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The High Cost of Rooftop Solar Subsidies

How Net Metering Programs Burden the American People

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October 2016

Table of Contents

Section I: Introduction

Countries around the world have recently prioritized regulation seeking to address climate change, pushing renewable energy subsidies in order to incentivize production of energy from renewable sources. A great deal of this regulation has been geared toward incentivizing the use of technologies that harness solar energy, such as solar photovoltaic (SPV) technology, which converts sunlight into electricity.

Despite incentives, solar energy technology continues to remain a high-cost energy option—making up just 1% of U.S. and global electricity generation.[1] The investments made to generate solar output are often at a premium much higher than for energy output derived from traditional measures or other renewable energy options. Therefore, solar technology has relied significantly upon government assistance to drive market entrance and development.

The U.S.'s approach to solar energy has been largely facilitated by the concept of "energy independence" rather than allowing market forces such as economies of scale to produce the most effective forms of solar energy technology. As a result, the current structure of federal, state, and local subsidies creates unnecessary waste, as it ties investments to factors other than a technology's underlying profitability and efficiency. For instance, although the U.S. solar industry has struggled in the past few years as a result of increased global competition in solar technologies, many U.S. solar companies are finding that their continued existence relies heavily on generous government support. In its 2014 annual report, SolarCity claimed, "the expiration, elimination or reduction of these [solar] rebates, credits, and incentives would adversely impact our business."[2] Other solar companies have found themselves bankrupt despite large government subsidies, such as the $535 million government investment in Solyndra that vanished when the company went bankrupt in 2011, putting taxpayers on the hook for losses.[3]

As the federal investment tax credit (ITC) nears its expiration,[4] and the 2016 Presidential Election inches closer, solar companies have attempted to win over presidential candidates in order to secure the continuation of these subsidies. Hillary Clinton has consistently promoted solar as her renewable energy of choice, most recently calling attention to her solar energy plan during the 2016 Presidential Debate last Monday.[5] In response to a question on how she would help to bring jobs back to the U.S. and spur the economy, Clinton claimed her solar plan would create jobs and grow the solar energy capacity of the U.S. to 500 million SPV panels, or 25 million residential rooftop installations, by 2020—what would be the end of Clinton's first term should she be elected as president.[6]

Such claims overlook the costly consequences, both in jobs and in taxpayer dollars, of allowing inefficient solar subsidy initiatives to continue to distort the market for electricity generation; in this paper, we will demonstrate the following in support of this claim:[7]

- Net metering structures threaten today's electrical grid system by allowing solar customers to bypass grid maintenance costs, as well as by imposing additional operating stresses given that grids must transition from a one-way power flow, from centralized generators to users, to a decentralized, two-way power flow—a task that electrical grids are not built to handle given the current infrastructure.
- The retail price under many states' net metering schemes is often much higher than the rate that grids could reasonably obtain in the wholesale power market, creating immense distortions in the energy market that

[1] Nancy W. Stauffer, "The Future of Solar Energy: A Summary and Recommendations for Policymakers," MIT Energy Initiative, December 14, 2015. http://energy.mit.edu/news/the-future-of-solar-energy-a-summary-and-recommendations-for-policymakers/
[2] Stephen Moore and Kathleen Hartnett White, *Fueling Freedom: Exposing the Mad War on Energy*, p. 179, 2016.
[3] Kellan Howell and Stephan Dinan, "Solyndra Misled Government to Get $535 Million Solar Project Loan: Report," *The Washington Times*, August 26, 2015. http://www.washingtontimes.com/news/2015/aug/26/solyndra-misled-government-get-535-million-solar-p/
[4] The investment tax credit for solar energy was put into place following the Energy Policy Act of 2005 and provides a 30% tax credit of the value of solar projects. The credit was set to expire in 2016; however, in late 2015, the credit was extended through 2019 and will decline gradually to 10% in 2022, after which the credit will only apply to commercial solar installations (and be eliminated completely for residential solar installations). (Richard Martin, "Tax Credit Extension Gives Solar Industry a New Boom," *MIT Technology Review*, December 28, 2015. https://www.technologyreview.com/s/544981/tax-credit-extension-gives-solar-industry-a-new-boom/).
[5] "Transcript: First presidential debate at Hofstra University," *CBS News*, September 27, 2016. http://www.cbsnews.com/news/hillary-clinton-donald-trump-presidential-debate-hofstra-university-transcript-video/
[6] "Hillary Clinton's Vision for Renewable Power," Hillary Clinton, July 26, 2015. https://www.hillaryclinton.com/briefing/factsheets/2015/07/26/renewable-power-vision/
[7] Special thanks for Julia Roseman for her assistance in the research for and writing of this study. The study would not have been possible without her efforts.

incentivize inefficient forms of solar energy production technology, often at the expense of taxpayers and non-solar electricity users.

- As net metering schemes continue to pay out elevated rates to solar customers, the amount paid back by net metering customers is often below utilities' costs for servicing those customers, resulting in higher amounts charged to non-net metered customers—the result is doubly regressive, as non-solar customers, who are often less well-off, must cross subsidize solar customers, who are generally wealthier.
- Solar energy job creation estimates do not take into account the effects stemming from any offsetting impact of these distortionary subsidies, thereby failing to account for jobs lost or foregone as a result of government support of solar energy.
- The current subsidization structure of solar energy facilitates market distortions by taking capital away from more efficient forms of energy production and by unevenly distributing the costs of these distortions.

Section II: Background

In addition to a 30% Solar Investment Tax Credit (ITC) that is applied at the federal level, each U.S. state offers its own set of grants and tax credits that are paired with state-individualized Renewables Portfolio Standards (RPS).[8] RPS agreements require electricity suppliers, such as utilities, to purchase a growing quantity of renewable energy over time from renewable energy producers, expressed in either mW or as a percentage of total energy supplied to customers. RPS laws occasionally allow electricity suppliers to trade renewable energy credits or certificates as a means to reduce compliance costs.[9,10] Within an RPS, each state has the flexibility to create "set-asides" or "carve-outs" that require a certain portion of energy produced to originate from solar energy.[11]

Given the high cost of producing solar energy in comparison to traditional electricity options, governments have often paired RPS goals with a variety of tax cuts and deductions, direct financing, and subsidies in order to incentivize the market to produce solar energy in lieu of more efficient, cheaper electricity options. In the U.S., most states seem to offer a combination of incentives: as of 2012, 24 states offered corporate and personal income tax credits and deductions, 28 states offered sales tax exemptions or refunds, and 36 states enacted property tax exemptions or reductions in order to encourage renewable energy equipment purchases.[12] Beyond tax policy, 37 states, as well as the federal government, offer some kind of direct financing in order to help fund renewable energy projects.[13]

SPV installations are scalable such that they can be "deployed in configurations ranging from just a few kW (residential-scale) to hundreds of mW (utility-scale)."[14] Utility-scale solar installations often serve the energy needs of one large buyer at wholesale prices—such as a utility or a commercial company—but have also recently taken the form of community solar farms, where individual customers can collectively both participate in ownership of and receive a share of the output from a large solar installation.

