantities of oil from outside the Western Hemisphere, the Task Force recommended that imports from the Eastern Hemisphere should be limited to ten percent of total national oil consumption. If this level should be approached—and the Task Force thought it would not be before the mid-1980s—then barriers should be raised. In fact, as soon as the level of Eastern Hemisphere imports reached five percent of total consumption, "the volumetric limits on imports from the Western Hemisphere should be expanded proportionately to forestall such excess imports," i.e., Canadian and Venezuelan oil could largely take the place of Middle East oil above five percent of U.S. consumption.

These projections were spectacularly wrong. Total imports this very year, 1973, will be well over six million barrels per day—substantially above the level the Task Force predicted for 1980. Imports from the Eastern Hemisphere constituted 15 percent of consumption in 1972, and are expected to rise in 1973 to 20 percent of a total consumption that will already be around 17 million barrels.

The errors of the Task Force were not those of isolated academics, as its critics were (and still are) wont to charge. The staff based its projections on information provided by the major oil companies, by the National Petroleum Council and by the Department of the Interior. There were two main reasons for their errors. Perhaps both should have been avoided, but as always, hindsight is clear and uncluttered. The first error was an uncritical acceptance of oil company and well owners' estimates of the capacity of their own domestic producing wells. These were almost always exaggerated. The second was the ignoring, or at least the deemphasis, of the decline in natural gas supplies and its effect on oil demand. We were, by 1970, already consuming far more gas than we were finding, and demand for gas continued to grow unabated, while domestic gas production leveled off (1973 production will actually be below that of 1972). The unsatisfied demand for gas was, of course, a real demand for energy. It could be covered only by oil—in fact, only by imported oil.

During 1970 the effect of drawing down natural gas reserves became fully apparent, at least to the State Department, which converted the shortfall to oil equivalents and added it to projected oil demand. The resulting estimate was that by 1980 the United States would consume 24 million barrels of oil a day, that domestic production would cover only half of this, and that two-thirds or more of the imports (or about 35 percent of total consumption) would, of necessity, come from the Eastern Hemisphere.

These figures were not immediately accepted as a new insight; they were, in fact, attacked as alarmist or provocative when first made public. And the Department's sins were compounded by its making public, during 1970, an estimate that oil prices in the Persian Gulf (then somewhat less than $2.00 per barrel) would rise by 1980 to a level equal to the cost of alternate sources of energy, i.e. to $4.50 in the Persian Gulf or an even $5.00 landed in the U.S. Gulf of Mexico.[1] These figures were used in testimony in the House and Senate and in various public speeches, both because they were honestly believed to be reasonable judgments and because it seemed essential to alert the Congress and the public to the impending dimensions of the problem. They were (and still are by some) considered even more provocative than the supply-demand projections.

It is not my main purpose to defend these and other actions by the Department of State. They can be best judged in a context badly needed for its own sake, that of the best possible assessment of the basic facts of the world oil situation as it affects the United States. Have the startling changes in prediction and experience in the last three years been an aberration? Have the Department and others been crying wolf unnecessarily, or is the "oil crisis" a reality? If it is, what can the United States and other countries do to live bearably with it?

II

The place to start is with oil reserves, those that are "proven" or sure, those that appear "probable" of early discovery and development at reasonable cost, and those that might be called "secondary"—conceivable or involving special cost or technology.

Figures on proven reserves of oil would be more useful if the companies involved did not generally understate them, usually for tax purposes, and if governments did not use them for political purposes. Those governments with large reserves tend to understate them in order to reduce the envy of their neighbors; those with smaller reserves and large populations tend to greet every new discovery as the cure for all present and future economic ills. Nonetheless, there are a few figures which it is probably safe to accept.

Proven reserves in the non-Communist world today amount roughly to 500 billion barrels.[2] On present trends, world demand (exclusive of the Soviet Union and China) will rise by 1980 to 85 million barrels per day—compared to an actual 39 million barrels per days in 1970.[3] Consumption between now and 1980 would then total 200 billion barrels, and even if no more oil were found—a most unlikely eventuality—the remaining 300 billion barrels would be ten years' supply at the 1980 consumption level, about the ratio of reserves to production that has historically applied to U.S. domestic oil.

Those who feel no concern about oil availability cite this comparison. And indeed it is agreed on all sides that there is no question of a physical shortage of fuel in the world, up to 1980 or 1985, at costs of production comparable to today's. But to sustain the view that physical supply and cost are decisive, one must assume that the world's oil is distributed, if not uniformly, at least so that adequate amounts will always be available to all users, in all circumstances and at reasonable prices. This is an assumption that has never been well founded. To begin with, at least 300 billion of these proven 500 billion barrels are in the Arab countries of the Middle East and North Africa.

Far more important is that the world's probable reserves, those which must still be found to make up for the consumption of the coming decades, will also be in the Middle East on any presently realistic prediction. This is not for want of effort by the major oil companies to find new sources of supply. In fact, 95 percent of their exploration activities (as opposed to development of discoveries already proven) are now outside the Middle East. Bluntly, the companies have little in-

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[1] In terms of currency value, all price and tax figures used in this article are in "current dollars," i.e. dollars at their value in the given year. Dollar values after 1972 are projected at an assumed inflation rate of 3.5 percent per year.

[2] Calculations here and throughout this article omit the U.S.S.R. and China, which appear likely to be roughly self-sufficient at least in this time-frame. Other Communist countries will probably be importing most if not all of their oil from non-Communist sources by the end of this decade.

[3] This estimate of 1980 world demand is that of the Department of State. Its principal components are: United States, 24 million barrels per day; Western Europe, 28 million; Japan, 14 million; others, 19 million. Compare the 1971 estimates of Walter J. Levy, "Oil Power," *Foreign Affairs*, July 1971. Mr. Levy estimated world demand at 67 million barrels per day in 1980, with the United States taking 21, Western Europe 23, and Japan 10.

centive to explore in the Middle East, for they already have all the reserves they can use before the dates presently set for the expiration of their concessions. Instead they are active on a large scale in Indonesia, in Australia, in the Canadian and American Arctic, in the North Sea—wherever there are sedimentary basins. The results have not been encouraging.

In the first flush of activity in Indonesia, the State Department projected, in its internal working papers, a production of five million barrels per day in 1980 in that country. When oil was found in Prudhoe Bay, in the Arctic, one famed economist stated that the world's oil center had shifted permanently from the Persian Gulf to the north coast of the North American continent. Another economist, in a meeting of oil experts and oil company executives, said in 1970 that the North Sea discoveries would free Europe forever from dependence on the Middle East. All of this was wishful thinking. It would certainly make us more comfortable if true, but alas, all these "facts" have had to be revised. Indonesia, we now hope, will produce two or three million barrels per day by 1980; Alaska, if we are lucky (and if the courts approve the pipeline), will only enable the United States to keep national production levels at those of 1972 (12 million barrels per day). And the North Sea, important as it is, will produce no more than 15 percent of Europe's requirements in 1980; phrased differently, if North Sea production then reaches three million barrels per day this amount will cover two years of Europe's intervening growth in demand—leaving Europe still dependent on the Middle East not only for its basic demand but for future growth.

The world's oil reserve picture is even more startling when looked at in detail, for the oil is not distributed uniformly even through the Arab world. Jordan, Lebanon, Tunisia, Morocco and Yemen have virtually none; Egypt has little, Algeria and Libya somewhat more; but the giant reserves are concentrated in the countries of the Persian Gulf: the Federation of Arab Amirates, Kuwait, Iran, Iraq and, by far the most important, Saudi Arabia. The proven reserves of Saudi Arabia are frequently listed as 150 billion barrels, but this is almost certainly too low. One company with extensive experience in that country believes that the present proven reserves are over twice that figure. And the probable reserves could double the figure again.

True, the above picture takes no account of the enormous quantities of shale or coal in the United States, the tar sands of Canada or the heavy oils of Venezuela. The proven and probable reserve figures used above are only those which can be recovered easily by present technology and at costs near today's world prices. Let us come back later to what might be called the "secondary reserves" of shale and heavy oils.

III

That most of the world's proven oil reserves are in Arab hands is now known to the dullest observer. That the probable reserves are concentrated even more heavily in the Middle East must also be the judgment of anyone who is willing to look at the evidence. And that relations between the United States and the Arab countries are not generally cordial should be clear to any newspaper reader. Even King Faisal of Saudi Arabia, who has said repeatedly that he wishes to be a friend of the United States and who believes that communism is a mortal danger to the Arabs, insists to every visitor that U.S. policy in the Middle East, which he characterizes as pro-Israeli, will ultimately drive all Arabs into the Communist camp, and that this policy will bring disaster on all America's remaining Arab friends, as earlier Anglo-American policies did to Nuri Said of Iraq. Others in the Middle East frame their predictions in a different but almost equally menacing vein, in terms of a growth of radical anti-Americanism, manifesting itself in behavior that may at times be irrational.

King Faisal has also said repeatedly that the Arabs should not and that he himself would not, allow oil to be used as a political weapon. But on this issue it seems all too likely that his is an isolated voice. In 1972, other Arabs in responsible or influential positions made no less than 15 different threats to use oil as a weapon against their "enemies." Almost all of them singled out the United States as the prime enemy.

These threats have been well publicized; the common response among American has been: "They need us as much as we need them"; or "They can't drink the oil"; or "Boycotts never work." But before we accept these facile responses, let us examine the facts more carefully. First of all, let us dispose of the straw man of a total cut-off of all oil supplies, which some Arab governments, at least,

could not survive. Apart from threats made during the negotiations of December 1970, no Arab has ever taken such a position, and Arab representatives took it at that time, in concert with other governments, for economic bargaining purposes, not for political reasons.

Rather, the usual Arab political threat is to deny oil to the Arabs' enemies, while supplies would continue to their friends. In such a case, the producing countries would still have a considerable income under almost any assumption—unless we could assume complete Western and Japanese solidarity, including a complete blocking of Arab bank accounts and an effective blocking of deliveries of essential supplies to the Arabs by the Communist countries—in other words, something close to a war embargo. We must recognize that most of the threats are directed against Americans alone. Many of our allies and all others would be allowed to import Arab oil.

In the 1967 Six Day War a boycott was imposed against the United States on the basis of the false accusation that it had participated with Israeli planes in the attack on Cairo. The charge was quickly disproven, although the boycott lasted for over a month. It was then lifted through the efforts of Saudi Arabia, and its effects never became bothersome. We were then importing considerably less than a half-million barrels per day of oil from the Arab countries, and this was easily made up from other sources.

Today the situation would be wholly different, and tomorrow worse still. By 1980 the United States could be importing as much as eight million barrels of oil a day from the Middle East; some oil companies think it will be close to 11 million. Suppose that for some reason, political or economic, a boycott is then imposed—which, if the Middle East problem is not solved by that time, cannot be called a frivolous or unlikely hypothesis. The question we must face now, before we allow ourselves to get into such a position, is what would be our response? The choices would be difficult and limited: we could try to break the boycott through military means, i.e., war; we could accede to the wishes of the oil suppliers; or we could accept what would surely be severe damage to our economy, possibly amounting to collapse. Europe and Jaapn might conceivably face, or be asked by us to face, the same problems at the same time. Would their responses be in line with ours?

Moreover, a collective Arab boycott is not the only conceivable political threat.

Until now the world has enjoyed the luxury of considerable surplus production capacity, relative to total demand. Now that has changed. The United States now has no spare capacity and within the next few years, assuming other producer governments and companies do not invest in huge added capacity, the production of any one of seven countries—Saudi Arabia, Iran, Iraq, the Federation of Arab Amirates, Kuwait, Libya or Venezuela—will be larger than the combined spare capacity of the rest of the world. In other words, the loss of the production of any one of these countries could cause a temporary but significant world oil shortage; the loss of any two could cause a crisis and quite possibly a panic among the consumers.

No, the threat to use oil as a political weapon must be taken seriously. The vulnerability of the advanced countries is too great and too plainly evident—and is about to extend to the United States.

IV

So much for political nightmares. Closer to immediate reality, indeed already upon us, is the question of the economic leverage of the oil-producing countries, 90 percent of whose reserves are now represented in the 11-nation Organization of Petroleum Exporting Countries (OPEC).[4] Even if there should be no overtly political interference with the flow of oil, the OPEC group now has formidable economic power and has shown itself willing to use it to the full. Will OPEC hold together, to raise prices and conceivably to limit output? Or will it break apart, as producer cartels have historically done where the product is substantially the same from one member and place to another?

The answers require, first, a review of the history of OPEC. In 1958 and 1959, the international oil companies reduced their posted prices and tax payments

[4] OPEC currently comprises four non-Arab states—Iran, Venezuela, Indonesia and Nigeria—and seven Arab states: Kuwait, Saudi Arabia, Iraq, Abu Dhabi, Qatar, Libya, and Algeria.

because of a world surplus of oil. In reaction, Venezuela, Iran and Saudi Arabia took the lead in forming OPEC in 1960 with the avowed purpose of restoring the 1958 price level. They did not succeed, as the world surplus of oil continued and the OPEC countries were unable to agree on a formula for prorationing to limit output. Venezuela, then the largest producer, thought that historical levels of production should be used as the base, Iran favored national population and Saudi Arabia and Kuwait thought production should be on the basis of proven reserves. Disunity seemed to prevail, and the new organization was belittled by many.

OPEC was not a joke, however. Its pressures did contribute to the fact that the companies never again reduced posted prices, and it was able to achieve new methods of calculating taxes and royalties which added slightly to the revenues of producer governments. Its third and perhaps most important success is not generally known. In the early 1960s, most OPEC countries needed more income and pressed their concessionary companies to produce more oil—even at the expense of production in other OPEC countries. The companies responded in each case that they could not increase production unless the government gave tax rebates. So far as I know, the temptation to undercut its partners was not accepted by any major OPEC country—and I doubt by any minor one. In other words, the organization maintained its solidarity in a period of a buyers' market, and at a time when member-countries, save Venezuela, regarded their reserves as infinite and were generally eager for unrestricted growth in production.

Then, in mid-1967, came the closing of the Suez Canal in the Six Day War. The ensuing oil "shortage" was of course one caused by transport, but the effects were the same as an actual shortage of crude oil. Rapid steps were taken to increase tanker capacity, and the consumer noticed only slightly higher oil prices. But the increase in tanker rates put Libya in a special position by reason of its location. Production there was stepped up rapidly to meet European demand. Libya, in the short run, seemed the ideal answer to all the world's oil problems.

The "short run" was shorter than most had assumed. King Idris was overthrown in September 1969 by Colonel Qaddafi, a fanatic anti-Communist, but also a zealous pro-Arab, who considered Israel and the United States, which he characterized as the sole supporter of Israel, as even greater dangers to Arabism than was communism.

Early in 1970 Qaddafi and his colleagues moved to cut back oil production (then at almost four million barrels a day) for conservation reasons. New and extreme strains were also placed on the tanker market by the closing of the pipeline from Iraq, in a dispute over transit fees, and by the cutting of the Trans-Arabian line. Although most of the losses were made up, reserve stocks in Europe were drawn down. In this situation, the Libyan government demanded, in the spring of 1970, a large increase in tax payments on its oil. After an arduous round of discussions the international companies operating in Libya yielded one by one.

It seemed at the time, and still does, that they had little choice. Libya had $2 billion in currency reserves; its demands were not unreasonable; its officials could not be corrupted or convinced; and most important, Libyan oil could not be made up elsewhere. The Libyans, it should be noted, did not threaten to cut off oil deliveries to the consumer countries; their only threat was not to allow the companies to have the oil unless they paid the higher taxes.

Europeans, at this time, were almost unaware of what was happening and would have been totally unprepared if oil had been cut off. During the negotiations, a top official of a major oil company seriously urged the American government to dare the Libyans to nationalize; if they did, the Europeans would then be told they would have to tighten their belts, while Libya, according to this theory, would be forced to yield soon because it could not dispose of its oil. When it was noted that Libya's currency reserves could keep the government at current expenditure and import levels for four years, the company official stated his assumption that all of this would be blocked by all the European and American central banks. It was an assumption hardly likely to be realized.

But the main reason for not following this course was the fact that the loss of all of oil from Libya alone would have meant the drawing down of more than half of the European oil reserves within a year. It seemed unlikely, indeed inconceivable, that France, Germany, Spain or Italy would have allowed that to happen; especially as the goal would apparently have been only to protect the

Anglo-Saxon oil monopoly, which they had long sought to break. To have tried to explain to them that they would themselves suffer in the long run, would have been less than futile. We in the State Department had no doubt whatever at that time, and for those particular reasons, that the Europeans would have made their own deals with the Libyans; that they would have paid the higher taxes Libya demanded and that the Anglo-Saxon oil companies' sojourn in Libya would have ended. As for the possibility of using force (actually suggested since by a handful of imperialists *manqués*), suffice it that it was never for a moment considered.

I dwell on the 1970 Libyan demands and their success, primarily because they demonstrated, like a flash of lightning in a summer sky, what the new situation was; to be sure, it was Europe that was extraordinarily vulnerable and extraordinarily obvious, the United States as a consumer was not yet affected, and the fact that the companies caught in the middle were American and British made for misunderstanding and some bad feeling in the European consuming countries. But these points were incidental to the fundamental fact, which was that a threat to withhold oil could now be effectively employed to produce higher prices. Hindsight suggestions as to how that threat might have been countered, either by the companies or by the American or other governments, seem to me quite unrealistic, and the charge that the State Department by inaction was to blame for creating a new monster is, in simple terms, nonsense. The Libyans were competent men in a strong position; they played their hand straight, and found it a winning one.

So, in the course of 1970, Persian Gulf taxes were raised toward the new Libyan level, and at the end of 1970 Libya made it a complete spiral by a second wave of demands to "balance" the new Persian Gulf prices. In the course of this eventful year, the Department of State necessarily became deeply involved, consulting constantly with the companies and holding frequent meetings with the Libyans in particular, though never as participants or negotiators. Better informed itself, the Department was soon able to keep European governments abreast of OPEC actions, and in due course to help persuade the companies that they should do so directly—so that since 1971 relations between the companies and the European consuming countries have generally been smooth. We have not heard in the last two years any echo of what was said by one European minister in 1967: "American companies brutally conquered our market; if they do not keep us supplied at all times, they will be expelled."

Toward the end of 1970, the producers consolidated new tax demands through OPEC, and began to act as a single group and more stridently. Every OPEC member, with the exception of Indonesia, either made public statements or (more convincingly) told the companies privately that if their demands were not met, all oil production would be stopped and the companies would then have to face the wrath of the consuming countries. An OPEC resolution in December laid down a 15-day time limit for acceptance and called for "concerned and simultaneous action by all member countries" if the negotiations failed. Meeting with the companies on January 11, 1971, the Libyan Deputy Prime Minister left no doubt that what was meant was a cut-off of all oil production. The same message was conveyed directly and through official channels to the American and British Governments by two rulers of friendly countries.

