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Dr. Stephen D. Comello
Associate Director, Sustainable Energy Initiative
Research Fellow,
Steyer-Taylor Center for Energy Policy and Finance

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Modifying the U.S. Investment Tax Credit for Solar Energy – Alternatives to the Anticipated 2017 Step-Down

My co-author Professor Stefan J. Reichelstein and I would like to submit our paper titled "Modifying the U.S. Investment Tax Credit for Solar Energy – Alternatives to the Anticipated 2017 Step-Down" as a comment for consideration by the U.S. Senate Committee on Finance Bipartisan Working Group on Business Income Tax.

The federal Investment Tax Credit (ITC) for solar installations is scheduled to step-down from 30% to 10% at the beginning of 2017. Policymakers will need to assess whether solar photovoltaic (PV) is likely to be cost competitive post 2016. We examine the economics of solar PV for a sample of U.S. states and industry segments. Our model calculations indicate that for almost all of these sample settings the anticipated ITC step-down would render solar PV uncompetitive by early 2017, raising the specter of a `cliff' for the solar industry.

Our analysis evaluates an alternative phase-down scenario that would reduce the ITC gradually and eliminate it completely by 2024. Provided the solar PV industry can maintain the pace of cost reductions it has demonstrated in past years, we predict that solar energy would remain competitive, even as federal tax support would be gradually diminished under the alternative phase down-scenario.

An embedded link to a comprehensive working paper is located within our submission. Please let us know if there is other supplementary information that we should provide. Needless to say, we would be delighted to discuss at greater depth any aspect of our work.

Thank you for this opportunity.

With kind regards,

Knight Management Center, Stanford University, 655 Knight Way, C203C, Stanford, CA 94305
Tel: (650) 714-8753 · Fax: (650) 725-7979 · E-Mail: scomello@stanford.edu

Modifying the U.S. Investment Tax Credit for Solar Energy

Alternatives to the Anticipated 2017 Step-Down

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By **Stefan J. Reichelstein[1], Stephen D. Comello[1]**

The U.S. solar photovoltaic (PV) industry has experienced rapid growth in recent years, with installed capacity increasing from about 3.5 gigawatts (GW) in 2011 to over 16 GW by the end of 2014 (3). Solar energy systems now account for a substantial 36% share of new electricity generation capacity (3). This trend is generally attributed to substantial price declines for solar energy systems, coupled with significant financial incentives at the federal and state level. Importantly, the Emergency Economic Stabilization Act of 2008 enabled a federal Investment Tax Credit (ITC) which allows investors with sufficient taxable income to claim a 30% refund on their investments in new solar installations.

Current law stipulates a step-down in the ITC from 30% to 10% for corporate investors (0% for individuals) at the beginning of 2017, with the reduced rate remaining in place indefinitely. In anticipation of this change in the tax rules, the U.S. is poised to experience a run-up in new solar installations prior to the end of 2016. At the same time, policymakers will need to assess whether solar PV is likely to be cost competitive post 2016.

We examine the economics of solar PV for a sample of five U.S. states, considering for each one three industry segments: utility-, commercial- and residential scale installations.[2] Our model calculations indicate that for almost all of these sample settings, the anticipated ITC step-down would render solar PV uncompetitive by early 2017, raising the specter of a 'cliff' for the solar industry. Our analysis evaluates an alternative phase-down scenario that would reduce the ITC gradually and eliminate it completely by 2024. Provided the solar PV industry can maintain the pace of cost reductions it has demonstrated in past years, we predict that solar energy would remain competitive for most segments and locations, even as federal tax support would be gradually diminished under the alternative phase down-scenario.