Residential solar power generation largely occurs through net metering systems that allow residential customers producing solar energy to connect with electrical grids through distributed generation (DG) devices, which are small devices placed on the customer side of the meter that allow electric generation to feed into the distribution grid.[15] DG

[8] DSIRE, "Policies and Initiatives by State," N.C. Clean Energy Technology Center. http://www.dsireusa.org/
[9] Jeremiah I. Williamson and Matthias L. Sayer, "Federalism in Renewable Energy Policy," *Natural Resources & Environment*, Volume 27, Summer 2012, pages 19-23. http://www.jstor.org/stable/24426184?seq=1#page_scan_tab_contents
[10] Ryan Wiser and Galen Barbose, "Supporting Solar Power in Renewables Portfolio Standards: Experience from the United States," Lawrence Berkeley National Laboratory, October 2010. https://emp.lbl.gov/sites/all/files/REPORT%20lbnl-3984e.pdf
[11] John Edward Burns and Jin-Su Kang, "Comparative economic analysis of supporting policies for residential PV in the United States: Solar Renewable Energy Credit (SREC) potential," *Energy Policy*, Volume 44, May 2012, pages 217-225. http://www.sciencedirect.com/science/article/pii/S0301421512000717
[12] Jeremiah I. Williamson and Matthias L. Sayer, "Federalism in Renewable Energy Policy," *Natural Resources & Environment*, Volume 27, Summer 2012, pages 19-23. http://www.jstor.org/stable/24426184?seq=1#page_scan_tab_contents
[13] *Ibid*.
[14] Brattle Group, "Comparative Generation Costs of Utility-Scale and Residential-Scale PV in Xcel Energy Colorado's Service Area," First Solar, July 2015. http://brattle.com/system/publications/pdfs/000/005/188/original/Comparative_Generation_Costs_of_Utility-Scale_and_Residential-Scale_PV_in_Xcel_Energy_Colorado%27s_Service_Area.pdf?1436797265
[15] "The Potential Benefits of Distributed Generation and Rate-Related Issues That May Impede Their Expansion," U.S. Department of Energy, February 2007. https://www.ferc.gov/legal/fed-sta/exp-study.pdf

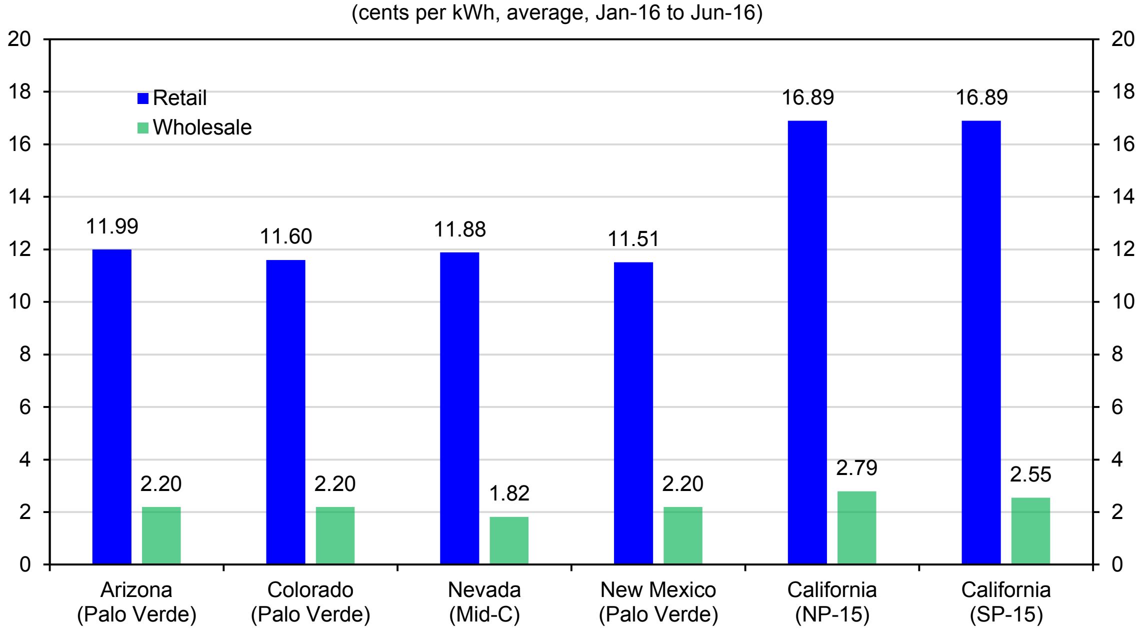
devices have been used throughout the years as a means for customers to install and operate their own electric power as needed, such as hospitals that require highly reliable power, thereby allowing customers to design their energy supply to more closely align with their demand.[16] In recent years, as the world seeks to integrate renewable energy production into its electric grids, the use of DG devices has expanded to include renewable energy applications.

In the case of net metering, DG devices work by crediting customers for renewable energy produced, as well as foregone electricity consumption, typically at the full retail rate and charging customers when they must consume energy from the grid—the resulting amount paid by the customer is then the net (i.e. grid power consumed minus customer-generated power) usage for a specified time period.[17] Currently, 41 states and D.C. have state-developed mandatory rules for net metering.[18]

The retail rate paid by electrical grids to residential solar power generators, however, often greatly exceeds the price of power that the utility could produce itself or purchase on the wholesale power market. Figure 1 below looks at the five states referenced in this report and demonstrates the cost of electricity at the retail rate versus the wholesale rate for each state's respective power plant for the first half of 2016. All of the retail rates exceed the wholesale rate by at least 500%, with California and Nevada markets witnessing a more than 600% mark-up. By continuing to pay retail rates to solar customers, utilities face unsustainable increases in costs—pushing many states, such as Nevada, to reconsider their net metering structures.

Figure 1: Wholesale vs. Retail Electricity Prices

(cents per kWh, average, Jan-16 to Jun-16)



Source: U.S. Energy Information Administration

[16] "The Potential Benefits of Distributed Generation and Rate-Related Issues That May Impede Their Expansion," U.S. Department of Energy, February 2007. https://www.ferc.gov/legal/fed-sta/exp-study.pdf
[17] David Dismukes, "Estimating the Impact of Net Metering on LPSC Jurisdictional Ratepayers," Louisiana Public Service Commission, February 27, 2015. http://lpscstar.louisiana.gov/star/ViewFile.aspx?Id=f2b9ba59-eaca-4d6f-ac0b-a22b4b0600d5
[18] Map of Net Metering States as of February 2016, DSIRE. http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2016/02/Net_Metering_022016.pdf

Section III: Key Findings

Long-term subsidization of residential rooftop solar has begun to take its toll not only on electrical grid systems and utilities, which have begun to find evidence of deteriorated grid capabilities and significant cross-subsidization between non-solar and solar customers, but it has also stunted the growth of technological development in the U.S. solar market by rewarding individuals and companies for investing in solar rather than for solar output or other measureable outcomes.