The demand for increased revenues, while alarming, had been an economic matter which would not traditionally have engaged the American government. The threats to cut off oil, however, brought the Department of State inevitably into an active and public role. First, Justice Department action was obtained to permit the companies to form a common negotiating front—not be picked off one by one as had happened in Libya. And, in mid-January, following a meeting with the chief executives of the oil companies, Under Secretary John Irwin was dispatched to present American official concerns to the Shah of Iran, the King of Saudi Arabia, and the Ruler of Kuwait. In these talks, Secretary Irwin explained that the United States took very seriously threats to cut off oil deliveries to America or her allies, and that any country which took such action would find its relations with the United States severely and adversely affected. In reply, all three monarchs assured him that the "threats" had been misunderstood, that they were directed solely against the companies, and that the oil would be made available to consumers even if the negotiations with the companies broke down.

Later threats by producing countries were in this sense—a form of pressure on the companies, but not a threat of total nondelivery.[5]

In addition, Secretary Irwin requested an extension of the deadline for negotiations and an assurance that agreements reached with the companies would be honored for their full terms. Both requests were agreed to. The negotiations then continued, and the settlement reached at Tehran in February 1971 provided for tax increases equal to about half the initial OPEC demands: these increases meant a rise of 45 cents per barrel in the Gulf price and of 80 cents in Libya, with a schedule for further increases through 1975.

There was jubilation in OPEC. The triumph and the demonstration of power seemed complete. But there was also, in the circumstances, some satisfaction in the industrialized countries represented in the Organisation for Economic Cooperation and Development (OECD). None had been in any position to hold out against the threat of even a brief suspension, for despite discussions since the Libyan episode, the level of reserves in Europe was still low. The underlying bargaining position of the European consumers was weak, and they knew it full well. Thus, there was genuine relief that the agreement appeared to promise assured prices for a substantial period, and that the consumer, because of lower tanker rates and increased company efficiency, would still be paying less for his petroleum in constant dollars than he had in 1958. In fact, after the OPEC settlement, prices to the retail consumer in Europe, including taxes levied in the consumer countries, went up only three to five percent, while one country, Italy, actually offset the increase by reducing her excise taxes by the same amount.

There was satisfaction, too, with the American role and with the fact that the major consuming countries had been consulted at all stages. The Italians, however, raised for the first time the suggestion that the consuming countries might in future have to play a greater and more direct role in negotiations; this position has since gained adherents in OECD.

Here it should be noted that, if the industrialized consumers were fairly well pleased with the outcome, it was quite otherwise with the underdeveloped consuming countries, which had counted on declining real fuel prices to sustain their economic growth. This group at once expressed alarm, and at least one key country, India, was unable to absorb the increase and was forced to cut back petroleum purchases proportionately. This possibility had been foreseen in the negotiations, and the question of a lower or differential tax for sales to underdeveloped nations had been broached with various OPEC countries, specifically Iran, Saudi Arabia, Kuwait and Venezuela. The idea was rejected, on the technical ground that it might lead to circumvention and resale, more broadly on the plea that the producing countries themselves were underdeveloped. If Europe, America or Japan were concerned about the welfare of India or Colombia or Tanzania, it was argued, they had the means to assist them. The issue has lain dormant since; it is sometimes still raised by Asian, African and Latin American states—without response.

V

In spite of the upheavals in the oil world of the last two years, the Tehran OPEC agreements have been both successful and stable. I say that with tongue only partially in cheek. The main agreements were on taxes and on the posted prices of oil. These have not been changed. The OPEC countries insist that the agreements only covered these matters. When currency values were changed by the Smithsonian accord of 1971, the Tehran agreements were interpreted, under a supplemental Geneva agreement of 1972, to provide for a proportionate increase in payments to the producers. The same kind of increase will presumably result from the recent 1973 U.S. devaluation.

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[5] The OPEC position was codified in Resolution XXII. 131 (1971): the American view on threats to cut off deliveries has been reiterated on many occasions since, most recently by the author in September 1972. It has been suggested that American representatives virtually invited the threat of cut-off and thus built up OPEC's bargaining position, specifically through statements at a meeting of OECD in Paris on January 20, 1971. (See M. A. Adelman, *The World Petroleum Market*, Baltimore: John Hopkins University Press, 1972, pp. 254–5; also the same author's "Is the Oil Shortage Real?," *Foreign Policy*, Winter 1972–73, pp. 80–81.) By January 20, however, as the above chronology shows, the threats had already been made; thereafter, on American representations, they were modified. As for the thought that the OPEC countries needed to be told how damaging a withholding could be, this seems to me to belong to a bygone view of the capacity of leaders in less-developed countries.

Yet OPEC dissatisfaction was not long in manifesting itself. Various members, in the next half year, started looking at the figures more harshly. They could see large and growing incomes for their governments and were generally pleased. But they could also see that their income per barrel was still low—especially when compared with the excise taxes which Europe levies on its fuel. Much more important, indeed of overwhelming importance to the changing world oil picture, was that the OPEC countries, for the first time, began to recognize and discuss openly the fact that their reserves were exhaustible and should be conserved.

At the Arab Oil Congress in Algiers in May-June 1972, OPEC was castigated for having been too soft, for having yielded too easily and readily to company and consumer government pressures. The OPEC "triumph" thus lasted in the eyes of many Arab observers a scant 15 months. And the idea began to take root that it was important to maximize present revenues but without exhausting what was now perceived to be a wasting asset.

In this mood, the OPEC countries turned their attention in mid-1972 to the question of participation, i.e. a defined percentage share in the producing operations and assets of the international companies. At once there was a sharp difference of view on whether this issue had been laid aside, at least until 1976, by the Tehran agreements. The producer governments took the position that participation was an old demand in no sense relinquished at Tehran, and indeed that the companies had been told explicitly that it would be raised as soon as the price issue had been settled. The company position was that participation had not been discussed and that the Tehran agreements guaranteed the existing concessions in their present form for the full five-year period. Possibly the case was one of an ambiguity that neither side had wished to clarify. Undoubtedly there had been mention of participation, but each side preferred to leave the meeting undisturbed by possible conflicting interpretations.

From a careful study of the Tehran agreements, the State Department concluded that the company position was correct. The OPEC argument, that there was an inherent right to renegotiate the concessions whenever circumstances changed, seemed to us contrary to both Western and Islamic jurisprudence.[6] Accordingly, our ambassadors made representations in Iran, Saudi Arabia and Kuwait, but were met by reiteration that participation was an issue totally outside the Tehran agreements, and that the companies "knew" before those agreements were signed that participation would be next on the agenda of talks.

Participation was also discussed in the OECD, but it was of limited interest, being viewed as an issue between the Anglo-Saxon oil companies and the producing governments. Perhaps the companies were being partially nationalized, but the OPEC countries had given renewed assurances that prices would remain the same. At best, therefore, participation would mean nothing to the consumer countries. At worst, it would mean only a few cents a barrel increased cost.

At any rate, the companies did enter long negotiations on participation. In these the United States played one major role, forcefully noting that it would have to consider compensation based on "book value" as confiscation. In the discussions, it was pointed out that many of the OPEC countries themselves would soon be investing large sums abroad; any principle that meant in practice no compensation might later apply to their own investments. Ultimately, the issue was resolved by a new compensation formula, based on many complex factors. Face was thus saved on all sides.

The agreements reached in Riyadh by the end of 1972 provided for the producing governments to acquire percentage shares starting at 25 percent and working up gradually to 51 percent, or an assumption of control, by 1982. The companies were far from pleased, although the arrangements did give them and the consuming countries a basis for continuing. Within three years, the producing governments will be permitted to take their full 25 percent of the oil, and it seems likely that if existing market conditions continue the governments will be able to dispose of their rising percentages, including the 51 percent to which they will be entitled in 1982. The effect, of course, will be to further increase the

[6] It may be pointed out here that a surprisingly large number of oil company officials were already examining the possibility of offering a new relationship to the oil producers. The day of traditional concessions, they saw, had clearly ended and a dramatic new offer to the producers might guarantee another generation of tranquility, as ARAMCO's offer of the 50–50 profit split in the early 1950s had done. This view did not prevail, and participation was only discussed when OPEC demanded that it be discussed.

return to the producing governments, at least to the extent of the present margin of profit of the companies' own production operations.

At this writing, there are several developments which could reopen the Riyadh agreements. One is the Iranian demand for total ownership and management of its oil resources now, i.e. for a conversion of the companies into long-term buyers of Iranian oil. Another would be the "success" of the Iraqi nationalization of Kirkuk fields—and by this I mean little or no compensation for the fields and unrestricted freedom in selling the oil; the third would be the yielding of the companies in Libya to government demands for 50 percent participation now. It cannot be said that any one of these would surely result in the reopening of the Riyadh agreements in their present form. But resisting change at this point will not be easy or even desirable.

Regardless of what happens to the current agreements, the companies will continue to play a major role in transporting, refining and distributing oil. And they very likely will also play the major role in oil production for the next ten years. Predictions for longer than ten years in the energy field are daring, but the companies probably have even a much longer life than that. It seems doubtful that the national oil companies of the present OPEC will look for oil in third countries; this action will be left to the Western companies.

In sum, the international companies will probably go on playing an active role in finding, developing and marketing oil for as long as it is used as a fuel or as a raw material. But in this role the companies may increasingly find themselves minority partners of both producer and consumer governments—and they must reconcile themselves to the probability that their role in negotiating with the OPEC countries will in the future be more circumscribed than it has been until now.

The idea was first expressed, I believe, by the Italians, that the oil companies should be turned into "regulated utilities"; that consumer governments must have the right to set the prices the companies pay for crude and the prices they can charge for products; and that consumer governments will then allow the companies a fair return on their investment. This has long horrified most of the top company management, and I have no doubt that it would be an undesirable method of finding and developing oil. But there is no doubt that this concept too is finding more adherents in the consuming countries. How the companies react to these pressures, and what they offer as alternatives, will to a large extent determine their future form and their future activities.

VI

As can be seen, OPEC has moved hard and fast in the last three years. One result has been to reduce the position of the companies and to make bargaining more and more a political matter between governments. In economic terms, moreover, the series of agreements create a new price situation which is defined through 1975 only, and thereafter subject to renewed demands and changes.

What, then, is the likely picture of Middle East and North African production and revenue, taking into account reasonable projections of demand in Europe, Japan, and other consuming areas, plus the added share of American consumption that cannot be met through domestic U.S. production?

The Tehran and subsequent OPEC agreements raised the average 1970 tax of around $.80 per barrel in a single jump to around $1.25 per barrel in 1971, with provisions for further annual increases to around $1.80 in 1975. There was no noticeable inhibiting effect on consumption: while some less-developed countries reduced their imports, the imports of the industrialized nations, notably the United States, grew more rapidly than expected. Already in this current year 1973, the United States will be importing something over three million barrels per day from the Eastern Hemisphere. The total gross cost of all U.S. oil imports will exceed $8 billion, although in our balance-of-payments accounts more than half of this will be offset by company remittances and increased exports generated through the purchases.

For 1975, a reasonable estimate of the situation, based on the tax rates flowing from the Tehran agreements and without taking into account any further increases, would be as follows:

ESTIMATED PRODUCTION AND REVENUE, 1975

[Stated in thousands of barrels per day; billions of dollars annually]

	Production	Revenue [1]
Middle East:		
Iran	7,300	4.7
Saudi Arabia	8,500	5.4
Kuwait	3,500	2.2
Iraq	1,900	1.2
Abu Dhabi	2,300	1.5
Other Persian Gulf	1,800	1.0
Subtotal	25,300	16.0
North Africa:		
Libya	2,200	2.0
Algeria	1,200	1.1
Subtotal	3,400	3.1
Total	28,700	19.1

[1] These figures are based on the taxes and royalties in effect prior to the dollar devaluation of February 1973. If the 1972 Geneva agreements on currency revaluation apply, the income figures should be increased about 8.5 percent.

After 1976, of course, any estimate of taxes and prices becomes considerably more speculative. The 1970 State Department projection that prices would rise by 1980 to $5.00 per barrel may now be on the low side: sources within OPEC are publicly discussing an increase of $1.50 in taxes in 1976 alone, with "substantial" increases thereafter. If one takes, however, a $5.00 American production cost as decisive for the delivered import price, and deducts company profits and cost of production and transport, the revenue to the producing countries would come to approximately $3.50 per barrel in the Persian Gulf and $4.25 per barrel in North Africa. At these levels, it is generally estimated that consumption would still rise roughly in the same way as had been projected prior to the latest round of price increases; this amounts to saying that a price of $5.00 for delivered crude oil is still below the level that would cause any significant contraction in the use of oil in Europe, Japan or the United States. The startling fact is that world consumption within the next 12 years is now expected to exceed total world consumption of oil throughout history up to the present time.

On the basis of demand trends and the 3.50/$4.25 rates of return per barrel, the picture for 1980 would be as follows:

ESTIMATED PRODUCTION AND REVENUE, 1980

[Stated in thousands of barrels per day; billions of dollars annually]

	Production	Revenue
Middle East:		
Iran	10,000	12.8
Saudi Arabia	20,000	25.6
Kuwait	4,000	5.0
Iraq	5,000	6.4
Abu Dhabi	4,000	5.0
Other Persian Gulf	2,000	3.2
Subtotal	45,000	58.0
North Africa:		
Libya	2,000	3.1
Algeria	1,500	2.3
Subtotal	3,500	5.4
Total	48,500	63.4

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It must be noted that the estimated production figures are higher than others cited elsewhere in this article. Iran, for example, has said its production will level off at eight million barrels per day; Kuwait has said its will be kept at three million. Iraq will have difficulty in realizing five million unless the Western climate changes, and the others will strain to meet six million. Yet the world with its present habits will need this quantity of oil unless there is a war or a major recession. The only alternative to a shortfall before 1980 will be Saudi Arabia, and its projected production of 20 million barrels per day (set by Minister of Petroleum Ahmad Zaki Yamani as a goal) already seems improbably high.

If production levels fall significantly short of these numbers, there could be a real supply crisis in the world, and competition among the consumers could drive prices even higher. In this and other respects, the projection for 1980 is of course subject to a substantial margin of error. But it does seem likely that the general picture is an accurate projection of current trends, with all that it implies for costs to consuming countries and revenues to the Middle East and North African producers.

VII

With the possible exception of Croesus, the world will never have seen anything quite like the wealth which is flowing and will continue to flow into the Persian Gulf. There have been and still are countries which are richer than any country in OPEC, but there is none which is so small, so inherently weak and which has gained so much for so little activity of its own.

The cumulative OPEC income is even more startling than the annual figures. Let us ignore the income of Iran—for it will have no trouble absorbing funds in its vast development projects—and concentrate on the Arab countries. Their cumulative income from 1973 through 1980 will probably be over $210 billion. Even assuming a 20 percent compounded growth in expenditures (and it should be pointed out that all of the main Arab producers except Algeria are not spending all of their present income; in some cases, they are spending less than half), their cumulative expenditures for this period would be well under $100 billion. Capital accumulations therefore could be the balance—over $100 billion by 1980. At eight percent, just the income from this enormous sum would be $8 billion—larger than the current expenditures of Kuwait, Saudi Arabia and the Federation of Arab Amirates combined.

What will be done with this money will be a matter of crucial importance to the world. The first place for its use must certainly be in their own countries; the second must be the Arab world, which will not, as a whole, be capital-rich. At the Algiers Arab Oil Congress in mid-1972, the proposal was made that the Arabs should solve their "problem" in an inter-Arab agreement whereby the main producer nations would limit their income from oil to the 1972 tax structure. That is, as oil production went up, the increased payments at the 1972 rates would go to the producer governments, but all or at least part of any *increases* in payments per barrel over 1972 levels would go into an inter-Arab development bank for projects in the entire Arab world. This additional money would be, in a sense, unearned. Moreover, such action would be in perfect consonance with Islamic law practice, which demands twice as much *zakat* from income derived from lands fed by God-given rain as from lands irrigated by man.

It was interesting to note the enthusiasm with which this suggestion was accepted by the oil have-nots. It was much more gratifying to see the interest shown by some Kuwaitis, Iraquis and Libyans. Although it should be pointed out that interest shown by individuals is a long way from governmental acceptance of an idea, it must also be noted that both Kuwait and Saudi Arabia are already providing very substantial loans and gifts to other Arab countries.

Yet the sums we are talking about probably could not all be absorbed in the next eight, ten or 20 years in the Arab world; at least for part of that time they could be more usefully invested in the developed world. And one of the main tasks of the producers will be to find adequate investment opportunities for their funds. This matter was discussed in the spring and summer of 1972 with Arab officials, who seemed interested in investing in the United States. In a Middle East Institute speech of September 29, 1972, I suggested that the enormous capital requirements of the oil and energy industry could be met only by large new infusions from the main capital-rich consuming countries (Germany

and Japan), and from the producer countries themselves. I also suggested that Saudi Arabia, Kuwait and Iran might consider investing in the United States in other energy fields and even in non-energy-related industries. Sheikh Zaki Yamani of Saudi Arabia replied the following day that he strongly agreed with the suggestion of Arab investment in the "downstream" oil sector (refining, distribution, etc.), but did not believe Saudi Arabia would be interested in other types of investments.

In a recent meeting in Kuwait it was suggested that Arabs accumulate their money and simply float it from country to country, depending on how each country reacts to Arab problems. The difficulties of such an action are surely underrated, but the fact that it was considered and debated must give us some pause. Frankly, however, it is a problem I am convinced we will never face. I do not believe the Arabs will ever accumulate anything remotely approximating the figure of $100 billion. Either they will spend the money at home or in the Arab world or they will find adequate investments for it abroad. If they do not, or cannot, they will very likely conclude that the oil had best stay in the ground—and this would cause a problem for the developed world far greater than the floating billions.

If finding a use for the money is of great importance to the Arabs, it is of even greater importance to us. There are many trained and sophisticated Arabs; there are Arab engineers who can run oil fields and there are Arab economists who can calculate the value of investments. There are also, unfortunately, Arabs who are venal, who are susceptible to flattery, who could quite easily be taken in by charlatans, and the sky over Riyadh today is black with vultures with great new get-richer-quicker plans under their wings. Whether an Arab is a Harvard Business School graduate or an illiterate bedouin he strongly dislikes being cheated. If one grandiose project is sold to Saudi Arabia which fails to produce the ingots or pipes or widgets it is designed for; or if it produces them at costs far above the imported cost; or if the Saudi government buys into one shaky American concern which then fails, I seriously doubt that the reaction would be: "We've been had. Too bad. Let's try harder next time." It much more likely will be "We're still not trained enough to deal with the Westerners. The oil can always be sold—as a raw material if not as a fuel. Let's not increase production further." Or worse: "Let's restrict production."

