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Solar Building Standards:

How American Cities Can Lay Foundations For A New Generation Of Solar Development

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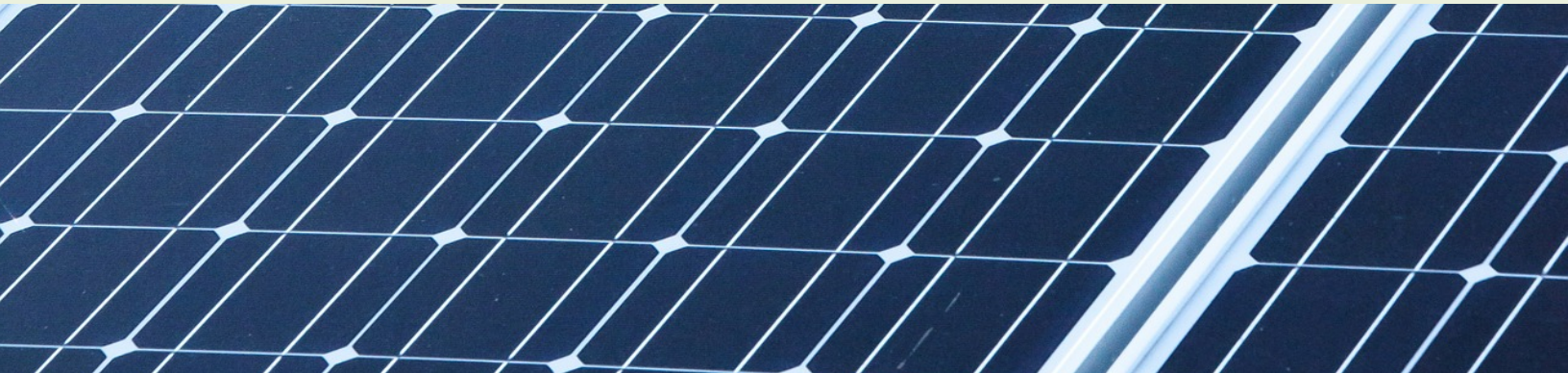

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Executive Summary

Solar building standards are local requirements for the installation of solar power on new or renovated buildings. Lancaster, California enacted the nation's first solar building standard in March 2013, and Sebastopol, California followed suit two months later. Currently, these two California cities are the only jurisdictions with solar building standards, but the increasingly strong economic and environmental case for solar power suggests that more cities may soon adopt these new policies.

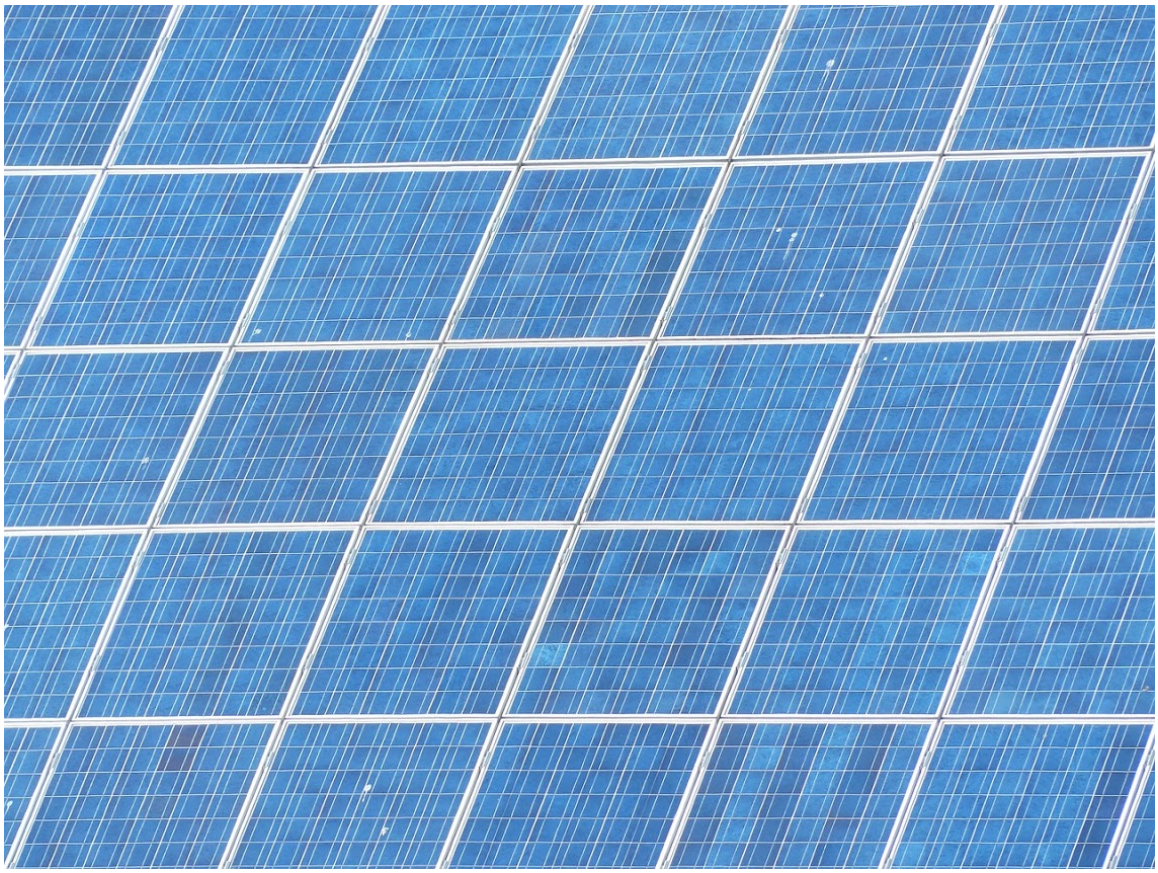
This report aims to help regulators, property owners, and other energy market stakeholders understand and evaluate the merits of solar building standards. In short, solar building standards could lead to swift, extensive solar deployment at substantially reduced costs. Well-crafted solar building standards will have widespread benefits for governments, utilities, independent power producers, and ratepayers.

The current paradigm for distributed solar development relies on a narrow set of foundational policies such as subsidies and net metering to make the economics of solar power work for individual property owners. Although these policies have resulted in rapid growth of the solar industry, they have not led the industry to achieve its full potential. Costs are declining and installations are increasing, but solar power remains inaccessible for many Americans and satisfies only a minuscule portion of overall U.S. energy demand.

Solar building standards have the potential to dramatically expand access to solar power by treating it as a standard feature in new or renovated properties. The result would be solar deployment that keeps pace with construction and growing energy demands. Moreover, solar building standards would allow for low-cost financing options and economies of scale that could significantly reduce the cost of solar power. Solar building standards would also raise property values, lower and stabilize electricity bills, and allow access to solar power in lower-income communities—all without raising the price of new homes by more than 6%.

Solar building standards could also solve several vexing problems for the energy industry. These new policies could facilitate integration of solar power onto the energy grid by expanding peak production hours. Moreover, these policies could also offer utilities opportunities to become valuable partners in the development of distributed solar power, which some utilities now regard as an existential threat. Finally, these policies can help cities develop resiliency to power outages from severe weather, which are becoming increasingly common.