These problems originate from the fact that subsidies are largely being directed towards the least-efficient method by which to generate solar energy—e.g. residential solar—rather than allowing for the market to distribute capital to more efficient solar power generation methods—e.g. utility scale solar. Recent studies, such as one by Brattle Group analyzing Colorado's utility Xcel Energy Colorado, have found that utility-scale solar systems offer "significant cost and environmental benefits" over rooftop residential installations as a result of "higher electric output and economies of scale."[19]

As a result, the Massachusetts Institute of Technology (MIT) Energy Initiative recently released a study advising policymakers to alter the current system of subsidies, which is described as wasteful and contributes to distortions in technology investments such that "the solar subsidy per installed watt is higher where solar costs are higher (i.e. in the residential sector) and the subsidy per KWh of generation is higher where the solar resource is less abundant."[20]

In light of such findings, many U.S. states have called upon their respective public utility commissions in order to determine whether current net metering programs should continue to provide subsidies in their current forms, with many studies confirming not only that non-solar consumers are cross-subsidizing solar consumers, but that often solar consumers are more well-off than non-solar consumers, thereby contributing to additional cost burdens on the poor.[21]

This has led a small number of states to move towards restructuring their net metering programs from a system that pays high retail rates to a system that will phase in wholesale rates to renewable energy DG consumers in order to properly allocate increased cost burdens. In October 2015, Hawaii closed its current net metering program to new participants and introduced an alternative to those SPV customers seeking to join: invest in energy storage, restrict energy exports to the grid, and receive no compensation for generated energy; or agree to receive the wholesale power rate.[22] Hawaii cited increased technical and operational challenges stemming from a surge in rooftop solar DG systems as its reasoning, leading the state to conclude it was time to move towards a fairer and more equitable rate structure now that net metering has achieved its desired effect. Aptly put by previous Hawaii House Energy Chair, Mina Morita, "The bountiful subsidies of NEM and tax credits have been used to sustain an uncompetitive and dysfunctional market that has been carried on the backs of the Hawaii taxpayer and non-PV electric customers."[23]

The following are summaries of similar reports issued by each state's respective public utilities commission:

Arizona

Arizona is one of the four top states in the U.S. with the best solar resource and currently has a Renewable Energy Standard (RES) requiring that 15% of the state's energy is derived from renewable energy sources by 2025,[24] as well

[19] Ben Willis, "First Solar-funded study reveals benefits of utility versus residential PV," *PV Tech*, July 14, 2015. http://www.pv-tech.org/news/study_reveals_cost_benefits_of_utility_versus_residential_pv
[20] MIT Energy Initiative, "The Future of Solar Energy," Massachusetts Institute of Technology, 2015.
[21] Tom Tanton, "Reforming Net Metering: Providing a Bright and Equitable Future," ALEC, March 2014. https://www.alec.org/app/uploads/2015/12/2014-Net-Metering-reform-web.pdf
[22] Julia Pyper, "Hawaii Regulators Shut Down HECO's Net Metering Program," *Greentech Media*, October 14, 2015. http://www.greentechmedia.com/articles/read/hawaii-regulators-shutdown-hecos-net-metering-program
[23] Mina Morita and Marco Mangelsdorf, "It's Time to End Net Energy Metering in Hawaii," *Greentech Media*, July 6, 2015. https://www.greentechmedia.com/articles/read/Its-Time-to-End-Net-Energy-Metering-in-Hawaii
[24] Jocelyn Durkay, "State Renewable Portfolio Standards and Goals," National Conference of State Legislatures, March 23, 2016. http://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx

as a net metering system that has no limit, but caps production at 125 percent of a customer's total connected load.[25] In terms of tax policy, Arizona offers a sales tax exemption for solar and wind renewable energy equipment purchases.[26]

Recently, Arizona Public Service (APS), the state's largest utility, found that solar customers avoid on average around $1,000 annually in costs for operating the electric grid, costing the average power user, who must make up the cost, a $16.80 premium per year. As a result, in 2013, Arizona approved a charge of $0.70/kW be applied to new rooftop SPV customers' bills, effective January 2014.[27]

California

California has one of the most aggressive Renewables Portfolio Standards in the country, with current renewables requirements for retail sales of electricity of 25% by the end of 2016. The share of electricity generated by renewable energy sources is mandated to rise to 33% by the end of 2020, increasing three more times until reaching a 50% requirement by the end of 2030.[28]

Solar energy has been heavily subsidized by the state, with the California Solar Initiative program one of the largest of its kind in the U.S., distributing solar rebates to the 11+ million customers of Pacific Gas & Electric, Southern California Edison and San Diego Gas & Electric. A 2013 California Public Utilities Commission (CPUC) report summarizing the costs and effects of California's NEM system on both solar and non-solar electricity customers examined the gap between the bills of these two consumer groups, as well as the full cost faced by the utility in providing services to the customer. The study found California residential electricity customers paid, on average, bills that were 154% of their total cost of service before DG, but only 81% of their total cost of service after DG, indicating that bills paid by NEM customers are below the level of cost recovery for utilities.[29]

Despite this apparent cross-subsidization, the CPUC voted in January 2016 to maintain the current retail rates for NEM customers through at least 2019, guaranteeing that NEM households will continue to see high compensation rates for their rooftop solar generated electricity over the next four years. The January decision was not completely one-sided in favor of NEM customers, however, as the decision also adds a time-of-use provision to new NEM customers, which will compensate solar production at different rates depending on real-time demand for electricity.[30]

Colorado

Established in 1998, Colorado's RPS requires that 30% of the state's energy come from renewable sources by 2020, with a 2% cost cap and several credit multipliers for difference technologies.[31] In 2010, the state passed legislation authorizing meter aggregation, thereby allowing solar gardens that did not exceed 2 mW of capacity; in 2014, the state expanded this incentive such that the percentage of electricity generated by solar gardens is fully exempt from property tax for residential or government subscribers.[32]

[25] Jocelyn Durkay, "Net Metering: Policy Overview and State Legislative Updates," National Conference of State Legislatures, December 18, 2014. http://www.ncsl.org/research/energy/net-metering-policy-overview-and-state-legislative-updates.aspx
[26] Jeremiah I. Williamson and Matthias L. Sayer, "Federalism in Renewable Energy Policy," *Natural Resources & Environment*, Volume 27, Summer 2012, pages 19-23. http://www.jstor.org/stable/24426184?seq=1#page_scan_tab_contents
[27] Tom Tanton, "Reforming Net Metering: Providing a Bright and Equitable Future," ALEC, March 2014. https://www.alec.org/app/uploads/2015/12/2014-Net-Metering-reform-web.pdf
[28] "Renewable Energy – Overview," California Energy Commission, December 22, 2015. http://www.energy.ca.gov/renewables/tracking_progress/documents/renewable.pdf
[29] "Introduction to the California Net Energy Metering Ratepayer Impacts Evaluation," California Public Utilities Commission, October 28, 2013. http://www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/Utilities_and_Industries/Energy/Reports_and_White_Papers/NEMReportwithAppendices.pdf
[30] Herman K. Trabish, "Inside the decision: California regulators preserve retail rate net metering until 2019," *Utility Dive*, February 1, 2016. http://www.utilitydive.com/news/inside-the-decision-california-regulators-preserve-retail-rate-net-meterin/413019/
[31] Jocelyn Durkay, "State Renewable Portfolio Standards and Goals," National Conference of State Legislatures, March 23, 2016. http://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx
[32] Jocelyn Durkay, "Net Metering: Policy Overview and State Legislative Updates," National Conference of State Legislatures, December 18, 2014. http://www.ncsl.org/research/energy/net-metering-policy-overview-and-state-legislative-updates.aspx

Nevada

Nevada, also one of the four top U.S. states in terms of best solar resource, currently has in place an Energy Portfolio Standard (EPS), mandating that 25% of the state's energy be generated by renewable energy; the policy carves out 5% of this requirement for solar energy through 2015, after which solar energy should make up 6% of total energy for 2016-2025.[33] Prior to 2016, Nevada applied a 2.4 credit multiplier towards utility-sited solar generation and a 2.45 multiplier to distributed solar generation for portfolio energy credits generated to meet Nevada's EPS; these credits will no longer apply to new solar installations.[34] Nevada also offers a reduced sales tax on qualifying renewable energy equipment purchases,[35] as well as financial incentives through Nevada Energy's RenewableGenerations program.

