Shrinking Solar Soft Costs:

Policy Solutions to Make Solar Power Economically Competitive

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Executive Summary

The past decade has seen a remarkable decline in the price of solar panels and, consequently, remarkable growth of the solar industry. However, without government support, solar power is not yet economically competitive with other forms of energy. For the solar industry to attain competitive prices in the absence of government support, **the non-hardware costs, or soft costs, of solar power must decline** substantially. The current price trends for solar panels themselves are already falling, but the remaining costs of bringing solar power online are not. The United States Department of Energy has recently launched the SunShot Initiative, which aims to make solar power more economically competitive, in part by substantially reducing soft costs. To that end, this paper explains what soft costs are and provides five policy solutions for reducing soft costs.

Soft costs are all the costs of bringing a solar photovoltaic system online, except the costs of the solar panels themselves. The soft costs of solar power include the following categories: (1) customer acquisition; (2) permitting, inspection, and interconnection; (3) financing; (4) installation labor; (5) affiliated, non-module hardware; and (5) taxes. This paper offers a detailed description of each type of soft cost.

The heart of the paper focuses on policy solutions for reducing these soft costs, offering five ways policy makers can help make solar power economically competitive:

(1) New Corporate Forms and Financing for Solar Power: Currently, the solar industry cannot use some of the most desirable business forms and financing methods. For example, the solar industry cannot use Real Estate Investment Trusts because the Internal Revenue Service does not consider solar panels to be real property. Similarly, the solar industry cannot use Master Limited Partnerships because the federal statute creating this structure makes fossil-fuel companies eligible, but not renewable energy companies. The federal government should reform these policies in order to level the playing field for various sources of energy and to allow the solar industry to take advantage of these business forms.

(2) Standardizing System Designs: Standardized solar power system designs would reduce soft costs at all phases of a solar project. The basic goal is to develop “plug-and-play” solar PV systems that are modular, easy to produce, and easy to install. Standardized hardware that includes integrated electronic components could obtain reduced costs through economies of scale. Additionally, standardized system designs should reduce permitting, inspection, and interconnection costs by reducing uncertainty about solar power’s safety risks or impacts on the utility grid. Fourth, standardized system design would reduce installation labor by providing simpler projects. All of these impacts should make the solar industry more profitable and predictable, turn lowering financing costs by attracting investors and lowering customer acquisition costs by attracting more customers. This paper argues that governments should promote standardization of solar system designs.

(3) Streamlining Permitting and Inspections: Unwieldy, redundant, and needlessly complex permitting and inspection regimes add substantially to the soft costs of solar power. However, because permitting and inspection systems are the products of regulation, policy makers are uniquely well-poised to reduce these unnecessary costs. This paper argues that states should take the lead in streamlining permitting and inspection and should work with local governments. Particularly, states should develop standard technical and procedural requirements, implement clear guidelines and checklists for permit applications, and allow online completion and submission of permit applications. Additionally, states should eliminate unnecessary or redundant reviews and inspections, reduce wait times for inspections, and reduce permit fees.

(4) Utility Regulation to Promote Swift Interconnection: Interconnecting to the utility grid can prove to be a costly roadblock to the development of solar power. In areas with considerable solar power penetration, a new solar photovoltaic system may face supplemental interconnection studies that can add thousands of dollars to the system's cost. The Federal Energy Regulatory Commission (FERC) recently issued a final rule, Order 792, revising the pro forma agreement under which small electricity generators may interconnect to existing transmission grids. This order regulates the supplemental studies a utility may require for small electricity generators such as distributed solar systems. Order 792 is an excellent step toward promoting swift, low-cost interconnections. This paper describes Order 792 in greater detail and argues that states should follow FERC's lead to issue similar rules.

(5) Mandating Solar Buildings: The vanguard of government promotion of the solar industry, solar mandates require that new and renovated buildings include solar power. In 2013, the cities of Lancaster and Sebastopol in California passed solar mandates. Although these mandates are so recent that there is little empirical evidence of their effects, solar mandates should reduce solar soft costs in several important ways. Solar mandates should reduce customer acquisition costs by guaranteeing a customer base. Additionally, they would facilitate standardized system designs by incorporating solar power into the designs of entire communities, which often feature a limited number of housing designs. Moreover, solar mandates would also reduce financing costs by allowing solar power to be included in traditional, low-cost real estate financing mechanisms such as mortgages. This paper explores these benefits of solar mandates and advocates for more jurisdictions to implement them.

This suite of policies should help bring down the soft costs of solar power substantially, helping solar power to become cost-competitive with other forms of electricity generation as soon as possible.

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I. Introduction

The market for solar power is growing dramatically. In fact, the solar industry has reported record growth each year since 2010.[1] In 2013, the solar industry developed more new power than any other source of energy except for natural gas.[2] The solar industry's growth results mainly from rapid declines in the overall price of solar power, which is plunging in turn because solar panels been becoming steadily less expensive over the last decade.[3] For the solar market to continue to grow, prices must continue to decline. Solar panels are already on the right track, getting steadily more efficient and less expensive. [4]However, the "soft costs" of solar power are holding steady, making them the major obstacle to the sustained growth of solar industry.

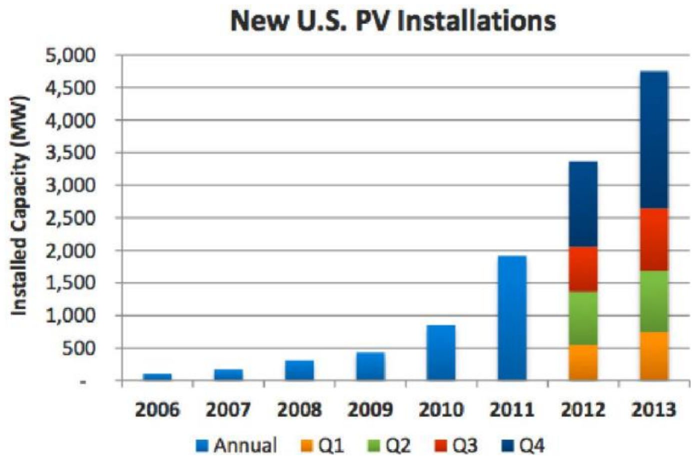

Figure 1: Growth of PV Installations, Solar Energy Industries Association (SEIA).

Solar panels are no longer the most expensive part of solar photovoltaic power (PV). Instead, most of the current price of PV comes from "soft costs," or the costs of the other necessary aspects of getting a PV system up and running. The most obvious soft costs come from the other necessary hardware, such as rooftop mounting equipment and wiring, as well as from having an electrician install the system. Other soft costs, which are perhaps less obvious, are the costs of permits, inspections, and interconnection with the power grid. While the cost of solar panels has fallen dramatically recently, soft costs have held steady. As a result, soft costs now account for most of the price of solar power. Moreover, as the United States resolves a recent trade dispute with China, the price of solar panels may increase, bringing increased importance to the project of reducing solar soft costs.[5]

Soft costs now account for more than half of the price of solar power.

Soft costs are now the major roadblock to the growth of solar power.[6] Indeed, the most common criticism of solar power is that it is not cost-competitive.[7] Because consumers, utilities, and governments generally prefer to get electricity at the lowest price, the solar industry has focused on reducing costs to become economically competitive with other forms of energy. The result has been a dramatic reduction in the price of solar panels. However, **unless soft costs decline, solar power will not be able to compete for a larger share of the energy market**.

This paper explains what soft costs are and offers five ways policy makers can help reduce them. These policy proposals build on prior soft cost scholarship to provide more concrete detail on the actions policy makers should take. This paper focuses on solar projects under 10kW, the size of most solar projects.[8] Still, this paper's insights are also important for larger projects. Although larger projects enjoy economies of scale that reduce overall costs, soft costs are a majority share of the overall price of solar power even at the utility scale.[9]

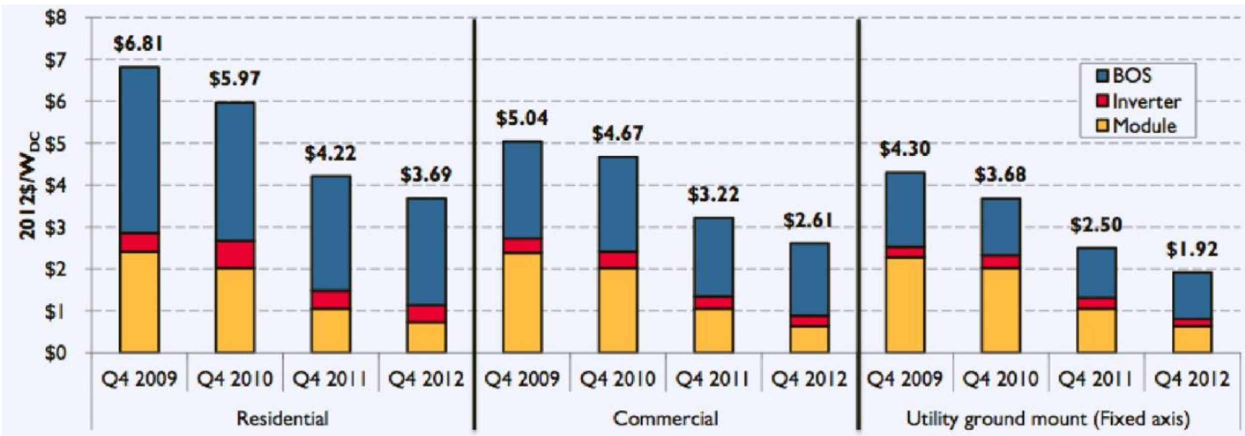

Figure 2: Soft costs remaining relatively steady in comparison to declining module costs, Feldman et al., National Renewable Energy Laboratory (NREL).

To reduce the soft costs of solar power, the U.S. Department of Energy has launched the SunShot Initiative,[10] which aims to have solar power contribute 14% of the U.S. electricity supply by 2030 and 27% by 2050.[11] The Initiative's main goal is to reduce the levelized cost of solar power to $0.06/kWh to make it economically competitive with other forms of energy.[12] To that end, the Initiative aims to reduce solar soft costs.[13]

The National Renewable Energy Laboratory (NREL) recently published a "roadmap" that proposes strategies to reduce solar soft costs.[14] NREL notes that "achieving the SunShot residential aggregate target of $0.65/W requires an 80% reduction" in soft costs[15] Such an ambitious reduction will require "concerted efforts of numerous PV market actors and stakeholders."[16] NREL offers various policy proposals that are quite valuable, some of which receive discussion below. However, it is important to note that NREL's roadmap does not purport to offer a complete array of solutions.[17] In other words, reducing soft costs will require further policy innovations.

Solar soft costs must decline by 80%.

This paper aims to help fulfill that need. To that end, section II describes price trends in solar power. Section III describes the categories of soft costs. Section IV presents five policy solutions that can help to reduce soft costs: (1) new business forms; (2) standardized system designs; (3) streamlined permitting and inspections; (4) utility regulation to promote interconnection; and (5) solar mandates. The paper concludes that significant reductions in soft costs are attainable and can help make solar power economically competitive.

Pricing Solar Power

This paper presents costs of solar power in price-per-watt. For example, the nation-wide average price of solar power is around six dollars per watt ($6/W), but to become economically competitive with other energy sources, the price of solar power must fall to one dollar per watt ($1/W).

Price-per-watt is the best metric for soft costs of solar power. First, price-perwatt makes it easy to understand the importance of reducing soft costs by showing that soft costs are more than half of the price of solar power.

Second, price-per-watt makes it easy to compare different types of soft costs, which would be more difficult with other metrics. This comparison can help show which types of soft costs have the greatest impact on the overall price of solar power, which should help policy makers set priorities.

Other studies of solar power often use two other price metrics. First, studies often use the Levelized Cost of Energy (LCOE), which presents prices in dollars or cents per kilowatt-hour ($/kWh). The virtue of LCOE is that it can make it easier to compare solar power to other forms of energy—to show, for example, how solar power compares over time to power from natural gas.

The other common metric for pricing solar power is the concept of “grid parity,” or the point at which solar power requires no incentives or subsidies to be cost-competitive with other forms of energy. The virtue of grid parity is that it makes it easy to know when solar power becomes cost-competitive with other forms of energy.

However, both LCOE and grid parity have significant problems. For example, although policy makers use LCOE most frequently, it has no standard definition and no standard method of calculation. Moreover, LCOE depends sensitively on several underlying assumptions, such as capital costs, system longevity, capacity factor, and operation and maintenance costs. Different assumptions yield profoundly different results. The resulting variability in LCOE makes it hard for policy makers to compare PV to other energy sources.

Calculating grid parity requires this difficult comparison between LCOE of PV and other energy sources, which makes grid parity the most flawed metric of all. The problem with this comparison is that small solar projects contribute power at the retail level (i.e., directly to a consumer) rather than at the wholesale level (i.e., to a utility for distribution to consumers). Because wholesale prices are lower than retail prices, the comparison makes other forms of power seem cheaper and solar power seem more expensive.

Finally, both LCOE and grid parity often rely on outdated information that fails to take into account the dramatic recent plunge in the price of solar power. Outdated, misleading information works against the solar industry.

For more on difficulties of calculating the price of solar power, see Morgan Bazilian et al., *Re-considering the Economics of Photovoltaic Power*, 53 Renewable Energy 329, 332 (2013), *available at* www.bnef.com/WhitePapers/download/82.

II. Solar Power Price Trends

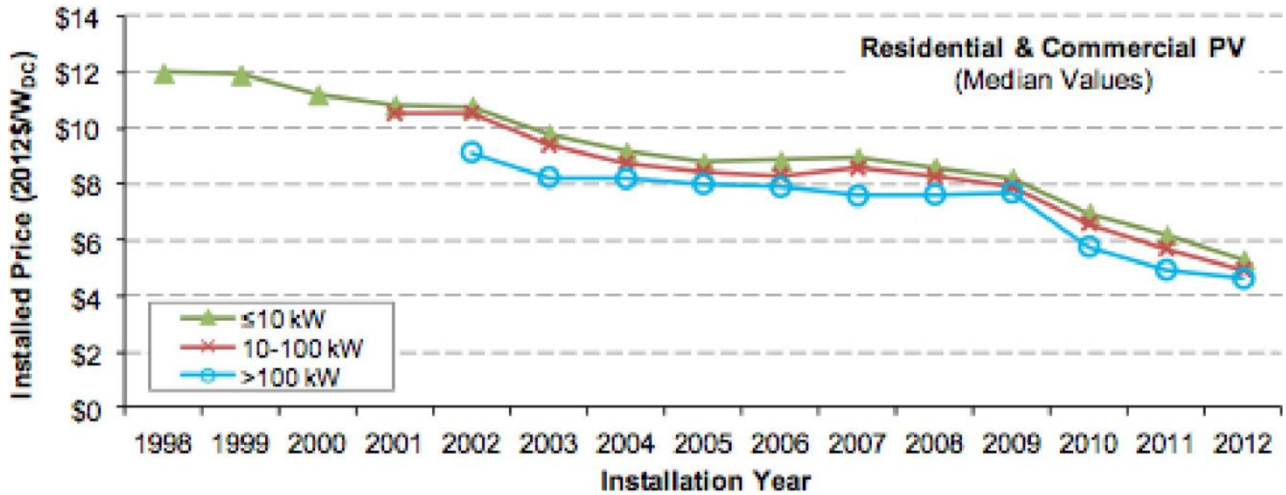

Figure 3: Declining Solar Power Prices, Barbose et al., Lawrence Berkeley National Laboratory (LBNL).

Solar power has become significantly more affordable over at least the last fifteen years: on average, prices have declined by roughly seven percent each year.[18] However, the decline has been driven chiefly by falling prices of solar panels.[19] Although soft costs have also declined during this fifteen-year period, they have remained fairly constant in the last five.[20] These trends have made soft costs the largest share of the overall price of solar power..[21] As hardware prices continue to fall, this trend continues as well.[22] This section first describes how solar costs vary through time and by region, and then reviews the history of falling solar prices to show that policy makers can successfully bring costs down.