VIII

So far we have looked at the world oil reserve situation; at length at the recent history of bargaining by the producer countries through OPEC; at projections for the future; and at the situation of the producer countries in the light of all factors. It is time now to return to the question asked early in this article: Can OPEC hold together? The answer seems to me, if not certain, clear enough so that it would surely be foolhardy to bet on a contrary outcome for the next several years at least.

Repeated suggestions that OPEC would not notice its strength, if only the consumers did not refer to it, represent perhaps the single most pernicious fallacy in our past thinking on world oil. It assumes an unsophistication and ascribes an ignorance to the major producer countries, particularly the Arabs, but also Iran, Venezuela and the others which, for better or worse, has not existed in recent years—if it ever did. OPEC economists are fully as capable of making supply-demand calculations as are Western economists. And they reach the same conclusions.

OPEC cannot usefully be compared to other producer cartels. It controls a product which is irreplaceable in the short run, and is vitally necessary to the economies of every technologically advanced country. The main oil producers are not competing with each other for larger shares of the consumer market—as would be the case in other producer cartels. Probably the most important reason for OPEC solidarity is that the key countries, notably Kuwait, Saudi Arabia and Libya, do not need more income; they are unsure of how they could use it if they had it, and they fear the international consequences of acquiring too much wealth.

Almost as important is the recognition of all OPEC countries that their reserves are finite and must be conserved. These proven reserves are indeed very large. Yet, for example, Kuwait's 66 billion barrels today seem much less impressive to Kuwaitis themselves than they did a decade ago. Hence, Kuwait recently

stopped expansion and plans to keep production at three million barrels per day. At this level, Kuwait will have oil for a couple of generations—but even this is a short period for a nation; and Kuwait's prospects of finding more oil are very small. Iran has stated that it will limit production to eight million barrels per day before the end of this decade; production will be held there for eight or ten years and then will decline. Increases in Iranian income from oil will only come from increases in taxes per barrel, and it counts on this. North Africa's reserves are not large enough to play a dominant role in world oil in 1980; and the rest of the world will produce whatever it can. This leaves for consideration two countries: Iraq, whose government does not encourage foreign investment and seems unable, on its own, to produce substantially greater quantities of oil; and Saudi Arabia, by far the most important.

In the last analysis, whether Saudi Arabia or any other OPEC country with large reserves would act to disrupt the market is a question of the behavior of men in control of national governments, affected by political factors as much as by theoretical economics. Thus, it is frequently noted by observers outside the area that from an economic standpoint an increase in present income should be vastly more useful than the discounted value of income deferred for 10–20 years—and that with other energy sources in prospect oil may not even command high prices in such future periods. To Arab countries, such arguments are simply not persuasive. In the personal experience of their leaders, past income has been wasted and even current income is not invested profitably. Moreover, just about every top official in OPEC, starting with Perez Alfonso in Venezuela 20 years ago and including Zaki Yamani of Saudi Arabia today, is convinced that his country can sell its oil profitably in ten or 100 years as a raw material (primarily for petrochemicals) if not as a fuel.

The predictions of Western economists that competition in OPEC for larger shares of the market will soon bring down prices are read not only in the West but in OPEC countries. They merely increase the already firm determination to avoid such a development. The producers may want to "maximize" their income but they also recognize that, until there are alternatives to oil as a fuel, this can be done most easily by raising prices. No OPEC country, no matter how great its wealth, is interested in "breaking" world oil prices.

It is difficult to see how these elements of self-interest would be changed or how any of the OPEC countries would act differently if they should now move quickly toward complete nationalization of the producing operations and assets of the Western companies. Bargaining directly with the consuming countries, the producing countries would still be just as disinclined as now to drive prices down; and needing no additional income, would not feel under pressure to increase their market shares.

The Kingdom of Saudi Arabia, without doubt, could destroy OPEC. It could produce oil in much greater quantities than it does today; it could drive the price of oil down to th · mythical $1.00 a barrel, and every OPEC country would be ruined. But Saudi Arabia would also ruin itself in the process. Using the economists' expression, Saudi Arabia would not "maximize" its income; it would only "maximize" its production, and even its enormous reserves would soon be exhausted. It is difficult to see what folly could possess Saudi Arabia to take such action; any consumer government that assumed that Saudi Arabia would (or could) do this without an internal revolution would be guilty of an even greater folly.

The "collapse" of OPEC would indeed seem a serious possibility on either of two conditions—if there were discoveries of vast new reserves in areas which could be kept outside OPEC, or if there were an unexpected breakthrough in the development of new energy sources. Both are unlikely to occur; and neither could, even if it occurred tomorrow, operate rapidly enough so that it would necessarily drive down oil prices in the next decade. The world cannot simply wait for or expect such a *deus ex machina* to solve its energy problems.

IX

This article up to now has dwelt almost exclusively on the strengths of the oil producers. The consumers are not without power of their own—or they would not be if they were united. So far they have not been, and they have as yet shown little inclination toward collective action in spite of repeated urgings

by the United States. In the fall of 1969 meetings of the OECD oil committee, before the first OPEC crisis, the Department of State first raised with the EEC the possibility of a common approach to the energy problems we would all soon be facing. Assistant Secretary of State Philip Trezise, in the OECD meeting in Paris in May 1970, urged that energy problems be considered in a multilateral context, but got little positive response. The general attitude was that the United States was becoming vaguely hysterical as its import needs grew; the United States, they thought, worried too much about losing Arab oil. This was something they, the Europeans and Japanese, did not need to think about. Israel was a milestone around the neck of the United States; this was the U.S. choice; the Europeans and Japanese could make their accommodations with the Arabs. Restrictions on oil deliveries would apply only to the United States; its allies would have much less to worry about. Not every OECD member took this view; the U.S. position was always supported strongly by the United Kingdom, the Netherlands and a few others; but generally American fear of a cut-off of oil supplies was not widely shared.

In the course of the last two years attitudes have changed. Italy has gone through a rather traumatic experience in Libya; 50 percent of her oil company was nationalized before production began. And the French experience in Iraq went sour. France had taken a markedly pro-Arab position in the Arab-Israeli dispute; she had reached oil accords with Iraq which were the most favorable to the producing government of any agreement theretofore signed, and many Frenchmen looked forward to a new French oil empire in the Middle East. But the agreements with the French national company, ERAP, did not measure up to the new OPEC agreements and the Iraqis demanded renegotiation. This very likely will be achieved, and oil certainly will be produced by France in Iraq; but the French have found that the doctrine of changing circumstances is also applied to outspoken friends of the Arabs.

In the fall of 1971, the United States raised more formally with the Europeans and the Japanese the possibility of a joint approach to the energy problem; apart from a general expression of support for the companies in their dealings, no ideas were forthcoming. The subject of cooperation was raised again in the spring of 1972 with the same lack of response. Finally, in October 1972, in both Brussels and Paris, the Europeans and Japanese were told that the United States would need some indication, at least in principle, of their intentions. Did they prefer a purely autarkic approach, or did they think we should try (as the United States strongly preferred) to tackle our energy problems jointly? The European Community, speaking together for the first time replied that it too favored a cooperative approach. The Japanese reply was ambiguous but seemed to be inclined toward cooperation.

The United States has discussed at various times a two-pronged approach to consumer cooperation. The first would be cooperation among the major consumers to find new sources of hydrocarbons and to develop new forms of energy. This could be as simple as expanded exchanges of information, or could go as far as supranational authority with power to direct research and allocate funds. We have not put any specific plan on the table but have indicated our willingness to discuss all possible approaches. The second and more difficult part would be the formation of an international authority to avoid cutthroat competition for available energy in times of shortage. Such competition could drive prices far higher than we can presently imagine. The producers, in such a case, would need still less production to maintain their incomes and could restrict production even further.

Such competition for oil, of course, has already begun. Various companies are trying to conclude long-term purchase contracts for oil with various OPEC countries. At least three governments have made overtures to Saudi Arabia with offers of attractive long-term contracts, since the Yamani offer of a special relationship to the United States made in his Middle East Institute speech of September 1972. Japan has recently concluded a deal with Abu Dhabi which went beyond the OPEC agreements; and small American companies are now offering the producers long-term contracts with equity participation in their firms. With OPEC production limitations in the future, or even with normal slow growth, with only Saudi Arabia and perhaps Iraq capable of substantial expansion, bidding for supplies could soon get out of hand, and the projected price of $5.00 per barrel in 1980, or even a price of $7.00, could seem conservative.

There was strong agreement in the OECD that a consumer organization (which all agreed should be formed) should not be considered a challenge to OPEC; it would not be designed to drive prices down and certainly not to ruin the producers; it would only be designed to protect the consumers. It could even be used to bring the OPEC producers into closer ties with the consumers. Producer country investments in Europe (and possibly Japan) as well as in the United States should be encouraged. In September 1972, I stated the American position in these terms:

> If consumers band together to search for new energy forms or to ration available energy in periods of shortages, this should cause no surprise or offense. If consumers encourage companies to resist further price increases, this should also cause no surprise. Many consumers already believe that the companies have not been adequately vigorous in resisting producer demands, as they could and usually did pass on to the consumer any tax increases. The producer governments have banded together in a well functioning organization. Their immediate adversaries are only the companies—an unequal contest.

Lastly, there is the possibility of some additional measures to build up reserve stocks for bargaining purposes. These are indeed badly needed for their own sake, in Europe and also in the United States. They could have some importance in future dealings with the OPEC countries, although it must be realized now that the enormous financial resources of the OPEC countries give them a considerable advantage in any endurance contest.

X

Consumer solidarity will be necessary if the present trend toward bidding up prices is to be halted. It will be indispensable if political or economic blackmail is to be successfully countered. There are various interpretations of what this means and how far the consumers could go or would want to go in a confrontation with the oil producers, particularly if the issue were exclusively one of oil prices.

In the long run, though, the only satisfactory position for the United States (and to a lesser extent for its main allies) must be the development of alternative energy sources. The United States is particularly blessed with large reserves of coal which can be converted to hydrocarbons, and of shale oil. The United States shares with all nations the possibility of developing geothermal energy, solar energy, and energy from nuclear fission and fusion. But the lead time is long for the development of all of them and some are still purely hypothetical.

Suggestions a few years ago for a vast program of development of new energy sources received no support in the Congress or from the public. Yet, had the United States a few years ago been willing to accept the realities which became evident in 1967 or even in 1970, it might have started sooner on the development of Western Hemisphere hydrocarbons and domestic energy sources.

The potential is there. Venezuela probably has close to a trillion barrels of heavy oil in place, with at least ten percent recoverable by present technology; the United States has large reserves of oil tied in shale, and coal which could be turned into hydrocarbons in almost unlimited quantities. And there are probably over 300 billion barrels of recoverable oil in the Athabascan tar sands.

Let us not exaggerate all this, however. The shale, the heavy Venezuelan oil, and the tar sands all require capital investment on the scale of $5–$7 billion for each million barrels per day of capacity. Above all the lead time is long—perhaps 15 years, certainly eight—before significant production could be achieved from any of these sources.

On the diplomatic front, we have for years discussed an agreement with Canada which will permit free entry of Canadian oil into the United States. This has lost much meaning by now, for Canada is currently sending us all her surplus oil and has imposed export controls. But we still may reach agreement. We have also discussed a treaty with Venezuela which would permit the development of her heavy oils. We have proposed free entry of these oils into the United States in return for investment guarantees to the companies developing these oils.

Within the United States itself, a wide sweep of actions can be taken to increase domestic energy production and to use energy more efficiently. Finally, there is the question of controlling the rise in oil demand through reasonable conservation actions. Such measures as the spread of effective mass-transit

systems could do much to limit our present profligate use of energy for a host of marginal purposes.

No one action will solve our energy problem, much less that of the entire world. But taken together these steps—collaboration with other nations, the development of alternative energy sources, and controlling our consumption reasonably—could allow us to reduce our imports significantly below those projected in this article. This must surely be our immediate goal.

XI

To look simply at the world's oil reserves and conclude that they are sufficient to meet the world's needs can no longer be acceptable. We could allow ourselves such fatuities as long as we had large spare oil production capacity, and while our overseas imports were small. We can do so no longer. Our security and balance-of-payments problems are large and growing. Whether we focus on today, or 1980, or 1985, it ils abundantly clear that we must move on a variety of fronts if we are to avoid a situation which could lead to or even force us into highly dangerous action.

Having argued throughout this article that the oil crisis is a reality that compels urgent action, let me end on a note of hope. The current energy problem will not be a long one in human terms. By the end of the century oil will probably lose its predominance as a fuel. The measures we have the capacity to take to protect ourselves by conserving energy and developing alternative sources of energy should enable us, our allies, and the producer nations as well, to get through the next 25 years reasonably smoothly. They might even bring us smiling into the bright new world of nuclear fusion when all energy problems will be solved. This final note would ring less hollow if we did not remember the firm conviction of the late 1940s that the last fossil fuel electricity generating plant would have been built by 1970; and that in this new golden age, the home use of electricity would not even be measured. It would be so cheap, we were told, that the manpower cost of reading meters would be greater than the cost of the energy which the homeowners conceivably could consume. But perhaps in 2000....

[From the Foreign Affairs, July 1973]

A Plan for Energy Independence

(By Carroll L. Wilson)

I believe the United States is facing a national energy emergency. It arises from our extravagant and wasteful use of energy and from a shift in the sources of fuels. Per capita consumption is three times that of Western Europe, and we may ask ourselves whether our greater use enriches the quality of life by any such margin. Our cars are twice as heavy and use twice as much fuel as European cars which run about the same mileage each year, and the ratio is getting worse because of the sharp drop in fuel economy on recent models of American cars, owing to emission controls and air conditioners. We keep our houses and buildings too hot and use large amounts of fuel in air-conditioning everywhere. We have not given a thought to fuel conservation and efficiency since the days of rationing in World War II—an era which only 30 percent (those over 45) of the population can remember. These are some of the reasons why with six percent of the world's population the United States uses 33 percent of the world's energy—and why Europe and Japan are unlikely to be sympathetic to our plight as we ask them to share with us their traditional supply sources in the Middle East.

The costs and perils of dependence upon Middle East nations around the Persian Gulf were eloquently stated by James Akins of the State Department in the last issue of this journal.[1] His analysis of the expected scale of payments to Middle East countries and the inability of the largest producer, Saudi Arabia, to absorb or use a significant fraction of these payments for internal purposes underscores the perils of open-ended dependence upon these nations for our oil. The

[1] "The Oil Crisis: This Time the Wolf Is Here," *Foreign Affairs*, April 1973.

most critical aspects of the national energy emergency are the shift to such dependence and the enormous foreign-exchange drain it must progressively entail by the late 1970s alone. Recent "symbolic" interruptions by some Middle East countries, in protest against U.S. policy toward Israel, may be one hint of what the future holds; the continued hard bargaining on price is another. Although we will have to live through a period of substantial reliance on Middle East oil, it is hardly an acceptable national policy to leave the emergency situation in this highly unsatisfactory state. There are simply too many cumulative problems and dangers involved.

The question, of course, is what *could* we do about it. The time has come to propose solutions. I propose a strategy to overcome this emergency, a program of action to implement such a strategy, the machinery needed for implementation, and an assessment of the global and environmental consequences of the adoption and execution of such a program by the United States. Obviously, the number of variables is immense and only by gross simplification can one define a strategy and program; there should be alternative strategies and plans. But this may be a place to begin.

II

The objectives of my proposal are to achieve, by 1985: first, the independence of the United States from critical reliance on imports of energy in any form—defining critical reliance as anything more than ten percent of our needs; second, energy costs below some target level, in dollars per million British Thermal Units (BTU), which is a common energy pricing unit for all fuels. I suggest as a goal keeping energy costs for premium fuels such as gas or oil below $1.00 per million BTU. This is equivalent to oil at $6.00 per barrel, roughly twice present prices, or to gas at $1.00 per thousand cubic feet, twice present wellhead prices on new contracts. The current cost of coal is very low in relation to its heat content, and the proposed ceiling gives great latitude for its use.

To see how we might reach these goals, let us start by examining the components of energy supply in the United States—past, present and future. Current projections make three key assumptions—that total energy consumption will continue to grow at the rate of 4.5 percent a year that has prevailed in the past decade, that the present pattern of use of particular energy sources will continue, and that nuclear power will be rapidly developed. As we shall see, all three of these assumptions can be challenged. If they were the case, however, the currently projected picture (seen in relation to present and past) would look as follows:

TABLE 1.—U.S. ENERGY SOURCES AT STATED PERIODS

[In percent]

	Actual, 1960-63	Actual, 1970-73	Projected, 1980-83	Projected, 1985
Oil	44	44	44	47
Natural gas	29	33	28	20
Coal	23	18	17	17
Hydro/geothermal	4	4	5	6
Nuclear	5	1	6	10

As the table shows, the crux of the problem is that oil has had to assume a large and slowly increasing share of the total. Natural gas appears to have reached its peak and will decline as a proportion of total supply even if higher prices produce increased exploration and discovery. Hydro sources can at most hold their place.

There remains, of course, the question whether present geothermal sources can be expanded to a greater degree and whether now "miracle" sources of energy can be found from solar energy, nuclear fusion, hydrogen broken down by nuclear methods, or any other. In all of these there is hope if we look ahead on a 30-year projection—and in the most promising areas there is justification for much greater research and development effort. But if one puts together the theoretical possibilities and the best available sense of what it would take to develop any of these "miracle" sources to major production levels, the honest judgment at this stage must be that they will contribute nothing by 1985 nor be substantialy operative before roughly the year 2000, if then. And we simply cannot wait that long.

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Rather, then, we have to look to our present sources of energy within the 1985 time frame. Obviously, we must have the maximum possible expansion of domestic oil and natural gas production, but the increases cannot be large in relation to total need. In addition, we should establish synthetic oil industries based on shale and on coal, building some large-scale plants to demonstrate feasibility and costs and to test features that minimize environmental impact. Such developments might yield a few million barrels per day, and we might require refineries to mix such oil with regular crude oil for a fraction of their feedstocks—even if initial prices of synthetic crude oil exceeded the $6.00 per barrel ceiling target for 1985 energy costs.

Looking at all the technological possibilities, however, it is my conclusion that the best sources of energy that can be greatly expanded in this time frame, at reasonable cost and with an impact on resources and on the environment that we can bear, are nuclear fission and the production of gas from coal through gasification—a process which produces from coal a clean, all-purpose and readily transportable gaseous fuel. For this purpose, some of the necessary technology now exists, but some still requires additional development. Gasification itself has been demonstrated, and technologies are already in use that produce low-BTU gas. However, the technological obstacles to producing gas of pipeline quality from coal are still formidable; a massive crash program of parallel pilot and demonstration plants for the four or five processes that now appear possible should permit construction to start in two to three years on production plants that make use of whichever process or processes then look best.