In 2014, the Public Utilities Commission (PUC) of Nevada conducted a study evaluating the impact of its net metering system on non-solar customers. The study found that, prior to 2014, there were significant cost shifts from net metering customers to non-net metering customers as the "utility incentives exceeded the utility costs avoided by the NEM generation."[36] However, given that financial incentives through the RenewableGenerations program were lowered such that the impact on all customers' bills was reduced, the study found that there was no substantial cross-subsidization occurring from 2016 forward in light of the changes made to Nevada's EPS policy, indicating that any net cost/benefits should be relatively small. These adjustments to Nevada's EPS policy are meant to correct distortions created by the previous cost shifting structure from NEM solar customers to non-participating solar customers by recognizing the costs associated with solar customers using the grid as a backup. Thus, Nevada serves as an example of a state that recognized the harmful effects stemming from its net metering program and took measures in order to limit the excessive subsidies in place.

Nevada also moved to limit these subsidies further—in December 2015, the PUC of Nevada tripled the fixed charges solar customers will pay over the next four years, as well as reduced the retail rate paid to solar net metering customers by three-quarters, citing the need for solar customers to pay "their fair share for use of NV Energy's grid."[37]

New Mexico

New Mexico has a significant RPS, which mandates that renewable energy should make up 20% of the state's energy by 2020—of that 20%, at least 20% must be solar, 30% wind, and 3% distributed generation. In addition, in 2006, New Mexico passed its Solar Market Development Tax Credit (STC), which is available to individual solar customers and reduces the cost of solar systems by up to 10% with a cap of $9,000. The credit is scheduled to expire in 2016, but in January the state legislation committee approved a bill that would extend the tax credit.[38]

New Mexico's net metering system currently allows up to 80 MW, which stands in contrast to almost half of all states with net metering policies that authorize net metering systems up to 1 MW in capacity.

Other States

Following these leaders in solar net metering policies, several other U.S. states have also requested their public utilities commissions to conduct studies evaluating net metering systems currently in place. After seeing its solar energy tax incentive payments grow from $500,000/year to about $42 million in 2013, Louisiana decided to conduct a

[33] Jocelyn Durkay, "State Renewable Portfolio Standards and Goals," National Conference of State Legislatures, March 23, 2016. http://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx
[34] "Energy Portfolio Standard," DSIRE, January 20, 2016. http://programs.dsireusa.org/system/program/detail/373
[35] Jeremiah I. Williamson and Matthias L. Sayer, "Federalism in Renewable Energy Policy," *Natural Resources & Environment*, Volume 27, Summer 2012, pages 19-23. http://www.jstor.org/stable/24426184?seq=1#page_scan_tab_contents
[36] "Nevada Net Energy Metering Impacts Evaluation," State of Nevada Public Utilities Commission, 2014. http://puc.nv.gov/uploadedFiles/pucnvgov/Content/About/Media_Outreach/Announcements/Announcements/E3%20PUCN%20NEM%20Report%202014.pdf?pdf=Net-Metering-Study
[37] Julia Pyper, "Does Nevada's Controversial Net Metering Decision Set a Precedent for the Nation?" *Greentech Media*, February 4, 2016. http://www.greentechmedia.com/articles/read/nevada-net-metering-decision
[38] Herman K. Trabish, "New Mexico House committee advances 10% solar tax credit extension," UtilityDIVE, January 28, 2016. http://www.utilitydive.com/news/new-mexico-house-committee-advances-10-solar-tax-credit-extension/412883/

study estimating the impact of its net metering structure. Overall, the state found that its net metering structure resulted in an $89 million negative net benefits to electricity rate payers, meaning the net metering program costs are greater than program benefits, and that over $2 million of utility costs per year were being subsidized by non-solar consumers.[39]

Following these studies, more states are proposing measures to make retail rates paid to net metered customers more reasonable by pushing price transparency and enabling free market forces to prevail. In 2015, Utah's utility, Rocky Mountain Power, imposed a surcharge on solar customers; in response to backlash by solar energy proponents, Utah's Public Utilities Commission asked Rocky Mountain Power to also conduct a cost-benefit analysis of the cost of providing electricity if not for net metering customers' self-generation in order to make the reasoning behind the surcharge as transparent as possible.[40]

International Examples

Integrating higher amounts of solar energy into the existing electric grid requires subsidies, with governments around the world currently using one of two methods in order to meet RPS goals: feed-in tariffs (FITs) or net metering. FITs allow renewable energy technologies that are connected into an electricity grid to receive a cost-based price for electricity generated that is meant to generate a reasonable profit for investors over a period of time.[41,42] As of 2013, FITs were in place in about 71 countries,[43] with Germany being one of the primary examples used given the country's immense push for renewable energy with *Energiewende* in 2000.[44]

Germany's experience with renewables policy serves as an excellent case study as to the harmful effects that can materialize when the government intervenes within the market place. Many look to Germany as a success story in that forceful renewable energy policy and FITs have pushed the country's energy market to reach 40GW of installed solar capacity, more than all of the U.S. states combined, despite the fact that its available sunlight is less than that of any U.S. state barring Alaska.[45] However, what is often forgotten is that it is ultimately private consumers who have had to bear the costs created by heavily subsidizing solar energy—Germany's FIT structure has facilitated drastic increases in the average residential price for electricity consumed, which is around 36 cents per kWh, and is expected to surge another thirty to fifty percent in the next ten years.[46] In contrast, the average U.S. rate is around 12 cents per kWh as of January 2016.[47]

In fact, it has been found that Germany's FIT system has not produced several of the benefits consistently associated with subsidizing solar energy technology, such as energy security, employment, and positive environmental impact. Rather, environmental impacts have been minimal and net employment is likely to be in the negative due to high opportunity costs associated with the incentivizing solar energy production—as estimated by Frondel *et al.*, "the