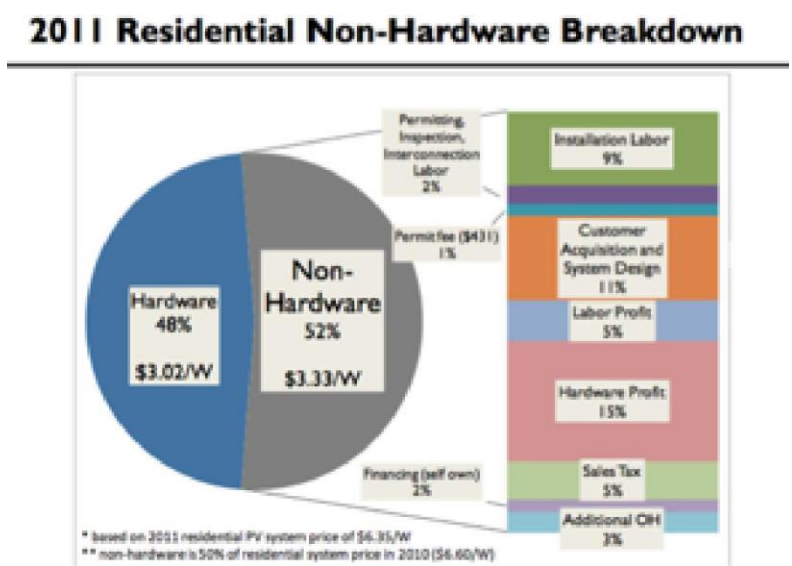

Figure 4: Soft Costs as the Majority of Solar Power Price, Ardani et al, NREL.

A. Significant Variations in Solar Power Prices

The installed price of solar power varies according to numerous factors.[23] For example, even among systems smaller than 10kW, prices vary significantly by project size: systems below 1kW cost an estimated $8.50/W, while systems between 9–10kW cost roughly $5/W.[24] Similarly, prices vary significantly among states, with systems in California or Wisconsin costing as much as $2/W (roughly 30%) more than systems in Texas or Colorado.[25] Additionally, local cost of living "has a significantly positive impact on installation prices."[26] Some sources of variation are more surprising. For example, "tax-exempt systems generally have higher installed prices than similarly sized residential and commercial systems."[27] Similarly, more educated communities tend to pay lower prices for solar power.[28] This significant variability in the market for solar power makes calculating a nationwide average price for solar power difficult.

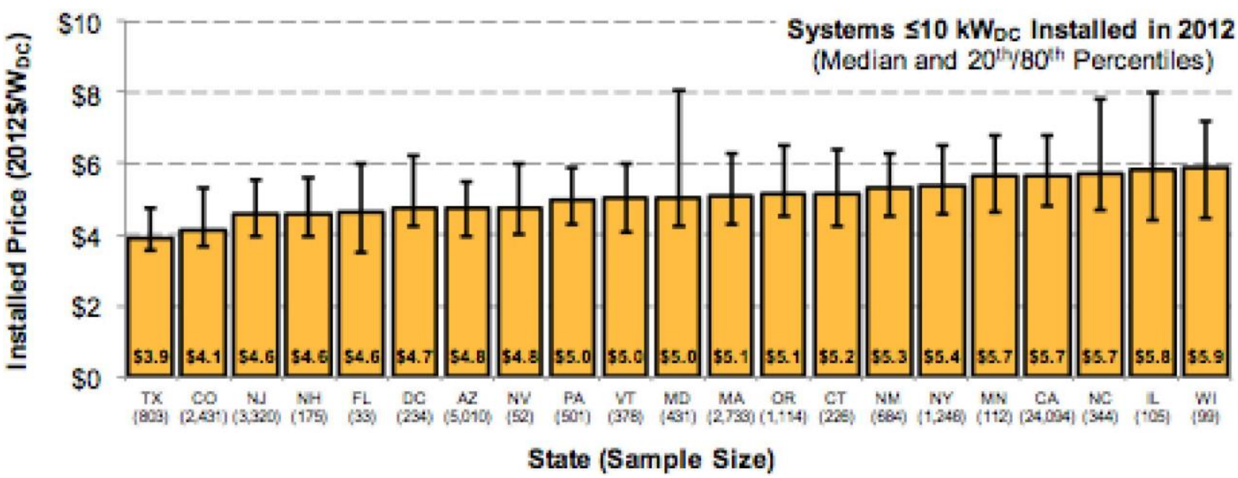

Figure 5: State Variation in Solar Power Prices
Barbose et al., LBNL.

B. Declining prices show that policy can reduce costs

The history of solar prices strongly suggests that policy makers can drive down soft costs. For one, soft costs have fallen in the past.[29] In fact, reductions in soft costs have accounted for "38% of the decline in the total installed price for ≤10kW systems over [the last fifteen years], clearly indicating the significant impact of non-module cost reductions over the long term."[30]

Similarly, dramatic international differences in the price of solar panels "suggests that near-term price reductions in the United States are possible."[31] For example, soft costs of solar power are dramatically lower in Germany than in the United States, illustrating that Germany has achieved significant reductions in solar soft costs.[32]

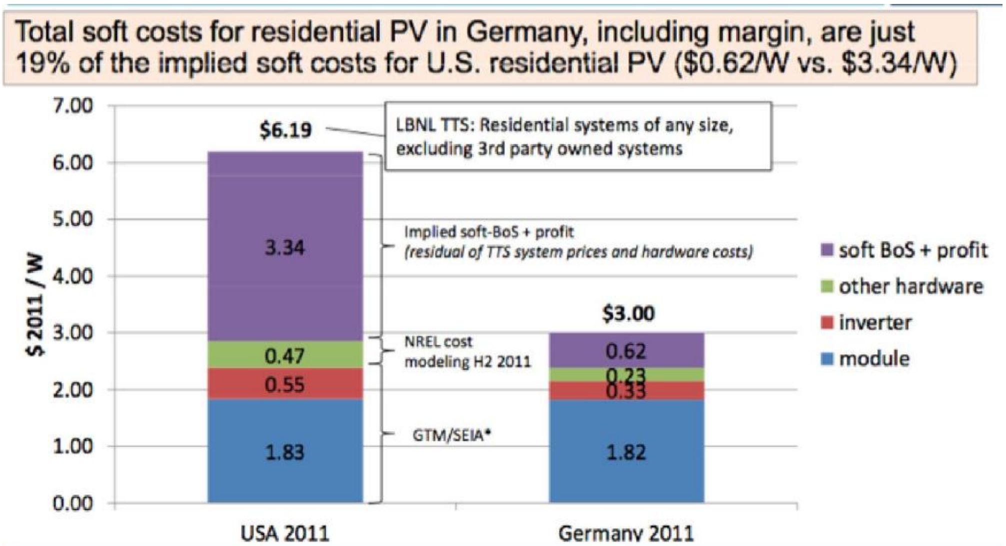

Figure 6: Soft Costs in the United States and Germany
Seel et al., LBNL

The same is true in other nations as well: the installed prices of solar systems are also significantly lower in Australia, Italy, and France.[33] International success in reducing soft costs suggest that U.S. policy makers could achieve similar cost reductions.

The history of U.S. energy policies also suggests that policy makers can reduce costs. Indeed, government incentives have historically driven the solar market.[34] Although government incentives have promoted solar power by reducing the prices consumers pay, governments have also aimed to drive down costs using regularly scheduled reductions of incentives to send market signals.[35] In fact, incentives for solar power have declined "steadily and significantly over the past decade" by 85% to 90%.[36] This scheduled withdrawal of incentives may have helped to drive down solar panel prices,[37] suggesting that policy makers could use a similar tactic to reduce soft costs.

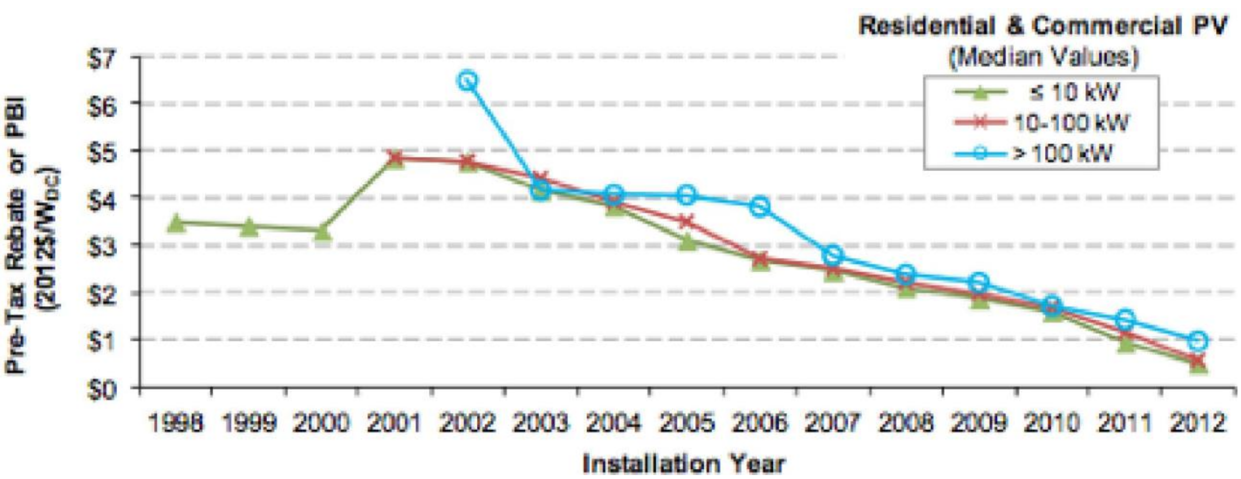

Figure 7: Declining Government Support for Solar Power,
Barbose et al., LBNL.

The Downside of Withdrawing Government Incentives

Scheduled withdrawal of government incentives may help drive down prices, but it also reduces consumer benefits from cost reductions. In fact, withdrawal of government incentives for solar panels has offset up to 88% of the decline in installed prices.[34]

Thus, withdrawal of government support for solar power has meant that consumers cannot enjoy the full benefits of significant price reductions. Policy makers should carefully weigh the benefits of cost reductions against the resulting diminished consumer benefits.

In fact, soft costs should be especially responsive to local policies. "Unlike module prices, which are primarily established through global markets, non-module costs consist of a variety of cost components that may be more readily affected by local policies."[38] Indeed, state policies can have a significant, demonstrable impact.

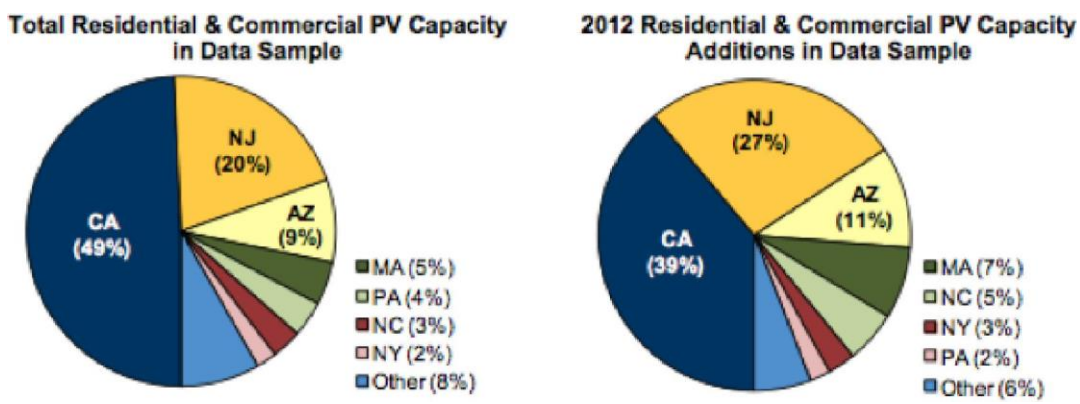

Figure 8: Different State Markets for Solar,
Barbose et al., NREL.

Figure 8 shows dramatic differences in PV market development in states with similar solar resources.[39] California's overall solar market and market growth dwarf those of Arizona, though both states have ample solar resources.[40] Similarly, New Jersey's PV market dwarfs New York's, though both states have similar solar resources.[41] The essential difference must be in state policies: these data suggest that policies in California and New Jersey promote the solar industry much more effectively than policies in Arizona and New York. This paper aims to help identify policy strategies that can reduce the soft costs of solar power in order to attain thriving markets like those in California and New Jersey. However, reducing soft costs requires a clear understanding of what soft costs are. The next section addresses the nature of soft costs and previews strategies for reducing them.

III. Categories of Soft Costs

The term “soft costs,” as used in this paper, includes all costs associated with a solar power project except the price of the solar panels themselves. These costs include affiliated hardware, taxes, financing, permits, inspections, interconnection with the utility grid, installation labor, and customer acquisition.[42]

Estimates of total soft costs vary significantly. This variability results partly from the fact that soft costs are generally implied from a comparison of the total installed price of the system to the price of the solar panels themselves, as in the following figure.[43]

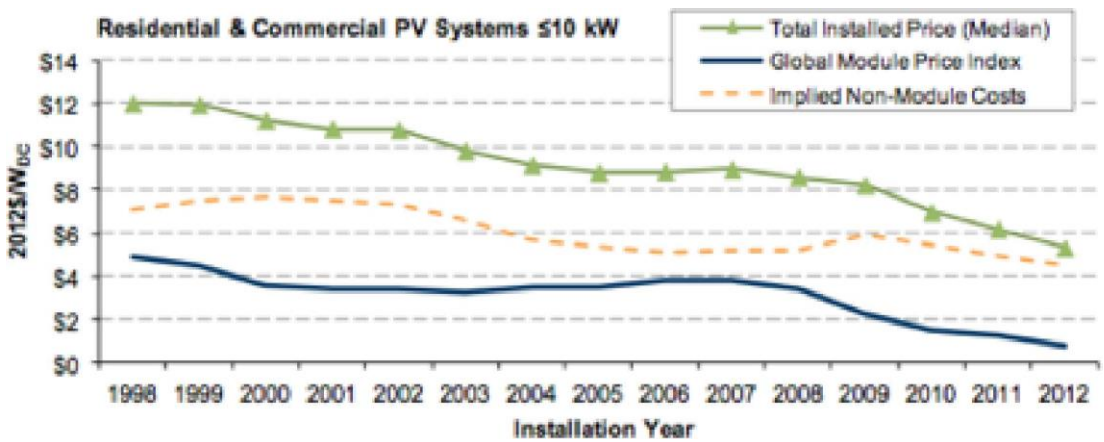

Figure 9: Calculating implied soft costs,
Barbose et al., NREL.

Two studies from the National Renewable Energy Laboratory (NREL) calculate current soft costs to be roughly $3.30/W, accounting for slightly more than half of the overall installed price.[44] NREL also has attempted to benchmark soft costs using surveys, with differing results. One survey revealed soft costs of only $1.50/W, but did not include several concededly important costs, such as financing, overhead, contracting, and installer profit.[45] A subsequent and more detailed NREL survey revealed costs more in line with prior results, with soft costs totaling $3.19/W for residential systems.[46] Importantly, this study noted that despite a decrease in soft costs from 2010 to 2012 of roughly $0.11, soft costs became an increasingly important share of the overall price, growing from 50% to 64%.[47] Another study puts soft costs much higher, at $4.6/W.[48] As with the overall installed price of solar power, soft cost calculations reveal considerable variability.

Despite variability in soft cost calculations, research on soft costs reveals broad consensus on several important points. First, soft costs have gained importance as the price of solar panels has fallen.[49] Second, soft costs now comprise the majority of the price of solar power.[50] The following sections describe different types of soft costs.

A. Customer Acquisition

> *To reach SunShot Initiative goals, customer acquisition costs must fall by 80%.*

Customer acquisition represents at once among the largest and most amorphous share of soft costs. Customer acquisition includes advertising and marketing, screening potential projects for viability, and designing systems.[51] Aside from paying for advertising, the customer acquisition process usually involves the following steps: a screening by phone to determine a potential customer's utility bills, credit-worthiness, and ownership of the relevant property; a site visit to assess whether the property is suitable for solar; and, finally, engineering of an appropriate system design.[52] Installers must bear the costs of these steps before a customer signs a contract.[53] Accordingly, if any of these steps reveal that the project cannot go forward, the installer must then either bear those costs itself or pass them on to other customers, thus raising soft costs.

On average, customer acquisition costs add $0.67/W to the price of a residential PV system.[54] Some installers report customer acquisition costs as high as $1.00/W.[55] Of the average sum, $0.33/W is devoted to marketing and advertising, $0.11/W is devoted to system design, and $0.23/W is devoted to a remainder of customer acquisition costs that studies do not specify.[56] Some of the remainder may reflect costs passed on from projects never reach completion. Alternatively, the remainder may reflect costs devoted to aspects of developing a professional reputation other than traditional advertising or marketing, such as paying staff to attend professional conferences or to participate in a trade organization. Customer acquisition costs must decline by about 80% to $0.12/W to meet the DoE's SunShot Initiative targets.