Assessing Cost Competitiveness. The Levelized Cost of Electricity (LCOE) is a metric commonly used to compare the cost of generating electricity from different energy sources

[1]Stanford Graduate School of Business, Stanford, CA 94305, USA. E-mail: reichelstein@stanford.edu; scomello@stanford.edu

[2]For a complete exposition, please refer to the working paper located here: http://tinyurl.com/GSB-ITC

and technologies. LCOE is a life-cycle cost measure that identifies the break-even value that an investor would need to receive per kWh in order to achieve the required rate of return on the initial capital investment. For instance, if the electricity to be generated from a new facility is sold under a power purchasing agreement, the corresponding average price would need to equal the LCOE in order for the investment to be competitive. The dominant LCOE factor for solar PV installations is the system price, comprising solar panels, inverters and so-called balance of system (BOS) components. Since the system price represents an upfront capital expenditure, it must be 'levelized' across the stream of future energy output derived from the system in order to arrive at a unit cost per kWh. This calibration incorporates a range of technological and financial parameters including, in particular, the system's capacity factor which varies with the insolation rate in specific locations, the required rate of return for investors and the applicable tax rules.

Multiple data sources were used to parameterize our model (2, 5, 6, 7). Excluding any state level incentives, the most recent 2014 figures indicate that commercial-scale solar installations are the most competitive among the three industry segments. For the states of Colorado, New Jersey, Texas and North Carolina, the current LCOE figures are closely matched with the average electricity rates that commercial users have to pay in those locations. Meanwhile, commercial-scale installations in California are better positioned, owing to both relatively high insolation factors and high electricity rates for commercial users in that state. For residential installations, where the LCOE is to be compared to the applicable retail electricity rates, a similar pattern emerges except that residential solar does not yet appear competitive in Texas and New Jersey.

The vast majority of currently installed capacity in the U.S. is at utility-scale, that is, solar PV systems with at least 1 MW of peak power. Our findings indicate that the federal 30% ITC alone cannot explain the recent deployments in utility-scale systems, since as of 2014 their LCOE significantly exceeds the average wholesale electricity rates in all the five sample states we examine. Arguably, the economics of utility-scale solar systems is more favorable than suggested by an LCOE calculation based on averages only, because solar systems generate much of their power at times when wholesale electricity prices tend to be relatively high (4). Yet, a proper accounting for these synergy effects appears to improve the LCOE figures by at most 10–15% (8). The emerging conclusion is that state-level incentives, most notably Renewable Portfolio Standards, have been essential in enabling the significant deployment of new utility-scale installations. While portfolio standards will remain in effect for the future, the market value of the corresponding credits has generally fallen in value. In addition, most state-level direct incentive programs are currently scheduled to expire by 2017.

Projecting Cost by the End of 2016. It is well known that solar PV system prices have steadily declined over several decades. For PV modules, in particular, earlier studies have documented that average sales prices have conformed closely to an 80% learning curve (9). Accordingly, prices have come down by 20% with every doubling of the cumulative volume of modules produced. Module prices have declined even more rapidly in recent years, a development that many industry observers attribute to an unprecedented expansion of global manufacturing capacity. Our estimates for future module prices are based on the concept of 'economically sustainable' prices which take into consideration both current industry capacity levels and intrinsic reductions in the cost of manufacturing PV modules (7). Specifically, our price projections assume that market prices for PV modules will remain constant until 2016 and thereafter decline according to a 78% learning curve.

Because of the dramatic decline in module prices, the costs associated with balance of systems (BOS) items now account for the majority of overall PV system prices. In accordance with the further improvements anticipated by industry analysts, our model calculations assume annual percentage reductions around 4–5% for BOS costs, with the specific percentage varying by segment and location. The accompanying table summarizes our estimates of how the drop in ITC from 30% to 10% will impact LCOE figures by the end of 2016. For reference, the table also lists the applicable Comparison Price (CP), given by retail- and commercial electricity rates for residential and commercial customers, respectively, and wholesale electricity prices for utility-scale projects.

	Utility			Commercial			Residential		
State	$LCOE_{30}$	CP	$LCOE_{10}$	$LCOE_{30}$	CP	$LCOE_{10}$	$LCOE_{30}$	CP	$LCOE_{10}$
CA	6.96	5.44	9.43	10.34	15.17	14.01	11.98	17.06	20.71
CO	6.50	5.63	8.70	9.23	9.32	12.33	11.34	11.83	17.29
NJ	8.74	6.28	11.83	12.80	11.97	17.34	20.89	14.74	28.97
NC	7.25	5.78	9.76	9.84	9.52	13.21	11.50	12.53	18.29
TX	6.83	5.48	9.04	9.20	10.17	12.15	13.25	10.77	18.45

Projected levelized cost with 30% and 10% ITC. Applicable comparison prices according to (1).