[39] David Dismukes, "Estimating the Impact of Net Metering on LPSC Jurisdictional Ratepayers," Louisiana Public Service Commission, February 27, 2015. http://lpscstar.louisiana.gov/star/ViewFile.aspx?Id=f2b9ba59-eaca-4d6f-ac0b-a22b4b0600d5
[40] Brian Maffly, "Step toward deciding Utah power rates is a blow to rooftop solar, advocates say," *The Salt Lake Tribune*, November 12, 2015. http://www.sltrib.com/home/3169653-155/step-toward-deciding-utah-power-rates
[41] Brian Maffly, "Step toward deciding Utah power rates is a blow to rooftop solar, advocates say," *The Salt Lake Tribune*, November 12, 2015. http://www.sltrib.com/home/3169653-155/step-toward-deciding-utah-power-rates
[42] Wilson Rickerson et al., "Feed-in Tariffs and Renewable Energy in the USA—a Policy Update," May 2008. http://www.renewwisconsin.org/policy/ARTS/MISC%20Docs/Feed-in%20Tariffs%20and%20Renewable%20Energy%20in%20the%20USA%20-%20a%20Policy%20Update.pdf
[43] Sebastian Oliva H., Iain MacGill, Rob Passey, Assessing the short-term revenue impacts of residential PV systems on electricity customers, retailers and network service providers, Renewable and Sustainable Energy Reviews, Volume 54, February 2016, Pages 1494-1505. http://www.sciencedirect.com/science/article/pii/S1364032115011739
[44] David B. Raskin, "The Regulatory Challenge of Distributed Generation," *Harvard Business Law Review*, Vol. 4, December 2013. http://www.wecc.biz/committees/BOD/TEPPC/SPSG/Lists/Events/Attachments/706/CITIRising%20Sun%20Implications%20for%20US%20Utilities.pdf.
[45] Solar resource indicates the amount of direct sunlight that a region has access to; Germany's solar resource is actually comparable to Alaska's, which has the lowest annual average of direct solar energy. For more information, see: "2015 State Solar Jobs Census Compendium," The Solar Foundation, February 2016. Ryan Wiser and Galen Barbose, "Supporting Solar Power in Renewables Portfolio Standards: Experience from the United States," Lawrence Berkeley National Laboratory, October 2010. https://emp.lbl.gov/sites/all/files/REPORT%20lbnl-3984e.pdf
[46] David B. Raskin, "The Regulatory Challenge of Distributed Generation," *Harvard Business Law Review*, Vol. 4, December 2013. http://www.wecc.biz/committees/BOD/TEPPC/SPSG/Lists/Events/Attachments/706/CITIRising%20Sun%20Implications%20for%20US%20Utilities.pdf.
[47] "Table 5.6.A. Average Price of Electricity to Ultimate Customers by End-Use Sector," U.S. Energy Information Administration, January 2016. http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a

resulting drain of purchasing power and investment capital of private and industrial electricity consumers causes negative employment effects in other sectors."[48] In Spain, where a similar renewable energy structure has been implemented, it is estimated that "each green job created led to the loss of two jobs in the rest of the Spanish economy."[49] It has been estimated that the overall loss of purchasing power of Germany is equal to billions of euros.[50]

The German electric grid system is also increasingly at risk. The strains introduced by variable energy producers, which require the grid to change from a centralized, one-way distribution to a two-way decentralized grid, have continued to take their toll. Current electric grids were developed to facilitate a centralized generation system, not to integrate multiple generating sources; the decentralization has thus increased maintenance costs substantially for utilities, which must now pay more to maintain power quality and reliability.[51] This has led Germany to consider an additional charge to be placed on customers in order to help pay for increased maintenance costs.[52]

Several areas in Australia have sought to mitigate many of these harmful effects by altering their electric systems from FITs to net metering systems that pay residential solar energy producers the wholesale price of electricity rather than an inflated retail rate. Given the rapidly decreasing cost of SPV panels, rising retail electricity tariffs, and growing acceptance of renewable energy technology, Australia has found that SPV deployment has continued to grow despite the changes made to its system.[53] Additionally, similar concerns that non-solar consumers are cross-subsidizing solar consumers' electricity bills has led for proposals by Australian states to impose PV specific charges on SPV households.[54]

Section IV: Summary of Arguments for Preserving Pro-Rooftop Solar Policies

Proponents of U.S. solar incentive programs continue to cite RPS goals and net metering policies as primary drivers of SPV generation, claiming that without continued government assistance, solar energy will not become a viable energy source within the near future—a goal that must be met to combat the threat of climate change.

In addition to environmental reasons, proponents of pro-rooftop solar policy claim governments should continue incentivizing solar energy production and growth in order to gain an advantageous foothold in the industry before other states move to become industry leaders.

For the past six years, The Solar Foundation (TSF) has released its annual "National Solar Jobs Census," which estimates job creation and growth trends across the U.S., as well as state specific census reports for the past three years. In the 2015 report, The Solar Foundation estimated that the solar industry employed about 35,000 workers between November 2014 and November 2015, and would increase by 14.7%, or 13 times faster than the overall economy (projected to grow at 1.1%), in 2016.[55] Additionally, The Solar Foundation has estimated that employment in the solar energy industry has grown by 123% since 2010 to almost 209,000 jobs in 2015.[56]

[48] Manuel Frondel et al., "Germany's solar cell promotion: Dark clouds on the horizon," *Energy Policy*, Volume 36, 2008, Pages 4198-4204. http://www.sciencedirect.com/science/article/pii/S0301421508003686
[49] Dr. Jonathan Lesser, "Renewable Energy and the Fallacy of 'Green' Jobs," *The Electricity Journal*, Volume 23, Issue 7, August–September 2010, Pages 45-53. http://www.sciencedirect.com/science/article/pii/S1040619010001788
[50] Manuel Frondel et al., "Germany's solar cell promotion: Dark clouds on the horizon," *Energy Policy*, Volume 36, 2008, Pages 4198-4204. http://www.sciencedirect.com/science/article/pii/S0301421508003686
[51] David Dismukes, "Estimating the Impact of Net Metering on LPSC Jurisdictional Ratepayers," Louisiana Public Service Commission, February 27, 2015. http://lpscstar.louisiana.gov/star/ViewFile.aspx?Id=f2b9ba59-eaca-4d6f-ac0b-a22b4b0600d5
[52] Tom Tanton, "Reforming Net Metering: Providing a Bright and Equitable Future," ALEC, March 2014. https://www.alec.org/app/uploads/2015/12/2014-Net-Metering-reform-web.pdf
[53] Sebastian Oliva H., Iain MacGill, Rob Passey, Assessing the short-term revenue impacts of residential PV systems on electricity customers, retailers and network service providers, Renewable and Sustainable Energy Reviews, Volume 54, February 2016, Pages 1494-1505. http://www.sciencedirect.com/science/article/pii/S1364032115011739
[54] *Ibid*.
[55] "National Solar Jobs Census 2015," The Solar Foundation. http://www.thesolarfoundation.org/wp-content/uploads/2016/01/TSF-2015-National-Solar-Jobs-Census.pdf
[56] *Ibid*.

Numerous studies attempt to assess the impact of SPV facilities in terms of jobs, income and output on state & local economies using the IMPLAN software package.[57,58,59,60] A 2015 study used the IMPLAN software to estimate the indirect and induced impacts, or multiplier impacts, based on the expenditures associated with construction and operations and management (O/M) of a new solar facility on Arizona. The results of that study estimated that for every $1 million dollars spent on the construction of a new solar facility in Arizona, a total of 9.29 jobs, $0.45 million in income, and $1.4 million in output would be generated, thus implying multipliers of 1.92, 1.84, and 1.81 in Arizona. Studies using IMPLAN to estimate economic impacts are inherently biased upwards due to the software and can be further biased upwards depending on the assumptions of the IMPLAN user (this will be discussed in detail in a forthcoming section).

Finally, proponents also claim that current government support of solar energy technology development and installations is warranted given that the price of consuming traditional electricity does not reflect the adverse environmental impacts (externalities) of burning fossil fuel.[61] However, SPV technology has current—and very large—environmental costs, which, along with their economic costs, are deserving of analysis, as will be discussed in the following section.