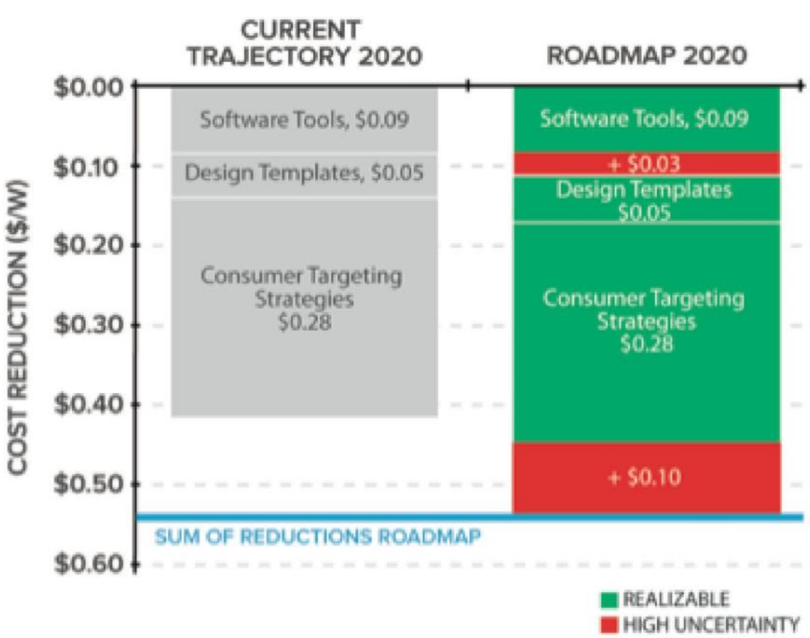

Figure 10: Current trends in customer acquisition cost reductions, Ardani et al., NREL.

Fortunately, customer acquisition costs are currently declining. The solar industry has already begun to use NREL's three suggested strategies for reducing customer acquisition costs: software tools for remote site assessment, design templates, and consumer-targeting strategies. However, these strategies will not reduce customer acquisition costs enough to meet SunShot Initiative goals. In fact, current strategies will achieve only 75% of targeted cost reductions. To complete the cost reductions, new policy strategies are necessary.

Policies to Reduce Customer Acquisition Costs

Policy makers can reduce costs of customer acquisition in several ways. **Standardized solar PV systems** could reduce costs by limiting the need for customized designs. **Streamlined permitting, inspection, and interconnection** could help prevent costs from customers that abandon PV projects due to delays or costs associated with bureaucratic hurdles. Finally, **mandating solar homes and businesses** could reduce customer acquisition costs by guaranteeing a pool of customers from new construction.

B. Permitting, Inspection, and Interconnection

Permitting, inspection and interconnection (PII) costs add significantly to overall solar soft costs. Unsurprisingly, estimates of PII costs vary. Different organizations calculate significantly different costs for obtaining permits, with a range between $0.20/W and $0.77/W.[57] This large range for permitting costs likely does not reflect inaccuracies in the various studies, but more likely accurately represents the fact that permit processes, and their consequent costs, vary widely among jurisdictions.[58] The same is true of inspection and interconnection: different jurisdictions have different requirements and different resulting costs.[59] As a result of this variability among jurisdictions, it is difficult to calculate average PII costs. Nonetheless, PII costs contribute significantly to overall solar soft costs and thus offer a good opportunity for policy makers to help bring soft costs down.

PII costs must decline by more than 75%.

This paper treats PII costs together for several reasons. First, the Department of Energy's (DoE's) SunShot Initiative treats them together when setting cost-reduction goals.[60] Following DoE's lead, many soft cost studies also treat PII costs together.[61] Second, it makes sense to treat these costs together because **policy makers are uniquely well-poised to reduce PII costs**; unlike other soft costs such as affiliated hardware costs, which result from larger commodity markets, PII costs are the product of regulations and thus are particularly susceptible to reduction through regulatory reform. And third, as discussed above, permitting, inspection, and interconnection costs each vary widely among jurisdictions, suggesting that successes in some jurisdictions can teach others how to bring down the bundle of PII costs. However, despite the fact that some jurisdictions are developing policies to reduce PII costs, these costs are falling far too slowly to reach the SunShot Initiative's goals.

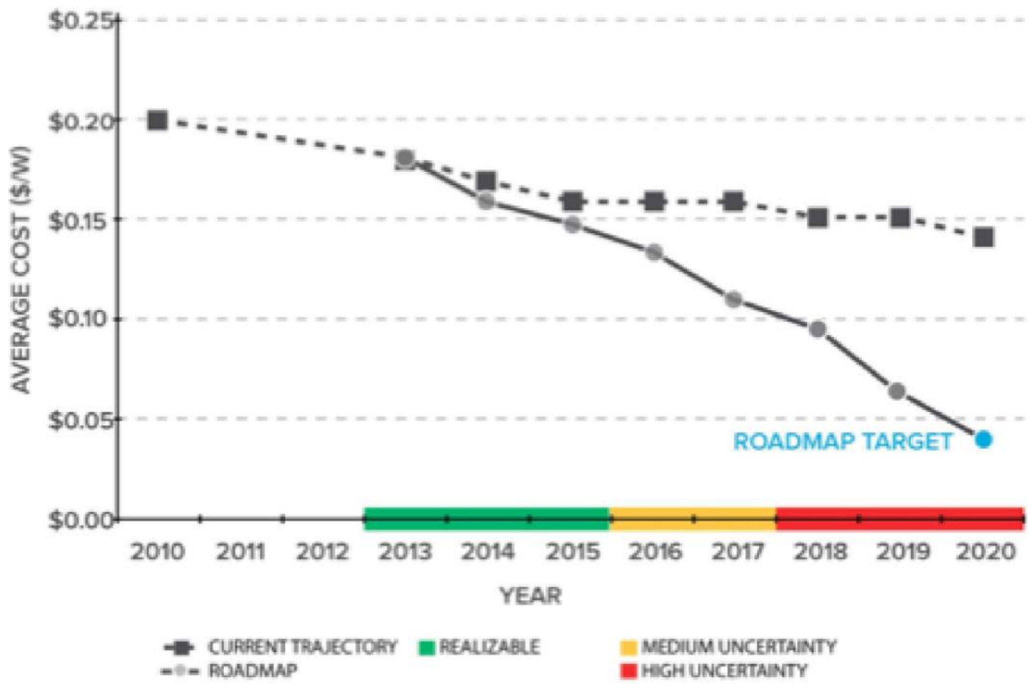

Figure 11: PII costs are not declining quickly enough to meet targets. Ardani et al., NREL.

Variability between jurisdictions helps to keep PII costs high. PII processes vary not only by state, but also by county and city. For example, “[i]n most states, the local or county building department controls the review and issuance of permits.[1162] Inspection and interconnection processes also vary among governments and utilities.[63] Some utilities seem resistant to facilitating interconnection, while others (chiefly municipal utilities) seem more eager.[64] The result of variable PII processes is that installers must familiarize themselves with different processes in each jurisdiction where they work, and either the installer or the consumer must pay the cost of that education.[65] By forcing installers to spend staff time deciphering different jurisdictions’ requirements,[66] variable and inconsistent PII processes raise soft costs.

1/3 of installers avoid jurisdictions with difficult permit requirements.

Onerous jurisdictions may deter installers altogether: “more than one third of installers avoid jurisdictions with particularly challenging permitting processes.[1167] This trend is understandable, given that Sunrun reports that “[o]ne installer lost money on its first four installations in a jurisdiction due to complicated and unclear requirements.[1168] Deterring installers has two significant negative effects. First, that deterrence means that solar power will not be competitive in markets where installers refuse to do business.[69] Second, by restricting the market to more savvy installers, complicated PII processes can erect a barrier to entry into the marketplace, potentially subjecting solar power to anticompetitive market manipulation. Either of these effects would likely raise soft costs.

Jurisdictions may have difficult or complex PII processes for several reasons. Permits may require input from many different divisions of a local government, "such as building, electrical, mechanical, plumbing, fire, structural, zoning, and aesthetic reviews."[70] Cumbersome or redundant processes may also be due to unfamiliarity with solar power.[71] Finally, jurisdictions may unnecessarily inflate costs by designing PII processes "for the minority of complicated installations that require more in-depth review."[72]

Fees for permitting, inspection, and interconnection, which vary widely, [73] are also a significant part of PII costs. For permit fees, some jurisdictions charge only a sum necessary to recover the cost of processing the permit application,[74] but other jurisdictions consider permit fees to be sources of revenue,[75] implying that fees may be higher than necessary for cost-recovery. Above-cost fees may be based on a PV system's overall cost or size, but "neither system costs nor size are necessarily reflective of the amount of time it takes ... to process the permit application."[76]

The results are substantial permit fees. A Sierra Club study of permit fees in California revealed an average fee of $343, with a range from $0 to roughly $1,400.[77] Inspection and interconnection fees can add up to $2,500 per installation.[78] Moreover, if a solar PV system is not standardized, or if the electricity distribution system already hosts numerous small generators, utilities can require supplemental interconnection studies, which sometimes feature extreme fees: "Even residential systems proposed in areas of high [solar] penetration have been quoted supplemental interconnection study fees of $25,000."[79]

Current trends in regulation of permitting, inspection, and interconnection are unlikely to reduce costs sufficiently to meet SunShot Initiative goals. Although solar installers can help keep costs down by completing permit applications correctly and being prepared for inspections, PII costs are for the most part products of policy. Accordingly, policy makers should bring renewed focus on reducing PII costs.

Policies to Reduce Permitting, Inspection, and Interconnection Costs

Policy makers are uniquely well-poised to reduce PII costs. For example, cities, counties, or states may **limit permit fees** to recover only permit-processing costs. **Uniform, streamlined permitting and inspection processes** would also reduce PII costs.

Standardized solar systems would reduce the need for extensive, expensive permits and inspections.

Mandating solar buildings would also make the solar permitting process a part of the required permitting for new construction, which would reduce costs as well.

Finally, states have the opportunity to **promote swift interconnection** by modeling utility regulation on FERC's recent Order 792.

C. Financing

Unlike many other soft costs of solar power, which tend to increase the upfront cost of a PV system, the cost of financing most solar projects today tends to be distributed over the life of the system, with financial backers expecting a return on an investment.[80] In recent years third-party ownership of solar PV systems has come to dominate the field, largely displacing the older model in which homeowners themselves bought and owned PV systems.[81] Under this model, as popularized by businesses like SolarCity and Sunrun,[82] homeowners pay little or no upfront cost for a solar PV system and instead make monthly payments to a third party owner for solar power,[83] in addition to paying utility bills for the rest of their energy use. Although these monthly payments are lower than a utility bill, over time the arrangement may cost consumers more than simply buying a system, because the third-party owner must recoup the upfront cost of installation as well the greater cost of third-party financing.[84]

Most small-scale solar systems are leased from—and thus financed by—third-party owners.

Although the most common system of ownership spreads costs over the life of the system, this paper discusses financing along with soft costs that raise upfront costs for two reasons. First, and most fundamentally, as for other soft costs contributing to upfront prices, policy is important to the cost of financing; state and federal lawmakers can take actions that will bring financing costs down. Second, bringing down the cost of financing has very similar effects as reducing other soft costs, reducing the overall cost of a PV system for consumers.[85]

NREL reports that the weighted average cost of capital for small solar PV systems is nearly 10%.[86] However, third-party financing tends to be even more costly, ranging up to a 14% weighted average cost of capital, because third-party owners of solar projects typically rely on financing sources that demand higher rates of return.[87] Thus, PV customers may attain more favorable financing terms by simply buying a system themselves.[88] However, regardless of whether property owners finance their own systems or opt for third-party ownership, achieving the reduced soft costs envisioned by the DOE's SunShot Initiative will require reducing the cost of capital to 3%.[89]

Weighted average cost of capital

Various sources of revenue—such as common and preferred stocks, different types of debt, and tax equity investment—generally demand different rates of return. The weighted average cost of capital is the minimum rate of return a company must earn to provide various investors with their expected rates of return.

Policies to Reduce Financing costs

Policy makers can reduce financing costs by **improving access to third-party financing,** which generally relies on tax-equity investment. Policy makers can help by either increasing the number of tax equity investors or increasing the appeal of PV projects to existing tax equity investors. For example, to continue attracting tax equity investment, Congress could **amend the Investment Tax Credit** to prevent it from declining from 30% to 10% in 2017.

Utility financing could also provide capital for solar projects at lower cost. One model would have utilities make upfront payments for solar PV systems, and then **allow ratepayers to pay off the PV system over time through increased utility bills**. Alternatively, utilities could themselves finance and own residential and commercial solar systems. **Direct utility ownership of distributed solar systems** could help persuade utilities that distributed solar power is an opportunity rather than a threat.

Two other forms of financing that could reduce overall costs are **PACE financing**, which would allow mortgage-like financing for solar projects, and **community solar**, which would allow groups of investors to finance and own PV systems and to use the solar energy. However, both systems face significant legal hurdles that prevent their use in most states. Policy makers should act to make these attractive alternative financing mechanisms available to consumers throughout the nation. Section IV discusses all these policy options in greater detail.

D. Installation Labor

Installation labor contributes on average $0.59/W to the overall cost of a solar PV system, accounting for roughly 15% of the total soft costs. Notably, labor costs in the United States are ten times higher than similar installation costs in Germany,[90] suggesting that U.S. policy has ample room for improvement. The chief reason for this discrepancy is that installing an average solar PV system takes ten times longer in the U.S. than in Germany.[91] In short, installing a solar PV system in the U.S. requires more labor at higher wages, inflating overall labor costs.

Figure 12: Installing Solar Panels Oregon Dept. of Transportation., Creative Commons License.

Installing a solar system is costly in the United States in part because neither solar

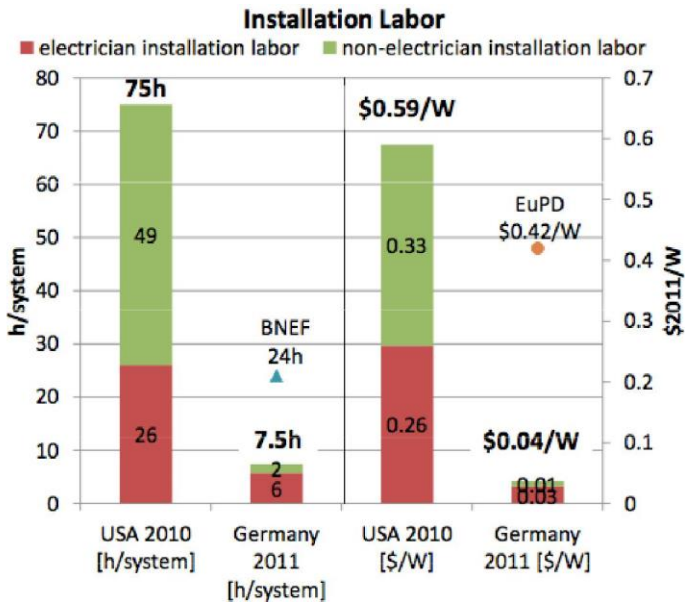

Figure 13: Discrepancy between the U.S. and Germany

Seet et al., LBNL.

systems nor rooftops are standardized. Sources of variability include different roof designs, electric systems, utility requirements, and customer preferences.[92] For example, PV installers must often adapt systems to fit existing roofs, or must refit roofs to guarantee that they can bear the increased load of solar panels. Additionally, many roofs are at least partially shaded, requiring installers to adapt a PV system to maximize energy production.Ó[93] These constraints make standardization difficult and raise the cost of solar PV installations.

Permit and inspection delays also inflate installation costs. Inconsistent permitting requirements, multiple inspections, and long inspection appointment windows cause solar installations to take far longer than they should, and longer than they do in other nations. Delays inflate costs, which is especially clear for long inspection appointment windows: work is put on hold while waiting for an inspection, but because workers remain on site, wages continue to accrue. The installer incurs costs without getting work done. The costs pass through to consumers, and the installed price of solar rises.

Labor costs are a good example of how reducing soft costs can benefit consumers and the solar industry alike. **Reducing labor costs does not mean losing jobs.** Instead, reducing labor costs means having employees work more efficiently. Efficient work yields more completed projects, a better reputation, and more customers.

Policies to Reduce Installation Labor Costs

Standardizing solar PV system designs would help reduce the labor necessary to install them.

Streamlining permitting and inspection procedures will minimize labor necessary for regulatory compliance and will reduce delays that inflate costs.

Solar mandates for new construction or large renovations would help reduce installation costs. Mandates would guarantee that buildings are solar-ready, reducing necessary preparatory work. Mandates would also provide large batches of projects, reducing travel time and associated expenses.

E. Affiliated Hardware

Apart from solar panels, the hardware for a PV project can add appreciably to the project's overall costs. Affiliated hardware can include racks for the solar panels, systems that allow the panels to move to track the sun, and inverters.[94] As this equipment becomes more sophisticated, it adds to the overall cost of solar power. For example, "systems with tracking equipment exhibit consistently higher installed prices than their fixed-tilt counterparts.Ó[95] For projects less than 10kW, sophisticated tracking systems can add as much as $1.2/W, roughly 20%, of the overall installed cost.[96] Similarly, inverters add substantially to the cost of PV projects, adding roughly $0.30/W, or about 5%, to an average PV project. More sophisticated microinverters,[97] which have become more popular in the last decade, add even more to the price of a PV project.[98]

Figure 14: Solar Tracking System, Leonard G., Creative Commons License.