Figures based on authors' calculations; see Supplementary Materials. All figures in 2014 cents per kWh.

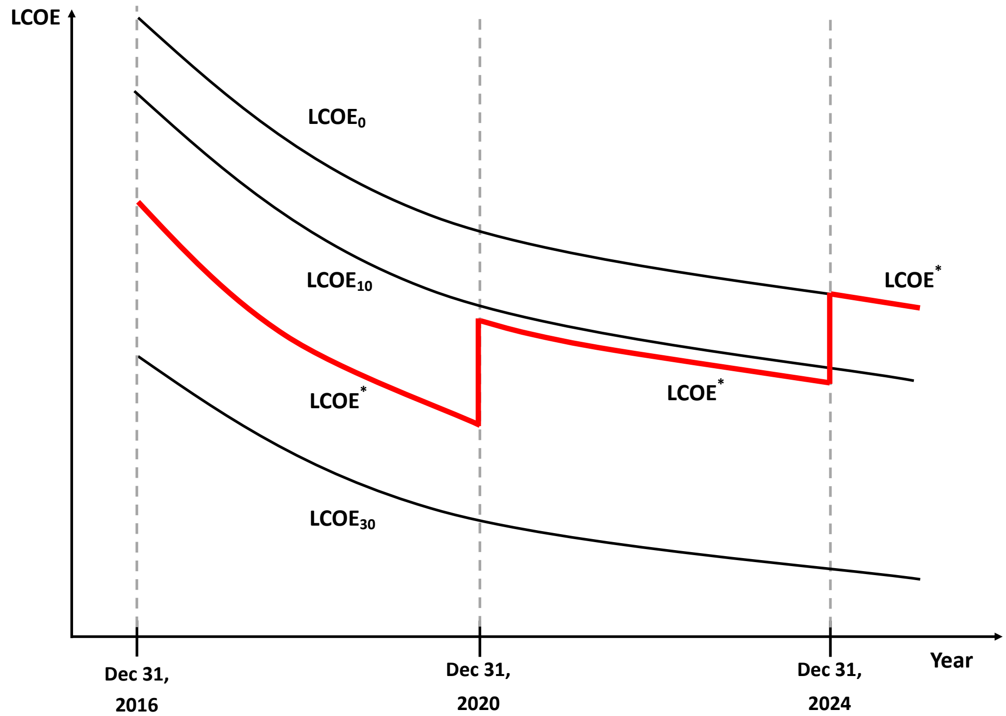
The figures reported in the accompanying table show that with a 30% ITC, most of the solar installations considered here would either be cost competitive by 2016, or at least come close. This conclusion would, however, be reversed across the board if the ITC were to drop to 10% at the beginning of 2017. It should be noted that the resulting percentage increase is most pronounced for residential systems which exhibit a relatively high system price in terms of dollars per Watt installed. Furthermore, for tax valuation purposes the price of residential systems is generally assessed by independent appraisers based on a fair market value approach. The resulting valuations typically exceed the cost incurred by the developer. The difference between the cost basis and the fair market value effectively represents the developer's profit margin and explains the outsized effect that a percentage drop in the ITC has on the LCOE of residential systems.

Alternative Phase-Down Scenarios. The magnitude of the anticipated step-down in the ITC is likely to result in a 'cliff' for the U.S. solar industry in early 2017. At the same time, the sustained reduction in PV system costs demonstrated over many years suggests that solar energy will not require an indefinite continuation of the 10% ITC. An alternative to the current tax law could therefore specify a smoother glide path that could lead to a complete elimination of the federal tax incentives at some definitive future date. The latter feature introduces a *quid-pro-quo* element that could make alternative phase-down scenarios more acceptable politically.