This report first describes various design options for solar building standards and explains the relative merits of each. It then places these policies in a broader policy context. Next, the report offers detailed analysis of the likely impacts of solar building standards, which are overwhelmingly positive. It then examines reasons why solar building standards have not yet become common, including formerly high costs and potential legal obstacles. The report concludes that the obstacles to solar building standards have dwindling validity, that their advantages are clear, and that as the economic case for solar power continues to improve, more cities are likely to enact solar building standards.



I. INTRODUCTION

In 2013, two cities in California became the first in the United States to enact solar building standards, requiring solar panels as standard features in construction projects. In March 2013, Lancaster required that all new residential buildings install solar power.[1] Two months later, Sebastopol followed suit with an even stronger standard for new residential and commercial buildings and large retrofits.[2] These cities are quite different: Lancaster is a small, right-leaning city just north of Los Angeles, while Sebastopol is an even smaller, left-leaning city in the Sonoma Valley north of San Francisco.

The fact that these two cities with different climates and political temperaments both adopted solar building standards suggests that these policies could soon spread to other locales. Further suggesting that possibility, a San Francisco city councilor recently proposed a similar solar building standard, which would be the first in a major U.S. city, though its political fate is uncertain.[3] Other cities could soon enact their own solar building standards.

Defining "Solar Building Standard"

The term "solar building standard" describes a city or county requirement for installing solar panels on buildings. Local governments may adopt a solar building standard in a zoning code, as in Lancaster, or in a building code, as in Sebastopol. Local governments may also vary the categories of buildings to which solar building standards apply. For example, Lancaster's standard applies only to residential buildings, while Sebastopol's also applies to commercial buildings. Similarly, local governments may apply their standards to new buildings only, or to renovations as well; Lancaster's standard applies only to new construction, while Sebastopol's also applies to large renovations.

Solar building standards are at the vanguard of renewable energy policy. Most requirements for renewable energy happen at the state level, not the local level.[4] And very few policies at any level actually require renewable energy on particular properties.[5] This command is precisely what makes the solar building standards in Lancaster and Sebastopol so interesting. These new policies lay the foundation for the next wave of widespread solar adoption by requiring buildings to feature solar power.

Still, solar building standards are related to widespread, successful renewable energy policies such as green building requirements and state renewable portfolio standards. And as the costs of solar power continue to decline,[6] solar building standards should offer local governments a cost-effective way to achieve a whole host of environmental and economic benefits. Viewed in this context, solar building standards appear to be the next logical step in renewable energy policy.

This report aims to help energy market stakeholders understand and evaluate solar building standards. Section II offers details about the policies in Lancaster and Sebastopol, describes design options for solar building standards, and briefly discusses possible implications for existing energy policies. Section III places solar building standards in the broader context of federal, state, and local renewable energy policies. Section IV explains the likely impacts of solar building standards, and Section V discusses potential obstacles to their enactment. Finally, this report concludes that as solar power's costs continue to decline and its benefits become more apparent, local governments should give solar building standards increasingly serious consideration.

II. DESIGN OPTIONS FOR SOLAR BUILDING STANDARDS

A 2014 study from the National Renewable Energy Laboratory (NREL) revealed that solar policies are most effective when designed with local contexts in mind.[7] NREL noted that states with similar policies do not necessarily deploy solar power at the same pace and concluded that "policy suites are more effective if they are tailored to the economic and demographic background of the state."[8] In short, there is no one-size-fits-all state solar policy. This conclusion will likely be true for solar building standards as well.

Solar building standards will prove most effective where local governments tailor them to fit local economic, demographic, and policy conditions. For example, a city that is growing quickly by adding new neighborhoods, like Phoenix, Arizona,[9] would benefit from a solar building standard that targets new construction. In contrast, older cities that shrank in the 20th Century and are now growing again, like Philadelphia, Pennsylvania,[10] would benefit more from a solar building standard that targets renovations.

Important design questions for a solar building standard include which buildings it will affect and who may own resulting solar arrays. For example, solar building standards can apply to public buildings or private buildings or both. Similarly, solar building standards can either require property owners to purchase their own solar arrays or can allow utilities or third-party financiers to own arrays and provide power or payment to host properties. Additionally, local governments should consider alternative compliance mechanisms such as in-lieu fees or development of larger, community-scale solar arrays. Finally, local governments should evaluate how solar building standards may interact with existing energy policies.

Mayor Rex Parris of Lancaster, California. Photo courtesy of City of Lancaster.

"Requiring solar power assets for new residential construction in the coming years will bring Lancaster one huge step closer to becoming the Alternative Energy Capital of the World, while providing new homeowners with earth-friendly and cost-effective benefits."

Lancaster, California

The solar building standard in Lancaster, California was the nation's first.[11] *Backed by Republican mayor Rex Parris in March 2013, Lancaster's new policy reveals solar power's bipartisan appeal.*[12] *The policy, which took effect January 1, 2014, requires all new residential buildings to include 1 kilowatt of solar power capacity.*[13] *However, Lancaster's solar building standard does not require solar panels on the roof of every new home. Instead, developers of multi-unit housing projects can choose to satisfy the standard by installing a community-scale solar power system in a new neighborhood, so long as the installation achieves an average capacity of 1kW per new home.*[14] *For multi-family housing, a common solar array may be placed on the roof or on a free-standing structure.*[15] *Where local conditions make solar power impractical, a developer must propose an alternative compliance strategy, subject to approval by local building regulators.*[16]

The adoption of Lancaster's solar building standard was notably uncontroversial.[17] *It passed unanimously through the city council and faced little opposition.*[18] *Although some local developers voiced concern that the standard would raise construction costs and the price of new housing, one prominent local developer disagreed.*[19] *KB Homes, one of the largest developers in Lancaster, already included solar power as a standard feature for new houses, suggesting that even before the new policy was in place, solar power was affordable in the local housing market.*[20] *Mayor Rex Parris noted that even in "an extremely conservative area … there was almost no push-back."*[21]

Mayor Parris views the city's solar building standard as part of a global battle against climate change through a local effort to develop a "net zero" city—one which produces as much power as it consumes.[22] *Lancaster's stated goal is to have residents benefit from "energy savings and greater usage of alternative energy."*[23] *Mayor Parris also notes that Lancaster's solar building standard will provide "new homeowners with earth-friendly and cost-effective benefits."*[24]

Lancaster seems proud of its progress so far. A press release from October 2014 notes that Lancaster has already achieved 52% of its net-zero goal and has more solar power per capita than any other city in California, the nation's largest solar market.[25] *The press release also notes that Lancaster had already issued 2,000 new permits for solar power on single-family homes in 2014, and that city-wide energy savings average $470,000 annually.*[26] *And as for the potential for local action to combat climate change, Mayor Parris is clear: "A large percentage of these problems can be resolved at the local level, and I am setting out to prove it."*[27]

Summary of Lancaster's Standard

- Residential buildings only
- New construction only
- 1 kW average capacity per home
- Compliance through larger, community-scale facilities