Section V: The Reality of the Solar Industry's Claims on Costs and Jobs

Costs

The economy relies upon prices in order to drive consumption, production, and investment behavior. When prices are low, demand is high as consumers substitute away from higher priced goods to lower priced goods, and supply is low as a result of decreasing profits that disincentive production; however, when prices are high, demand is low and supply is high.

The current 30% federal ITC, combined with states' net metering structures, create significant distortions in the market for electricity power sources, and run counter to economic reasoning. As the price being paid to solar energy producers remains artificially high, it continues to motivate the market to invest in a method of energy generation that is not the most efficient option available, thereby diverting capital investment away from its most productive use. This is evident in the fact that solar remains considerably more expensive when compared to conventional electricity sources, such as coal, natural gas, or nuclear. For example, it is estimated that the levelized cost of electricity (LCOE) for new SPV technology will be $74.20 per MWh in 2020 and $56.40 for new natural gas plants.[62]

Additionally, due to continuing reliability challenges, solar installations often do not work in sync with electric grids. Rooftop solar customers produce energy in excess of their demand for maybe one to two hours of the day; for the rest of the day, as well as all hours of the night, they must rely primarily on the electric grid as their source of electricity.[63] The unevenness in energy entering and leaving the electric grid imposes considerable costs onto the

[57] S. Grover, "Energy, Economic, and Environmental Benefits of the Solar American Initiative," National Renewable Energy Laboratory, August 2007. http://www.nrel.gov/docs/fy07osti/41998.pdf
[58] Jinwon Bae and Sandy Dall'erba, "The Economic Impact of a New Solar Power Plant in Arizona: Comparing the Input-Output Results generated by JEDI vs. IMPLAN," Regional Economic Applications Laboratory (REAL) Discussion Papers series, University of Illinois. http://www.real.illinois.edu/d-paper/15/15-T-5.pdf
[59] George Frisvold, William P. Patton, and Stan Reynolds, "Arizona Solar Energy and Economics Output," prepared for Arizona Solar Energy and Economics Summit, January 9, 2009. http://www.solarthermalworld.org/sites/gstec/files/story/2015-03-14/arizona_solar_energy_and_economic_outlook_a6875.pdf
[60] Ann Weaver Hart, David N. Allen, and Bruce A. Wright, "The Economic Impact of the UA Tech Park," January 2015. https://techparks.arizona.edu/sites/default/files/UA%20Tech%20Park%20Economic%20Impact%20Report%202013.pdf
[61] Sebastian Oliva H., Iain MacGill, Rob Passey, Assessing the short-term revenue impacts of residential PV systems on electricity customers, retailers and network service providers, Renewable and Sustainable Energy Reviews, Volume 54, February 2016, Pages 1494-1505. http://www.sciencedirect.com/science/article/pii/S1364032115011739
[62] "Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2016," U.S. Energy Information Administration, August 2016. https://www.eia.gov/forecasts/aeo/pdf/electricity_generation.pdf
[63] Tom Tanton, "Reforming Net Metering: Providing a Bright and Equitable Future," ALEC, March 2014. https://www.alec.org/app/uploads/2015/12/2014-Net-Metering-reform-web.pdf

grid system, and can result in rapid destabilization. In Hawaii, just 12% of houses with DG solar is enough to cause concerns of grid destabilization.[64]

These grid destabilization fears arise because current electrical grids were not built to accommodate multiple distribution and entry points. Grids are most effective when there is a centralized output producer that then distributes electricity according to demand, allowing for proper balancing of power generation. The unpredictability brought by DG, such as periods of over-generation followed by periods of steep ramping-up, imposes added pressures onto grid systems, which in and of themselves require a great deal of upkeep in order to maintain power quality.[65] The net effect is then an increase in distribution costs and local rates.[66]

Yet, current net metering policies do little to address these increasing costs. Instead, they often overemphasize solar customers' role as energy producers, neglecting the fact that solar customers rely significantly on the electrical grid for more than half of all hours. This is because solar energy generation relies on the availability of the sun, which is unpredictable during the day, at best, and completely unavailable during the night. Most consumers also do not have storage facilities given that suitable technology has not yet been developed to efficiently store solar energy.[67] As a result, rooftop and utility-scale solar customers must remain connected to the grid, thereby taking advantage of consumption-smoothing services, such as balancing and backup for power, provided by electric grids, as well as a means by which to sell electricity onto the grid if they happen to produce electricity in excess of their demand.

Adding insult to injury, net metering structures then subsidize this inefficient and cumbersome form of solar energy production, with the retail rate paid by utilities to residential renewable energy producers in net metering grids estimated to be anywhere between two and six times the market price for energy.[68] This overvaluation, on top of increasing maintenance costs, hurts both existing customers who must bear the increasing cost burden, as well as utilities, which are being forced to pay more for less energy produced in order to sufficiently meet energy demands. A recent study by Satchwell *et al*. confirms this trend, highlighting considerable revenue erosion of utilities as a result of residential PV installations, as well as increasing retail rates as the costs incurred by utilities are spread over an increasingly smaller base of customers.[69] This presents significant dangers to the reliability of electricity, which face threats of overloading circuits that cause power quality problems and jeopardize the safety of utility employees and the public.

State net metering policies continue to drive increasing cost burdens, inefficiently distribute public and private funds, and are doubly regressive—non-solar customers, who are primarily less-affluent, are forced to not only subsidize costs created by solar customers, who are primarily more-affluent, but they must also pay higher prices to help make up for the utilities' loss of revenue,[70,71] explained further below.

In order to correct these market distortions, states must seek to alter their generous subsidy schemes to allow the market to competitively allocate funds and develop technologies that will achieve long-term growth. The success of this approach can be seen in the difference in competition vs. costs between utility-scale and residential solar installations: utility-scale costs and overall prices are much lower due to intense supplier competition, whereas competition is much less in the residential market.[72] Therefore, it is reasonable to project that increased competition

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[64] Severin Borenstein, "Is the Future of Electricity Generation Really Distributed?" Energy Institute at Haas, University of California Berkeley Haas School of Business, May 4, 2015. https://energyathaas.wordpress.com/2015/05/04/is-the-future-of-electricity-generation-really-distributed/
[65] "Residential Solar: Myth vs. Fact," Institute for Energy Research, March 22, 2016. http://instituteforenergyresearch.org/analysis/residential-solar-myth-vs-fact/
[66] MIT Energy Initiative, "The Future of Solar Energy," Massachusetts Institute of Technology, 2015.
[67] Tom Tanton, "Reforming Net Metering: Providing a Bright and Equitable Future," ALEC, March 2014. https://www.alec.org/app/uploads/2015/12/2014-Net-Metering-reform-web.pdf
[68] David B. Raskin, "The Regulatory Challenge of Distributed Generation," *Harvard Business Law Review*, Vol. 4, December 2013. http://www.wecc.biz/committees/BOD/TEPPC/SPSG/Lists/Events/Attachments/706/CITIRising%20Sun%20Implications%20for%20US%20Utilities.pdf.
[69] Andrew Satchwell, "Quantifying the financial impacts of net-metered PV on utilities and ratepayers," *Energy Policy*, Volume 80, May 2015, Pages 133-144. http://www.sciencedirect.com/science/article/pii/S0301421515000622
[70] Ashley Brown, "Matching Prices and Value for Distributed Solar PV: SRP's Proposal," Harvard Electricity Policy Group. http://www.srpnet.com/prices/priceprocess/pdfx/ABReport.pdf
[71] Tom Tanton, "Reforming Net Metering: Providing a Bright and Equitable Future," ALEC, March 2014. https://www.alec.org/app/uploads/2015/12/2014-Net-Metering-reform-web.pdf
[72] *Ibid.*

will provide downward pressure on both installed prices and underlying costs of residential systems and in the solar industry as a whole.