This selection of technological possibilities is the first element in the proposed strategy. The second—at least equally important and urgent—is a program effectively to reduce the rate of growth in our energy consumption. Actually to lower our consumption substantially is not, I believe, acceptable without far too drastic changes in our whole society. But I believe it is feasible, and should be our target, to achieve and maintain a rate of growth in our energy consumption of three percent per year, rather than the present 4.5 percent. In arithmetic terms, instead of our energy consumption in 1985 being 70 percent greater than it is now, it would be "only" 43 percent greater—a large and critical difference without which no action program can, I believe, do the job.

This is still a drastic target. To achieve it requires a recognition and acceptance that we are in a national emergency. Since shortages are upon us, we will have to begin to practice conservation not because of price but because of shortages are upon us, we will have to begin to practice conservation not because of price but because of shortages. Although the first guidelines for voluntary "sharing of shortages equitably" have been issued by the government, we have no rationing machinery except to give priority to dometic heating and to drop other loads if not enough energy is available. There are not even the rudiments of machinery for rationing fuel. The only serious study of an emergency program has been made by the Office of Emergency Preparedness, which has produced two very useful studies indicating measures that could be taken if the will existed to diminish significantly our energy demands, thereby reducing our dependence upon imported oil. Yet, before the year is out, shortages of gasoline and heating oil in many parts of the country will make it clear that a national emergency exists and that appropriate steps must be taken.

Some of the necessary measures will involve presently extravagant uses and waste, and some an increase in efficiency. Here it is striking to note how little scientific and technical effort now goes into this latter question; a very modest improvement in our present low fuel efficiency may turn out, over time, to be in itself sufficient to bring us close to the three percent growth rate. But in the meantime we must surely cut back painfully.

III

On the whole we do very well in dealing with national emergencies. Many examples come to mind from World War II when we created the machinery; gave it the necessary authority; provided the money; mobilized the parts of the society, public and private, which were needed to overcome the emergency or meet it; energized the program by a system of contracts; and achieved the target results.

A notable example was our action in dealing with the abrupt cessation of the natural rubber supply. We carried out a crash program to set up a synthetic rub-

ber industry, quickly creating the necessary machinery, authority and money. The results were dramatically successful. Another example was the decision to produce an atomic bomb in time to be usable in World War II. The decision was taken at a time when there were four or five possible routes to securing fissionable material from uranium and only some clues as to how to make a weapon from fissionable material. Special machinery was set up with the needed authority, with superb leadership and organizing capability, and within the tradition of mobilizing the private sector by contract. The Manhattan District then conducted that remarkable program of carrying forward simultaneously four different approaches to making a weapon, while building everything from cities to railroads to huge and completely novel factories, all in the space of less than three years. It worked.

Another example of how we can mobilize resources against an explicit target was the space program. In 1960, for reasons then considered sufficient, we decided that we should put a man on the moon before the end of the decade. To accomplish this, we created a special agency with great authority and lots of money and manned it with extraordinarily capable leadership. The fantastically complex and difficult scientific, technical and logistical problems were overcome, and, indeed, we put the first man on the moon in July 1969.

These are a few examples of how we have acted successfully when we have accepted the existence of a national emergency and taken the necessary actions (through Congress and the President) to provide the authority, the money, the machinery and the leadership to meet and overcome it. It is our national style to be most effective in tackling concerted programs, or working toward specified goals. Sometimes that approach is not appropriate as, for example, in solving the problem of cancer; in this case, however, it is the right one.

What might be the action program aimed at 1985—the Decade Program if you will—if we accepted the existence of a national energy emergency and then took the necessary steps to cope with it through meeting the specific targets suggested?

The first element in any such program must concern the use of oil. To limit our oil imports to ten percent of energy requirements by 1985—using now the target three percent annual growth rate to estimate total 1985 energy consumption—would mean that we would be importing no more than five million barrels of oil per day at that time (compared to the roughly 15 million barrels now projected).[2] In the total energy picture shown in Table I, oil (domestic and imported) would have to drop markedly from its projected 47 percent to a proportion of roughly 30 percent in 1985.

This at once suggests the first component of the action program. Thirty percent is roughly the proportion of our energy that now goes to transportation, especially automotive uses—for which, of course, oil is uniquely suited. It will take work to keep our transportation uses down to this proportion, for they are now expanding faster than total energy consumption and this tendency will be accentuated by lowered efficiency due to tighter emission controls—not to mention the current sales rate of a million passenger cars a month! But if the proportion can be kept down—actually slightly reduced—then it can and should be met from oil, and oil should be withdrawn from other energy uses such as heating. This is a harsh measure but an indispensable one—the keystone of the whole program in fact.

The next component of the action program concerns nuclear power—currently providing one percent of our total energy, and projected in Table I to provide ten percent by 1985. In this respect, Table I reflects technological possibilities with proven techniques, but it does not reflect current political realities, nor, in my judgment, the true difficulty of meeting valid safety and environmental objections to the kind of major expansion it would take to achieve the projected figure.

Like others who have followed closely the development of nuclear fission as an energy source for more than 25 years now, I originally and for some time be-

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[2] Oil would not, of course, be the only energy source imported. As we would, substantial possibilities exist for the importation of natural gas from Canada and of liquefied gas from Algeria, the Soviet Union and perhaps other sources. Without judging the wisdom of expanding any of these sources, their proportion of total energy is not likely to add much to the ten percent of total energy represented, for this program, by imported oil. We would still be within reasonable overall margins of import dependence.

lieved that it could, without undue difficulty, become the most important source of energy we have, especially for electricity. But problems have mounted, and delays, restrictions and technical uncertainties have dogged nearly every one of the many steps needed to bring a new nuclear plant into full operation, thus drastically slowing down the nuclear input to our energy system. The determined opposition of states and localities and citizen action groups, plus rising caution by the Atomic Energy Commission, has stretched out to ten years the interval between application for a plant permit and bringing the plant "on line" at an economic power level.

In part, the political forces at work reflect an exaggeration of the problems, or at least a failure to weigh fully the inevitable trade-offs between energy supply and other factors. But these politically reflected concerns do have a substantial basis, both as to safety and as to unnecessary and unacceptable environmental consequences. Only if we deal with these factors can nuclear fission play the role I believe it must play in our total energy picture by 1985.

On safety, a real uncertainty now exists concerning possible accidents which could have disastrous consequences—especially the failure of liquid cooling systems resulting in a meltdown of the highly radioactive core and release of the gaseous fraction of these radioactive products into the atmosphere. A year of hearings by the AEC has not persuaded the critics that current reactor plans are safe against such accidents, and the problem exists as well in the liquid-metal-cooled breeder reactor designs.

As I see it, the only way to meet these objections and so resolve the current impasse is to put all new plants underground. This is an entirely practicable course of action. Studies indicate that placing nuclear power plants underground would add only a small fraction to their cost. The extensive know-how of the mining industry plus that of the underground gas storage industry could be applied in placing such plants in suitable geological formations 500 or more feet underground near load centers. So located, with suitable locks in the elevator shafts to contain and hold back any pressure of radioactive gas in the event of an accident or a meltdown, these plants could meet the requirements for nuclear safety. Placed in a suitably impermeable geological formation, a meltdown, even if it buried itself below the underground chamber level, would not leak radioactive products into underground water or into the atmosphere.

The second big nuclear production problem today is primarily environmental; it concerns the effects of the water discharge from large reactors in heating up streams and larger bodies of water, thus altering the ecology in many harmful ways. Here Europe has pointed the way to the answer—large cooling towers, built on the surface to recycle and cool the hot water discharges with very low net water heating.

Finally, there are problems in the safety and security of handling and transporting plutonium, and in the perpetual storage of radioactive wastes. In these areas, risks cannot be totally eliminated, but they can and should be sharply reduced to an acceptable level by determined action—as we enter an era of massive production, transport and handling of plutonium, which is one of the most toxic substances known.

All in all, the measures required to permit expansion of nuclear-fission plants will not be cheap or easy. But if the necessary steps are taken, nuclear-fission plants should be able to provide roughly ten percent of our total 1985 energy needs at tolerable levels of risk and bearable costs. And experience in this next decade should tell us much about the degree to which we can hope to expand, by the end of the century, our use of nuclear fission, especially through the breeder reactor; in the 1985 time frame, the breeder is not likely to make a significant contribution.

If roughly ten percent is the best we can hope to get from nuclear sources by 1985—the figure used in our original Table I—it follows that there remains a very large shortfall from the proposed reduction in overall oil use. Even if we now assume that total consumption would be less than assumed in Table I, the proportion to be made up is on the order of 15 percent. Indeed, on my own best guess about the amount of domestic natural gas we shall be able to find by 1985, I should think that natural gas (even with some imports) should not be counted on for more than 15 percent of the total, and perhaps as little as ten percent; perhaps new gas reserves will be found on a large scale, but at the moment much expert opinion doubts this. We would do well to plan

prudently on a figure not exceeding ten percent, or a total shortfall of roughly 25 percent of the total to be made up from sources other than oil or gas.

Inevitably, we are drawn to coal—and to greatly expanded coal production and gasification as the third central element in an action program. To whatever extent possible, coal as a solid fuel should be expanded in its own right, especially in electric power plants—using processes to remove the sulfur from stack gas such as the Japanese now employ. But for every reason—adaptability, transportability and environmental consequences—gas from coal is particularly important.

Available options for processing coal include, conversion to low-BTU gas, high-BTU pipeline-quality gas, oil or various combinations. Technical, economic and time criteria should guide the choices made. But the great advantages of pipeline-quality gas for most uses justify major emphasis on this choice. A massive crash program is needed to move present process options forward. Current estimates indicate that the cost of capital investment in new gasification plants should be on the order of $20,000 per ton of daily coal feed to process coal into pipeline-quality gas.

Any program to increase coal mining must face up fully to the problem of environmental impact. The necessary coal must come overwhelmingly from surface mines, predominantly west of the Mississippi. In the past, such strip mining has rightly acquired a bad reputation. Fortunately, a large part of the coal reserves in the West are located on public lands. Therefore, the federal government is in a position to set the conditions for mining operations. I believe it essential that such conditions include provision for restoring the land after the coal is extracted, putting solid waste from the mining process back underground and creating a land surface that must be at least as stable, fertile and valuable as the original. An allowance of $2,000 per acre for such purposes may be a fair approximation of what it would take, and this cost would have to be considered a basic cost of production. Underground mines must control pollution and use several practices which might increase costs up to a dollar per ton. Similarly, coal gasification plants can and must incorporate controls to avoid air and water pollution. Altogether, while the mere existence of the plants means that the countryside can never be quite the same in the future, the problem of environmental impact can at least be reduced to bearable proportions in view of the stakes involved.

Building up our reliance on coal would involve capital costs for mining production as well as for the gasification plants. In 1970 U.S. coal production was about 500 million tons and accounted for roughly 20 percent of our energy needs. To meet 50 percent of total energy needs in 1985 (at the three percent intervening growth rate) would require a production level of two billion tons per year—a quadrupling of the 1970 level and an average growth rate for the next 12 years of 12 percent per year. Investment needed to produce this basic production increase can be roughly estimated at $10 per ton, or $15 billion. If two-thirds of the increase, or one billion tons, went to gasification, the plant investment would be approximately $60 billion, and there would be a major additional investment in gas pipelines. Finally, for the one-third of increased coal output burned directly in power plants (to replace present oil and natural gas supplies), a substantial railway transport investment would be required, as well as costs of conversion to coal where feasible, and desulfurization of stack gases.

Obviously, such a buildup of coal production and coal gasification is a truly major undertaking, difficult from a technical standpoint and costly and complicated in terms of the mix of private and public effort involved. It is a big job, but no bigger than the Manhattan or Apollo projects—in fact substantially less in proportion to the scale of the American economy in the 1970s and 1980s.

One crucial question remains—the adequacy of reserves. Before embarking on a course designed to make coal our principal source of energy by 1985 and thereafter, we need to assess the scale of our coal reserves and how long they might last. While I have stated my proposal purely in terms of 1985, it is obvious that we would not wish to mount an effort on this scale and then change course quickly thereafter; on the contrary, it is my own belief that we should plan tentatively at this stage to meet not just 50 percent but as much as 75 percent of our energy needs from coal by the year 2000. It is now forecast that natural gas reserves will be gone before 2000 and that global oil reserves will be declining fast (even with less U.S. consumption than now forecast). Thus, coal and

nuclear power *could* be our overwhelming energy sources by that time, with coal by then being converted on a large scale to oil for transportation needs. Oil from shale might also have become a substantial source; present reserves of oil shale are such that we could produce five million barrels of oil a day for more than 300 years before such reserves were exhausted. We need not be quite this futuristic for concrete planning—but we do need to assess reserves on the basis of large assumptions, to be sure of what we are doing in the 1985 time frame.

Happily, the coal reserve picture is reassuring even if all this comes true. The current Bureau of Mines estimate (1970) of U.S. coal reserves is 1,600 billion tons. If coal use now moves up steadily to 50 percent of total energy by 1985 and to 75 percent by 2000 (again allowing for a small but steady annual increase in energy use), then total consumption in the entire period from 1974 to 2000 would be on the order of 70 billion tons, or four and one-half percent of known reserves. Exhaustion of reserves would be roughly 100 years away in 2000, even if the use continued to increase at a steady rate.[3]

In sum, coal reserves are ample to meet the projected needs through the balance of this century and to leave us with supplies to last another century. Through the use of coal on this scale, coupled with the restriction of oil supplies to transportation uses and the regaining of our momentum on nuclear power, we could meet the strategic goals stated at the outset: minimal dependence on overseas supplies and reasonable rises in energy costs—to levels not over two or three times present rates. This is the best action program now available. It would get us through this period and buy crucial time for whatever innovations may develop, while allowing us to continue with expanded coal use if such innovations do not appear on a larger scale.

IV

I have outlined this "Decade Program" first in order to define the key elements in our effort between now and 1985. These key elements are essential, they take time to bring about, and we must get started on them at once.

But as we do so we must also reckon that the required changes cannot be brought about immediately. The program needs at least the whole decade to take full effect, and in the meantime—even if we have cut our energy growth rate to three percent—we face evtraordinarily serious problems. Hence, in addition to our Decade Program, we must have what might be called an "Emergency Program." This would dovetail as well as possible with the Decade Program but inevitably would not be wholly consistent with it.

Oil remains the crux of our present problem. The standsitll on new refinery construction, partly for environmental and related political reasons and partly because of unattractive return on investment, may compel rationing of gasoline this summer and of fuel oil next winter. And even if new refinery capacity existed today, an adequate supply of crude oil from abroad could not now be landed without at least one new "superport" and also large-scale new tanker construction. As for domestic oil development, the Alaska pipeline is still in abeyance, and off-shore exploration is inhibited by state opposition and disputes with the federal government about royalties. Also significant is the public belief that all offshore operations are as disastrous as the Santa Barbara episode (which disregards the large-scale operations conducted in the Gulf of Mexico and the North Sea for years without major accidents).

The fact is that we cannot avoid a continuing increase, for some years to come, in our imports of oil—especially from the Middle East. In 1973 we shall be importing 3.4 million barrels a day from the Middle East and North Africa, and two million from Latin America. These figures are bound to rise—for some years well above the Decade Program goal of only five million barrels a day of imports by 1985.

Finally, there is a basic policy question that must be faced—whether in common prudence the United States should now have a strategic reserve of crude oil or refined products to protect against interruptions. Crude stocks are currently below 20 days and refined products in the form of working inventories in the

[3] The actual calculation here is that 17 billion tons of coal would be consumed between now and 1985 and 50 billion in the next 15 years. The latter figure assumes that growth in total energy needs (in terms of BTU content of fuels) would have been reduced to two percent per year, versus the three percent target of the Decade Program and the present 4–5 percent.

distribution system are less than 40 days—essentially minimum working levels with no strategic reserve. Such a reserve is something individual Americans have quietly urged on Europe for years, and in 1968 the members of the European Community accepted the obligation to build up oil stocks equivalent to 65 days' use. Now it has been proposed that this reserve be raised to 90 days. In the case of the United States, the targets need not be defined in terms of such periods of total oil use, but as our imports increase we should at least have a strategic reserve equal to perhaps 90 days of our imports, to cushion the shock of any interruption for political or bargaining reasons. To urge this does not indicate the slightest degree of hostility to the supplying countries; it is what businessmen all over the world prudently do in order to negotiate on a relatively even keel with suppliers.

Solving all of these emergency problems will take both resources and ingenuity. In the case of refineries, I believe inland sites must be found, and new refineries must adopt available technology which produces virtually no air or water pollution. Such refineries exist in Europe; they can be matched here, and not at excessive cost. Similarly, superports must be built with expensive safeguards—their cost would be perhaps as high as $1.5 billion to unload ten million barrels a day, with additional pipeline costs to bring the oil to inland refineries, and conceivably an investment of $15 billion for tankers adequate to haul the ten million barrels a day from the Persian Gulf. It is a daunting prospect—and underscores the vital importance of preventing our maximum import dependence from going beyond roughly the ten million figure at any time, and the importance of reducing dependence as soon as possible to our target ceiling of five million barrels. The painful fact is that some part of total refinery capacity, and as much as half of the planned superport capacity, will become obsolete or surplus as we carry out the shift to coal and the reduction in the production of our energy needs supplied by oil imports.[4] When a problem has been neglected as long as we have ignored or misjudged the energy situation, the short-term requirements may not mesh with the requirements for the medium and longer term—and so it is in this case. We have to fix the roof and build a new house at the same time.

V

In short, it will take a two-fold crash program to master the situation, part directed to a transformation in our energy pattern by 1985, part directed to getting along in the meantime. The dual task involves a series of massive new efforts, some of them within the capacity of private companies, some beyond that capacity, some which will be so clearly uneconomical that private companies would be reluctant or unable to undertake them with their own funds. No one can now say just what the mix of public and private effort will be—but what seems absolutely clear is that a much larger public role will be required than now exists, partly to pull together all the strands of both parts of the program, partly to support private effort, partly to undertake those aspects that cannot be handled by private companies.

I see no alternative to new government machinery at the federal level. Accordingly, I propose a National Energy Authority (NEA) with a ten-year life and with appropriate powers to deal with the national emergency. This will mean authority to override obstacles in regard to land acquisition, siting, environmental impact, and other areas as necessary to carry out the program. This should not relieve the NEA of a very serious obligation to make environmental assessments of its proposed projects and to hold public hearings to develop the best available means to minimize the environmental consequences and risks of the actions it takes, but it would authorize the NEA to proceed with its program and not be stopped by the obstacles which stall so many things today.

Under the NEA it would be essential to create a National Energy Finance Corporation (NEFC) to provide funds for parts of the program which may not be privately financable, including the superport, a billion-barrel strategic stock and its storage facility, sites for refineries, offshore production units, tankers, coal gasification plants, and gas, oil and coal pipelines. Large amounts of capital are going to be needed. An important obstacle today is that some of these essential investments are not attractive to private capital. In designing the NEA and the

[4] It seems likely that substantial strategic reserves of crude and refined products may still be important to protect against the effects of important interruptions.