On the other hand, equipment like tracking devices and microinverters also boost the overall efficiency of PV systems, helping offset installation costs more quickly. Microinverters may produce up to 12% more energy annually, with greater efficiency gains in shaded areas.[99] Tracking systems may increase overall annual energy production by 12–45%.[100] Over the PV system's life, these gains in efficiency may more than offset upfront costs. However, increased upfront costs may deter property owners or investors who would otherwise be interested in solar power.

Policies for Reducing Non-Module Affiliated Hardware Costs

Targeted, phased subsidies for efficiency-boosting equipment could help reduce costs. Predictable, regularly scheduled reductions in government support—which may have helped stimulate reductions in the price of solar panels—could **send market signals to bring prices down** as subsidies diminish.

Standardized system designs with integrated electronic components may substantially reduce costs. Policy makers could encourage standardization with **streamlined permitting** and **greater rebates** for standardized systems.

F. Taxes

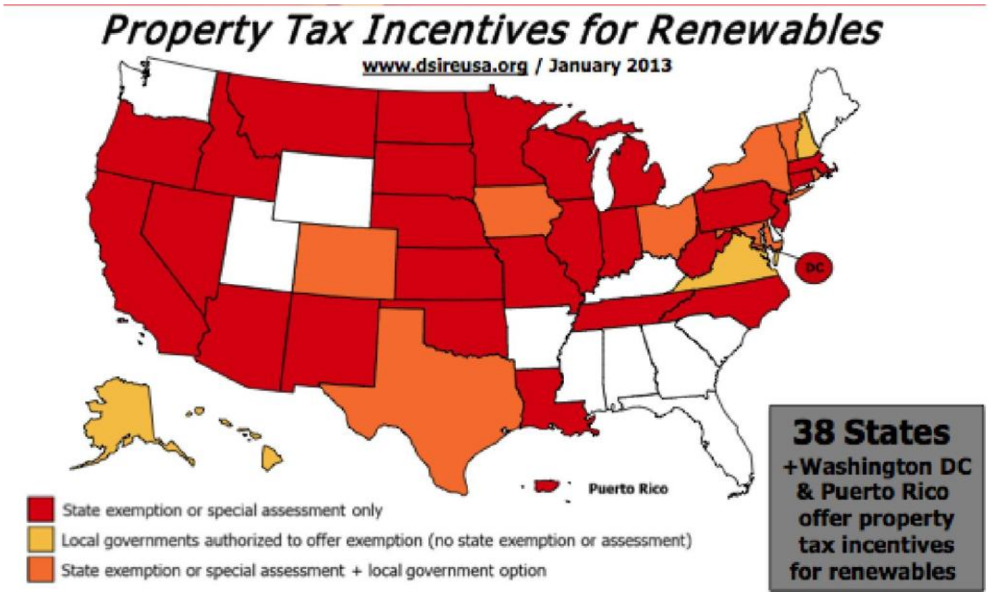

Figure 15: Property Tax Incentives for Renewables, dsireusa.org/

Tax treatment of solar PV projects varies dramatically by jurisdiction and in some locations can add significantly to the price of solar power. Generally, taxation affects solar projects through sales taxes on hardware, payroll tax on installation labor, and increased property taxes resulting from the increase in value from the solar project.[101] Tax treatment of solar projects varies by state and sometimes by local jurisdiction, so there is no single estimate of the average tax burden for a solar PV project. However, because sales taxes range as high as roughly 12% in some jurisdictions,[102] sales taxes can add significantly to the overall cost of a solar project in some places. Similarly, property taxes can make a solar PV project more costly; although these taxes do not accrue at the purchase or installation of the PV system, a PV system may add substantially to the value of a home, thus increasing later property taxes.[103]

Tax Policies for Reducing Solar Soft Costs

Many state tax policies reduce solar soft costs. 38 states have adopted property tax exemptions. 28 states have adopted sales tax exemptions for renewables, which include solar PV projects. The remaining states should also **adopt policies exempting solar projects from burdensome taxation**.

Some states treat residential and commercial property differently. For example, New Mexico offers property tax exemptions to homes that install solar panels, but not to businesses. **Property tax exemptions for commercial property** would help reduce soft costs and spur the growth of the solar industry.

IV. Policy Solutions for Reducing Soft Costs

Policy makers can play a key role in driving down the soft costs of solar PV power. Indeed, policy makers have helped to bring down the overall costs of solar PV power in the past.[104] Moreover, soft costs are already declining, although too slowly,[105] meaning that policy makers need only accelerate an existing trend rather than create a new one. The National Renewable Energy Laboratory's (NREL's) Soft Costs Roadmap identifies how various types of soft costs are projected to decline by 2020.[106] This trend shows that the growth of the solar PV market itself leads to some decline in price. However, if the NREL's Roadmap is a cause for hope, it is also a cause for caution, as the Roadmap demonstrates that current soft cost trends will not reach the DoE's Sunshot Initiative goals. Thus, policy makers have an opportunity—indeed, an imperative—to take action.

Market growth will reduce soft costs.

NREL's Soft Costs Roadmap offers valuable suggestions for bringing down many of the soft costs discussed in this paper. The Roadmap focuses on customer acquisition, permitting, inspection and interconnection, installation labor, and financing,[107] describing the likelihood that its suggested cost-reduction opportunities will actually take place.[108] Rather than merely recite the NREL's recommendations, this paper commends that invaluable source to readers.

However, the Soft Costs Roadmap by no means completes the task of devising policies to bring down soft costs. For example, within the various categories of soft costs the Roadmap measures, NREL notes that "undefined" solution sets are necessary in order to reach its targets.[109] Moreover, the Roadmap does not attempt to measure or to plan strategies to reduce what it calls "other soft costs."[110] Yet these "other soft costs" are the largest single share of soft costs, at $1.86/W out of a total $3.32/W.[111] These "other soft costs" include profit and overhead, but may also include other factors also.[112] Both these limitations reveal that the roadmap, while very valuable, will not achieve the SunShot Initiative's goals on its own.

Soft costs are not falling fast enough to meet Sunshot Initiative goals.

To further the goal of reducing solar PV soft costs to meet SunShot targets, this paper discusses five policies: (1) promoting new business forms for solar developers; (2)standardizing system designs; (3) streamlining permitting and inspection; (4) reforming utility regulation to promote swift interconnection; and (5) mandating installation of solar power. Although prior works have suggested some of these policies, no prior work has offered the depth of detail this paper offers. These five policies have great potential to substantially reduce the soft costs of solar and should help bridge the gap between the Soft Cost Roadmap's identified cost-reduction opportunities and the overarching goal of the SunShot Initiative.

A. New Corporate Forms and Financing for Solar Power

As discussed above,solar PV projects face a high cost of capital because solar installers do not have access to some lower-cost financing mechanisms and to some business forms that would enable such access. This section argues that policy makers at the federal and state level should enact policies that will allow solar PV projects greater access to low-cost capital.

New business forms can attract more investment at lower cost.

Certain business forms could allow access to a lower cost of capital by securing more favorable tax treatment that attracts investors. Generally, "[p]roject developers draw funding from up to six tiers of capital from cheapest to most expensive É [which are] Treasury cash grants, government-enhanced debt, straight debt, tax equity, back-levered debt, and true equity."[113] The basic goal of using new business forms is to gain more investment at lower cost[114] To that end, developers would like to use Real Estate Investment Trusts (REITs) and Master Limited Partnerships (MLPs).[115] Additionally, solar project developers would like to have direct access to cheaper forms of capital through traditional real-estate financing mechanisms such as mortgages. This section describes the advantages of these business forms and financing methods and argues that regulators should allow their use in the solar industry.

1. Yield Cos and REITs

Yield Cos and REITs provide incentives for investment by allowing favorable tax treatment and the ability for investors to liquidate assets by trading stocks on a public market.[116] REITs avoid paying income taxes at the entity level,[117] and thus avoid a problem of double taxation common to other corporate forms. Yield Cos, on the other hand, do not avoid double taxation. Yield Cos, however, legal under current regulations, while REITs may not be. This section first describes how each corporate form operates, then explains what policy reforms are necessary to allow the solar industry to use the more advantageous REIT form. This section describes Yield Cos first in order to illustrate why REITs are superior. The goal is for solar developers to raise capital that demands a lower rate of return, reducing the weighted average cost of capital and thus overall solar soft costs.

Yield Cos create different subsidiary businesses for existing solar systems and those still under development. Existing systems attract investors at lower cost because they entail fewer risks. The developer then uses funds raised from existing projects to finance those under development. As a developer completes projects, it moves them to the subsidiary for existing systems, increasing that subsidiary's allure. Recently, the major solar developer SunEdison launched a Yield Co that it hopes will raise as much as $300 million.[118] Other developers are considering this corporate form also. However, because Yield Cos do not avoid double taxation,[119] they are not as attractive as REITs.

REITs do avoid double taxation but may not be entirely legal under current regulation. REITs allow small investors to pool investments in real estate projects without facing corporate taxes, but “cannot own an operating business.[120] Rather, a REIT would provide tax benefits to investors by owning solar panels and leasing them to another company that operates the assets as a business.[121] For this approach to be legal, the IRS will have to clarify that renewable energy assets—particularly solar panels—qualify as real property.[122] Although at least one renewable energy project has asked the IRS to do so, “[n]o ruling has been issued, and indications from the IRS to date have been that the agency is not prepared to treat solar panels as real property.”[123]

The IRS should issue a rule clarifying that solar panels do qualify as real property for two reasons. Such a ruling simply makes sense: solar panels are like real property in that they are typically a structural element of a real property asset (a home or building) that is fixed to real property for at least 15–20 years. There is no doubt that a roof,

Figure 16: Solar panels enjoy warranties that last as long as normal roofs, Maehlum, Energy Informative.

which likely lasts for roughly the same time, is a component of real property, and there should similarly be no doubt for rooftop solar. This IRS ruling would allow PV installers to access capital more cheaply, bringing down the cost of capital. Reducing the cost of capital would in turn contribute to the soft cost reductions the federal government has advocated through the Department of Energy’s SunShot Initiative.

2. Master Limited Partnerships

Like the REIT, the Master Limited Partnership (MLP) is an advantageous business form that is not quite legal for solar companies under current regulations. Unlike most partnerships, MLPs enjoy the ability to sell ownership interests on a stock exchange while retaining the favorable single taxation of a partnership.[124] "The liquidity, or the ability to exit the investment in a public market, and the fact that earnings are only taxed once[,] mean that equity can be raised at a higher multiple to earnings.Ó[125] However, while natural gas, oil, and mineral companies can take advantage of MLP status, the federal statute allowing MLPs does not allow solar installers to use this business form.[126] Because MLPs and their limitations were created by federal statute,[127] Congressional action is necessary to allow solar PV companies to qualify as MLPs.

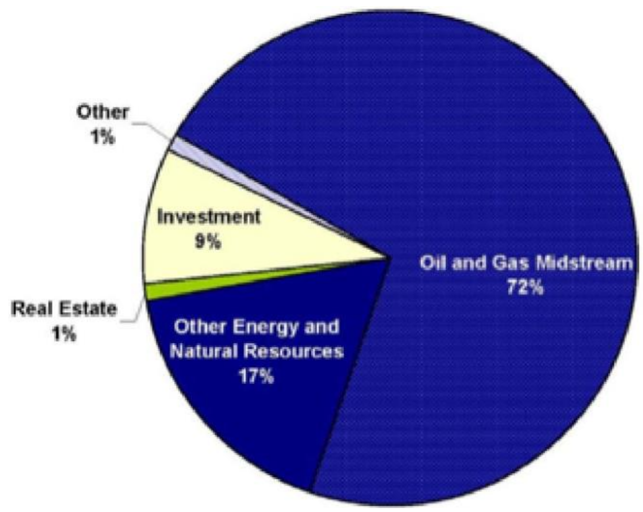

Figure 17: MLPs used mainly for fossil fuels, Congressional Research Service.

Although hope for a federal statutory fix may be slim, given current Congressional paralysis, in principle Congress should enact such a fix. First, such a statutory amendment would be consistent with the federal government's goals of promoting renewable energy.[128] Second, by allowing renewable energy companies to take advantage of the same business forms that fossil-fuel companies enjoy, this amendment would help level the playing field for energy developers. Finally, and most relevant to this paper, such a statutory fix would allow solar PV companies easier access to low-cost capital, thus helping to reduce the soft costs of solar.

3. Real Estate Financing

As discussed above, property owners who directly buy solar PV systems may get a better economic deal because third-party financing generally faces a higher cost of capital.[129] Property owners could obtain capital at even lower cost, thus reducing the overall soft costs of solar PV systems, through traditional, low-cost real estate financing tools. Perhaps the clearest example is a mortgage; unlike most loans for solar retrofits, which have an average weighted cost of capital of 9.9%,[130] average mortgage rates are generally much lower, ranging from roughly 3.5% to 4.5%.[131] The Federal Housing Administration (FHA) does insure loans through an Energy Efficient Mortgage program,[132] and some private lenders do offer these insured mortgages for retrofits to install solar panels on existing homes.[133] These Energy Efficient Mortgages require a 3.5% down payment and offer property owners the lesser of either the cost of energy improvements or 5% of the property's value.[134] These mortgages may be bundled into an existing mortgage only if the value of consequent energy savings is greater than the sum of the loan.[135] Energy Efficient Mortgages are an attractive option for homeowners because they provide capital at lower cost than other financing sources. Additionally, homeowners may be able to use traditional mortgages to finance solar power if a solar project is part of the initial construction or purchase of property. Traditional mortgages may yield capital at an even lower cost than the FHA-administered program. Access to these low-cost real estate financing mechanisms should help substantially reduce the cost of capital.

Even more dramatically, Property Assessed Clean Energy (PACE) programs, which finance renewables through subsequent property taxes rather than through upfront payments, could essentially eliminate the cost of raising capital for solar power. Essentially, PACE financing allows property owners to borrow money from a local government to purchase a renewable energy system, and then to pay that money back through property taxes in subsequent years.[136] 29 states and the District of Columbia states created PACE financing programs between 2008 and 2010.[137]

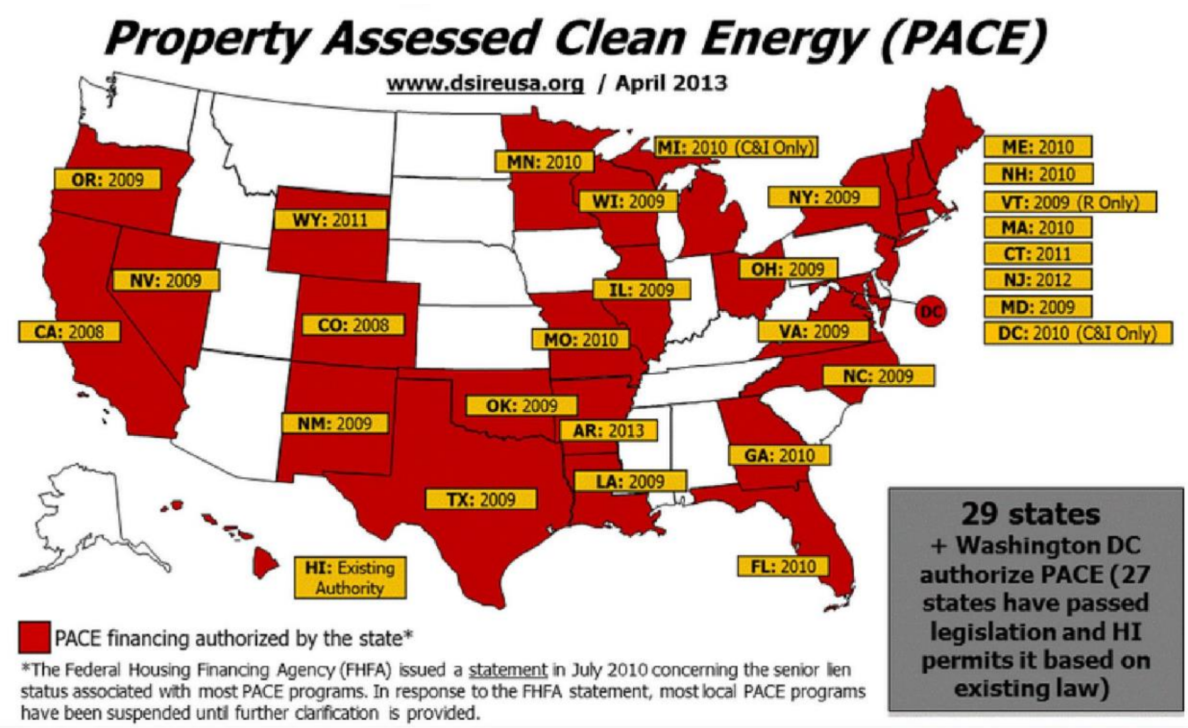

Figure 18: PACE programs were popular in many states, dsireusa.org

However, the Federal Housing Finance Agency (FHFA) essentially put a stop to PACE financing due to concerns that PACE financing would interfere with mortgages and disrupt a fragile housing market.[138] Although California and several of its counties challenged the actions of the FHFA,[139] the Ninth Circuit recently upheld the FHFA's decision.[140] As a result, neither Fannie Mae nor Freddy Mac, which provide backing for a majority of mortgages,[141] will back mortgages for properties featuring PACE financing, essentially ending the PACE program.