In addition, while proponents make strong claims of the environmental benefits of SPV, SPV is not without present and future environmental costs—some of which are considerable. In terms of present costs, the manufacturing of current generation SPVs is very energy intensive and requires large quantities of raw materials.[73] A small amount of toxic element cadmium (Cd) is a byproduct of the manufacturing process and must be either directed to other productive processes or released into the atmosphere.[74] Costs associated with transportation of finished SPV hardware to the installation site also contribute to air pollution, though the impact is estimated at 1/100th of the air pollution generated in the manufacturing process.

Future costs to be incurred when SPV panels are decommissioned are far greater than those from the manufacturing process and deserve attention.[75] Unlike many other energy sources, the lag time between when SPV creates energy and when it generates waste, i.e. when SPV hardware is decommissioned, is very long—currently estimated at 25-30 years.[76] The incredible growth in SPV over the last decade will lead to the decommissioning of much of the nation's SPV infrastructure starting in 2020. SPV contains many hazardous materials that cannot currently be recycled in an economically viable manner and must be disposed of with care. If they are not disposed of properly, the hazardous materials could be passed to humans through the food chain. They also have the potential to adversely impact air quality. The disposal of the last decades' worth of SPV in will require significant planning and investment, thereby lowering any long term economic benefits of SPV.

It is critical that the pricing of SPV provides the proper incentives and price signals to the market place. The use of subsidies has created distortions in the market for electricity, directing investment away from more efficient electricity power sources, such as nuclear, combined cycle natural gas, coal, and hydro.[77] Therefore, it is not surprising that, as states work to reduce distortions stemming from current net metering schemes and solar subsidies, markets are normalizing and responding accordingly.

Jobs

Several states have already begun to alter their net metering schemes in order to address pressing issues and correct distortions, thereby allowing capital to be allocated according to the most efficient energy generation method. Many solar industry lobbyists and studies have responded by arguing that the reduction in incentives resulting from the normalization is driving much needed jobs and economic growth from these states, advising that such changes should not be replicated in other states seeking to alter their net metering schemes.

Proponents continue to argue that the solar industry leads other sectors of the economy in job growth. The Solar Foundation estimated that, in 2015, the solar industry added workers 12 times faster than the overall economy and accounted for 1.2% of all jobs created in the U.S.[78] The Solar Foundation defined solar employees as workers who spent at least 50% of their time on solar-related work.

What should be immediately apparent is that The Solar Foundation tends to skew their reports to highlight job *growth* rather than the increase in the *number* of jobs. For example, if Industry A had one employee in 2014 and grew by one employee in 2015, it has experienced a 100% growth rate. Alternatively, if Industry B had 10 employees in 2014, and grew by 4 employees in 2015, it has experienced only a 40% growth rate, yet Industry B added more jobs to the economy than Industry A.

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[73] Theocharis Tsoutsos, Niki Frantzeskaki, Vassilis Gekas, "Environmental impacts from the solar energy technologies," *Energy Policy*, 33, 289-296, 2005. http://www.calepa.ca.gov/Cepc/2013/Feb28/Comments/AppA_Ex5.pdf
[74] *Ibid.*
[75] N.C. McDonald and J.M. Pearce, "Producer Responsibility and Recycling Solar Photovoltaic Modules," *Energy Policy*, Volume 38, Issue 11, November 2010. http://www.sciencedirect.com/science/article/pii/S0301421510005537
[76] *Ibid.*
[77] "Residential Solar: Myth vs. Fact," Institute for Energy Research, March 22, 2016. http://instituteforenergyresearch.org/analysis/residential-solar-myth-vs-fact/
[78] "National Solar Jobs Census 2015," The Solar Foundation. http://www.thesolarfoundation.org/wp-content/uploads/2016/01/TSF-2015-National-Solar-Jobs-Census.pdf

Additionally, The Solar Foundation fails to take into account the difference in the quality of solar jobs created by rooftop solar compared to utility-scale solar installations. In a study released on California solar job creation, The Solar Foundation found that the solar industry employed 54,700 solar workers, with the majority of these workers—almost 31,500—worked in the installation sector. Installers were also reported to be more concentrated in residential installations, with almost 25% in commercial projects and a little over 5% in utility-scale projects.[79]

However, the National Solar jobs report by The Solar Foundation indicates that "average wages for installers in utility-scale firms are 20% higher than in firms working on residential and commercial distributed projects."[80] In California, evidence suggests that there are many more middle class careers in utility-scale solar than exist in rooftop solar, given that utility-scale projects often make use of labor contracts that govern their construction projects and provide higher pay and better benefits for installation workers. Rooftop solar, on the other hand, has no comparable data documenting similar wages and benefits for installation workers, with The Solar Foundation indicating that installers are the lowest paid class of workers in the industry, adding that no distinct career progression has yet formed for photovoltaic installers.[81]

Finally, the method used to calculate the number of jobs added includes both a survey administered by phone and email, as well as employer-reported data from the Bureau of Labor Statistics (BLS) Current Employment Survey. In 2010, it should be noted that the national census was based on responses from only half of U.S. states; the 2010 census has since been used as the foundation for subsequent census counts by TSF, meaning there could be considerable skews in data reported.

The Labor Center at UC Berkeley confirmed as much when it found large discrepancies between wage and employment data issued by California versus the BLS, noting that the wages published by the BLS for the residential construction industry failed to "capture the low end of the pay spectrum due to the prevalence of cash pay, misclassification of workers as independent contractors, and other characteristics of the underground economy."[82] Rather, the authors found actual salary data to be much lower than salary data reported by The Solar Foundation and BLS.

Overall, what the studies and estimates published by The Solar Foundation and the BLS overwhelmingly fail to address are the effects stemming from any offsetting impact, thereby failing to account for jobs lost as a result of "the crowding out of cheaper forms of conventional energy generation," "indirect impacts on upstream industries," and from "the drain on economic activity precipitated by higher electricity prices."[83,84]

Examples of these consequences include: continued drains on tax revenues contributing to budget deficits without any realized benefit, increased cost of energy utilizing greater portions of individuals' budgets, jobs foregone by investing in solar energy production rather than a more efficient form of energy production, jobs lost by increasing the burden on utility companies that face increasing costs and decreasing revenue, and jobs created in the base case scenario if solar energy were not subsidized in its current form. Studies also do not account for creation of jobs had investments made in solar companies gone towards alternative, more beneficial companies based on fundamentals and free market signals.