NEFC we have many examples such as the TVA and the New York Port Authority, the Reconstruction Finance Corporation and the Export-Import Bank. There are ample precedents for the kinds of authority needed and the appropriate legislation, controls and accountability.

The NEA should be an independent agency, perhaps modelled on the original Atomic Energy Commission, in any event as resistant to political pressures as that Commission was. I propose that NEA have a ten-year life and go out of existence in 1985 except for the NEFC, which is likely to be needed beyond that time. There are several reasons for this proposal. First, the exercise of emergency powers is anomalous in our system and should be limited to as short a time as required to overcome the emergency. I believe the job will take a full ten years, but can be done in ten years if the program is geared to such a timetable. Second, when the job is done most of the programs should be carried forward by industry on a commercial basis, and necessary continuing governmental functions can be transferred to other agencies. Third, the best period in the life of any agency is the first ten years. After that the sclerosis of bureaucracy sets in and we certainly do not need any more bureaucracies. No one should seek a career in NEA—only the excitement and satisfaction of doing a critically important job and finishing it. Meeting numerical targets and being measured on performance in meeting them through frequent public reports is the kind of a challenge which should attract the kinds of people needed.

The NEA will have to undertake extensive research and development and pilot plant and demonstration operations. It should, for example, underwrite the incremental costs and use its authority to clear the way for the first two or three nuclear power plants which are built underground. It should back the construction of several demonstration units of large offshore oil production operations incorporating the maximum safeguards in technology and procedures and should use these for public education and to provide a model for the industry. NEA can work out with the AEC appropriate joint activities in regard to the underground power plants, waste disposal, plutonium shipment handling and so on.

In addition, in the Program for the Decade and beyond, conservation should be an important component; this might include the creation of a national fuel efficiency service to effect economies in the use of fuels. Currently, there is an almost complete absence of professional interest, activity, or experience in this subject—whether in universities, engineering firms, business enterprises or the government. A major task of NEA would be to stimulate such expertise and put it to work. As a result of coping with limited fuel supplies during the next few years, we may discover economies which are not only relatively painless but which reveal to us better life-styles. Adopting such life-styles might substantially reduce per capita energy use.

In the Emergency Program of NEA, one of the first projects will be a superport. It may be sufficient for the NEA to exercise the authority to establish the superport and to supplement its financing. Clearly the NEA must work in close collaboration with the oil industry in many of the things it does. It must be shown that gas and oil pipelines can come ashore on their way inland and leave no offensive trace of their transit across the coastline. A second project is to acquire inland sites for oil storage and refineries. It should be noted that even packed closely together a billion barrels of oil storage would take 10,000 acres, or 15 square miles. Inland sites will save our finite coastline for better public uses. Another major project is the question of supplementary finance for tankers—at a time when world shipyards ar solidly booked.

The NEFC will have much to do. To repeat, one problem in the financing of facilities such as the superport, tankers and perhaps the refineries is that at the end of the Decade imports are to be brought down again to only five million barrels per day. Thus the success of the Decade Program may mean a fairly early obsolescence for part of the capacity of the superports and tankers—hence one key need for significant public financing.

VI

In laying out this proposed program, I have indicated some specific steps to minimize its consequences for the physical environment. In some areas we should be better off in the new 1985 situation: our cars should be smaller and have reduced volumes of emissions; most fossil-fueled electric power plants would be taking sulfur out of the stack gases or burning clean non-polluting

gas; new nuclear power plants would be safely underground and out of sight save for their enormous cooling towers; most important, a declining rate of energy expansion would make a great difference to the environment all across the board, at least as compared to what we are headed for at our current rate of expansion. This would represent a sensible modification of our past craze for growth, and the environment would be the gainer in some respects.

But not in others. Up to now we have behaved as if we had the luxury to have the best of both worlds. We have not made the tough choices. Now the energy emergency makes us choose, and the choices are few. Some environmental prices must be paid: one or more oil superports off the East coast, and added refineries (however pure) inland; the Alaska pipeline with residual risks that even the safest design and procedures cannot avoid; much increased offshore oil development, and much increased coal mining largely from surface sources—which even with the best possible measures would tend for a time to deface the particular area. I do not minimize these costs, but feel them keenly as one who has been active for several years in the scientific effort in support of national and international environment measures. In each case, the trade-off has been weighed, and it seems to me that the gain outweighs the loss.

VII

What I have proposed is a national program for the United States, calculated on the basis of particular American resources and American needs. One of its major purposes is, of course, an international one, to shorten the duration of the costs, pain and strain—and of the dangers to world harmony and peace—that lie in a situation of growing American dependence on external energy sources, especially Middle East oil. But it is primarily the United States that would be hitching up its belt and putting its energy house in order, by measures that do not in themselves harm any other nation.

Is the program, however, not only national but nationalistic? Would it affect the world energy picture indirectly to the disadvantage of others, whether suppliers or consumers? Does it mean an increase in American autarky, fortifying the tendency other countries now see for the United States to take care of its own needs and let the rest of the world go hang?

The answer to all these questions is a resounding "No." This is most obvious if we look at the relations between the United States and the other major industrialized countries, which are also the major consumers of energy. As things now stand, Western Europe and Japan are inescapably dependent, far more than the United States and far longer into both past and future, on imported oil and gas; if the United States becomes a vastly increased buyer of both, the effect can only be, at best, friction, and, at worst, price wars and preemptive deals that would cut at the very roots of cooperation between the United States, Europe and Japan. This danger is indeed already visible, and it will take a good deal of statesmanship to avoid it as things stand now; by 1980 or 1985, on present trends, the seeds of strife could be beyond control.

Yet Japan and most of Europe have no alternative comparable to what coal can be for America. Only the United Kingdom, among the major European countries, can meet a significant part of its needs from coal and from North Sea natural gas—and the latter only at the expense of its neighbors' expectations.

Hence these countries should welcome a determined American effort to reduce dependence on the oil sources that are a "must" for them. And the same should hold true for the oil-consuming developing countries, now being badly hurt by the price rises of Middle East oil.

But does this mean that the oil-producing countries would be hurt? I think not. If Mr. Akins and others are correct, the 1980 prospect already assumes that at least two key countries (Saudi Arabia and Iran) will produce more oil, and tap a higher proportion of their predicted reserves, than they may like.[5] To prolong the life of these reserves and to space out the income of the producers can mean a net benefit to most of the producing countries. Their prices will rise in any event in the years to come, but the present prospect of runaway increases in production cannot be attractive compared to a more orderly expansion that prolongs their assets.

Indeed, I would go one step further. I believe that an American program such as I have described could be an essential ingredient in a new approach to the

[5] Akins, *loc. cit.*, p. 480.

energy situation by the whole international community. On any rational look at the production and consumption of energy all over the world, the United States represents not only a statistical discrepancy and target for the role of villain (six percent consuming 33 percent, and getting greater), but a potential disruptive force in almost every market day by day; only if this is brought under control can the United States play any responsible role in the effort that may have to be undertaken within the next decade, or at least by the end of the century—to balance and distribute world energy supplies much more fairly and reasonably than nature or men have ever done to date. For unless we do this there is scant hope for human progress and peace in the long run.

Thus, I propose a program based in the first instance on American national interest. But I deeply believe that this program could make a vast difference to international relations in the next 10 to 20 years, and serve as a step toward a more rational world use of energy for the benefit of man.

PRESENTATION BY PETROLEUM INFORMATION CORP. TO HON. JOHN A. LOVE, DIRECTOR, OFFICE OF ENERGY POLICY

INTRODUCTION

Thank you for your invitation to review with you some of the data, particularly from the exploration-production phases of the petroleum industry, which pertain significantly to the energy situation in our country today. Because this sort of data is Petroleum Information's reason for existence, we are prone to talk at length about it at the slightest excuse, and the present situation is one of the best excuses we've had for a long time.

We are honored to sit with you today, doubly honored in that we are visiting with a fellow Coloradan whose qualifications we know and whose acumen we have seen displayed through some of the most progressive years in Colorado's history. Governor Love, we know better than most not only the enormity of the task that you have undertaken, but also the ramifications of that task, because we have seen the progression of events leading to the problems you face. The industry responsible for the major portion of our energy supply has been warning of today's problems for many years. But, in a time of abundance, listeners were few.

The pertinent items of this history are known to you. This has been shown in your actions to ward off a deepening of the problem and to create a climate in which the "less is better" philosophy need not be applied to the energy field as it influences our way of life.

We may as well say at the outset that this sort of negative philosophy is not our idea of furthering the American dream. We have both observed and served the oil industry long enough to have faith in its ability to deliver the seemingly impossible. Which is not to minimize the problems ahead. We do recognize that the current situation is the most challenging the oil industry has ever faced.

As we all know, we are not going to reduce energy demands to a no-increase situation. Though we may be able to slow the rise in demand without sacrificing too much of the fabric of our social and economic system, we will still have to rely on the petroleum industry to supply most of our energy through the rest of this century, especially through the next dozen years. When we speak of the oil industry, we speak of the people who will be instrumental in supplying energy, from whatever source, for as long as most of us here will be using it.

Our objective today is to be helpful, if we can, in some of the decisions that you must make in the weeks ahead. We won't survey the picture in detail, nor will we attempt to cover every ramification. But, hopefully, the material we do present will include some concepts and some specific items which might not otherwise have been a part of your decision making process.

Our energy supply is a function of so many interrelated factors that the effects of an action require several years to take definite form and to be fully felt. We know now that actions taken in 1954 in respect to control of gas prices are manifested today, nearly 20 years later, as part of the energy shortage. A recent review of the national energy situation in the Conference Board *Record* noted that our options with respect to energy supply have already been severely limited, and that "Unless commitments are made now, future options will be foreclosed."

Obviously, it behooves one to consider the maximum amount of data available when defining alternatives and comparing outcomes of potential commitments. This was recognized in recent recommendations of the National Commission of Materials Policy establishment of a minerals inventory and data base to provide reliable information for materials policymaking.

Petroleum Information was organized in 1928 as an information service to the oil and gas industry in the Rocky Mountain states. It came to the present management in 1946, and since that time has grown so that its scope is national, and international, in that it covers all the oil and gas drilling activity in Canada.

Petroleum Information operates by covering every well drilled for oil and gas in the U.S. and Canada. It lists a location as soon as it is announced or filed with the proper state or provincial authority. The well progress is followed through completion, and the information collected becomes a part of Petroleum Information files. Petroleum Information pioneered the adaptation of well data to the computer format. This operation, unique to Petroleum Information, is accomplished b ya sta ffof approximately 400 people in 38 locations whose sole occupation is the accumulation, processing and publication of data.

Our existence attests to the need for broad operational data by all segments of the petroleum industry. Indeed, it is the use of these data in the search for oil and gas that keeps us in business. Long ago, companies both large and small concluded that the dissemination of information, even though acquired at considerable cost by some individual company, was a matter of enlightened self interest. More comes back from such an exchange than is disclosed.

The accumulating and processing agent—PI—is free of any conflict of interest, since PI has consistently avoided direct involvement in the oil and gas industry.

What I have said is background, and I do not intend to talk of PI at length. It is enough to say that over the years PI has accumulated files which contain well data as shown:

Wells in PI computer file

Region:	*Total well units*
Appalachian basin	24,500
Gulf coast-East Texas	77,900
Louisiana-Arkansas-Florida offshore	128,000
Michigan basin	31,800
Midcontinent	141,400
Mississippi-southeast	20,700
Permian basin	185,200
Rocky mountain region	108,700
Illinois basin	13,100
Totals	731,300

Not all of what follows has come exclusively from these files: much of it has. We have sometimes drawn on figures published by others. I might be forgiven, I hope, if I indicate that the statistical data from other sources which we may sometimes present as pertinent, but not necessarily proprietary, is many times derived, by the sources themselves, from PI basid data.

PRESENTATION

Gentlemen, we might argue that over the years it has been PI's good fortune to have had a positive influence on oil and gas discoveries in these United States. We have collected and made available to the industry information which proved useful in the exploratory effort. Also, the expressed need of the industry over those years has permitted expansion of the services which PI provides. Though sobering, it is gratifying to know that we might now be helpful with policy considerations of actions which must be taken in the immediate future—actions which will have a long-term effect on the energy supply.

We might say that we stand at the crossroads of the energy dilemma in this country at this moment, but that would not be a fact. We stood at that crossroad nearly 20 years ago, when the Phillips decision was made. Our problem now is not which road should have been taken in 1954, but rather how we should cope with that decision.

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Long before now you have become keenly aware that you will need every resource, datawise, that can be placed at your disposal to assist with the definitions of the problem and the formulation of alternatives, if not solutions. As Maury has said, we do not presume to be able to hold up all the considerations which you will eventually entertain or all the alternatives which you will eventually consider. But, we hope we can contribute a few ideas, offer a few examples of modes of thinking, examples of cause and effect and examples of tools which you may use to structure at least a near-term approach to the problem of today's energy reality.

It is perhaps too easy to be simplistic in the approach to any situation. Yet the simplistic approach is notable for the starkness with which it displays the problem. To that end it's not necessary for me to recap the various forecasts of demand, and indeed it is not Petroleum Information's primary area of expertise. The fact is that demand forecasts run traditionally on the low side, and newly introduced environmental considerations have helped expand demand without improving the efficiency of utilization of energy resources.

The consensus of nearly all estimators of demand is that oil and gas supplies more than 75 per cent of our total energy requirements today and must continue to supply a majority of that demand through the remainder of the century.

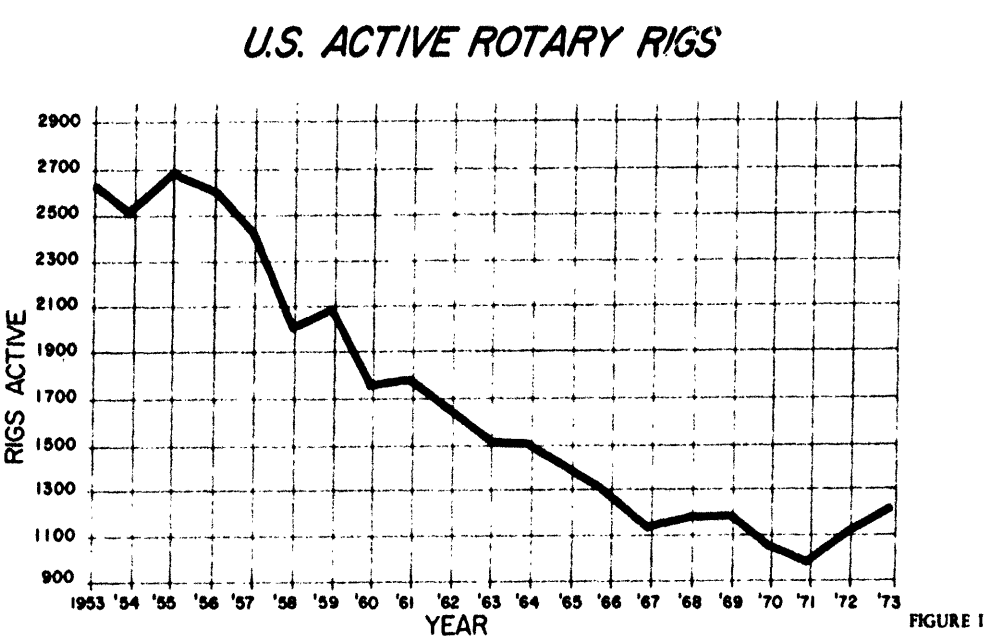


FIGURE 1

Here I would like to display the energy shortage and trace the growth of that shortage in one chart, figure 1, which is to me very dramatic. Reviewing the number of U.S. active rotary rigs over a period of time yields some concept of the amount of energy being added annually to our supply, since we can compute the average amount added per successful oil or gas well drilled, and because the number of successful oil and gas wells drilled varies directly with the number of total wells undertaken. The chart shows the decline in the average annual employment of rotary rigs in the United States. Very graphically it displays the effects of the so-called Phillips decision made in 1954, which put rigid controls over the price paid for natural gas at the wellhead. Simply controlling the price of gas would not have made that much difference in the total rig count or the total drilling in the United States, but controlled prices made natural gas the biggest energy bargain in the country and the net result was restraint of the movement of the prices of crude oil in anything which resembled an open market place. Also, the cost of drilling continued to advance, but the economic incentive to drill and produce declined. The influence of then-cheap foreign oil, which has not been referred to, was also a factor in the decline of domestic drilling.

And if I had to take one chart and summarize the energy problem in the United States today, it would be this one. The chart does have a positive side.

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Note that the active rotary rig count has turned upward in the past couple of years. This coincides with rising prices for natural gas, with higher prices for crude oil, and with the increase in the price of foreign crude. Any continued observation of the oil industry over a period of years will show the effort to find and develop new reserves to be in direct proportion to the possibility of reasonable economic realization. And . . .

We still have a long way to go before we reach the point where diminishing returns will terminate the exploratory effort as we have known it. The American Association of Petroleum Geologists tells us that there remains to be found almost as many barrels of oil as we have already discovered. Their studies show that if we can increase our ultimate recovery rate to about 42 per cent of the oil in place, we can add some 47 billion barrels to present reserves and about 34 billion barrels to expectable reserves. If we could increase the ultimate recovery rate to 60 per cent of the oil in place, a rate some geologists deem attainable by the end of the century, we could increase the value of present reserves by 100 per cent and do almost as well by the expectable reserves.

Figure 2 displays the history of oil and gas found per new oil well or per new gas well drilled over the past 20 years. Note that the total ultimate recovery credited to the new oil wells has ranged from 85,000 barrels per well to more than 225,000 barrels per well. What is more important to us now is that there is no evidence of a downward trend in the amount of oil found per new oil well drilled.

Over the past twenty years the amount of gas credited to each new gas well drilled fluctuated from highs in the vicinity of 6 billion cubic feet per well to lows of 2 billion cubic feet. The average over the entire period falls just short of 4 billion cubic feet per well. Again, the important thing is that there is no particular downward trend in the amount of gas found per new gas well drilled.