Because PACE financing offers property owners access to capital for solar power at a very low cost, this paper urges the FHFA to reconsider its position on PACE financing. As the housing market recovers,[142] concerns about interfering with existing mortgages should diminish, and the FHFA should reevaluate its opposition to PACE financing. Alternatively, Congress should direct the FHFA to allow Fannie Mae and Freddy Mac to purchase mortgages that feature PACE financing. A less attractive alternative is for states to conform their PACE financing programs to reduce the FHFA's concerns. The FHFA's basic problem was that PACE financing creates a lien on the financed property that is senior to a mortgage.[143] The prospect of senior liens could reduce the enthusiasm of mortgage lenders. States could address this concern by subordinating PACE financing to existing mortgages. Any of these alternatives would improve property owners' access to capital for solar power, thus helping to substantially reduce solar soft costs.

The federal government should allow PACE financing.

B. Standardizing System Designs

Standardizing PV system designs could significantly reduce soft costs at all phases of a solar project. The basic goal is to develop **"plug-and-play" solar PV systems** that are modular, easy to produce, and easy to install. First, standardized hardware that includes integrated electronic components such as inverters could allow installers and consumers to take advantage of economies of scale. Second, by standardizing the design of solar PV systems, installers could reduce the amount of customization inherent in the current customer acquisition model. Third, standardized system designs should reduce permitting, inspection, and interconnection costs by reducing the uncertainty about each system's safety risks or impacts on the utility grid. Fourth, standardized hardware and system design would reduce necessary installation labor by allowing laborers to become familiar with solar projects and by simplifying the task through integration of electronic components. All of these impacts together should help **make the solar industry more profitable and predictable**, which would in turn lower financing costs by attracting investors and lower customer acquisition costs by attracting more customers.

However, while standardization of solar PV systems will likely lower costs, it also has potential drawbacks. First, because most existing homes and communities are not standardized, retrofitting existing buildings to install solar panels requires a certain degree of customization.[144] Too much standardization could prevent installers from adapting to existing conditions. And second, standardization of solar PV systems should be careful not to stifle innovation in this still rapidly changing technological field.

In light of these two important cautionary notes, this paper recommends that solar installers offer a menu of standardized designs. For example, installers could offer a standardized system for the flat roofs typical of commercial buildings and other standardized systems designed to fit the most common residential roof shapes. Additionally, installers could offer a set of standardized designs of different sizes to fit the needs of common sizes of homes and businesses. This menu-style approach to standardization could allow for the necessary flexibility in system design while still taking advantage of the cost-reduction opportunities.

A menu of standardized PV system designs can reduce every category of soft costs.

One way that standardized PV hardware designs could reduce costs is by allowing solar panel manufacturers and installers to **take advantage of economies of scale** for affiliated hardware. For example, rather than having installers purchase inverters on an ad hoc basis for each project, solar PV manufacturers could buy large batches of inverters and integrate them into the panels before resale to an installer. Presumably, such a large purchase would allow for lower prices. Similarly, installers could buy large batches of racking or tracking equipment, taking advantage of similar price breaks.

Additionally, standardized system designs would **reduce the labor necessary for customer acquisition**. As described above, customer acquisition typically entails designing a system for a customer before that customer enters into any binding contract. However, featuring a menu of standardized designs might reduce the amount of customization required, especially if the menu featured an array of designs tailored to fit the most common building shapes. By reducing the amount of customization necessary, installers could reduce the labor required for customer acquisition and thus reduce soft costs. This increased efficiency in customer acquisition should allow the industry to successfully complete more projects, improving its reputation, which in turn will allow it to attract capital and more customers more easily.

Standardized designs should also **reduce permitting, inspection, and interconnection costs**. For one, a standard design is unlikely to pose any novel safety risks or to feature any unusual building elements. As a result, it should be possible to allow streamlined permitting of standardized PV systems without entailing much cost to the reviewing jurisdiction. For the same reason, inspecting standardized systems should be faster and less costly as well. Similarly, standardized PV systems would have predictable impacts on the electricity grid, suggesting that interconnection should require very little analysis from a utility. Accordingly, standardized system designs should substantially reduce the permitting, inspection, and interconnection costs for solar PV systems.

Standardized solar PV systems should also be **easier and less costly to install**. The cost of installation labor would be especially likely to decline if the solar PV system came integrated with such affiliated hardware as inverters and a racking or tracking system. Labor by electricians installing affiliated electronics is especially costly;[145] integrating electronic components with panels before installation could substantially reduce this cost. Similarly, prefabricating solar panels with racking or tracking systems could avoid the necessity of performing such installation later in more customized, more costly settings. One company, SolarPod, currently produces a line of plug-andplay solar PV systems that they claim take between 30% to 50% less time to install.

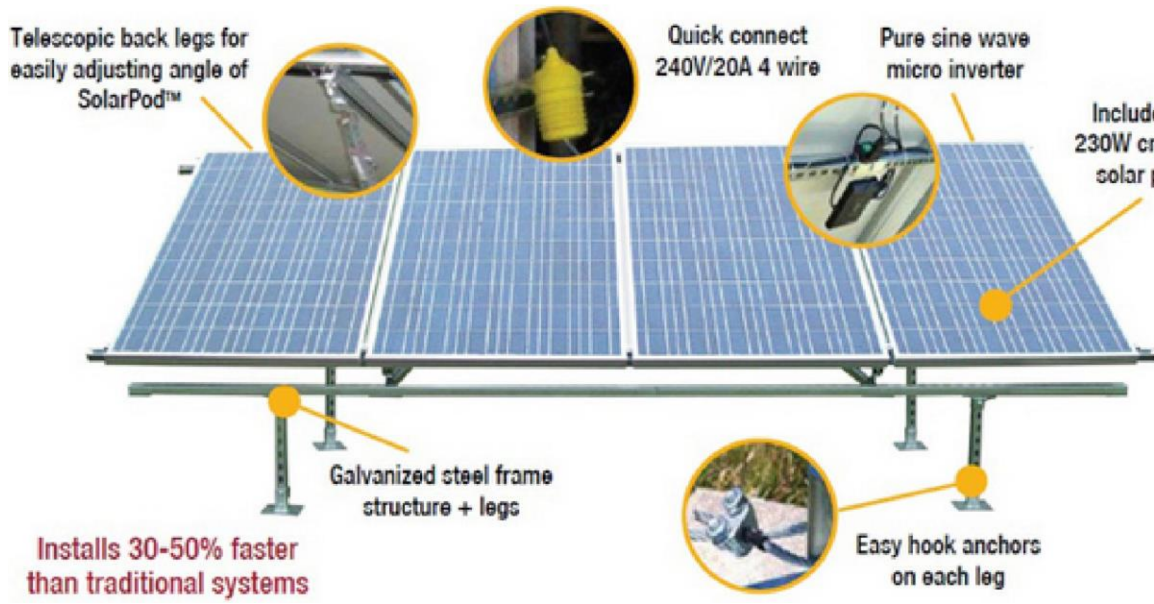

Figure 19: SolarPod's PV systems are modular and easy to install, mysolarpod.com.

If standardized system designs can reduce the soft costs of solar power, they should contribute to reducing customer acquisition and financing costs also. By reducing soft costs, standardized designs could make PV affordable to more consumers. More successfully completed solar projects would build the industry's reputation and attract more consumers in turn. Similarly, an enhanced industry reputation for viability and profitability would attract investors as well, thus helping reduce the cost of financing.

To achieve cost reductions, policy makers should encourage standardization of solar PV systems. State or federal policy makers could provide **direct financial incentives** such as grants for standardized solar PV systems. Similarly, policy makers could offer more generous **tax breaks** to solar PV projects that feature standardized designs, or could offer incrementally greater rebates for systems that feature integrated electronics or other standardized features. A more revenue-neutral alternative would be to offer **streamlined permitting, or a general permit,** for such standardized solar PV systems. Standardized solar systems would have predictable impacts, making the job of permitting and inspection much easier. Permitting reforms could incentivize standardization at no cost to government. These tools would encourage standardization, helping to reduce solar soft costs.

C. Streamlining Permitting and Inspections

Reducing the soft costs of solar power through streamlined permitting and inspection processes is a topic that has received a great deal of attention. For example, Sunrun has recommended that the Department of Energy spearhead a "Residential Solar Permitting Initiative."[146] Sunrun has also recommended that California engage in comprehensive streamlining of local permitting practices.[147] That study concluded that streamlining the permitting process would have dramatic economic benefits, reducing the cost of permitting from $2500 per installation to $600 per installation and growing the California economy by roughly $5 billion by 2020.[148] Somewhat less dramatically, a study by LBNL concludes that "streamlining the permitting process could potentially reduce the price of a 4kW residential PV system by $1,000 or more, on average."[149]

Streamlined permitting could save thousands of dollars on each solar installation.

Researchers have reached considerable consensus on what steps are necessary in order to streamline permitting and achieve cost reductions. Common ways to streamline permitting include the following, as reported by LBNL:

1. Standard state or regional technical and procedural requirements;
2. Clear guidelines and checklists for permit applications;
3. Online completion and submission of permit applications;
4. Eliminating unnecessary or redundant reviews and inspections;
5. Reducing wait times; and
6. Reducing permit fees.[150]

NREL's soft costs roadmap makes similar recommendations, suggesting standardization of requirements, increased transparency, online permit applications, and reduced permit fees.[151] Similarly, a study by the Interstate Renewable Energy Council (IREC) has identified common elements of efficient permitting processes, including regionally consistent requirements, simplified standards and processed, and permit fees limited to cost-recovery.[152]

IREC's study also comprehensively reviews existing permitting reforms at the state, regional, and local levels.[153] For example, "Colorado and Arizona have implemented statutes requiring local jurisdictions to set fees for solar permits at certain levels."[154] Oregon has implemented a Solar Installation Specialty Code that governs technical requirements and permit processing, featuring expedited permitting for conventional rooftop installations and limited permit fees.[155]

Some jurisdictions allow **expedited permitting for installers that have a good track record** of submitting complete applications and installing solar projects successfully;

these jurisdictions include Portland, OR and various counties in New Jersey implementing the Long Island Unified Solar Permitting Initiative.[156] IREC recommends that qualifications for expediting permitting be based either on certification from an independent agency or on a track record of successful installations within a jurisdiction.[157] "For example, a jurisdiction could pre-qualify installers that have successfully installed five systems that passed the plan review and inspection without necessitating any major modification."[158]

Installers with good records for completing projects should be eligible for expedited permitting.

Perhaps reflecting greater enthusiasm for reform, Vermont has overhauled its solar permitting system by exercising strong state control. Under Vermont law, net-metered systems less than 150kW need only "self certify that they comply with interconnection and certain siting requirements."[159] Although utilities, municipalities, and neighbors can object to this self-certification, if none do object, the permit is granted with no further review.[160] Similar streamlining has happened in Germany as well.[161]

Indeed, in Vermont and Germany, few or no inspections are necessary for a solar PV system.[162] This radical approach to reducing inspections would, of course, dramatically reduce inspection-related costs. However, completely eliminating or even substantially reducing the number of safety-related inspections is not completely necessary to substantially reduce costs. One of the most common complaints regarding inspections is simply that the appointment window for each inspection is too long, causing needless delays.[163] Accordingly, to substantially reduce soft costs related to inspections, policy makers could **insist that inspectors adhere to more narrow appointment windows**. Policy makers could design penalties for inspectors who miss appointment windows. For each missed appointment, an inspector could earn a demerit. An inspector who earns too many demerits could face pay deductions, demotion, or even termination. This system would reduce the soft costs of solar by reducing delays associated with long appointment windows.

However, eliminating safety-related inspections altogether is likely not a good idea. In fact, LBNL cautions that streamlined permit processes should avoid "eviscerating the benefits of permitting for protecting consumers, promoting public safety, and rewarding the most diligent installers."[164] Not only could such inspections guard the public against preventable risks, but they could also guard the solar industry's reputation for safety and reliability. As a result, this paper advocates for reducing appointment windows and eliminating redundant inspections, but not for eliminating safety-related inspections altogether.

Similarly, state policy makers should be careful about how they promote permitting and inspection reforms at local levels. Too aggressive an approach may have counterproductive results. For example, imposing a cap on permit fees for solar projects, instead of simply requiring that fees cover only costs of permit processing, may "cause jurisdictions to simply set the fee at that cap."[165] Similarly, LBNL notes that "[s]treamlined procedures must take care to adequately fund local governments for their time."[166] In the same vein, IREC's study of permitting reform suggests that "responsibility for change should be shared" between municipalities and the solar industry.[167] Noting that many delays associated with permitting are due to incomplete applications and failure to comply with codes, that study argues that meaningful reform will require participation from government and industry alike, and "should offer benefits to municipal governments as well as solar installers and their customers."[168]

States should develop short, clear permit applications, put them online, and require their use by local governments.

This paper argues that **state governments should take the lead in streamlining permitting and inspections**, but should attempt to work with local governments, rather than against them. Particularly, state reforms should make sure to allow local governments to recover costs associated with issuing permits and performing inspections. This cooperative approach should reduce the costs of solar power without making the solar industry into a net cost to local governments. One clear way to achieve this goal is for states to develop short, clear permit application forms, make them available online, and require local governments to use them. This would allow all parties to clearly understand the requirements for solar PV permits and would reduce variability among jurisdictions that raises costs. The result would be to reduce the soft costs of solar power without making the solar industry a burden on local governments.

D. Utility Regulation to Promote Swift Interconnection

As described above, delays and studies associated with interconnecting a solar PV project to the electrical grid can substantially increase soft costs of solar power.[169] To ameliorate this problem, the Federal Energy Regulatory Commission (FERC) recently promulgated a final rule, Order 792, revising the pro forma agreement under which small electricity generators may interconnect to existing transmission grids.[170]

FERC's amended rule responds to growth of the solar power market that had made the prior rule's technical screening for speedy interconnection seem less than "just and reasonable."[171] Particularly, the old rule had limited interconnection under a "15 Percent Screen" in proportion to the annual peak load of a distribution circuit: this screen allowed generators to interconnect to the distribution circuit under a streamlined process only if local small generation contributed less than 15% of the circuit's annual peak load.[172] The effect was to prohibit swift interconnection once utilities reached this 15 percent cutoff. Indeed, substantial growth in the solar market had led some new PV projects to fail this 15 Percent Screen, resulting in lengthy, expensive interconnection studies[173] FERC reasoned that the interconnection process

Dramatic growth of the solar market made new interconnection rules necessary.

should adapt to allow new projects to "continue participate in the less costly and time-consuming Fast Track Process while maintaining the safety and reliability of the Transmission Provider's system."[174] Particularly, FERC concluded that **the old rules "inhibit[ed] the continued growth in Small Generating Facilities and cause[d] unnecessary costs to be passed on to consumers.**"[175]

FERC amended the old rule in order to avoid "inefficient interconnection queue backlogs" and to prevent small solar generators from suffering a costly and time-consuming interconnection process "when they could be interconnected under the Fast Track Process safely and reliably."[176] Order 792 aims to prevent "[c]osts resulting from ... inefficiencies in the interconnection process" from falling on consumers.[177]

FERC's amended rule "does not modify the 15 Percent Screen" or any other technical screen, but rather modifies the supplemental review process that occurs if a solar PV project fails a technical screen.[178] "[T]he revised supplemental review will offer an opportunity to continue to be evaluated under the Fast Track Process."[179] The goal for the revised supplemental review process is to "enhance transparency and consistency É and ensure that interconnection remains just and reasonable and not unduly discriminatory."[180]

Particularly, the new FERC rule allows supplemental interconnection studies to include three technical screens: a minimum load screen,[181] a voltage and power quality screen,[182] and a safety and reliability screen.[183] A generation project passes the minimum load screen if the aggregate generating capacity on the relevant line section is less than 100% of that line's minimum load.[184] A generation project passes the voltage and power quality screen if the transmission provider can maintain voltage in compliance with all relevant technical standards despite the introduction of the generation project.[185] A generation project passes the safety and reliability screen if its impacts on safety and reliability do not require a more complete study.[186] If a generation project that fails the initial 15 Percent Screen successfully passes each supplemental technical screen, it may still participate in the Fast Track interconnection process.[187]

"[T]he three screens in the supplemental review are designed to balance between handling the increased volume of interconnection requests and penetrations of small generators and maintaining the safety and reliability of the electric systems."[188] The transmission provider may choose the order in which it conducts the supplemental technical screens. [189] However, to prevent excessive costs, if a generation project fails one screen, the transmission provider must obtain the generator's permission to continue supplemental screening.[190] Similarly, FERC aimed to restrict unnecessary costs by "adopt[ing] a supplemental review fee based on actual costs."[191]

FERC's new final rule will allow an interconnection customer access to a pre-application report that contains information about system conditions at an interconnection point in order to help customers consider where to site projects.[192] That pre-application report must be made available for a fixed fee, with $300 as the default, that "should include only the cost of providing the incremental information" that the pre-application report contains.[193]

The new rule also raised the size limits for eligibility for Fast Track review.[194] This amendment will allow some larger projects to qualify for Fast Track review. However, this aspect of FERC's new rule will not be relevant to the smaller (<10kW) solar PV projects that are the subject of this paper, because the lowest limit is 500kW.[195] Nonetheless, this aspect of FERC's new rule could substantially reduce soft costs of interconnection for utility-scale projects.