Sebastopol, California

In May 2013, Sebastopol, California, a small city in the Sonoma Valley wine country, enacted the nation's second solar building standard.[28] Sebastopol's policy applies to all new residential and commercial buildings and to large renovations as well.[29] For commercial buildings, any addition of more than 1,800 square feet or any remodel of more than 50% of the structure will trigger the solar building standard.[30] For residential buildings, additions or remodels of more than 75% of a structure trigger the standard.[31]

Sebastopol's solar building standard requires a significant amount of solar power, but gives developers two options for compliance. One option is to install 2 watts of solar capacity per square foot of the building.[32] The alternative is to install sufficient renewable energy to offset 75% of the building's annual energy use.[33] Sebastopol's standard would require more power than Lancaster's. For example, in Sebastopol a 2,600 square foot home (the average for new homes in the United States)[34] would need a 2.6kW solar array, while that same home in Lancaster would require an array of only 1kW. As in Lancaster, developers building multiple properties may comply by installing a community-scale solar facility large enough to satisfy the aggregate requirements for the properties.[35]

Because some properties may not be suitable for solar power, Sebastopol allows its building officials to grant conditional exceptions to its solar building standard.[36] For example, a building official could decide that a home shaded by trees would qualify for an exception, but could require that home to use more stringent energy efficiency measures. The policy also empowers the City Council to allow compliance through payment of an in-lieu fee, valued at 90% of the price of a compliant solar power system.[37]

As in Lancaster, Sebastopol's solar building standard faced little local controversy. Sebastopol's City Council passed the policy unanimously and faced few objections.[38] City Councilman Robert Jacob praised the new policy, stating "this ordinance is not only cost-saving…it's the responsible thing to do."[39] As for practical impact, although Sebastopol's policy is significantly stronger than Lancaster's, it is likely to result in less solar development for the simple reason that Sebastopol is a much smaller city. While Lancaster has a population of 146,000, Sebastopol hosts only 7,400 residents. As a consequence, its construction market is significantly smaller.[40]

Sebastopol also differs from Lancaster in politics. Lancaster tilts right, with a Republican mayor, while Sebastopol tilts left, with Democratic Mayor Michael Kyes at the helm. This significant political difference demonstrates that solar power's bipartisan appeal.

Summary of Sebastopol's Standard

- Residential & commercial buildings
- New construction and renovations
- 2W/ft^2 or 75% of annual energy consumption
- Compliance through larger, community-scale facilities or payment of in-lieu fees

"This ordinance is not only cost-saving … it's the responsible thing to do."

--Sebastopol City Councilman Robert Jacobs

Solar Panels on Sebastopol's Fire Station. Photo courtesy of City of Sebastopol.

A. PUBLIC OR PRIVATE SOLAR BUILDING STANDARDS?

The simplest solar building standard would apply both to public and private property. This straightforward design would have the advantage of promoting the greatest possible amount of solar power. Similarly, the benefits of reduced power demand and lower power bills would be widespread under this design. However, some governments may prefer to limit the scope of their standards to either public or private property exclusively.

1. Public-Sector Standards

Local governments may apply a solar building standard only to public property for several reasons. A public-sector standard can provide an opportunity to lead by example, with public buildings serving as pilot projects. Public facilities affected by a solar building standard would enjoy reduced power bills, saving the government money over time and freeing local funds for other priorities. Moreover, solar power can provide resiliency to outages for essential services such as police and fire stations. Finally, a public-sector standard would not impose direct costs on citizens, which may increase its political appeal.

Governments may also see reductions in solar installation costs. Cities may achieve economies of scale through bulk purchases of hardware or longer-term, lower-cost labor contracts if they plan to build or renovate multiple public facilities at once. Governments also generally face low financing costs, because they raise funds either through taxes or through very low-interest bonds.[41] These advantages may allow cities to purchase solar arrays at relatively low cost.

There is momentum toward public-sector solar building standards. Both Oregon and California require some renewable energy on public facilities.[42] The U.S. Conference of Mayors reported in January 2014 that 86% of surveyed mayors are "targeting city-owned buildings for energy retrofits"[43] and 54% of mayors see solar power as the most promising technology for reducing energy use and carbon emissions.[44] Solar building standards could help local governments achieve these priorities.

2. Private-Sector Standards

Private-sector solar building standards will yield more solar power simply because private facilities outnumber public facilities. Private-sector standards may also offer more significant cost reductions. A 2014 NREL report showed that competitive markets and installer experience lower prices.[45] A private-sector standard would foster a larger, more competitive market with more opportunities for installers to gain experience, yielding lower prices.

Private-sector solar building standards could also alleviate a concern about inequitable development in solar markets. Currently, most solar consumers are relatively affluent, which has led to concerns that lower-income ratepayers are being left behind and may be paying unfair shares of grid-management costs. (See "Net Metering Under Attack," page 28.) However, a solar building standard for all new construction or major renovations of private property would lead to more widespread solar installations, including installations in lower-income communities. This market expansion could in turn reduce concerns about lower-income citizens paying an unfair share of grid-management costs by ensuring that all economic sectors benefit from solar power.

Existing solar building standards in Lancaster and Sebastopol both apply to private property, indicating the feasibility of this design option. Despite the fact that Lancaster is a conservative area and Sebastopol is more liberal, both cities implemented solar building standards for private property. Moreover, neither city seems concerned that its standard will have negative economic impacts; each city has made an express finding that its solar building standard will be cost-effective.[46]

Properties Affected	Fiscal Impacts	Policy Implications
Public Facilities	• Reduced energy bills • Low-interest bonds reduce financing costs • Economies of scale for simultaneous projects	• Improved resiliency of essential public services such as police and fire stations • Lack of direct cost to citizens may be a political advantage • May create need to issue bonds • May lead to argument that private ratepayers will subsidize public facilities' use of the energy grid
Private Property	• Reduced energy bills • Mortgage financing reduces financing costs • Economies of scale for larger, multi-unit developments	• More competitive market lowers costs • Installer experience reduces costs. • Reduced cross-subsidization issues • Improved lower-income access to solar

Table 1: Impacts of public-sector and private-sector solar building standards.

B. STANDARDS FOR NEW CONSTRUCTION OR RENOVATIONS?

The solar building standards in Lancaster and Sebastopol differ in that Lancaster's applies only to new construction while Sebastopol's also applies to large renovations. Either option should incur lower costs in comparison to a later, solar-specific project. For example, solar permits and inspections can be bundled with other project permits and inspections, leading to lower overall costs. However, each of these design options also has risks that local governments should consider.

Focusing a solar building standard exclusively on new construction risks exacerbating inequitable development patterns. New construction tends not to create affordable housing for several reasons, including dwindling federal support for housing programs and local opposition to development of affordable, multi-family dwellings.[47] A solar building standard that applies exclusively to new construction may exacerbate this trend by adding to the price of new homes. Additionally, by focusing solar deployment in more affluent neighborhoods, a standard that applies only to new construction could lead to lower-income communities paying an increased share of grid maintenance costs. One way to mitigate this risk would be to allow compliance through payment of in-lieu fees dedicated to solar deployment in lower-income areas. Still, these risks suggest that a local government should think twice before limiting the application of a solar building standard to new construction only.