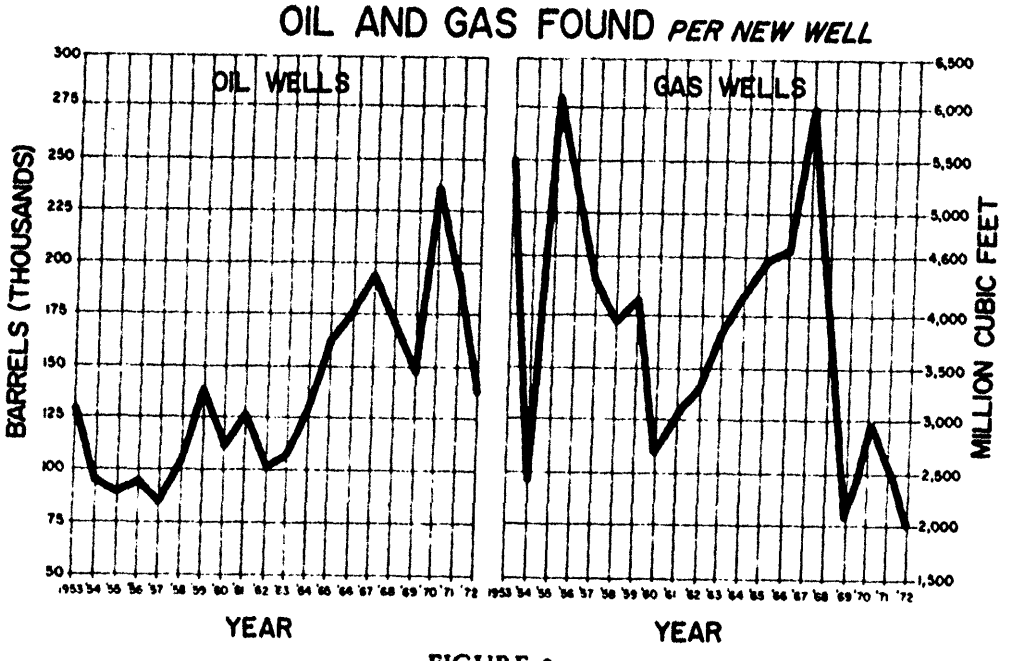


FIGURE 2

Let's look now at the importance of the total drilling process. Figure 3 reviews total drilling in the United States from 1966 through 1972 as to the effect on reserves of the discoveries, made in each of the years in question. Each bar represents all the oil discoveries in the year indicated. The bottom figure on the right of each bar represents the total recoverable reserves, in millions of barrels, assigned to the discoveries in the year of discovery. Additions to or revisions of reserves are indicated by the figures associated with subsequent years. Note for instance, that all discoveries made in 1967 had 136 million barrels of recoverable reserves assigned in the year of discovery. By the end of the second year, 1968,

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these reserves had grown to a total of 373 million barrels, as a result of development drilling. At the end of 1969, the 1967 reserves had grown to 513. Ultimately, after the fifth year of successive upward revision through drilling and through production history, we knew that 1967 discoveries had really been responsible for the proving of 734 million barrels of oil. There is no indication at this point that further expansion of the reserves credited to these discoveries cannot take place.

But the estimation of reserves is not an exact science, and this is illustrated by 1968. In the year of discovery 192 million barrels were credited to 1968 successes. By the end of 1969 engineers believed that these discoveries had turned up 466 million barrels. These were revised sharply downward to 208 million barrels in 1970, then upward again to 322 million barrels in 1971. At the end of 1972 it appears that 379 barrels had been discovered by 1968 successes.

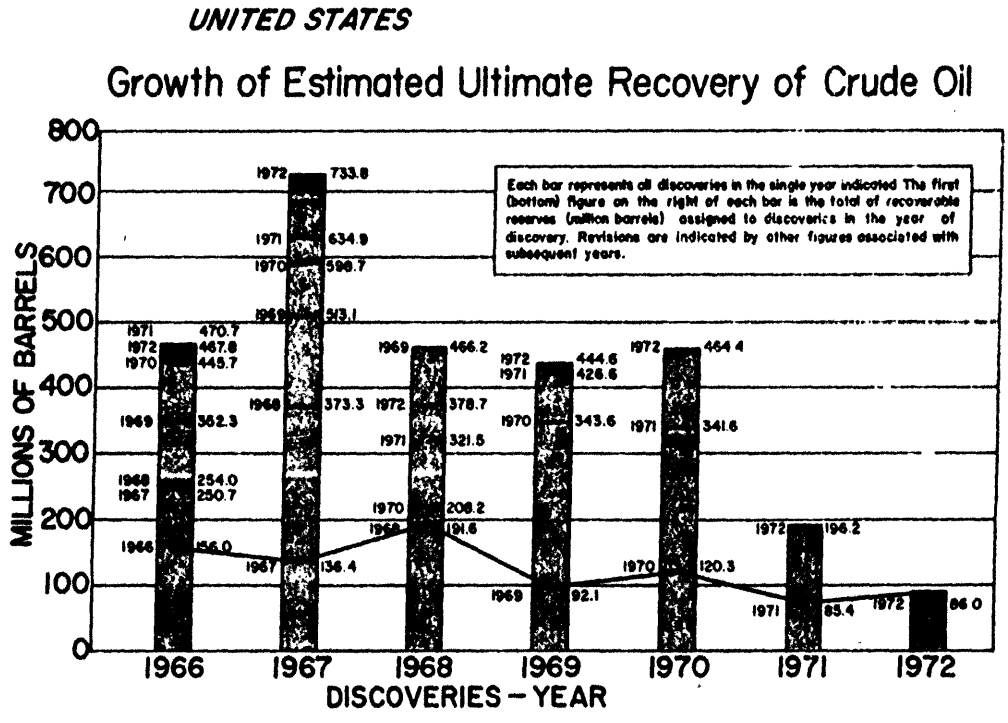


FIGURE 3

Now notice the extreme importance of development drilling in the second year of 1969 discoveries. These successes were credited with just over 92 million barrels. Development drilling has expanded those reserves to 344 million barrels at the end of the second year of their existence, and subsequent expansions have been significant, but smaller. Similarly, the initial year's reserves assigned to 1970 discoveries amounted to 120 million barrels and, at the end of 1971, this had grown to more than 341 million barrels. It now stands at almost 465 million barrels. Hopefully, the same process will apply to reserves found in 1971 and 1972.

Several things are worth noting about the chart in figure 3. Seven years of history may not suffice to definitely establish the amount of recoverable oil for which a given year's discoveries are actually responsible. More important, it is imperative that development drilling be encouraged to proceed as rapidly as possible once discoveries have been made. Not only does this expand the reserve base on which the country must depend, but it also establishes a higher productive capacity by quickly expanding the number of producible wells. This is a rather critical matter at this point since we are concerned not only with barrels of reserves ultimately to be recovered but also with the question of

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whether we can produce those reserves at a rate sufficient to maintain a relatively stable percentage of domestic supply versus total demand.

While we're on this subject, let's look at a year's record of completions in the United States by class (fig. 4). The new field wildcats, or rank wildcats, are shown in the lower part of the chart by the white band; other exploratory wells such as deeper pool tests, shallower pool tests, and wildcat outpost extensions are shown by the middle, grey band. Shown in black are the development completions.

It has been said by some that incentives to encourage development of our domestic reserves should be extended only to wells in the first category, or possibly in the first two; that is, those wells definitely carrying exploratory risks. I suspect, however, that we are at a time when one of our imperatives must be to insure early and complete development drilling to provide, as we said a moment ago, the earliest possible maximization of producibility from those fields which have rewarded exploratory efforts.

We should also note that development drilling in itself carries with it inescapable risks. If development is to proceed to full definition of reserves, inevitably those wells which are completed as producers will carry on their backs a number of dry holes which will be encountered as the field is defined. Though the unit cost of wildcats may be higher, the number of development wells needed to maintain an adequate producing rate requires a very substantial outlay.

Removing the incentives for drilling development wells would destroy a significant part of the capital generation capability of the industry and would inevitably lengthen the time required to realize the benefits of successful exploration.

Another aspect of the energy problem which we might consider is that of refining. Our demand is now approaching 17 million barrels a day, but our refinery capacity has not yet exceeded 14 million barrels. This creates a built-in inability to process crude from whatever source. But . . . we may not be that familiar with the distribution of existing refineries (fig. 5).

Here shown by the major production related regions is the distribution of refineries within the United States. We have 253; 46 of these, or 16 per cent of total capacity, are on the West Coast; 35, about 16 per cent, on the East

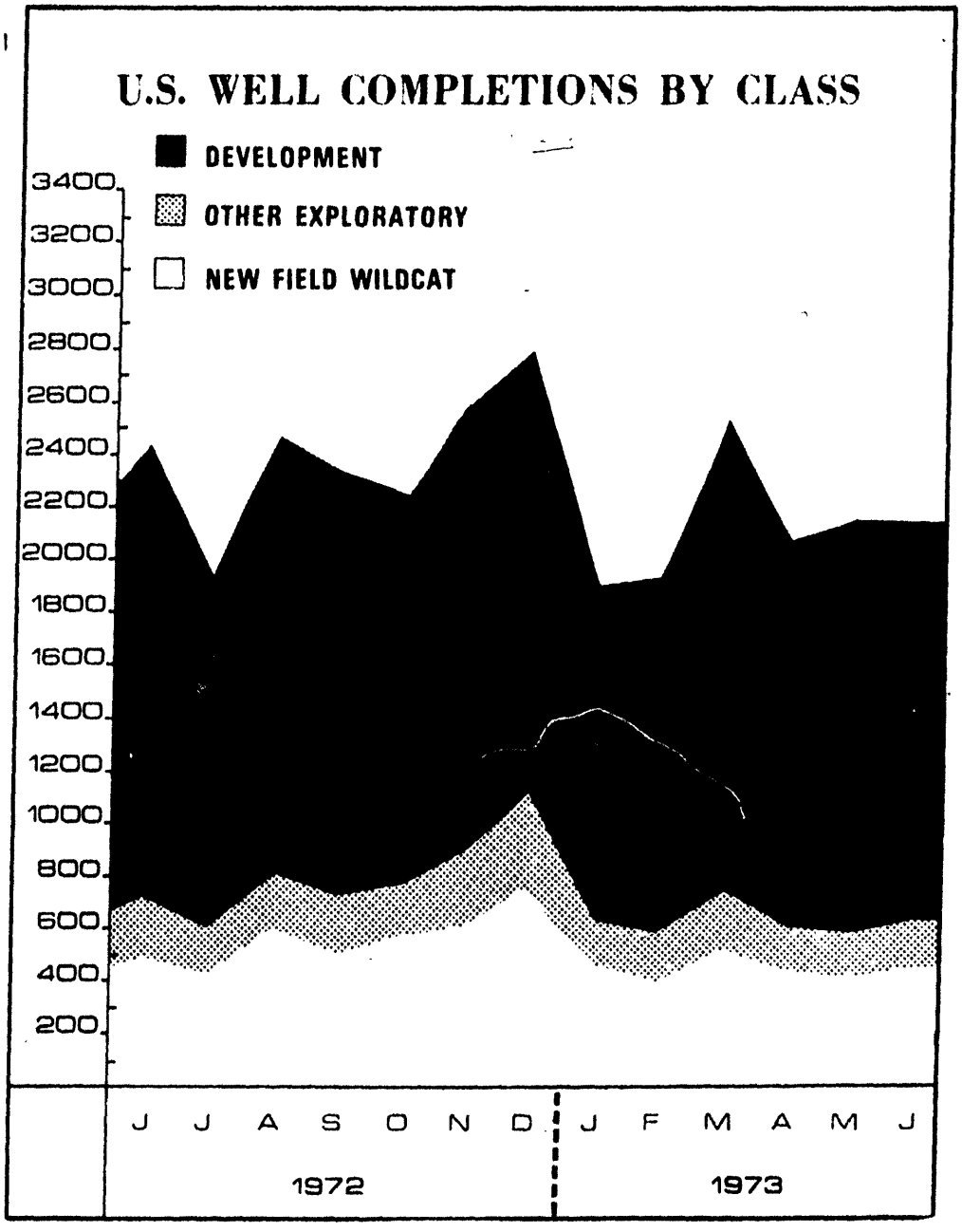


FIGURE 4

Coast, shown here as the Appalachian Region. The Midwest (Illinois and Michigan Basins) has 29, amounting to 14 per cent of total capacity. The Rocky Mountain Area has 32 refineries, accounting for 4 per cent of national capacity; the Mid-Continent 28, or 8.9 per cent, and the Southeast 13, or 3 per cent. Southern New Mexico and Texas have 45 refineries, 26 per cent of capacity, and the Louisiana-Arkansas area has 25 refineries, almost 12 per cent of total capacity. It is interesting to note the comparatively small percentage of refining capacity in the populous East Coast, and the West Coast has an equally small amount. Quite obviously, there is some imbalance between demand and the actual location of refineries, which have in the past tended to follow the location of the reserves.

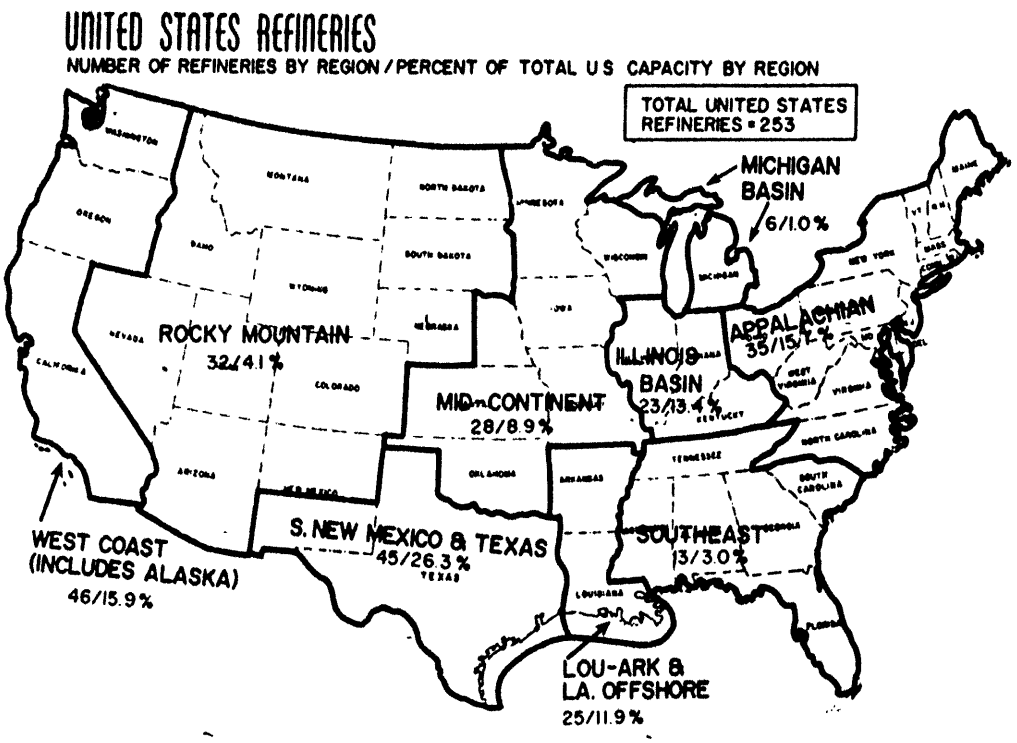


FIGURE 5

Figure 6 shows the distribution of reserves across the United States by major regions as of the end of last year. Note that 49 per cent of proved oil reserves are in Southern New Mexico and Texas and the Louisiana-Arkansas and Louisiana Offshore area. Note also that more than 66 per cent of the gas reserves are in those two areas. Now, where are we currently obtaining most of our production?

In 1972, 74 per cent of all United States natural gas production came from Southern New Mexico and Texas and the Louisiana-Arkansas and Louisiana Offshore areas (fig. 7). This is a higher percentage of total production than the reserves of those areas amount to, as a percentage of total U.S. gas reserves. Texas and Louisiana yielded 63 per cent of total crude and condensate produced in 1972, but had only 49 per cent of total reserves. Here the imbalance between percentage of reserves and percentage of total production is even better illustrated.

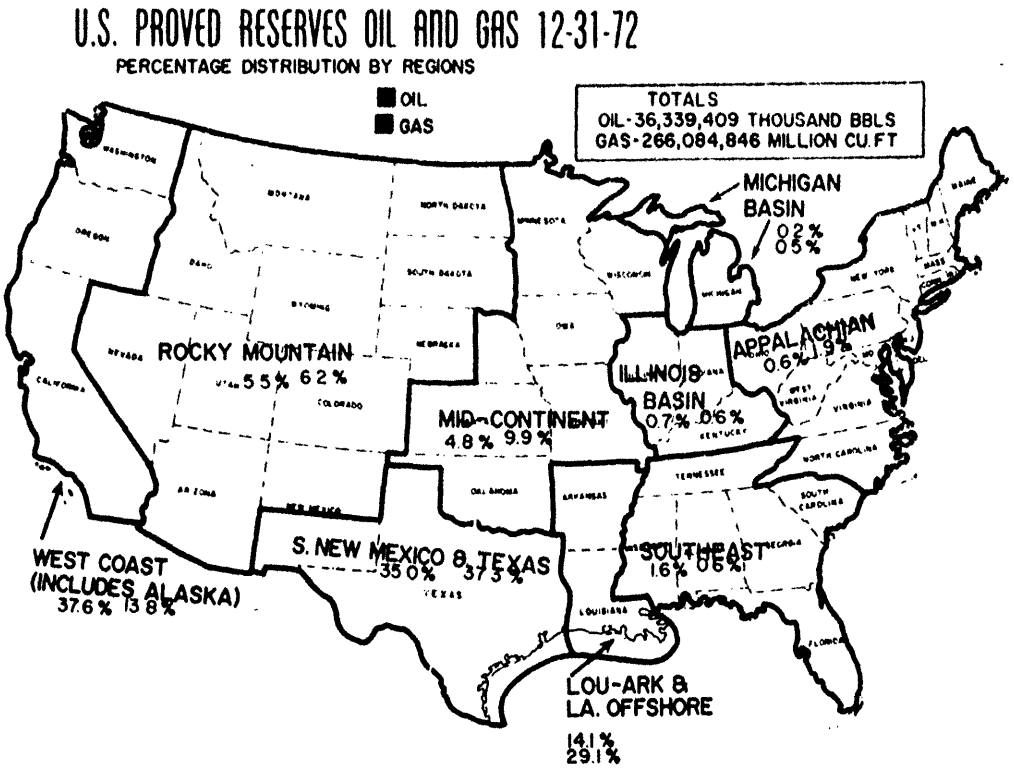
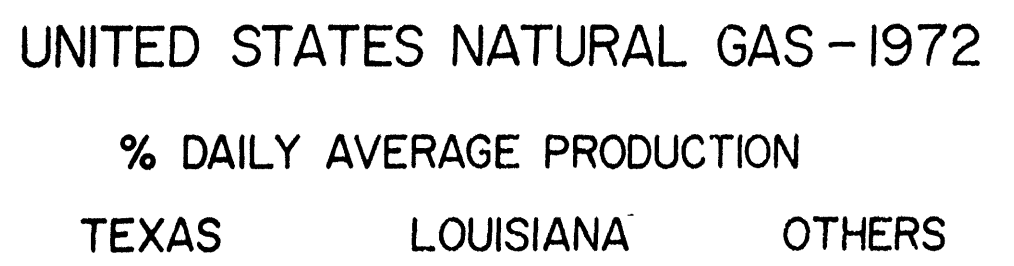


FIGURE 6



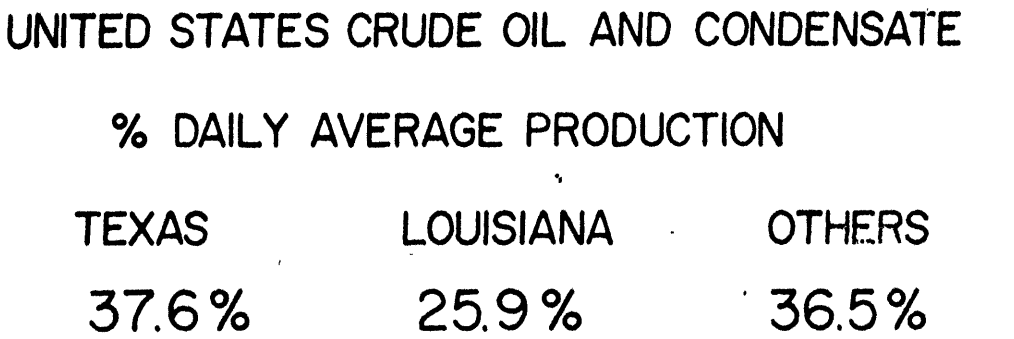


FIGURE 7

Today, Texas and Louisiana are carrying more than their pro rata share of the country's current production based on the reserves, and neither state has excess productive capacity. A check about ten days ago revealed that there are fewer than 15 reservoirs in the state of Texas which could produce beyond current rates of production. Three years ago, 32 such reservoirs were listed. In Louisiana, state authorities report that there are only a few wells capable of production beyond the present rates and that the total would not amount to more than 5,000 additional barrels per day.