FERC's Order 792 should promote swift interconnection for small solar projects.

FERC's new final rule on interconnection is an important step toward swift, transparent interconnection processes that will reduce soft costs associated with interconnection. One especially important aspect of the new rule that it limits fees for interconnection studies to cover only the costs of the studies. This limitation has the potential to reduce soft costs of interconnection. Additionally, the limitation should prevent the problem (or perceived problem) of utilities imposing prohibitive fees to stifle a burgeoning industry. More fundamentally, the new rule should help streamline interconnection in jurisdictions where there are already numerous small generators by allowing fast-track interconnection even where new solar projects fail the 15 Percent Screen. These new aspects of the pro forma interconnection agreement should help reduce soft costs by allowing for swifter, more hassle-free interconnection.

However, FERC's new rule has two important limitations. First, the supplemental safety and reliability screen gives utilities (or grid managers) some discretion to decide whether a proposed small generator, such as a solar power project, poses a risk to safety or reliability. Although the rule does require consideration of some technical factors, it allows the utility to consider other factors as well.[196] In fact, the safety and reliability screen is "intended to provide Transmission Providers with the flexibility to identify some of the specific issues that may arise due to a Small Generating Facility's unique variations."[197] While it may be proper to allow transmission providers some discretion or flexibility to consider unspecified technical factors, the rule seemingly would not prevent a recalcitrant utility from using the safety and reliability screen to thwart the rule's purpose of promoting swift interconnection. In other words, a utility hostile to distributed solar could simply assert that a project fails the supplemental safety and reliability screen, requiring further costly study. Seemingly, the solar project would not have any recourse to challenge this decision. Although there is as yet no evidence of utilities misbehaving in this manner, unbridled utility discretion is an apparent limitation of FERC's new rule.

Additionally, the sway of FERC's policy is limited by FERC's jurisdictional limits.[198] FERC's order states that it "is not encroaching on the States' jurisdiction and is not asserting jurisdiction over 'local distribution facilities.'"[199] Presumably, FERC thus aims to preserve the distinction between its jurisdiction over transmission and wholesale sale of electricity and state jurisdiction over distribution and retail sale of electricity.[200] However, FERC has blurred this jurisdictional line in the past in two ways. First, it has successfully exercised jurisdiction over unbundled transmission of electricity, and has suggested that it may have power to regulate bundled transmission of electricity as well.[201] Second, and less successfully, FERC has attempted to regulate net metering by insisting that the netting period for retail sales of energy be the same as the netting period for federal regulation of transmission.[202] These prior attempts by FERC to push its jurisdictional limits suggest that it is possible that FERC may in the future be willing to construe its jurisdiction broadly as it issues further interconnection regulations. However, Order 792 instead hews closely to the traditional distinction between federal and state jurisdiction over energy sales. As far as Order 792 is concerned, FERC's "hope is that states may find this rule helpful in formulating or updating their own interconnection rules," even though the states "are under no obligation to adopt [FERC's] provisions."[203]

This paper recommends that states take inspiration from FERC's action in Order 792 and streamline the interconnection process to avoid unnecessary costs. To this end, the Interstate Renewable Energy Council (IREC) has issued interconnection best practices that should provide helpful guidance.[204] These best practices strongly resemble FERC's rule for the interconnection process, including the 15 Percent Screen.[205] This paper recommends that states implement interconnection review processes that resemble FERC's and IREC's by providing transparency and balancing the grid's safety and reliability with the promotion of swift, low-cost interconnection.

States should follow FERC's lead and adopt similar policies to promote swift interconnection for solar projects.

E. Mandating Solar Buildings

State and local governments should also consider solar mandates as a method of reducing the soft costs of solar PV power. At heart, solar mandates simply require that new buildings or major renovations feature solar power. Such a requirement should reduce the soft costs of solar power by guaranteeing a customer base, allowing developers to achieve economies of scale and scope, and by facilitating standardized design. This section reviews existing solar mandates, describes their likely benefits, and explores some practical and legal issues regarding their implementation.[206]

In the United States, two cities in California are leading the way in implementing solar mandates. As of January, 2014, Lancaster, CA requires new residential buildings to feature solar generation assets with a power rating of 1kW.[207] To comply with the mandate, developers of larger, multi-unit projects may elect to install a form of community solar, building larger, centralized facilities that feature at least 1kW of generating capacity per home.[208] Sebastopol, California enacted an even more ambitious mandate on July 21, 2013, requiring a PV system for any new commercial or residential building.[209] In Sebastopol, large renovations also trigger the requirement to install a solar PV system, including: any addition to a commercial building of more than 1800 square feet; any addition to a residential building of more than 75% of the existing square footage; and any renovation of more than 50% of a commercial building or more than 75% of a residential building.[210] Sebastopol's mandate requires that the building either feature two Watts of power per square foot ($2W/ft^2$) of building size or be sufficient to meet 75% of the building's total annual energy demand.[211] The borough of Merton, in London, England, also pioneered a similar, but less rigorous, renewable energy requirement in 2003, requiring new buildings to feature sufficient renewable energy sources to meet 10% of their power requirements.[212]

Figure 20: Rex Parris, Mayor of Lancaster, CA (R), City of Lancaster.

Because the solar energy mandates in the United States are quite new, their benefits are still not yet well-documented. In fact, Lancaster's solar mandate only took effect in January of 2014.[213] Similarly, while Sebastopol has kept admirable records of the number of kilowatts of solar power installed in the city,[214] it has not tracked the costs of these projects.[215] Consequently, neither Lancaster nor Sebastopol have strong, empirical data to confirm whether solar mandates actually achieve the benefits that it seems that they should. The borough of Merton's experience suggests that renewable energy mandates are most efficient when coupled with energy efficiency mandates,[216] as discussed in greater detail below. However, analysis of Merton's policies has not focused on how it may have reduced renewable energy costs. Nevertheless, it stands to reason that **solar mandates should reduce the soft costs of solar power,** especially in comparison to installing solar panels on existing buildings.

Perhaps the clearest cost reduction should come in the area of customer acquisition. Whereas for a retrofit installers must woo customers, under a solar mandate installers would face a guaranteed customer in each new building. Similarly, a solar mandate would help reduce the costs of custom system designs associated with customer acquisition.[217] Whereas installers must often refurbish existing roofs to ensure that they can bear the weight of solar panels, as well as to install electrical components to receive solar energy, buildings constructed under a solar mandate would already have such features. Accordingly, solar mandates should facilitate standardization of systems, allowing increased efficiency in customer acquisition.

Solar mandates should also help reduce soft costs associated with affiliated hardware and installation labor by allowing installers to achieve economies of scale and scope. For example, installers of solar PV systems on new buildings should be able to achieve economies of scope “where certain labor or material costs can be shared between the PV installation and other elements of home construction.[11218] Similarly, in larger housing developments, installers should be able to achieve economies of scale by purchasing larger batches of hardware and through larger labor contracts.[219] This effect should be true as well for any community with a solar mandate, regardless of whether construction proceeds in large batches or small; either way, installers should know that a mandate guarantees a large group of guaranteed customers, meaning that they can safely invest in purchasing large batches of hardware or in long-term, lower-cost labor contracts. The cost reduction for labor contracts would come from savings on acquiring customers, rather than from reduced wages. In fact, such lower-cost labor contracts resulting from solar mandates should be a boon to workers, because they will guarantee that the solar industry not only creates jobs, but also promotes job stability.

Solar mandates should reduce costs of financing, customer acquisition, hardware, and installation.

Solar mandates should also help reduce the costs of financing solar power projects by allowing those costs to be incorporated into traditional, low-cost real estate financing mechanisms such as mortgages. As explained above, mortgages tend to have much lower interest rates, and thus much lower overall costs of capital, than either loans for energy retrofits or the forms of capital available to third-party solar developers. Accordingly, mandating the inclusion of solar power in new development should reduce the cost of financing. Moreover, by including solar projects in the overall cost of a new building, solar mandates could help to avoid the FHFA’s concerns about PACE financing. The solar project’s costs would be built into the home’s costs, so there would be no need for a separate financing mechanism that could subordinate existing mortgages. Accordingly, solar mandates may provide low-cost, low-hassle financing.

Solar mandates also offer several advantages to governments. First, they operate at a low cost to government, because “most of the costs of the new solar energy installations generated by such policies are borne by developers and by buyers.[11220]

Similarly, solar mandates require little support, either regulatory or financial, from state governments or utilities.[221] For example, solar mandates make it likely that solar development will proceed in large, standardized batches, allowing standardized and streamlined inspections. Additionally, mandates “tend to generate new solar energy installations from a much broader subset of citizens” than financial incentives,[222] suggesting that they may be more likely to succeed. Solar mandates may also help stimulate local economies by raising property values.[223] Thus, from a government’s perspective, solar mandates provide many potential benefits and few risks.

Finally, solar mandates could help reduce the soft costs of solar power by facilitating standardization of solar PV systems. Especially in larger developments where many buildings are built at once, the entire community could be designed with solar power in mind. In such communities, only a few solar panel configurations would be necessary. Even in other communities where development proceeds in smaller batches, solar mandates could similarly reduce costs. For example, a solar mandate could be integrated into a building code that required certain structural elements, such as a roof angle and orientation that are optimal for solar power. Featuring such common elements in a building code would enable standardization of solar PV systems.

Solar mandates should reduce costs by promoting standardized system designs.

The standardization of larger housing developments should also help reduce one of the issues that is most problematic for solar power: guaranteed continual access to sunlight. “A solar collector is rendered useless if there is no continuing access to sunlight.”[224] Unless local laws protect a solar project’s access to sunlight, development on neighboring lots or the growth of trees can shade the solar panels, reducing efficiency and potentially economic viability. Although some jurisdictions have included solar access guarantees in zoning laws or have passed legislation recognizing solar easements,[225] solar mandates offer an excellent opportunity for more governments to promote both the installation and the economic longevity of solar power. Solar mandates should feature not only requirements that new development include solar power, but also zoning provisions that guarantee ongoing access to sunlight.

Solar mandates for retrofitting existing buildings, such as Sebastopol’s, should receive more cautious consideration, because retrofit mandates run the risk of inadvertently deterring retrofits by adding cost to projects. The most prominent example of this unintended negative consequence is the Clean Air Act’s major modification rule. That rule provided that “major modifications” of existing power plants triggered the need to install costly emissions reduction technology.[226] In order to avoid those costs, many organizations simply declined to update their coal-fired power plants.[227] The net result was that—contrary to the goals of the Clean Air Act—many older power plants continued to operate in a very dirty fashion even after they were originally scheduled to be upgraded or retired.[228] A similar dynamic has taken place under seismic codes in some cities.[229] Thus, governments must craft their retrofit rules carefully.

Sebastopol, California, which is the only jurisdiction that has adopted a solar mandate for retrofits, designed its retrofit mandate in a thoughtful manner that other jurisdictions should consider emulating. Sebastopol's mandate applies only to very large retrofits: residential retrofits that affect more than 75% of an existing building or commercial retrofits that affect more than 50% of an existing building.[230] Such large retrofits may be costly enough anyway that the incremental cost of adding solar power may not daunt property owners. This type of limit is a good idea, and other jurisdictions should consider such limits for solar mandates for retrofits. Alternatively, governments can promote compliance with retrofit mandates by providing subsidies with the mandates. For example, a retrofit large enough to trigger a solar mandate could also trigger a property tax reduction, either for the increased value of solar power or, more generously, for the entire retrofit's value. Such an incentive would help prevent increased costs of solar power from deterring retrofits s. In turn, the incentive and mandate would work together to bring more solar power online at lower costs.

The longer experience of the borough of Merton suggests that solar mandates would be more economically attractive when paired with energy efficiency mandates. Merton developed a renewable energy mandate in 2003 ("the Merton Rule") that became the model for a similar mandate throughout London. A study of the Merton Rule concluded that a renewable energy mandate reduced CO_2 emissions further than an energy efficiency mandate alone, but noted that the renewable energy mandate cost 4.2 times as much per ton of CO_2 saved for only a 1.1% improvement.[231] In other words, a renewable energy mandate alone was somewhat more effective than an energy efficiency mandate, but much more costly. However, when the two mandates were paired, buildings achieved twice as significant a reduction in energy use for roughly 60% of the cost (per ton of avoided CO_2 emissions) of a renewable energy mandate alone.[232] This study suggests that a solar mandate would be much more effective if coupled with an energy efficiency mandate. Additionally, an energy efficiency mandate could help reduce the costs of solar power by reducing the necessary size of a solar installation; a home that requires less energy should be able to fulfill its energy requirements with a smaller solar array. A solar mandate coupled with an energy efficiency mandate could thus help reduce the overall cost of solar projects.

Solar mandates make the most economic sense when paired with mandates for energy efficiency.

This paper advocates for solar mandates because they are a simple, straightforward way both to stimulate the growth of the solar market and to bring down the soft costs of solar power simultaneously. Solar mandates should enable economies of scale that will make solar installations cheaper, should promote standardization of solar systems, and should allow for solar projects to remain economically viable over the long term.

V. Conclusion

Although soft costs are currently the largest share of the price of solar power, both soft costs and hardware costs are falling. These price reductions are a consequence of a robust global market for solar panels, ongoing technological innovation, and substantial government support. The fact that government policies have helped reduce the overall installed price of solar power in the past is a good reason to believe that policy makers can continue to help reduce the soft costs of solar power. This paper has described factors that have kept soft costs expensive and has explored five policy strategies that governments may use to reduce them in the future: encouraging new forms of business for solar installers; promoting standardized solar PV systems, streamlining permitting and inspection; promoting swift, low-cost interconnection to the utility grid; and mandating solar buildings. This suite of policies should help bring down the soft costs of solar power substantially, helping solar power to become cost-competitive with other forms of electricity generation as soon as possible.

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[3] GALEN BARBOSE, NAIM DARGHOUTH, SAMANTHA WEAVER, AND RYAN WISER, LAWRENCE BERKELEY NATIONAL LABORATORY, TRACKING THE SUN VI: AN HISTORICAL SUMMARY OF THE INSTALLED PRICE OF PHOTOVOLTAICS IN THE UNITED STATES FROM 1998 TO 2012 1 (LBNL 2013), *available at* http://emp.lbl.gov/publications/tracking-sun-vi-historical-summary-installed-price-photovoltaics-united-states-1998-201.

[4] *Id.*

[5] *See* Claudia Assis, *Chinese Solar-Panel Prices Rising 20% in the U.S.*, MARKETWATCH (Apr. 10, 2014), http://www.marketwatch.com/story/chinese-solar-panel-prices-rising-20-in-the-us-2014-04-10?link=MW latest news (noting that "[t]he ongoing U.S.-China trade case is the 'primary driver' behind behind the price increase").

[6] *See e.g.* U.S. DEPARTMENT OF ENERGY, *About the SunShot Initiative*, http://www1.eere.energy.gov/solar/sunshot/about.html (last visited Jan. 7, 2014) (noting that the purpose of the SunShot Initiative is to reduce the price of solar energy "to make solar energy cost competitive with other forms of electricity by the end of the decade").

[7] *See* Morgan Bazilian et al., *Re-considering the Economics of Photovoltaic Power*, 53 Renewable Energy 329, 332 (2013), *available at* www.bnef.com/WhitePapers/download/82 (noting that "[d]espite the substantial drop in PV costs, many commentators continue to note that PV-generated power is prohibitively expensive unless supported by subsidies or enhanced prices").