For simplicity, we evaluated a policy scenario with three distinct phases starting at the beginning of 2017, 2021 and 2025, respectively; see the accompanying figure for an illustration. For the first two phases, the revised tax rules would be targeted so as to result in LCOEs that are in between those corresponding to the 10%, and the 30% ITC benchmarks. The impact of gradually reduced tax incentives would be at least partially offset by the anticipated cost reductions during the previous phase. The corresponding levelized cost figures are captured by the 'seesaw' of the LCOE* curve.

Because smaller residential systems tend to be the most expensive on a per Watt basis, the current solar ITC provides the largest support to residential PV systems in terms of dollars per Watt installed. More flexible and targeted tax breaks can be achieved by providing investors with a choice between alternative methods for calculating the ITC. For the years 2017–2020, our phase-down scenario would offer a choice between a 20% ITC or a lump-sum ITC in the amount of 40 cents per Watt installed. The 40 cents figure is obtained by putting a price on the stream of future carbon emissions that would be avoided by generating power from solar rather than fossil fuel energy. Consistent with the overall concept of diminishing ITC support, the second phase would cut the previous parameters in half for the years 2021–2024. Investors would then have the choice between a 10% ITC or a lump-sum ITC in the amount of 20 cents per Watt.

Our simulation results show that the proposed alternative phase-down scenario would go a long way towards avoiding the cliff that is likely to result from the current federal tax rules. Residential installations would continue to opt for an ITC calculated as a percentage of the system price. The 20% ITC for the years 2017–2020 would be sufficient to keep the residential segment cost competitive in most of the five states we examine. Furthermore, the



anticipated additional reductions in cost are projected to leave residential installations with an LCOE that is within 10-15% of the retail rates expected for the years 2021–2024.

Commercial and utility-scale systems would prefer the lump-sum ITC under our policy proposal. With this option, commercial-scale installations would be cost competitive in California and Texas and close to break-even in the remaining three states of Colorado, New Jersey and North Carolina during the first phase. Without any ITC, commercial installations in California and Texas are projected to be competitive by 2025, at break-even in Colorado, and at a small disadvantage in New Jersey and North Carolina. Finally, the federal tax support we envision would leave utility-scale installations with LCOE values which at least match the projected wholesale electricity prices, starting in 2018. Importantly, utility-scale installations are projected to be fully cost competitive without any ITC by 2025. This pattern emerges for all of the states we consider, except New Jersey.

Taken together, we have examined a gradual phase-down, rather than an abrupt step-down, of the federal Investment Tax Credit that would avoid a major disruption for the solar industry in early 2017. The alternative ITC schedule evaluated in our analysis effectively shifts federal tax support to earlier years while this relatively new energy technology will still experience significant learning effects.

References

[1] EIA. National energy modeling system run ref2014.d102413a for the annual energy outlook 2014 with projections to 2040, doe/eia-0383(2014). Technical report, U.S Energy Information Agency (EIA), Washington, DC, 2014.

[2] GTM Research. Gtm research global pv balance of systems landscape 2014 (forthcoming). Technical report, GTM Research Inc., Boston, MA, 2014.

[3] GTM Research/SEIA. Gtm research / seia solar market insight report 2014 q3. Technical report, GTM Research Inc., Boston, MA, 2014.

[4] P. Joskow. Comparing the costs of intermittent and dispatchable electricity generating technologies. *American Economic Review Papers and Proceedings*, 100(3):238 – 241, 2011.

[5] Lux Research. The squeeze: Trends in solar balance of systems, December 2013. Available by subscription to Lux Research.

[6] NREL. Pvwatts calculator for overall dc to ac derate factor. http://rredc.nrel.gov/solar/calculators/pvwatts/version1/derate.cgi, 2014.

[7] S. Reichelstein and A. Sahoo. Cost- and price dynamics of solar pv modules. GSB Working Paper No. 3069, 2014.

[8] S. Reichelstein and A. Sahoo. Time of day pricing and the levelized cost of intermittent power generation. *Energy Economics*, 48(0):97 – 108, 2015.

[9] R. Swanson. The silicon photovoltaic roadmap. The Stanford Energy Seminar, November 2011.