It is interesting that very little has happened to the production of crude and condensate Offshore Louisiana and that only a relatively small increase has taken place in the daily averge production of gas in that area since 1970. For instance, in December of 1970 the daily average production of crude oil Offshore Louisiana was 1.1 million barrels per day. In March of 1973 it had fallen slightly. In December of 1970 the average daily rate of gas production Offshore Louisiana from both Federal and State acreage was 8.4 billion cubic feet per day. By March of this year it was 10.3 billion cubic feet a day.

Figure 7 and the statistics of the offshore producing situation as far as Louisiana is concerned have, I believe, made one salient point. The critical factor involved in the production of either oil or gas is deliverability, a function of the number of wells on production, if we can assume that each such producing well is being produced at or near maximum efficient recovery rate. This seems to be a rather safe assumption under today's conditions. Deliverability is the key to a comparatively stable flow of domestic oil and gas. Where a hiatus or a decline occurs in drilling, deliverability is negatively affected at some point. That the number of wells drilled has declined will be confirmed by another look at figure 1.

A very important contribution to deliverability is made by stripper wells. By definition, a stripper well produces an average of 10 barrels per day or less. In 1971, each of 354,000 stripper wells produced an average of 3½ barrels per day, a total of more than 423,000,000 barrels of oil, or about a tenth of total production. It is estimated that the reserves under these wells amount to some 4.8 billion barrels, about one eighth of our total estimated recoverable reserves. About half of the reserves credited to these wells is primary in nature, and about half is the final production to be realized thru secondary recovery methods in the present state of that art.

The reserves underlying these wells must not be abandoned. But they will be produced only if the revenues can exceed the cost of production. If we do not recognize the significance of the oil yet to be recovered from wells now economically marginal, we will be turning our backs on some 10 percent of the oil available to use. Fortunately as the average price of oil per barrel of a couple of years ago, $3.39, has moved toward an average of about $4.00 a barrel, the economic life of the stripper well has been extended. It may be worth considering whether special economic incentive should be offered to stripper wells.

Southwest Carlsbad field in Eddy County, New Mexico also illustrates improved economics at work. Production was found in this field late in 1968. It was necessary to drill to a depth of about 12,000 feet at a cost of about $200,000 for a dry hole or about $305,000 for a producing well. Cost of leases for such a well approximated $32,000. The amount of reserves to be found by a given well could not be classified as phenomenal and has since been shown to range somewhere between two billion and 15 or 16 billion cubic feet. At any rate, only two wells were on production in 1969. By the end of 1970, only 4 wells were on production, but then the tight gas supply situation and the inevitability of high prices became a fact, and at the end of 1971, 14 wells were on production. Increasing prices were dramatically reflected when, at the end of 1972, 25 wells were on production. As of the end of June of this year, 36 wells were producing. The field now has 45 wells which are completed and capable of production; some of those are not yet hooked up. Seven wells are drilling at this time. Locations which are not yet drilled indicate that the field may ultimately have as many of 93 producing wells and that the reserves recoverable from these wells may be approximately 750 billion cubic feet of gas.

The development of this field proceeded slowly until there was a change in economics. At the 16½ cent area price which prevailed at the time of the field discovery, a well with reserves of 8 billion cubic feet offered a 3.4 gross return of investment over 10 years. That same well at today's new area price of 35 cents will return its investment on a gross basis 11.9 times. This makes drilling

in an area of this sort a far more attractive situation. The prospect of the inevitable dry holes which must be drilled to define an erratic reservoir can be faced realistically when the gross return has risen as has been the case. Had the older price remained in effect, it is doubtful whether this field, which apparently will yield about 1/25 of a year's consumption of natural gas, would have been developed. Now a wide area in this portion of New Mexico is under intensive exploration. Speculative activity in such a wide area, where the odds against exploratory success are great, can only be supported by respectable rate of return on productive wells. It is not enough that the individual well perform as a single unit on an economic basis. It must shoulder the expense of exploration where success is a highly questionable factor.

It is encouraging that such stories as SW Carlsbad are being widely repeated today. These additions are not so dramatic as major discoveries in virgin areas such as the continental shelf or perhaps the Arctic Islands, but their impact is more immediate. They constitute a direct response to improving economics, and a possible means to get us through the near-term energy situation.

Whether the improved revenues to be received from higher prices are really reflected in desirable drilling has come under question in recent months.

Figure 8 shows that a real and immediate response may be expected as economic changes take place. For 1972 and the first half of 1973, oil and gas wells are plotted as a percentage of total successful wells. Note that as gas prices began to improve during this period, the percentage of gas wells rose from about 25 per cent to the present level of about 38 per cent and that it is still rising. Percentage of successful wells which were oil wells has declined, reflecting increased emphasis on gas prospects and a less obvious improvement in the economic position of crude oil.

In passing, it might be well to ask ourselves what would happen if gas prices rose to parity with today's $4.00 oil. This would mean 80 cent gas and we haven't had anything much over 50 cents approved in interstate commerce to this point. We do know that imported gas, substitute gas from coal gasification, or synthetic natural gas from petroleum liquids, is going to cost at least 80 cents. The consumer can take consolation in the fact that wellhead price is on the order of 17 per cent of this cost.

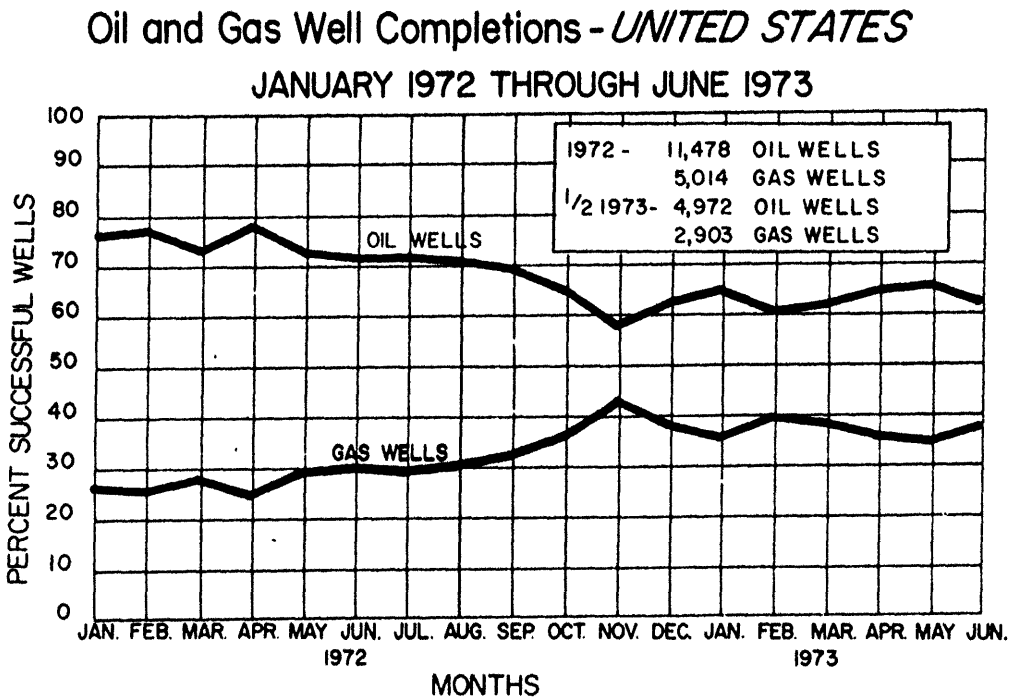


FIGURE 8

It has been said repeatedly that onshore exploration will involve vertical exploration to a high degree. In other words, there is still promise in the deeper formations of some of our basins where shallower formations have been highly productive and where the past economics of deeper exploration have not been particularly attractive. There are some rather striking examples of deeper exploration, which is now growing in importance. One such example is the Anadarko Basin, particularly in Western Oklahoma and the Panhandle of Texas. I am going to show what is going on in those portions of that basin. The figures presented here have not been previously published and constitute entirely new information which is here presented for the first time.

Figure 9 is a review of 1972 drilling in the Anadarko Basin by depth categories. Note that 23 wells were drilled below 17,500 feet. Of these, 16 were completed as gas wells, one was an oil well, and 6 were dry holes. Cost of drilling and completion through the Christmas Tree have been applied. Note that the cost of these 23 wells amounted to more than a million dollars each, and that the 17 producers must carry the burden of the more than $6 million invested in dry holes. Of course, not all of those producers may prove to be economic. Six of ten wells drilled below 20,000 feet in this basin were gas producers; each of these wells cost $1.8 million. In 1972 the industry spent more than $202 million to explore the Anadarko Basin, and more than half of that amount was spent to drill below 10,000 feet.

OKLAHOMA-TEXAS PORTION, ANADARKO BASIN

1972 Drilling, Results And Costs By Depth Categories

Depth	Oil Wells	Cost ($1,000)	Gas Wells	Cost ($1,000)	Dry Holes	Cost ($1,000)	Total Wells	Cost ($1,000)
0-1249								
1250-2499								
2500-3749	20							29
3750-4999	18							588
5000-7499	110							47
7500-9999	175	2						7
10,000-12,499	44	8						
12,500-14,999	1	372						
15,000-17,499			7					
17,500-19,999	1	1,708	16	18,647				
20,000 plus			6	11,598	4	7,197	10	
BASIN TOTAL	445	49,602	353	86,868	410	65,984	1208	264

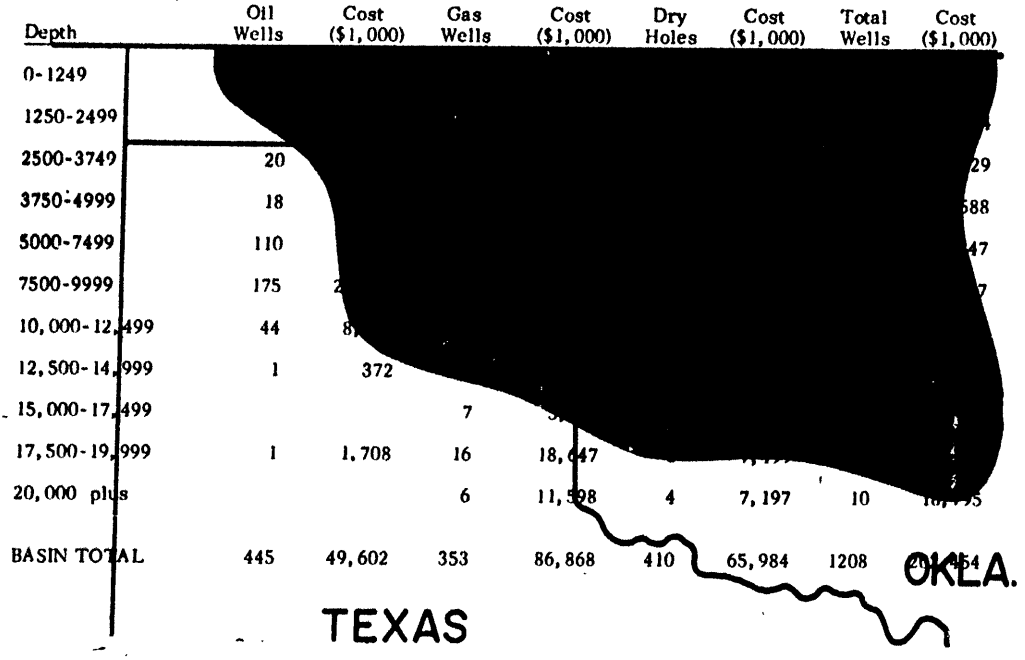


FIGURE 9

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OKLAHOMA-TEXAS PORTION, ANADARKO BASIN

First 7 months 1973 Drilling, Results And Costs By Depth Categories

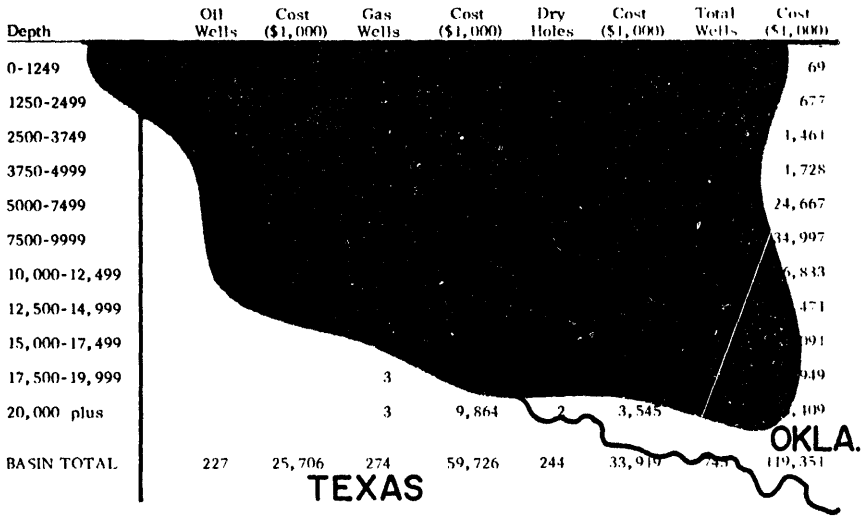


FIGURE 10

Figure 10 shows the picture of the first seven months of this year. Five wells were drilled below 20,000 feet. Three of them were productive. They cost more than $2.6 million each. Total drilling is running ahead of last year, and the number of successful completions is also running ahead. And, we might note, so is the amount of money spent. It is interesting that in Beckham County, Oklahoma the world's deepest well was recently completed at 30,050 feet. Another well in the Oklahoma Anadarko Basin went to 27,050 feet. Neither of these wells produced from the ultimate depth, but the deepest well did find production in shallower formations.

Figure 11 composites the 19 months, showing 1,053 wells drilled in the Anadarko and $322 million spent, about half of it in drilling below 10,000 feet.

Apparently the vertical exploration of a vast area of the Anadarko Basin is just getting underway. Obviously the attendant success is sufficient to spur additional activity, even in the face of astronomical costs.

Similar deep success in reservoirs not previously extensively tested has been realized in several other basins. Notable examples include a discovery in the Green River Basin in Southwestern Wyoming. The shelf areas of this basin have produced for many years, but little deeper drilling to formations older than Jurassic had been done in the central basin area. Drilling is now very much in progress to evaluate what appears to be a substantial oil discovery producing from Jurassic and from deeper Pennsylvanian as well as some shallower Cretaceous formations. In the Uintah Basin of Utah, deep and expensive drilling proved deeply buried Tertiary zones capable, in the opinion of some observers, of yielding more than a billion barrels of oil.

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OKLAHOMA-TEXAS PORTION, ANADARKO BASIN

1972 and First 7 Months 1973 Drilling, Results And Costs By Depth Categories

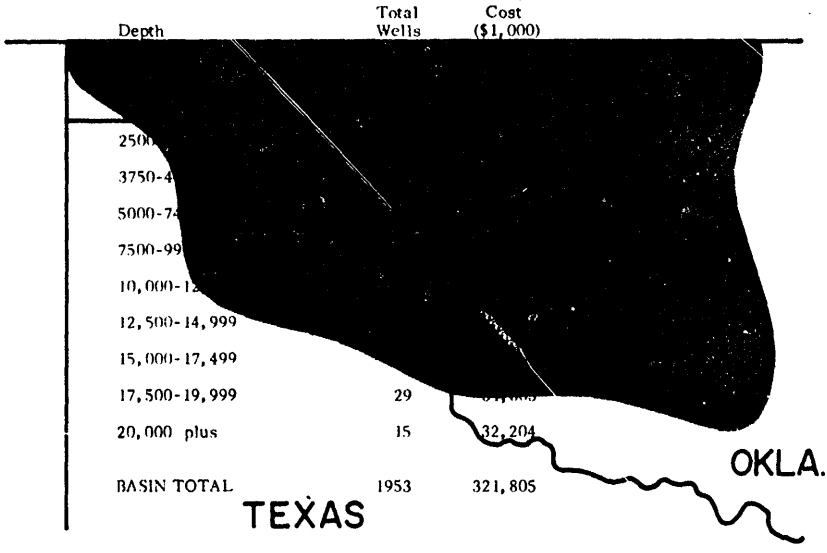


FIGURE 11

These exploratory trends and examples of recent successes show that there is significant onshore potential for new discovery. . . .

Who will do the drilling? Who has done the drilling? Who has made the discoveries in recent years in the U.S.? Is this industry dependent upon the efforts of a handful of very large companies or is it still a viable, widely based industry deriving its strength from the entrepreneurial aspirations of a substantial group of oil operators?

In truth, very much the latter situation does exist.

In figure 12, we have analyzed 1972 drilling as to the operators of record for all the wells drilled in that year in the U.S. We have compared the activity of the Chase Manhattan Bank's group of 30 larger companies with the activity of "all others," some 4,000 independent operators, whose potential can be readily recognized. You may have seen a summary of the information shown here in a recent Petroleum Information publication. You will not have seen it otherwise because the statistical capability for a current survey of this kind exists nowhere else to my knowledge.