[8] BARBOSE ET AL., *supra* note 3, at 9 (noting a total of 208,529 residential or commercial solar projects between 1998 and 2012, but only 190 utility-scale projects during the same period); *see also* Julie Cart, *After a Building Boom, Solar Energy's Prospects Now Aren't As Sunny*, LA TIMES (Jan 11, 2014), available at http://www.latimes.com/local/la-me-adv-solarslowdown-2-20140112,0,3755073.story#axzz2qJRCmolc ("In contrast to large-scale projects, mid-sized and rooftop solar power is burgeoning").

[9] DAVID FELDMAN ET AL., NATIONAL RENEWABLE ENERGY LABORATORY, PHOTOVOLTAIC SYSTEM PRICING TRENDS: HISTORICAL, RECENT, AND NEAR-TERM PROJECTIONS 2013 EDITION, PowerPoint Presentation July 16, 2013 slide 18, http://emp.lbl.gov/publications/photovoltaic-system-pricing-trends-historical-recent-and-nearterm-projections-2013-edi (depicting the large share of soft costs for larger solar projects).

[10] U.S. DEPARTMENT OF ENERGY, *SunShot Initiative*, http://www1.eere.energy.gov/solar/sunshot/index.html (last visited Jan. 7, 2014).

[11] U.S. DEPARTMENT OF ENERGY, *About the SunShot Initiative*, http://www1.eere.energy.gov/solar/sunshot/about.html (last visited Jan. 7, 2014).

[12] *Id.*

[13] U.S. DEPARTMENT OF ENERGY, *Reducing Non-Hardware Costs*, http://www1.eere.energy.gov/solar/sunshot/nonhardware_costs.html (last visited Jan. 7, 2014).

[14] KRISTEN ARDANI ET AL., NATIONAL RENEWABLE ENERGY LABORATORY, NON-HARDWARE ("SOFT") COST-REDUCTION ROADMAP FOR RESIDENTIAL AND SMALL COMMERCIAL SOLAR PHOTOVOLTAICS, 2013–2020 4 (National Renewable Energy Laboratory 2013), *available at* http://www.nrel.gov/docs/fy13osti/59155.pdf. [hereinafter NREL Soft Costs Roadmap].

[15] *Id.* at 2.

[16] *Id.* at vii.

[17] *Id.* at 7 (noting that "the roadmap incorporates future deployments of innovations with greater cost-reduction potential, referred to as 'undefined' solution sets and [cost-reduction opportunities]").

[18] BARBOSE ET AL., *supra* note 3 at 14.

[19] *Id.* at 1 (noting that falling module prices . . . represent[] roughly 80% of the drop in total PV system prices for ≤10 kW systems"); *see also* Bazilian et al., *supra* note 2, at 331, 334 (noting that the global price of silicon, while generally declining, has experienced spikes that have added volatility to the generally declining price of solar panels).

[20] BARBOSE ET AL., *supra* note 3, at 2.

[21] KRISTEN ARDANI, NATIONAL RENEWABLE ENERGY LABORATORY, BENCHMARKING SOFT COSTS FOR PV SYSTEMS IN THE UNITED STATES, Powerpoint Presentation May 17, 2012 slide 7, *available at* http://www.nrel.gov/ docs/fy12osti/54689.pdf.

[22] *E.g.* FELDMAN ET AL., *supra* note 9, at slide 5 (depicting a continuing decline in hardware prices from 2011 to 2012); *see also* BARRY FRIEDMAN, KRISTEN ARDANI, DAVID FELDMAN, RYAN CITRON, & ROBERT MARGOLIS, NATIONAL RENEWABLE ENERGY LABORATORY, BENCHMARKING NON-HARDWARE BALANCE-OF-SYSTEM (SOFT COSTS) FOR U.S. PHOTOVOLTAIC SYSTEMS, USING A BOTTOM-UP APPROACH AND INSTALLER SURVEY SECOND EDITION iv (NREL 2013), available at http://www.nrel.gov/docs/fy14osti/60412.pdf (last accessed Jan. 21, 2014) (noting that soft costs contribute 64% of the price of a residential solar system).

[23] *See* BARBOSE ET AL., *supra* note 3, at 2 ("The distribution of installed prices across projects is quite wide.").

[24] *Id.* at 23 fig. 18 (depicting the costs of solar projects in 1kW increments).

[25] *Id.* at 25 fig. 19.

[26] RYAN WISER & CHANGGUI DONG, EAST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY, THE IMPACT OF CITY-LEVEL PERMITTING PROCESSES ON RESIDENTIAL PHOTOVOLTAIC INSTALLATION PRICES AND DEVELOPMENT TIMES: AN EMPIRICAL ANALYSIS OF SOLAR SYSTEMS IN CALIFORNIA CITIES 16 (LBNL 2013), *available at* http:// emp.lbl.gov/reports.

[27] BARBOSE ET AL., *supra* note 3, at 33. This seemingly perverse trend is likely due to a number of factors, such as a preference among government employers for using costlier union labor and domestically manufactured hardware. *Id.*

[28] WISER & DONG, *supra* note 26, at 16 (noting that "[t]he reasons for this relationship are not well-known but may reflect better price negotiation and more price comparison on the part of more-educated customers").

[29] BARBOSE ET AL., *supra* note 3, at 2 ("Over the longer-term, installed system prices have fallen É as a result of reductions in non-module costs.").

[30] *Id.* at 16.

[31] *Id.* at 2.

[32] JOACHIM SEEL, GALEN BARBOSE, & RYAN WISER, LAWRENCE BERKELEY NATIONAL LABORATORY, WHY ARE RESIDENTIAL PV PRICES IN GERMANY SO MUCH LOWER THAN IN THE UNITED STATES: A SCOPING ANALYSIS, PowerPoint Presentation September 2012 slide 24, http://emp.lbl.gov/sites/all/files/german-us-pv-priceppt.pdf.

[33] BARBOSE ET AL., *supra* note 3, at 2; FELDMAN ET AL., *supra* note 4, at slide 25 ("Installed prices in the United States are high compared to most other international PV markets, due largely to differences in soft costs.").

34 BARBOSE ET AL., *supra* note 3, at 5 ("The market for PV in the United States is, to a significant extent, driven by national, state, and local governmental incentives, including up-front cash rebates, production-based incentives, renewable portfolio standards, and federal and state tax benefits.").

35 *Id.* at 17 (noting that "regular and scheduled incentive reductions can provide a long-term signal to the industry to reduce costs").

36 *Id.*

37 The merits of this strategy of withdrawing incentives for solar power are not altogether clear. Although the cost of solar panels has declined over the period during which governments have withdrawn incentives, solar panels are a global commodity with a price driven by global trends. For a more thorough discussion of the factors contributing to solar panel price declines, see Bazilian et al., *supra* note 2.

38 SEEL, BARBOSE, & WISER, *supra* note 32, at 43.

39 *Id.* at 11 fig. 2.

40 *See* Billy Roberts, NATIONAL RENEWABLE ENERGY LABORATORY, *Photovoltaic Solar Resource of the United States*, http://www.nrel.gov/gis/images/map_pv_national_lo-res.jpg (October 20, 2008) (last accessed Jan. 13, 2014).

41 *Id.*

42 *See* U.S. Dept. of Energy, *Reducing Non-Hardware Costs*, ENERGY.GOV, http://energy.gov/eere/ sunshot/reducing-non-hardware-costs.

43 *Id.* at 15 fig. 9.

44 *E.g.* ARDANI, *supra* note 21, at slides 6–7; NREL Soft Costs Roadmap, *supra* note 9, at 4.

45 KRISTEN ARDANI ET AL., BENCHMARKING NON-HARDWARE BALANCE OF SYSTEM (SOFT) COSTS FOR U.S. PHOTOVOLTAIC SYSTEMS USING A DATA-DRIVEN ANALYSIS FROM PV INSTALLER SURVEY RESULTS iv (National Renewable Energy Laboratory 2012), *available at* http://www.nrel.gov/docs/fy13osti/56806.pdf. Another reason that this study may produce a much lower figure for overall soft costs is that it featured a small sample size of "75 installers, representing approximately 13% of all residential PV installations and 4% of all commercial installations added in 2010." *Id.* Importantly, even this study concludes that the limited soft costs it analyzed constitute as much as 23% of the total installed price, and that the soft costs "present significant opportunities for further cost reductions." *Id.*

46 Friedman et al., *supra* note 22, at 3

47 *Id.*

48 BARBOSE ET AL., *supra* note 3, at 16.

49 *E.g. id.* at 2; Bazilian et al., *supra* note 2, at 331, 5; FELDMAN ET AL., *supra* note 4, at slide 18; SEEL ET AL. *supra* note 51, at slide 24.

50 BARBOSE ET AL., *supra* note 3, at 15 fig. 9 (reproduced here as figure 3, depicting the increasing importance of soft costs); Bazilian et al., *supra* note 2, at 331; NREL Soft Costs Roadmap, *supra* note 9, at 4; SEEL ET AL., *supra* note 51, at slide 24.

51 NREL Soft Costs Roadmap, *supra* note 14, at 8–9.

52 *Id.*

53 *Id.*

54 ARDANI ET AL., *supra* note 21, at 5–6.

55 *Id.*

56 *Id.*; NREL Soft Costs Roadmap, *supra* note 14, at 9.

[57] *See* NREL Soft Costs Roadmap, *supra* note 14, at 16 (calculating an average permitting cost of $0.20); SUNRUN, THE IMPACT OF LOCAL PERMITTING ON THE COST OF SOLAR POWER: HOW A FEDERAL EFFORT TO SIMPLIFY PROCESSES CAN MAKE SOLAR AFFORDABLE FOR 50% OF AMERICAN HOMES ES 1 (Sunrun 2011), *available at* http://www.sunrun.com/solar-lease/cost-of-solar/local-permitting/ (last accessed Jan. 7, 2014) ("Local permitting and inspection add $0.50 per watt, or $2,516 per residential install."); WISER & DONG, *supra* note 26, at iv (calculating costs between $0.27/W and $0.77/W).

[58] *See* NREL Soft Costs Roadmap, *supra* note 14, at 16; WISER & DONG, *supra* note 21, at 28 (noting that "national or regional average impacts can mask the more substantial impacts that occur at a local level across individual cities").

[59] *See* SUNRUN, *supra* note 57, at 18 (noting an average interconnection delay of three weeks across the country, with certain utilities taking as long as ten weeks"); JAMES TONG, CLEAN POWER FINANCE, NATIONWIDE ANALYSIS OF SOLAR PERMITTING AND THE IMPLICATIONS FOR SOFT COSTS 14 (Clean Power Finance 2012), *available at* http://solarpermit.org/media/upfiles/CPF-DOE_Permitting_Study_Dec2012_Final.pdf (noting that more than 80% of solar PV installations require "[a]t least one site inspection" by an electric utility and "[a]t least one site inspection" by a city department).

[60] *See Sunshot Initiative: Permitting, Inspection, and Interconnection*, U.S. DEPARTMENT OF ENERGY, http:// www1.eere.energy.gov/solar/sunshot/permitting_interconnection_inspection_costs.html (Feb. 1, 2013) (last accessed Jan. 7, 2014).

[61] *E.g.* NREL Soft Costs Roadmap, *supra* note 14, at 16–20 (discussing PII costs together).

[62] SKY STANFIELD, ERICA SCHROEDER, & THAD CULLEY, INTERSTATE RENEWABLE ENERGY COUNCIL, SHARING SUCCESS: EMERGING APPROACHES TO EFFICIENT ROOFTOP SOLAR PERMITTING 7 (IREC 2012), *available at* http://www.irecusa.org/wp-content/uploads/Sharing-Success-final-version.pdf (last accessed Jan. 7, 2014).

[63] *See id.* at 15–16 (describing one municipal utility's unique program of promoting solar PV installations); SUNRUN, *supra* note 57, at 18 (noting lengthy interconnection delays); TONG, *supra* note 105, at 14 (noting that PV installations may require review by city and county planning and fire departments).

[64] STANFIELD, SCHROEDER, & CULLEY, *supra* note 62, at 15–16, 41–43 (noting that "[o]ften utilities will not begin their interconnection review" until installers have received final permits, which likely increases delays unnecessarily, but also describing efforts by municipal utilities in Long Island, New York and San Diego, California to facilitate speedy interconnections).

[65] *See* SUNRUN, *supra* note 57, at 3 (noting that "local variation forces installers to spend time and money customizing plans for each jurisdiction").

[66] *See e.g.* TONG, *supra* note 59, at 17 (describing the time spent on average by different installer staff members on permitting).

[67] WISER & DONG, *supra* note 26, at 2; TONG, *supra* note 59, at 19.

[68] SUNRUN, *supra* note 57, at 18.

[69] TONG, *supra* note 59, at 19.

[70] WISER & DONG, *supra* note 26, at 2.

[71] SUNRUN, *supra* note 57, at 7.

[72] *Id.* at 3.

[73] STANFIELD, SCHROEDER, & CULLEY, *supra* note 62, at 36.

[74] Arizona, California, and Colorado each purport to limit solar PV permit fees in this manner. *Id.* at 38–39. However, California's Solar Rights Act seems not to have been tremendously effective. *See infra* note 77 and accompanying text (demonstrating a wide variety in California county solar permit fees, many of which seem too high to be aimed at mere cost recovery).

[75] STANFIELD, SCHROEDER, & CULLEY, *supra* note 62, at 36.

[76] *Id.*

[77] Kurt Newick, *PV Permit Fees for 3kW Residential Systems for 25 California Counties as of 12/26/2011*, SIERRA CLUB, http://www.solarpermitfees.org/PVFeesCaliforniaResidential.pdf (Dec. 26, 2011) (last accessed Jan. 7, 2014); *see also* CARL MILLS, JIM STEWART, & TAMARA WINTER COMPEAN, SOLAR ELECTRIC PERMIT FEES IN SOUTHERN CALIFORNIA 4–5 (Sierra Club 2009), *available at* http://www.solarpermitfees.org/SoCalPVFeeReport.pdf (June 21, 2009) (last accessed Jan. 7, 2014).

[78] ARDANI ET AL., *supra* note 21, at 9.

[79] NREL Soft Costs Roadmap, *supra* note 14, at 20.

[80] *Id.* at 29–30.

[81] *Id.* at 27 (noting that third parties owned roughly half of PV systems installed in 2011, and roughly 75% of PV systems installed in 2012); *see also* Todd Woody, *The Next Big Innovation in Renewable Energy Won't Be Technological*, THE ATLANTIC, Nov. 11, 2013, *available at* http://www.theatlantic.com/technology/archive/2013/11/the-next-big-innovation-in-renewable-energy-wont-be-technological/281345/ (last accessed Jan. 7, 2014) (noting that "between 75 and 90 percent of all solar systems are now leased" from a third-party owner).

[82] *See* Shayle Kann, *Can You Name All the Residential Solar Lease Providers*, GREENTECH MEDIA (March 26, 2013), http://www.greentechmedia.com/articles/read/can-you-name-all-the-residential-solar-leaseproviders (listing residential solar lease providers and providing information on each).

[83] NREL Soft Costs Roadmap, *supra* note 14, at 29.

[84] *Id.*

[85] *Id.* at 27 ("Reducing either the cost of capital or the 'other soft costs' (inclusive of financing transaction costs) to roadmap targets, while holding the other constant, results in nearly identical reductions in the cost of solar PV, as measured in cents per kilowatt-hour.").

[86] *Id.* at 29.

[87] *Id.* at 30.

[88] *Id.* at 29.

[89] NREL Soft Costs Roadmap, *supra* note 14, at 29*.*

[90] SEEL ET AL., *supra* note 32, at slide 31.

[91] *Id.* at slide 31. In addition, wages for installers are lower in Germany, due to dynamics that are beyond the scope of this paper. One such dynamic is that wages in the U.S. tend to incorporate the costs of employer-based health insurance, while wages in Germany do not incorporate this, due to universal health care in that country.

[92] NREL Soft Costs Roadmap, *supra* note 14, at 20.

[93] *Id.*

[94] Inverters are electrical components that convert the direct-current output from solar panels into alternating current that is suitable for residential use and compatible with the utility grid. *See* James Worden & Michael Zuercher-Martinson, *How Inverters Work*, SOLARPRO 68, 69 (April/May 2009), http://solar.gwu.edu/index_files/Resources_files/How-Solar-Inverters-Work-With-Solar-Panels.pdf.

[95] BARBOSE ET AL., *supra* note 3, at 37.

[96] *Id.* at 37, 38 fig. 31.

[97] Microinverters are a type of inverter that attach to each solar panel, in contrast to a centralized inverter that converts the power from all the solar panels together. These microinverters allow each solar panel to function more independently, improving the system's performance when part of it is shaded. *See Central Inverter vs. Microinverters: The Pros and Cons*, GOGREENSOLAR (June 6, 2012), http:// blog.gogreensolar.com/2012/06/central-inverter-vs-microinverters-pros-cons.html.