However, a solar building standard that focuses on renovations incurs risks as well. Most notably, such a standard risks deterring retrofits by adding costs. The Clean Air Act's major modification rule offers an example. Under that rule, "major modifications" of existing power plants trigger a requirement for costly emissions reduction technology.[48] To avoid those costs, many organizations have simply declined to update coal-fired power plants.[49] Thus, contrary to the goals of the Clean Air Act, many older power plants continue to pollute even after they were originally scheduled to be upgraded or retired.[50]A similar dynamic has taken place under seismic codes in some cities.[51] Thus, governments must craft retrofit rules carefully.

Sebastopol's solar building standard offers a thoughtful compromise that other jurisdictions should consider emulating. Sebastopol's standard applies only to very

Solar building standards create risks if imposed only on new construction or only on renovations. The most effective standards will apply to both new construction and renovations.

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.[52] The incremental cost of adding solar power to an already costly retrofit may not deter projects. This type of limit is a good idea, and other jurisdictions should consider such limits for solar building standards for retrofits.

Alternatively, governments can promote compliance with retrofit standards through subsidies. For example, a retrofit large enough to trigger a solar building standard could also trigger a property tax reduction, either for the increased value of solar power or, more generously, for the entire retrofit's value. These incentives would help prevent increased costs of solar power from deterring retrofits. In turn, incentives and solar building standards would work together to bring more solar power online at lower costs.

Similarly, cities could promote retrofits by dedicating a portion of in-lieu fees from new construction toward retrofits. To promote the most equitable development patterns, most of these in-lieu fees should be dedicated to retrofits of properties in lower-income areas.

The most effective solar building standards would target both new construction and renovations, and would include mechanisms to stimulate projects in lower-income areas. For example, projects above a certain size or cost could comply through in-lieu fees dedicated to promoting lower-income development. Similarly, state and local governments could offer low-interest loans or loan guarantees for projects in lower-income areas in order to promote equitable development patterns.

Properties Affected	Fiscal Impacts	Policy Implications
New Construction	• Reduced energy bills • Reduced installation costs through mortgage financing and a streamlined permitting and inspection process • Increased construction costs of up to roughly 6%	• May concentrate solar installations in more affluent communities • Compliance option of in-lieu fees could foster installations in lower-income areas
Renovations	• Reduced energy bills • Reduced installation costs • Increased renovation costs may deter some property owners from beginning renovations	• Can mitigate risk of deterring renovations by limiting application to large, costly projects, or by offering subsidies for qualifying renovations
Both New Construction and Renovations	• Expanded solar development • Improvements in equitable development patterns	• In-lieu fees can promote projects in lower-income areas • Low-interest loans and loan guarantees can promote projects in low-income areas

Table 2: Impacts of focusing on new construction and renovations.

C. ALTERNATIVE FINANCING OPTIONS

Once a local government resolves which buildings its standard will apply to, it must consider who will pay for and own resulting solar arrays. Under the simplest solar building standard, property owners will be responsible for financing, owning, and maintaining their own solar arrays. Whether the standard applies to public or private buildings, this simple design would reduce the cost of solar power in comparison to the current system of limited, solar-specific projects. For example, purchasers of private property would be able to finance the solar component of a larger construction project using traditional mortgage mechanisms, which generally face a lower cost of capital than other financing tools.[53] Similarly, governments could use low-interest bonds, achieving similar reductions in financing costs.

The simple design of having property owners finance and own their own arrays offers several advantages. One advantage is simplicity. Neither third-party financiers nor utilities nor significant changes to energy policies are necessary to make this design operable. Another advantage is the ease of reselling property. Arrays owned by third-parties would involve long-term contracts that may make resale more difficult, but a property owner's arrays would have no such encumbrance. Instead, the array would simply be a feature of the property, increasing resale value.[54]

However, having property owners finance and maintain their own solar arrays has disadvantages as well. For example, although upfront costs would likely be lower, they would fall squarely on property owners, increasing construction or renovation costs.[55] Property owners would also bear the cost of maintaining solar arrays and the risk of their failure (although long-term manufacturers' warranties could mitigate that risk). Similarly, public funding for solar array financing and maintenance may be scanty. The U.S. Census reports that state and local government revenues and financial holdings are declining while expenditures and indebtedness are increasing.[56] Local governments may balk at allocating limited funds to solar power, which may increase the appeal of other financing mechanisms.

Enabling either utilities or other third-party businesses to finance and own solar arrays could have significant advantages. Most notably, this design would allow buildings to enjoy energy savings at no upfront cost to property owners. Additionally, maintenance costs would fall on the arrays' owners rather than on the host properties' owners. Enabling third-party businesses or utilities to finance and own solar arrays could be especially helpful for promoting development of solar power in lower-income communities.

Photo credit Wayne National Forest

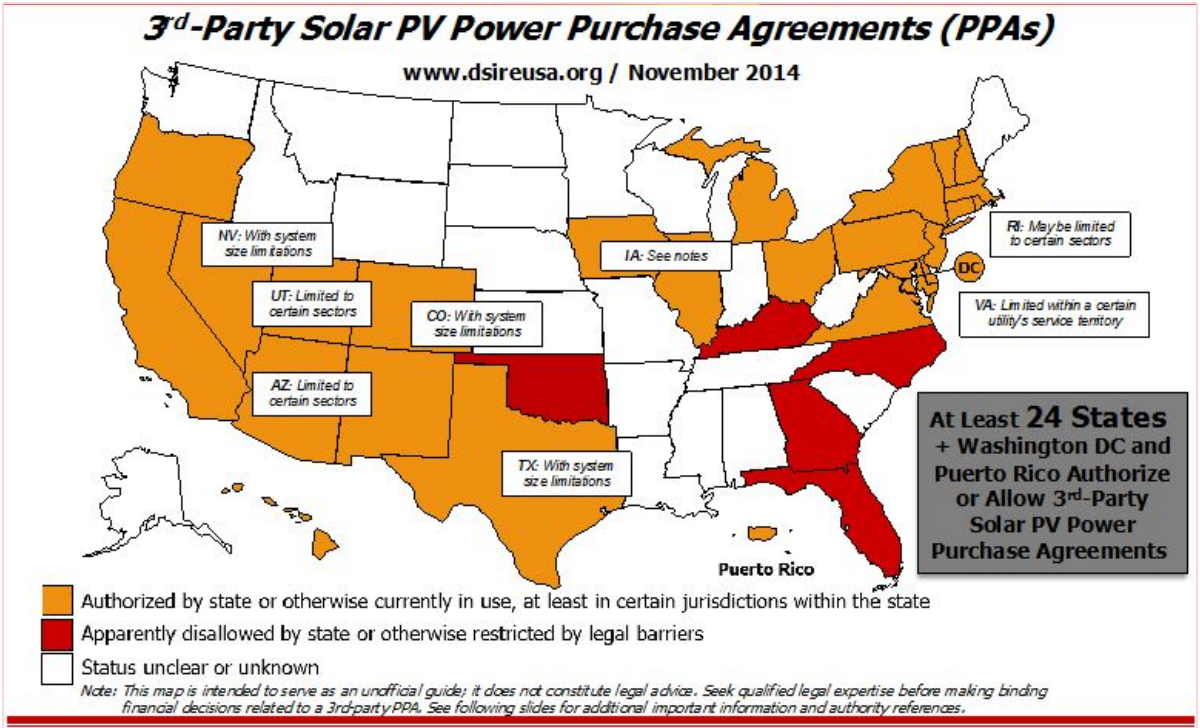
Third-party leasing or utility financing can provide solar power at no upfront cost to property owners.