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OPERATORS OF RECORD - *U.S. DRILLING, 1972*

CHASE MANHATTAN BANK GROUP OF 30 "LARGER" COMPANIES VS ALL OTHERS

	TOTAL WELLS	PERCENTAGE	TOTAL FOOTAGE	PERCENTAGE
ALL U.S. DRILLING				
CHASE GROUP	4,833	17.50%	30,598,231	22.39%
ALL OTHERS	[redacted]			
TOTAL	27,615		136,636,237	
ALL EXPLORATORY WELLS				
CHASE GROUP	1,000	11.08	8,823,474	16.46
ALL OTHERS	[redacted]			
TOTAL	9,024		53,579,876	
ALL DEVELOPMENT WELLS				
CHASE GROUP	3,833	20.62	21,774,757	26.22
ALL OTHERS	[redacted]			
TOTAL	18,591		83,056,361	

FIGURE 12

I must emphasize that this is an operator of record survey which is the only basis upon which it could be made, and it does not reflect dry holes and other support type contributions which may have been enjoyed by these smaller operators. The figures may surprise you. Note that the Chase Group drilled 17½ per cent of total U.S. wells. These companies with their major resources did drill a higher percentage of the total footage; that is, they carried a great many of the deeper wells. "All others" . . . a category which also includes some pretty sizeable companies, as well as the smaller independents, and the public limited partnerships which spent over $300 million in domestic drilling last year . . . drilled 82½ per cent of all the wells drilled in the U.S. in 1972.

The Chase Group drilled 1000, or 11.08 per cent, of all exploratory wells, and the other operators drilled 8,000 exploratory wells, almost 89 per cent of the total. The Chase Group drilled a higher percentage of development wells, nearly 21 per cent, as opposed to more than 79 per cent for all others.

Now let's turn to an analysis of the success realized by our two categories of operators (fig. 13). The Chase Group drilled 12.8 per cent of the oil discoveries. The others drilled 87 per cent. The Chase Group drilled 26 per cent of development oil wells, others 74 per cent. The Chase Group drilled 11.4 per cent of gas discoveries, others 88.6 per cent; and the gas development was conducted 17.73 per cent by the Chase Group, 82.27 per cent by others.

The dry hole record apparently credits the smaller operators with a greater willingness to take risks. The potential rewards to them are perhaps more significant. At any rate, the Chase Group drilled 11 per cent of the dry exploratory wells and 11 per cent of the dry development wells; all others drilled 89.2 per cent of dry exploratory wells and 89.1 per cent of dry development wells.

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Analysis of Exploratory and Development Success - 1972

CHASE MANHATTAN BANK GROUP OF 30 "LARGER" COMPANIES VS ALL OTHERS

		EXPLORATORY		DEVELOPMENT	
		WELLS	% OF CATEGORY	WELLS	% OF CATEGORY
OIL					
	CHASE GROUP	142	12.86	2,655	26.00%
	ALL OTHERS				
GAS					
	CHASE GROUP	130	11.40	683	17.00%
	ALL OTHERS				
DRY					
	CHASE GROUP	728	10.74	495	10.94
	ALL OTHERS				

FIGURE 13

Permit me to comment on that last figure. We said earlier that development drilling carries a considerable risk factor. Who assumes it? Obviously the smaller, more entrepreneurial operator who stands to benefit from extending the field to its ultimate limits. He is important because he can perform the function of defining the extent of discoveries already made and of proving those reserves not attractive to larger companies who may insist on elephant hunting.

It is in the national interest to keep this guy around.

Having surveyed who did the work on an operator-of-record basis and having analyzed the relative success attained, we were interested to know who spent the money on drilling costs through the Christmas Tree in 1972 and where it was spent. Using the same operator-of-record basis for computation and using costs derived from the Joint Association Survey in 1971, adjusted for inflation, we came up with figure 14.

years (fig. 2) and assume that (1) similar success can be enjoyed in new drilling on the average through 1985 and (2) the ratios of oil and gas wells to total drilling will remain approximately the same during the period. The analysis yields some rather interesting figures (fig. 15).

FIGURE 15

TOTAL WELLS NEEDED TO MEET FORECAST

	Oil	Gas	Total
1973	30,965	2,976	55,345
1974	31,080	2,579	55,178
1975	31,109	2,363	54,872
1976	31,283	2,150	54,808
1977	31,400	1,931	54,606
1978	31,502	1,714	54,452
1979	31,582	1,498	54,230
1980	27,754	2,287	49,248
1981	27,558	2,149	48,700
1982	27,216	2,013	47,916
1983	26,984	1,876	47,311
1984	26,700	1,741	46,625
1985	26,040	1,604	45,318

U.S. LIQUID HYDROCARBONS

[Figures, except in last column, in millions of barrels]

	Production	Reserves	Additions	Wells needed
1973	4,106	43,113	4,263	30,965
1974	4,121	43,270	4,279	31,080
1975	4,136	43,428	4,283	31,109
1976	4,150	43,575	4,307	31,283
1977	4,165	43,732	4,323	31,400
1978	4,180	43,890	4,337	31,502
1979	4,194	44,037	4,348	31,582
1980	4,209	44,194	3,821	27,754
1981	4,172	43,806	3,794	27,558
1982	4,136	43,428	3,747	27,216
1983	4,099	43,044	3,715	26,984
1984	4,063	42,660	3,676	26,700
1985	4,026	42,273	3,585	26,040

U.S. NATURAL GAS

[Figures, except in last column, in trillions of cubic feet]

1973	21.460	268.251	10.906	2,796
1974	20.615	257.697	10.061	2,579
1975	19.771	247.143	9.217	2,363
1976	18.927	236.589	8.373	2,150
1977	18.083	226.035	7.529	1,931
1978	17.238	215.481	6.684	1,714
1979	16.394	204.928	5.841	1,498
1980	15.550	194.375	8.918	2,287
1981	15.019	187.738	8.381	2,149
1982	14.488	181.100	7.851	2,013
1983	13.957	174.463	7.319	1,876
1984	13.416	167.825	6.788	1,741
1985	13.000	161.187	6,257	1,604

Note: Average new oil well equals 137,675 barrels ultimate recovery. Reserve production ratio used 10½/1. Average new gas well equals 3,900,000,000 cubic feet estimated ultimate recovery. Reserve production ratio used 12½/1.

It shows us that we should drill nearly 31,000 oil wells this year, more than 31,500 oil wells in 1979, and 26,000 oil wells annually in 1985. Gas wells are a little different situation because of the Conference Board's assumption of partial replacement of natural gas. But, we would need to drill nearly 2,800 gas wells this year, and by 1985 we would still need to be drilling more than 1,600 wells per year. Translated into total wells necessary to achieve these results with

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ratios of success remaining the same, we would need to drill more than 55,000 total wells this year, about the same in 74, and about 45,000 wells a year by 1985.

Is this possible?

We have done it before, and presumably, we could do it again. However, the number of rigs available for drilling has declined. The pool of manpower has declined. We have started an upward trend in rotary rig activity and the manpower has begun to flow back into the industry, but not at a rate high enough to get us to the desired level of drilling immediately. Hopefully, we can look forward to some discoveries, such as those on the North Slope of Alaska and those which have been made offshore, which would weight the results in our favor and make it unnecessary to drill what now appears to be a rather astronomical number of wells. But it is inescapable that we will have to materially increase our rate of drilling to stay anywhere within range of the Conference Board figures.

We have surveyed the industry, and we find that at the present time there are some 33 offshore rigs under construction in the U.S. This is up from 29 a year ago. We have found that there are some 85 to 100 land rigs currently under construction. This is not an overwhelmingly large addition to our total land rig supply, but it does represent a trend in the right direction. Manufacturers note that their rate of land rig construction is now up from 10 to 100 percent over last year.

As you know, the exploratory process of itself is a long one, and a number of years may elapse before the initial exploratory appraisal of an area results in testing by the drill. Even though we may move with all possible haste toward exploration of the offshore and other areas where major reserves are believed to exist, we still must support our short-term effort by expanded drilling in the older, more mature areas.

Fortunately, these areas have shown potential, as evidenced by the results in the Anadarko Basin, the Uintah Basin, the Powder River and Green River basins, West Texas and New Mexico, South Louisiana and so forth. This type of effort has been greatly assisted by certain government agencies. One such is the USGS which has within it the necessary expertise to materially aid in accelerating the expansion of our domestic energy supply.

The early phases of the exploratory process . . . leasing, geophysics, and analysis of historical data from an exploratory point of view. . . have continued, and it is here where the action must take place in the short term. Figure 16 shows the present lease situation of the industry in those areas which have shown past performance and future potential. The figures on the map add up to more than 332 million acres of nonproductive leases now held. By far the largest potential for future drilling exists in the public lands of the western states where, fortunately, current drilling continues to meet with significant success.

Finally, to support a rate of drilling approximating that of the mid-Fifties and in keeping with projections based on the Conference Board's analysis, it will be necessary to double our present drilling effort and, consequently, to at least double the money expended on exploration and production. In recent years, this expenditure has approximated $4.5 billion annually. Quite obviously, to attain the results we have hypothesized here, that rate of expenditure must approach nine or 10 billion dollars annually in the period of 1985.



FIGURE 16

Here we are caught in something of a split stick. This magnitude of expenditure must be made to supply the energy we need. It can be made with what we believe are demonstrably good probabilities of success domestically, or we can spend such sums abroad and contribute to an intolerable balance of payments situation.

Where are we to generate the kind of money that can come close to filling such a gap?

Well, we can let the price of gas and crude respond to market forces. Gas would still be a bargain if it went substantially higher. The price of crude oil is also going to have to advance. This would have a doubly positive effect in that it intrinsically would generate new revenue and also would draw to exploration-production activity outside capital, an attraction that we must encourage.

And . . . if a different method of awarding leases off Texas had been in effect in June, the industry would have over $1 billion available for exploration which it does not now have. It seems we should encourage the results of the hunt, rather than seeing how much we can charge for the license.

Also, in place of talking about imposing taxes as a deterrent to consumption, we can let the normal trend of prices do the job. The additional monies generated would increase supply rather than becoming the "dead dollars" of taxation which come to government alone and bring none of their aunts, uncles, and cousins along.

All these factors could shape the policy you strive to formulate. It is only our hope that we may have, this morning, injected a concept or a figure or two which may prove helpful.

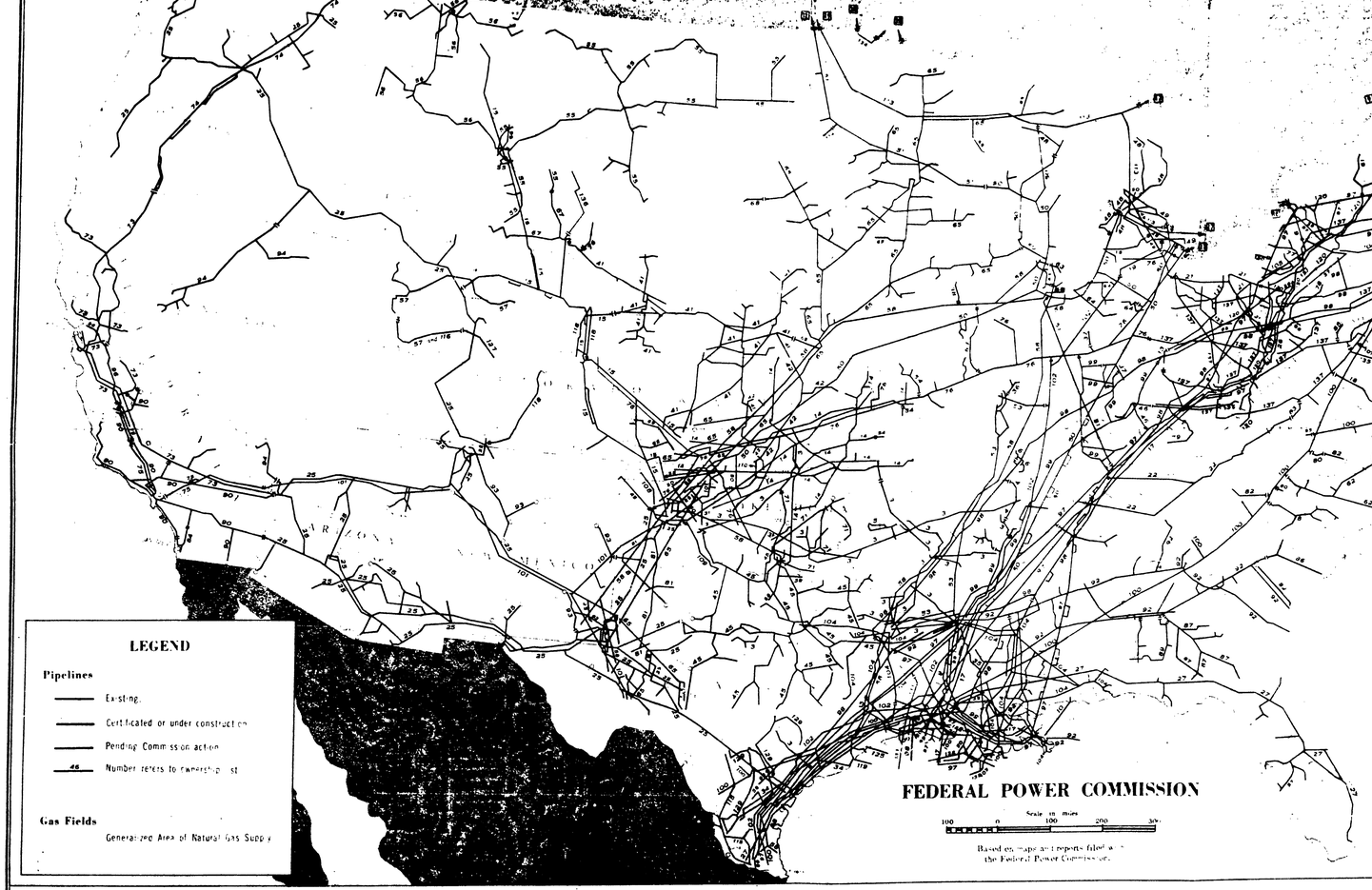
Thank you.

[Whereupon, at 4:05 p.m., the subcommittee adjourned.]

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NATURAL GAS PIPELINES

AS OF JUNE 30, 1973



1 *Alabama-Tennessee Natural Gas Co.
2 *Algonquin Gas Transmission Co.
3 *Arkansas Louisiana Gas Co.
4 *Arkansas-Missouri Power Co.
5 *Arkansas Oklahoma Gas Corp.
6 Associated Natural Gas Co.
8 Carolina Pipe Line Co.
9 Central Louisiana Electric Co., Inc.
10 *Chandeleur Pipe Line Co.
13 Chattanooga Gas & Electric Co., The
14 *Cities Service Gas Co.
15 *Colorado Interstate Gas Co.
17 *Columbia Gulf Transmission Co.
18 Commonwealth Natural Gas Corp.
19 Consumers Power Co.
21 *East Ohio Gas Co., The
22 *Eastern Natural Gas Co.
23 *Eastern Shore Natural Gas Co.
25 *El Paso Natural Gas Co
26 *Equitable Gas Co.
27 *Florida Gas Transmission Co.
31 High Plains Natural Gas Co.
34 *Houston Pipe Line Co.
35 *Mid Louisiana Gas Co
36 Illinois Power Co.
37 Indiana Gas Co., Inc.
39 *Iowa-Illinois Gas & Electric Co.
39 *Iroquois Gas Corporation
41 *Kansas-Nebraska Natural Gas Co., Inc.
42 *Kansas Power & Light Co.
43 *Lone Star Gas Company
45 Louisville Gas & Electric Co.
48 *Michigan Consolidated Gas Co.
49 *Michigan Gas Storage Co.
50 *Michigan Wisconsin Pipe Line Co.
51 *Midwestern Gas Transmission Co.
53 *Mississippi River Transmission Corp.
54 *Missouri Pub ic Service Co.
55 *Montana Dakota Utilities Co.
56 *Montana Power Co.
57 *Mountain Fuel Supply Co.
58 *Natural Gas Pipeline Co. of America
59 New Jersey Natural Gas Co.
61 *Niagara Mohawk Power Corp.
62 North Carolina Natural Gas Corp.
63 Northern Illinois Gas Co.
64 Northern Indiana Public Service Co.
65 *Northern Natural Gas Co.
67 Northern Utilities, Inc. Wyo
70 Northwestern Public Service Co.
71 Peoples Gas Light & Coke Co.
73 *Pacific Gas Transmission Co.
74 *Pacific Gas & Electric Co.
75 Pacific Lighting Service & Supply Co
76 *Panhandle Eastern Pipe Line Co.
77 *Pennsylvania Gas Co.
78 Peoples Natural Gas Co., The
79 Petroleum Exploration Inc.
80 Piedmont Natural Gas Co., Inc.
81 Pioneer Natural Gas Co.
82 Public Service Co. Of N. C., Inc.
83 Riverside Gas Co.
84 *San Diego Gas & Electric Co.
85 *Shenandoah Gas Co.
86 *South Carolina Electric & Gas Co.
87 South Georgia Natural Gas Co
88 *South Jersey Gas Co.
89 Southeast Alabama Gas District
90 Southern California Gas Co.
92 *Southern Natural Gas Co.
93 *Southern Union Gas Co.
94 *Southwest Gas Corp.
94 *Southwest Gas Corp
95 Southwestern Virginia Gas Co.
96 *Standard Pacific Gas Lines, Inc.
97 *Tennessee Gas Pipeline Co.
98 *Texas Eastern Transmission Corp
99 *Texas Gas Transmission Corp
100 *Transcontinental Gas Pipe Line Corp.
101 *Transwestern Pipeline Co.
102 *Trunkline Gas Co.
104 *United Gas Pipe Line Co.
105 *United Natural Gas Co.
106 *Valley Natural Gas Co.
107 *Washington Gas Light Co.
108 *Washington Gas Light Co.
109 West Texas Utilities Co.
110 *South Nat. Gas Co.
113 *Great Lakes Gas Transmission Co.
114 *Great Plains Natural Gas Co.
115 *South Texas Nat. Gas Gathering Co.
115 *South Texas Nat. Gas Gathering Co.
116 Utah Natural Gas Co.
117 *Vermont Gas Systems, Inc.
118 *Western Slope Gas Co.
119 *Blue Dolphin Pipe Line Co.
120 *Channel View Gas Co., Corp.
121 *Channel View Gas Transmission Inc.
124 *Texas Gas Transmission Corp.
125 *Texas Municipal Gas Co.
127 *Greater Texas Gas Corporation
128 *St. Lawrence Gas Co.
129 *Coastal States Gas Producing Co.
130 *Northern Utilities, Inc. Me
131 Mountain Fuel Res., Inc.
132 *Sea Robin Pipeline Co.
133 Kennedy, Clifford T. and Co.
134 *Union Co. Municipal Pipeline Unit
135 *Columbia LNG Co.
136 *Mobil Alaska Pipeline Co.
137 *Northern Natural Gas Company
*Indicates Companies
Pipelines Imports from Canada & Mexico
Pipelines Exports to Canada & Mexico
U.S. Pipelines Exports to Canada & Mexico
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