[98] BARBOSE ET AL., *supra* note 3, at 29.

[99] CHRIS DELINE ET AL., PARTIAL SHADE EVALUATION OF DISTRIBUTED POWER ELECTRONICS FOR PHOTOVOLTAIC SYSTEMS 1 (NREL 2012), *available at* http://www.nrel.gov/docs/fy12osti/54039.pdf.

[100] BARBOSE ET AL., *supra* note 3, at 38. The wide range here reflects differences between single-axis and double-axis tracking systems. The double-axis tracking systems, though more expensive, are also much more efficient. *Id.*

[101] *See* ALEXANDER QUINN, CHRISTINE SAFRIET, & CHRISTOPHER CLEMENT, SUNRUN, ECONOMIC AND FISCAL IMPACT ANALYSIS OF RESIDENTIAL SOLAR PERMITTING REFORM 7 (Sunrun 2011) (copy on file with author).

[102] *See State Sales Tax Rates*, SALES TAX INSTITUTE (Jan. 1, 2014), http://www.salestaxinstitute.com/resources/rates (describing state and local tax rates, which in Alabama ranges as high as 12.5%).

[103] QUINN, SAFRIET, & CLEMENT, *supra* note 76, at 25–26.

[104] *Supra* ¤ II(B) (discussing prior downward trends in solar PV prices).

[105] NREL Soft Costs Roadmap, *supra* note 14, at 7, 12, 15, 19, 23, 26, 34, 39 (describing the Roadmap's methodology as comparing recommended cost reductions to existing cost-reduction trends and depicting the contrast in graphs for the various categories of soft costs).

[106] *Id.*

[107] *Id.* at 8, 16, 20, 27.

[108] *E.g. id.* at 22 (depicting a projection that the use of solar-ready homes is much more likely to achieve cost-reduction targets than is the development of integrated, "plug and play" solar PV systems).

[109] *E.g. id.* at vi–vii (noting that attaining targets for PII costs will require "an undefined solution set É that may represent the combination of unknown regulatory mechanisms").

[110] *Id.* at 1.

[111] *Id.*

[112] *Id.*

[113] Keith Martin, Chadbourne & Parke LLP, *Drive to Reduce the Cost of Capital* 1, PROJECT FINANCE NEWSWIRE, April 2013, at 1, *available at* http://www.chadbourne.com/files/upload/Martin_Drive%20to%20Reduce%20the%20Cost%20of%20Capital_project_finance_april13.pdf (last accessed Jan. 7, 2014).

[114] *Id.*

[115] *Id.*

[116] *Id.* at 1–2.

[117] *Id.*

[118] James Montgomery, *SunEdison Launches YieldCo to Unearth, Leverage Solar Asset Values*, RENEWABLE ENERGY WORLD (Feb. 19, 2014), http://www.renewableenergyworld.com/rea/news/article/2014/02/sunedison-launches-yieldco-to-unearth-leverage-solar-asset-values; see *also* Martin*, supra* note 113*,* at 2 (noting that one wind developer utilized a business form like a yield co).

[119] *Will YieldCo Structure Change Energy Investments?*, PRETI FLAHERTY (Nov. 4, 2013), http://energypolicyupdate.blogspot.com/2013/11/will-yieldco-structure-change-energy.html

[120] Martin, *supra* note 113, at 2.

[121] *Id.*

[122] *Id.*

[123] *Id.*

[124] *Id.* at 3.

[125] *Id.*

[126] Martin, *supra* note 113, at 3. Some geothermal projects can exist as MLPs, but other renewable energy companies cannot. *Id.*

[127] Molly F. Sherlock & Mark P. Kneightly, Congressional Research Service, *Master Limited Partnerships: A Policy Option for the Renewable Energy Industry* 5–7 (Congressional Research Service 2011), *available at* http://www.ieeeusa.org/policy/eyeonwashington/2011/documents/masterlmtdpartnerships.pdf (last accessed Jan. 13, 2014) (discussing the legislative history behind MLPs).

[128] *E.g.* President Barack Obama, *The President's Climate Action Plan* 4–8 (The White House 2013), *available at* http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf (last accessed Jan. 13, 2014) (discussing deployment of clean energy as a national strategy to mitigate climate change); *see also* U.S. DEPARTMENT OF ENERGY, *About the SunShot Initiative*, http://www1.eere.energy.gov/solar/sunshot/about.html (last visited Jan. 7, 2014).

[129] *Supra* § III(C).

[130] *Id.*

[131] *Average Mortgage Rates and Points in the Top 10 Metropolitan Markets*, BANKRATE.COM, http://www.bankrate.com/brm/news/mtg/top10_averages.asp (Jan. 4, 2013) (last accessed Jan. 7, 2013); *Bankrate: Mortgage Rates Rebound Following Release of Fed Minutes*, WALL STREET JOURNAL (Nov. 27, 2013), http://online.wsj.com/article/PR-CO-20131127-905195.html?dsk=y (last accessed Jan. 7, 2014).

[132] *Energy Efficient Mortgage Program*, U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/sfh/eem/energy-r (last accessed Jan. 7, 2014).

[133] *E.g. Green Mortgage: Energy Efficient Mortgage Guide*, MORTGAGELOAN.COM (Apr. 23, 2013), *http://www.mortgageloan.com/environment/* (last accessed Jan. 7, 2014).

[134] *Id.* The property's value is measured either by the lesser of the literal value of the property, 115% of the median area price of a single family home, or 150% of the conforming Freddie Mac limit. *Id.*

[135] *Id.*

[136] *PACE Financing*, DSIRE.ORG, http://www.dsireusa.org/solar/solarpolicyguide/?id=26 (last accessed Apr. 17, 2014). The Database of State Incentives for Renewables & Efficiency (DSIRE) is a comprehensive source of information on state, local, utility, and federal incentives and policies that promote renewable energy and energy efficiency. Established in 1995 and funded by the U.S. Department of Energy, DSIRE is an ongoing project of the N.C. Solar Center and the Interstate Renewable Energy Council.

[137] *Id.*; *PACE Financing Map*, DSIRE.ORG, http://www.dsireusa.org/documents/summarymaps/PACE_Financing_Map.pdf (last accessed Apr. 17, 2014).

[138] *County of Sonoma v. Federal Housing Finance Agency*, 710 F.3d 987, 990–92 (9th Cir. 2013).

[139] *County of Sonoma*, 710 F.3d at 988–89.

[140] *County of Sonoma*, 710 F.3d at 993–95.

[141] *See* CONGRESSIONAL BUDGET OFFICE, FANNIE MAE, FREDDY MAC, AND THE FEDERAL ROLE IN THE SECONDARY MORTGAGE MARKET ix (CBO 2010), *available at* http://www.cbo.gov/sites/default/files/cbofiles/ ftpdocs/120xx/doc12032/12-23-fanniefreddie.pdf (last accessed Jan. 7, 2014) (noting that "more than 90 percent of new mortgages made in 2009 carried a federal guarantee" from Fannie Mae or Freddy Mac).

[142] *See, e.g.*, Julie Schmit, *What's Ahead for 2014 Housing Market*, USA Today (Jan. 1, 2014), http:// www.usatoday.com/story/money/business/2014/01/01/home-prices-2014-housing-starts/4181021/ (describing the housing market's recovery).

[143] *County of Sonoma*, 710 F.3d at 990.

[144] *See* NREL Soft Costs Roadmap, *supra* note 14, at 20 (noting that "it is difficult for installers to standardize processes and challenging for technology manufacturers to further integrate hardware without compromising needed system flexibility").

[145] *Id.* at 21 (noting that the average wage for electricians is roughly $60/hour, while the wage for roofers is roughly $40/hour).

[146] SUNRUN, *supra* note 57, at 4.

[147] ALEXANDER QUINN, CHRISTINE SAFRIET, & CHRISTOPHER CLEMENT, SUNRUN, ECONOMIC AND FISCAL IMPACT ANALYSIS OF RESIDENTIAL SOLAR PERMITTING REFORM (Sunrun 2011) (copy on file with author).

[148] *Id.* at 6, 21.

149 WISER & DONG, *supra* note 26, at 28.

150 *Id.* at 29.

151 NREL Soft Costs Roadmap, *supra* note 14, at 17.

152 STANFIELD, SCHROEDER, & CULLEY, *supra* note 62, at 3.

153 *Id.* at 8–22.

154 *Id.* at 8.

155 *Id.* at 11.

156 *Id.* at 29.

157 *Id.*

158 STANFIELD, SCHROEDER, & CULLEY, *supra* note 62, at 3.

159 *Id.* at 9.

160 *Id.*

161 NREL Soft Costs Roadmap, *supra* note 14, at 16.

162 *Id.*; STANFIELD, SCHROEDER, & CULLEY, *supra* note 62, at 9.

163 *See supra* § III(C).

164 WISER & DONG, *supra* note 26, at 29. Safety-related inspections may be particularly necessary in the solar PV industry, because there is some concern that solar panels may pose fire risks. Fires related to solar panels may be more difficult to extinguish and may pose greater risks to fire crews. *See* Timothy Kreis, *The Impact of Solar Energy on Firefighting*, FIREENGINEERING.COM (Jan. 1 2009), http://www.fireengineering.com/articles/print/volume-162/issue-1/features/the-impact-of-solar-energy-on-firefighting.html (last accessed Jan. 7, 2014); Daniel Kelley, *Rooftop Solar Panels Become New Enemy of U.S. Firefighters*, REUTERS (Sept. 5, 2013), http://www.reuters.com/article/2013/09/05/usa-solar-fire-idUSL2N0H114420130905 (last accessed Jan. 7, 2014). In the interest of fairness, it is worth mentioning that solar panels themselves are not particularly dangerous. For example, a large study of fire risks associated with solar panels in Germany, a nation with the highest concentration of solar panels, concluded that solar panels were not likely to cause fires. FRAUNHOFER ISE, *Fire Protection in Photovoltaic Systems—Facts Replace Fiction—Results of Expert Workshop* (Feb. 12, 2013), http://www.ise.fraunhofer.de/en/press-and-media/press-releases/presseinformationen-2013/fire-protection-in-photovoltaic-systems (last accessed Jan. 13, 2014). The risk is from solar panels that are themselves defective or are incorrectly installed. Kreis, *supra* this note.

165 STANFIELD, SCHROEDER, & CULLEY, *supra* note 62, at 12.

166 WISER & DONG, *supra* note 26, at 29.

167 STANFIELD, SCHROEDER, & CULLEY, *supra* note 62, at 1.

168 *Id.*

169 *Supra* § III(D).

170 Federal Energy Regulatory Commission (FERC) Order 792, 145 FERC ¶ 61,159 (Nov. 22, 2013), *available at* http://www.ferc.gov/whats-new/comm-meet/2013/112113/E-1.pdf (last accessed Jan. 7, 2014) [hereinafter FERC Order 792]. Procedurally, FERC promulgated this amended rule in response to a petition from the Solar Energy Industries Association in early 2012. *Id.* at 9.

171 *Id.* at 9, 11, 19.

172 *Id.* at 8.

173 *Id.* at 16–17

174 *Id.* at 11.

175 *Id.* at 20.

176 FERC Order 792, *supra* note 207, at 16.

177 *Id*.

[178] *Id.* at 18.

[179] *Id.* at 19.

[180] *Id.* at 69.

[181] FERC Order 792, *supra* note 207, at 142.

[182] *Id.* at 150.

[183] *Id.*

[184] *Id.* at 82.

[185] *Id.* at 85; Small Generator Interconnection Agreements and Procedures Notice of Proposed Rulemaking, 142 FERC ¶ 61,049, at Appendix C § 2.4.1.2, *available at* http://www.ferc.gov/whats-new/comm-meet/2013/011713/E-1.pdf (last accessed Jan. 7, 2014) [hereinafter Interconnection NOPR].

[186] FERC Order 792, *supra* note 207, at 88; Interconnection NOPR Appendix C § 2.4.1.3.

[187] FERC Order 792, *supra* note 207, at 103.

[188] *Id.* at 82.

[189] *Id.* at 91.

[190] *Id.*

[191] *Id.* at 94.

[192] FERC Order 792, *supra* note 207, at 22, 27–29.

[193] *Id.* at 31–32.

[194] *Id.* at 61 Table 3.

[195] *Id.*

[196] *Id.* at 88; Interconnection NOPR Appendix C § 2.4.1.3.1—2.4.1.3.6.

[197] Interconnection NOPR 25 ¶ 37.

[198] FERC Order 792, *supra* note 207, at 133–35.

[199] *Id.* at 134.

[200] *See New York v. FERC*, 535 U.S. 1, 21–24 (2002).

[201] *See Id.* at 25 (upholding FERC's regulatory choices).

[202] *See Southern California Edison Co. v. FERC*, 603 F.3d 997, 999–1002 (D.C. Cir. 2010) (holding that FERC exceeded its authority by insisting that the netting period for retail sales, traditionally the subject of state jurisdiction, comport with federal netting periods for energy transmission).

[203] FERC Order 792, *supra* note 207, at 22.

[204] INTERSTATE RENEWABLE ENERGY COUNCIL, MODEL INTERCONNECTION PROCEDURES (IREC 2013), *available at* http://www.irecusa.org/wp-content/uploads/2013-IREC-Interconnection-Model-Procedures.pdf (last accessed Jan. 7, 2014)

[205] *Id.* at 5–6.

[206] Because this paper focuses on reducing soft costs, it by no means provides exhaustive coverage of the topic of solar mandates. For example, this paper does not discuss solar access rights at great length. Nor does it address whether a federal solar mandate might exceed Congressional authority under the Commerce Clause. More fundamentally, it does not thoroughly address the economic wisdom of mandating economic activity rather than taking a more laissez-faire approach to regulating the energy market, which is a contentious debate beyond the scope of this paper.

[207] Herman K. Trabish, *Lancaster, CA Becomes First U.S. City to Require Solar*, GREENTECH MEDIA (Mar. 27, 2013), http://www.greentechmedia.com/articles/read/Lancaster-CA-Becomes-First-US-City-to-Require-Solar (last accessed Jan. 7, 2014); *see also Lancaster City Council to Consider Revised Residential Zoning Ordinance Requiring New Residences to Produce Solar Energy*, CITY OF LANCASTER, CA (Mar. 21, 2013), http://www.cityoflancasterca.org/index.aspx?page=20&recordid=3240&returnURL=%2findex.aspx (last accessed Jan. 7, 2014).

208 TRABISH, *supra* note 207.

209 Glenn Schainblatt, Building Official, City of Sebastopol, *Mandatory Photovoltaic System Requirements* 1 (copy on file with author).

210 *Id.*

211 *Id.*

212 NHBC FOUNDATION, THE MERTON RULE: A REVIEW OF THE PRACTICAL, ENVIRONMENTAL, AND ECONOMIC EFFECTS v (NHBC Foundation 2009) (copy on file with author).

213 TRABISH, *supra* note 207.

214 *See* Photovoltaic Installations Ð City of Sebastopol, 03/2003 to Current, Spreadsheet (copy on file with author).

215 Interview with City of Sebastopol Building Department, December 04, 2013.

216 NHBC, *supra* note 208, at 1.

217 *Supra* § III(F).

218 BARBOSE ET AL., *supra* note 3, at 34.

219 *Id.*

220 TROY A. RULE, SOLAR MANDATES FOR REAL ESTATE DEVELOPMENT: A GUIDE AND MODEL ORDINANCE 6 (SolarTech May 2013).

221 *Id.* at 8.

222 *Id.* at 7.

223 *Id.* at 6Ð7.

224 Edna Sussman, *Reshaping Municipal and County Laws to Foster Green Building, Energy Efficiency, and Renewable Energy* 16 N.Y.U. ENVTL. L.J. 1, 32 (2008).

225 *See id.* at 32–34 (discussing solar access rules in various jurisdictions).

226 Jonathan Remy Nash & Richard L Revesz, *Grandfathering and Environmental Regulation: The Law and Economics of New Source Review*, 101 Nw. U. L. Rev. 1677, 1681–1705 (2007).

227 *Id.* at 1708–1712 (describing the "old plant effect" and noting that such grandfathering policies "prolong the existence of older, dirtier facilities and give polluters incentives to make undesirable investment decisions").

228 *Id.*

229 *E.g.* Nathan Gilles, *Coding for Quakes: Novick's Ready to Fight for Seismically Safer Buildings—Will it be Enough?*, Portland Mercury (Oct. 16, 2013), http://www.portlandmercury.com/portland/coding-forquakes/Content?oid=10779474 (noting that property owners avoid retrofits in order to avoid triggering costly seismic retrofit mandates).

230 Schainblatt, *supra* note 209, at 1.

231 NHBC, *supra* note 212, at 1.

232 *Id.*

Table of Figures

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