Third-party ownership has rapidly become the most common model for solar installations in the United States.[57] Under this model, a third-party business such as SolarCity or SunRun installs solar panels and a building's owner enters into a long-term contract to purchase the resulting power at prices below local electricity rates. Third-party ownership is appealing because it allows property owners to enjoy solar power at no upfront cost.

However, the businesses that make this design possible operate only where supportive state policies exist. For example, SolarCity operates only in 17 states. Local governments in states that have enabled third-party financing of solar power (see map[58]) may already implement this design, while other interested local governments may have to work with state governments to create a policy framework that will attract third-party financiers.

Local governments may also design a solar building standard to allow utilities to finance and own solar arrays, if state law allows. Many cities work closely with utilities to advance local energy policies. Of mayors surveyed in January 2014, 71% reported that utilities are their most important partners for deploying new energy technology.[59] Solar building standards that allow utility-financed solar on new or renovated public buildings could take advantage of this relationship.

Under this design, a utility would finance and install arrays required by a solar building standard, rather than having the local government hire a contractor. One advantage of this design is that many utilities enjoy relatively low-cost access to capital, suggesting that they may be able to achieve installation cost reductions.



dsire.org

Though available only in a limited number of states, third-party leasing has become the most popular mechanism for financing solar installations.

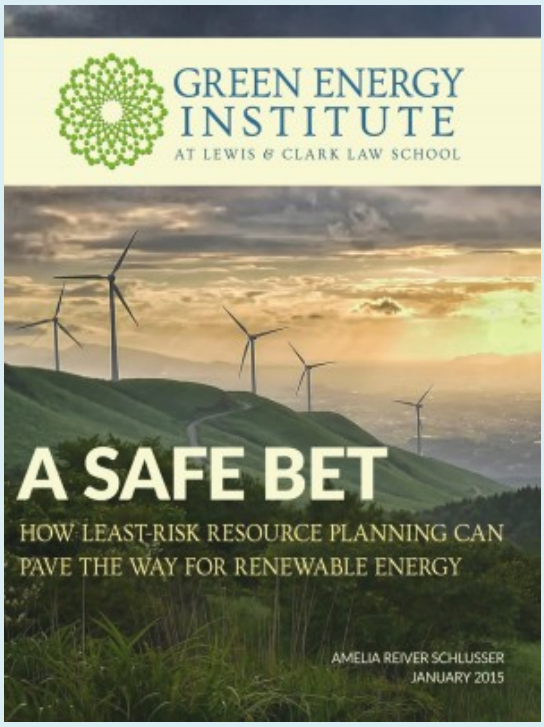
Similarly, utilities already have expertise in maintaining electrical generation equipment, suggesting possible operation and maintenance cost reductions. A utility may also enjoy an advantage from owning solar arrays that contribute toward compliance with state renewable portfolio standards. Moreover, this option may allay utilities' concerns about distributed solar power eroding their revenues.[60]

There are three designs for utility financing of solar arrays. First, on-bill financing allows a property owner to purchase and own an array and pay for it over time through higher utility bills.[61] This design leaves arrays under property owners' control and treats utilities as financiers. In contrast, the two other designs would actually allow utilities to own and operate rooftop solar arrays. Two Arizona utilities have proposed different models for how host buildings should benefit from utility-owned solar arrays.[62] One option proposed by Arizona Public Service is for the utility to essentially pay rent through monthly credits that reduce the host's energy bills. Alternatively, as proposed by Tucson Electric Power, the host could purchase power from the utility-owned rooftop solar array at low rates, essentially mimicking the third-party leasing model. Under any of these three design proposals, host buildings would enjoy reduced energy bills.

Utility financing may be available only in some areas. Many states impose a requirement on investor-owned utilities to invest in least-cost resources. Where solar power is not yet cost-competitive with other energy sources, a state least-cost resource policy may prevent an investor-owned utility from partnering with local governments to fulfill a solar building standard. Local governments in investor-owned utility districts should collaborate with state governments to enable utility ownership of rooftop solar arrays.

Least Risk Resource Planning

Least-risk planning favors energy sources with stable, predictable, long-term costs. Least-risk planning may allow utilities to help implement solar building mandates, because rooftop solar power is a safe investment. For more on least-risk planning, see "A Safe Bet: How Least-Risk Resource Planning Can Pave the Way for Renewable Energy."



Publicly owned utilities—such as municipal utilities, public utility districts, or electric cooperatives—are generally under greater local control.[63] Thus, cities with publicly owned utilities may already be able to enact this solar building standard design.

D. ALTERNATIVE COMPLIANCE MECHANISMS

Local governments should take into account the fact that not all properties will be well-suited for solar power. For example, installing solar panels on a building shaded by neighboring development or vegetation could prove wasteful. Additionally, developers building many facilities at the same time may be able to install the required amount of solar power more cheaply by building a community-scale array larger than any single roof can accommodate.

Both Lancaster and Sebastopol have designed their solar building standards to allow alternative forms of compliance. Both cities allow developers to comply by building larger arrays off-site or to propose other alternatives, subject to approval from local building officials. Sebastopol also allows compliance through payment of an in-lieu fee. These alternative compliance mechanisms are sound ideas, and local governments developing solar building standards should give them strong consideration.

A Model Ordinance for Solar Building Standards

Professor Troy Rule authored a report in May 2013 describing several design options for solar building standards and offering a model ordinance.[64] Professor Rule recommends both community-scale development and in-lieu fees, as well as a combination of both tools, as sensible alternative compliance mechanisms. Although Professor Rule notes that local governments should carefully tailor solar building standards to meet their own local conditions (as this report also argues), Professor Rule's model ordinance should still serve as a valuable starting point for jurisdictions interested in implementing a solar building standard.