Such effects have not been adequately measured using the U.S. scenario, and it is therefore worth revisiting the aforementioned net employment resulting from Germany's own form of solar subsidies. As a result of Germany's decision to subsidize a highly inefficient form of solar energy production—rooftop solar installations—that in turn

[79] The Solar Foundation, "California Solar Jobs Census," February 2015. http://www.thesolarfoundation.org/wp-content/uploads/2015/02/California-Solar-Jobs-Census-2014.pdf
[80] Betony Jones and Carol Zabin, "Are Solar Energy Jobs Good Jobs?" UC Berkeley Labor Center, July 2, 2015. http://laborcenter.berkeley.edu/are-solar-energy-jobs-good-jobs/
[81] *Ibid*.
[82] *Ibid*.
[83] Manuel Frondel et al., "Germany's solar cell promotion: Dark clouds on the horizon," *Energy Policy*, Volume 36, 2008, Pages 4198-4204. http://www.sciencedirect.com/science/article/pii/S0301421508003686
[84] Manuel Frondel et al., "Economic impacts from the promotion of renewable energy technologies: The German experience," Rheinisch-Westfalisches Institut fur Wirtschaftsforschung (RWI), October 2009. http://instituteforenergyresearch.org/media/germany/Germany_Study_-_FINAL.pdf

drove increasing energy costs, net employment effects were estimated by Frondel *et al.* to be negative given "the resulting drain of purchasing power and investment capital of private and industrial electricity consumers."[85]

Proponents also fail to assess the transferability of skills between solar jobs, such as panel installers, and positions within similar industries. This is important as job estimates provided by The Solar Foundation rely heavily upon BLS estimates of solar jobs in different solar subindustries. For example, solar panel installers typically have previous experience working as roofers, electricians, or plumbers; as such, the BLS has acknowledged the difficulty in separating solar installers from two types of subcategories: residential electrical contractors and commercial electrical contractors. This can heavily impact job estimate numbers, especially in the earlier years in which The Solar Foundation published its jobs report.[86]

In addition, this skill transferability is important to recognize when evaluating the long-term economic growth of a state should states choose to remove distorting subsidies and allow the market to normalize accordingly. These jobs "lost" do not take into account the fact that these individuals will be able to reenter the economy in similar jobs rather than remain unemployed. In the case of Nevada, where 95% of solar jobs are installation jobs, installers can easily reenter the construction industry as roofers or electricians. Applying this to the U.S. as a whole, in which almost 65% of the 35,000 solar job created in 2015 were in solar installation, the transferability of skills between these industries is very important.

As noted above, a 2015 study used the IMPLAN software to estimate the indirect and induced impacts, or multiplier impacts, based on the expenditures associated with construction and operations and management (O/M) of a newsolar facility on Arizona. IMPLAN is frequently used to estimate the economic impact of expenditures in a given sector (say car manufacturing, or retail) and how they "ripple" across all sectors throughout the economy.

A few general problems with using IMPLAN to estimate economic impacts are: IMPLAN cannot account for supply-side constraints (such as limited labor in a region) or dynamic changes in the market structure when generating estimates (say an influx or exodus of labor to or from a region that occur due to economic activity).[87] This is because to generate results, IMPLAN inserts new expenditures into the economy, and the relationship between the new expenditures to jobs, income, and output will be the same as the ratio between prior expenditures and jobs, income, and output. In short, $1 of new expenditures in a county or state will have the same impact in terms of the ratio to jobs, income and output it creates as $1 trillion of new expenditures in that same region.

Economic impact analyses using IMPLAN are also prone to overestimation due to assumptions and choices made by the IMPLAN user. The 2015 study examining the impacts of a new solar facility in Arizona serves as an example of how assumptions made by the IMPLAN user can lead to over estimation of results.

Section VI: Solar Subsidies Going to Corporations

On the federal level, in December 2015, the 30% Investment Tax Credit (ITC), that was set to expire at the end of 2016, was extended through to 2019 as part of the federal spending bill passed. After 2019, the tax credit percentage will gradually decline until the credit reaches 10% in 2022. Currently, the credits allow homeowners and businesses to deduct for home or commercial solar installations, or are given to leasing companies, such as SolarCity and Sunrun, if consumers choose to lease solar equipment for their installation. The extension of the solar tax credits is expected to cost taxpayers around $9.3 billion.

The transferability of the ITC between homeowners purchasing installations and leasing companies has allowed individuals, such as Elon Musk, to build multimillion dollar companies on this public-private sector teeter totter. While

[85] Manuel Frondel et al., "Germany's solar cell promotion: Dark clouds on the horizon," *Energy Policy*, Volume 36, 2008, Pages 4198-4204. http://www.sciencedirect.com/science/article/pii/S0301421508003686

[86] Anthony Evans and Melissa Gamez, "Solar Employment in Arizona: Critique of Estimates and Independent Quantification for 2013," Arizona State University, May 1, 2014.

[87] Dan S. Rickman and Keith R. Schwer, "A Systematic Comparison of the REMI and IMPLAN models: the Case of Southern Nevada," The Review of Regional Studies, Southern Regional Science Association, University of Birmingham, 1993. https://www.econbiz.de/Record/a-systematic-comparison-of-the-remi-and-implan-models-the-case-of-southern-nevada-rickman-dan/10001156554

Musk's company, SolarCity, seems to indicate the success of solar energy in the market, a deeper look proves otherwise. According to public records, SolarCity has received $497.5 million in direct grants from the Treasury Department. Yet, when looking at the cost and number of residential solar installations sold—217,595 since 2006, each at a cost of $23,000—the total cost to government of subsidizing SolarCity jumps to $1.5 billion.[88] Thus, SolarCity's success has largely been built on the back of government subsidies, and therefore on the backs of taxpayers. The theoretical payoff from the consumer perspective is pollution reduction, which has yet to occur and will only occur if solar panels edge away from their niche status and into the mass-market product category.[1] Furthermore, SolarCity's losses are likely only growing larger as energy prices decline and subsidies become more uncommon.[2]

Section VII: Conclusion

Current solar subsidies and net metering schemes through U.S. states continue to draw capital away from its most efficient use, often at the benefit of U.S. solar panel producers and installation companies, such as SolarCity, but at the expense of electricity consumers.

The costs associated with facilitating these distortions are numerous. Given that solar customers are often paid the retail rate for excess electricity produced, and do not share the burden of maintenance costs, electrical grids are finding they cannot keep up with the current dichotomy they are facing of rising costs and a decreasing customer base. Thus, many studies conducted by states have found evidence of cross-subsidization between non-solar customers, who are often less-affluent, and solar customers, who are often more-affluent.

Proponents of government assistance of solar energy have attempted to highlight job growth as a means to justify the immense support needed by the solar industry in order to stay afloat. These job growth estimates not only employ skewed survey data, but also fail to take into account many of the dynamic effects that result from the government's intervention, such as the consequences of draining tax revenues and foregone investments, increased cost of energy utilizing a greater share of consumers' budgets, jobs foregone by investing in solar energy production, and jobs created in the base case scenario if solar energy were not subsidized in its current form.

States should seek to restructure their net metering schemes and subsidies in order to promote the most efficient use of taxpayer dollars and normalize investments based on the fundamentals of different electricity generating methods. While utility-scale solar has proven more efficient than residential solar installations, both continue to lag behind traditional electricity generation methods that are able to generate greater output per dollar.

Any future technological development of solar energy alternatives relies heavily on whether the government will be able to take a step back and allow the market to distribute capital efficiently, thereby allowing the most competitive electricity options to survive and facilitate effective progress of solar power and other electricity options.

[88] Jerry Hirsch, "Elon Musk's growing empire is fueled by $4.9 billion in government subsidies," *Los Angeles Times*, May 20, 2015. http://www.latimes.com/business/la-fi-hy-musk-subsidies-20150531-story.html#page=1