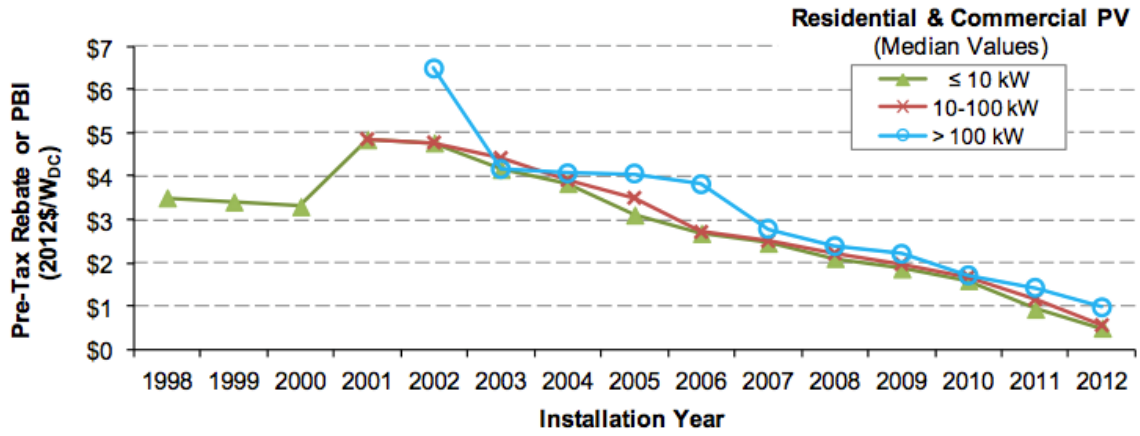
Community-scale solar development may offer an affordable alternative where a developer is building multiple facilities, or where some buildings are not well-suited as a site for solar power.

E. LIKELY IMPACTS ON EXISTING ENERGY POLICIES

Different solar building standard designs will likely interact with existing energy policies in distinct ways. For example, designs that enable third-party or utility financing and ownership of solar arrays would function only in jurisdictions with policies that allow this ownership model. In some states, least-cost mandates may prevent utility ownership, while legal protections for utility monopolies over retail power sales may exclude third-party businesses in others. To enable alternative financing and ownership, local governments would likely have to work with states to develop appropriate laws.

Solar building standards will very likely reduce the overall cost of installing solar power, as described below, which may help make some existing financial incentives less necessary. For example, if costs fall under a solar building standard to the point that rooftop solar becomes cost-competitive with other energy sources, then net metering—which essentially pays retail rates for wholesale power[65]—may no longer be necessary; even compensated at lower wholesale rates, owners of solar arrays would recoup investments within a reasonable payback period. Alternatively, states may choose to retain net metering, which is extremely popular among the solar industry and solar consumers, and phase out other financial incentives such as rebates or tax credits. The fact that solar building standards should reduce the necessity of direct financial subsidies should help make standards more appealing to governments, which generally design subsidies to diminish over time.

These possible policy impacts, however, are difficult to predict because solar building standards are quite new and their impacts on overall prices have not been empirically measured. Accordingly, governments that consider solar building standards would be wise to track the fiscal impacts of these new policies before modifying or withdrawing incentives such as net metering that have been proven to successfully promote solar power.



Lawrence Berkeley National Laboratory, *Tracking theSun VI*, Figure 10.

Direct subsidies diminish over time, but solar building standards reduce costs and provide a stable, long-term policy framework.

III. THE BROADER POLICY CONTEXT FOR SOLAR BUILDING STANDARDS

Although Lancaster and Sebastopol are the first U.S. cities to enact solar building standards, their new ordinances fit within the context of six significant renewable energy policy trends. First, and most conspicuously, solar building standards resemble green building requirements that have proliferated throughout the nation at various levels of government. Second, solar building standards offer local complements to Renewable Portfolio Standards, which are widespread, state-level requirements for utilities to procure renewable energy. Third, solar building standards continue a pattern of significant action by local governments to curb climate change. Fourth, solar building standards offer a way to help states comply with the U.S. Environmental Protection Agency's forthcoming Clean Power Plan. Fifth, solar building standards will likely contribute to the U.S. Department of Energy's goal of achieving cost-competitive solar power by 2020. And finally, in the short term, the strongest solar building standards will build on a suite of state policies proven to drive thriving U.S. solar markets, while in the long term solar building standards may help reduce costs to the point that existing subsidies are no longer necessary.

A. SOLAR BUILDING STANDARDS EXTEND THE TREND OF GREEN BUILDING REQUIREMENTS

Green building standards are becoming common, but generally do not require solar power. Instead, green building standards focus on energy efficiency, air quality, use of sustainable building materials, and reduced water use. Common green building standards include the International Code Council's *International Green Construction Code* and the U.S. Green Building Council's *Leadership in Energy and Environmental Design (LEED)* program.[66]

Various levels of government have enacted green building standards. In 2013, President Obama ordered federal agencies to obtain 20% of their energy from renewable resources by 2020 and prioritized distributed renewables.[67] However, this policy, the most ambitious at the federal level, also allows compliance through the purchase of renewable energy credits.[68] Moreover, this policy is limited to federal agencies and does not apply to private development.[69]

Also at the federal level, the U.S. Department of Energy's (DOE's) Office of Commercial High-Performance Green Building has "the goal of developing commercial buildings that have zero net energy consumption annually."[70] Although a solar building standard might seem to be the simplest way to achieve this goal, it is not the Department of Energy's tactic. Instead, DOE "provides states with financial and technical assistance to promote state and local building energy codes."[71]

A growing number of states are enacting green building codes. However, states generally focus on energy efficiency and do not require solar power, especially on privately owned buildings. Many states

and local governments require public buildings to attain certification under the LEED program.[72] However, while solar power is one way to earn credits toward LEED certification, many other energy efficiency or water conservation measures count as well.[73] Thus, LEED certification requirements will not necessarily achieve the same ends as solar building standards.

A few states do require renewable energy on public buildings. For example, Oregon requires that 1.5% of the cost of building or renovating a public building be devoted to on-site renewable energy.[74] Similarly, California requires solar power on public buildings where it is cost-effective and funding is available.[75]

Only Hawaii has a solar building standard for private property, but Hawaii's standard focuses on water heating rather than electricity. Hawaii requires new single-family homes to include solar water heaters unless they lack access to sun or install solar panels instead.[76] Still, because Hawaii's default rule requires solar water heating, not solar power, it is somewhat distinct from the solar building standards this report describes.

Solar building standards offer a good way to improve green building measures that are becoming common around the nation. Jurisdictions with existing green building requirements should consider adopting solar building standards to further improve the local energy economy.

SOLAR OFFER REQUIREMENTS

Three states have policies that come close to solar building standards. California, Colorado, and New Jersey each have laws requiring developers to offer to install solar power on new homes. These policies are like solar building standards in that they at least contemplate installation of solar power on some new homes. However, unlike solar building standards, these solar offer requirements leave the choice to install solar to either consumers or developers.

California limits its solar offer requirement to developers of 50 or more single-family homes and provides two compliance options.[77] A developer may offer solar power to each homebuyer, and the offer must include the solar array's total installed cost, projected energy savings, and information about state incentives. Solar arrays offered to homebuyers must have a capacity between 1kW and 5MW. Developers must also provide the California Energy Commission with certain information to verify compliance. Alternatively, developers in California may choose to participate in a "Solar Offset Program," under which developers build a larger, community-scale solar array. That array must generate as much energy as would have been generated had 20% of the subdivision's homes opted to install solar power, but the larger array may not exceed 5MW of capacity.[78]

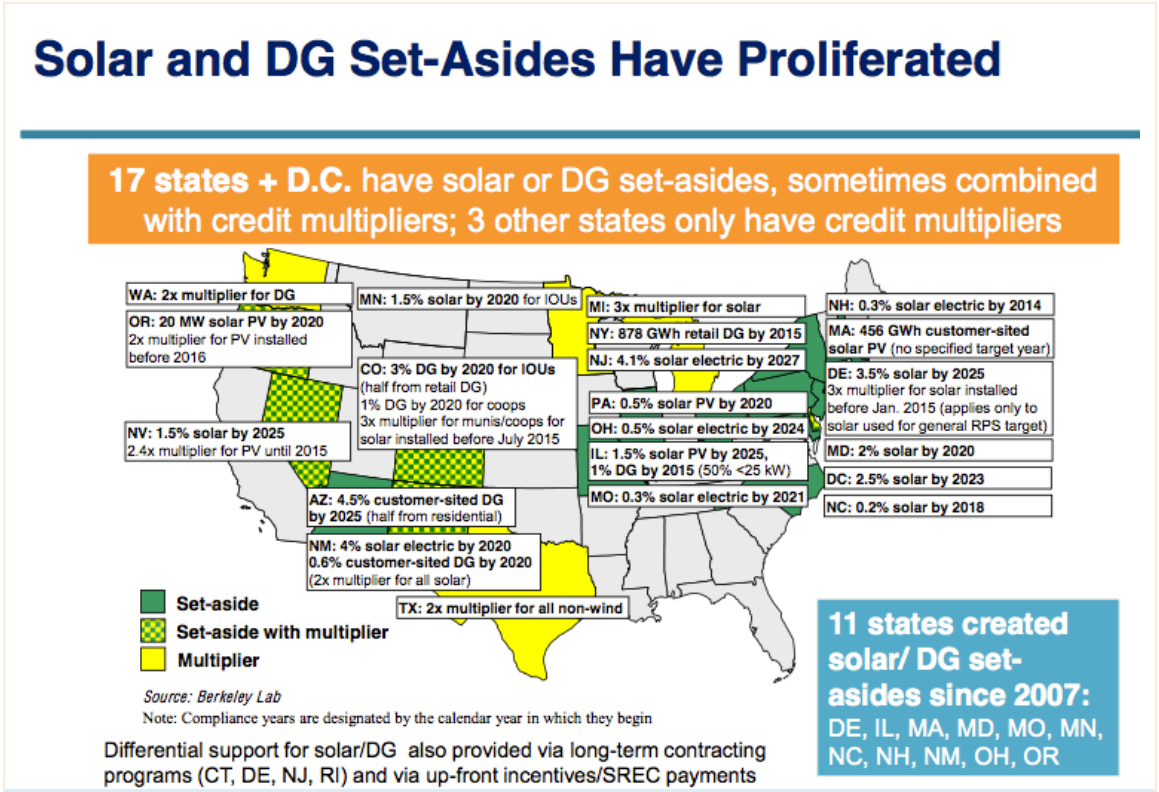
New Jersey's solar offer requirement purports to require developers of more than 25 residential units to offer solar power to prospective buyers.[79] However, though passed in 2009, the law does not become effective until the state's Department of Community Affairs issues implementing regulations, which it has not done, according to the state's Energy Master Plan.[80]

Finally, Colorado's solar offer requirement applies to developers of all new single-family homes.[81] These developers must offer to install solar power or solar water heating or wire and plumb the houses to prepare them for later solar projects. Builders must also provide a list of local solar installers, who can help determine whether solar is a good option for the new home.[82]

B. SOLAR BUILDING STANDARDS EXTEND THE SUCCESS OF RENEWABLE PORTFOLIO STANDARDS

State Renewable Portfolio Standards (RPSs) are another common, successful policy related to solar building standards. RPSs require utilities to obtain certain amounts of renewable energy by specific dates. RPSs are logical precursors to solar building standards because they prove that government requirements for renewable energy are a viable strategy.

Renewable Portfolio Standards have become quite common, with binding policies in 29 states and the District of Columbia and non-binding goals in 9 more.[83] Renewable Portfolio Standards have also been quite successful. Lawrence Berkeley National Laboratory (LBNL) reports that in 2013, RPSs applied to markets constituting 56% of all U.S. retail electricity sales, and that states are generally on track to meet their RPS targets.[84] Moreover, state RPS requirements have proven to be economically efficient, raising electricity rates less than 3% in most states.[85]



Lawrence Berkeley National Laboratory, RPS Status Update, Slide 10.

Solar requirements in Renewable Portfolio Standards are an effective mechanism for promoting thriving solar markets.

While many RPSs allow compliance through different types of renewable energy, a growing number include specific solar carve-outs.[86] These RPSs confirm that requirements for solar power can drive markets. Of 29 states with an RPS, 17 feature a requirement for either solar or customer-sited power, which is most often rooftop solar power.[87] The ten states with the most installed solar power all have an RPS; of those, most have an RPS with a solar carve-out.[88] The National Renewable Energy Laboratory recently reported that solar carve-outs in RPSs can be a very effective tool for driving successful solar markets.[89] Similarly, LBNL reports that solar or distributed generation requirements in RPSs are responsible for 60-80% of solar installations outside California.[90] Successful state RPS programs prove that requiring renewable energy is a viable strategy.

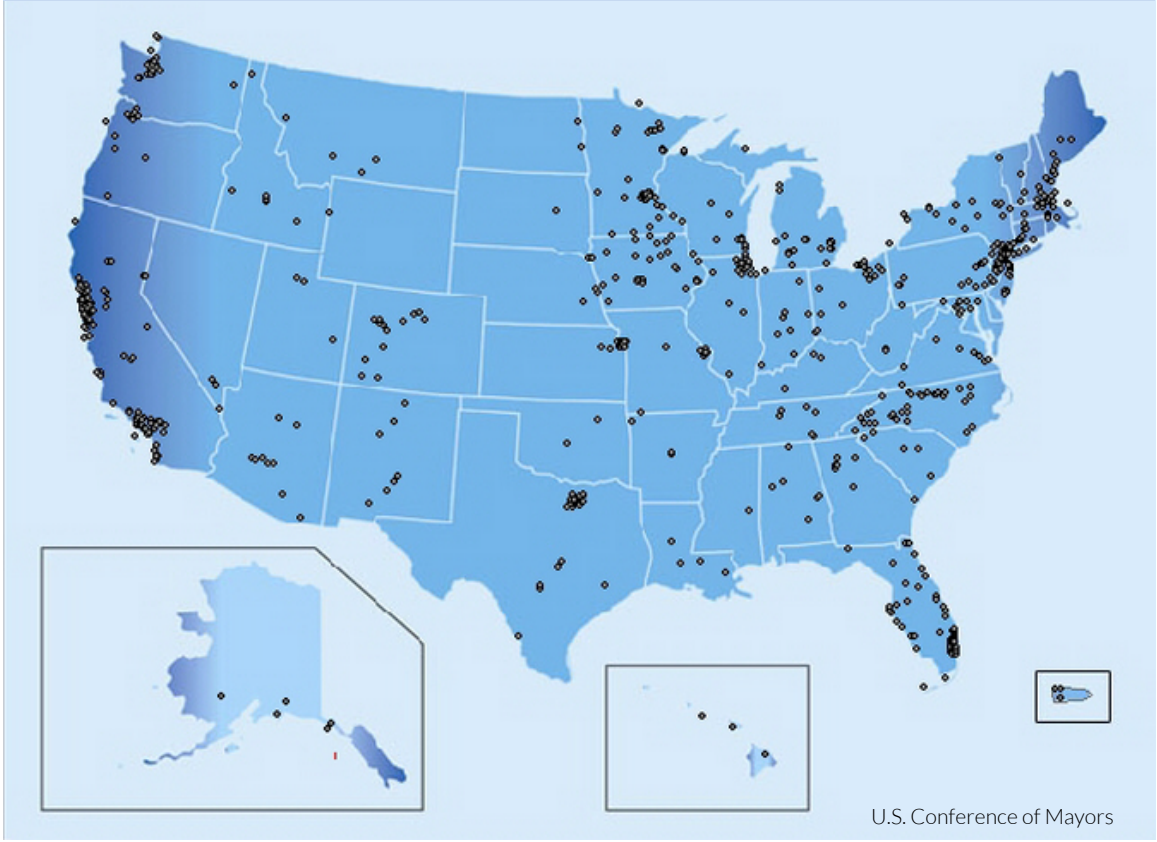
Solar building standards offer a means to extend the success of state RPS policies. RPSs are limited to specific target levels of renewable energy, and because most states are already on track to meet those targets, RPSs are beginning to have limited influence on further development. However, solar building standards have no such limitation. Instead, solar building standards allow renewable energy to keep pace with construction. Solar building standards thus offer an opportunity to help satisfy a growing energy demand with carbon-free energy on a continuous basis. Moreover, solar building standards complement RPS policies. While RPSs generally favor utility-scale development (except where states have distributed generation carve-outs), solar building standards promote distributed generation. Thus, solar building standards offer a way for local governments to build on the proven success of state Renewable Portfolio Standards.

C. SOLAR BUILDING STANDARDS EXEMPLIFY STRONG LOCAL ACTION TO CURB CLIMATE CHANGE

Local governments have promised significant action to combat climate change. For example, although the United States did not ratify the Kyoto Protocol to limit greenhouse gas emissions,[91] the U.S. Conference of Mayors created a Climate Protection Agreement that, among other promises, commits signatories to achieve the treaty's goals.[92] Since its creation, more than 1,000 mayors have signed on to the Climate Protection Agreement.[93] The widespread adoption of this agreement illustrates how cumulative local action may have significant global impact.

In June 2014, the U.S. Conference of Mayors adopted a series of resolutions noting that climate change mitigation and adaptation requires emergency action and embracing distributed generation as an effective strategy.[94] The resolutions provide some important background information, such as the fact that "commercial, residential and public buildings are responsible for more than 40 percent of the nation's energy consumption and greenhouse gas emissions and cities are best suited to improve and enforce building codes [and]

More than 1,000 cities have signed onto the U.S. Conference of Mayors' Climate Protection Agreement.



U.S. Conference of Mayors

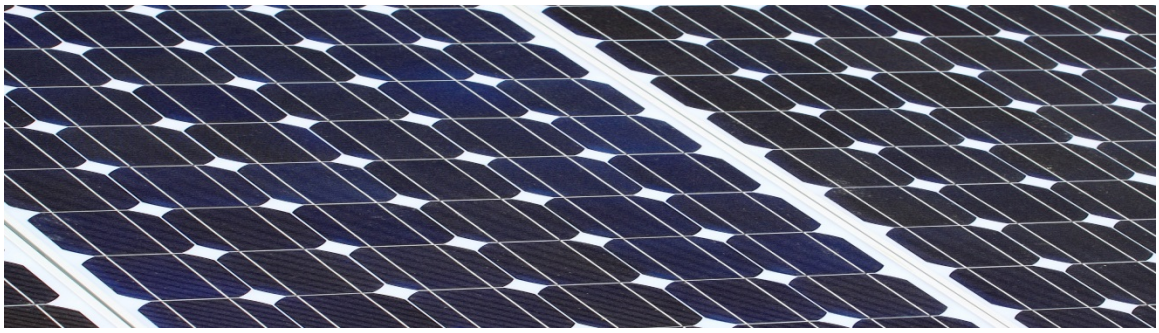
foster … distributed generation."[95] The resolutions call for the federal government and the states to support local governments in these efforts, both financially and with policies.[96]

The recent pledges from the U.S. Conference of Mayors include a resolution about "distributed generation and decentralized energy creation/distribution."[97] This resolution is replete with findings of the value of distributed generation, such as the recognition that "local deployment of distributed resources helps mitigate three drivers of higher power costs: transmission and distribution upgrades, fuel costs, and air emissions compliance."[98] The resolution further notes various benefits that this report explains more fully below, such as the fact that "a decentralized system of many dispersed generating units becomes more resilient, able to recover more readily from natural disasters or malicious attacks."[99] In short, the resolution recognizes broad benefits from distributed generation and "recognizes distributed generation as a viable means of providing reliable energy."[100]

However, the resolution by the U.S. Conference of Mayors stops short of committing cities to actually install distributed generation or to promote it with any particular policy. Instead, the resolution merely "supports the use of distributed generation … and urges cities to evaluate existing infrastructure and power supply chains to identify areas in need of improvement and prioritize the system's most pressing concerns."[101] In other words, the resolution does not commit cities to act, much less require the ambitious action of enacting solar building standards.

Nevertheless, a recent survey of 288 cities by the U.S. Conference of Mayors reveals that solar power is a priority for many cities.[102] 54% of surveyed cities said that solar power was the most promising technology for reducing energy use and carbon emissions.[103] 47% reported that they had already begun to deploy solar power.[104] And 19% reported that solar power would be their top priority in the next two years, making it the second most popular policy behind energy-efficient lighting.[105] This survey reveals that a significant number of cities regard solar power as a high priority.

Still, Lancaster and Sebastopol remain leaders for having adopted solar building standards. Only 26% of cities report that improving building energy codes is a priority,[106] suggesting that relatively few cities are currently moving to adopt solar building standards like those in Lancaster and Sebastopol. However, the growing recognition among local governments of the urgency of climate change and the benefits of distributed generation suggest that more cities may be willing to consider solar building standards.



D. SOLAR BUILDING STANDARDS OFFER A MECHANISM FOR COMPLIANCE WITH THE CLEAN POWER PLAN

The forthcoming Clean Power Plan offers another reason that solar building standards may become more common in coming years. The Clean Power Plan, a new rule proposed by the U.S. Environmental Protection Agency (EPA) under Section 111(d) of the Clean Air Act, will likely impose significant limitations on carbon emissions from existing power plants.[107] The Clean Power Plan's most ambitious feature is its "outside the fence" approach.[108] This approach proposes to allow states to comply by reducing overall carbon emissions from the electricity sector, rather than requiring compliance only through emissions-control technologies within fossil fuel-fired power plants.[109] This "outside the fence" approach would provide states with flexibility to create plans that reduce overall energy use and replace fossil fuels with renewable energy.[110] Because developing renewable energy may be less costly than installing pollution control technology at existing fossil fuel-fired power plants, many states may take this opportunity.

Although the legality of the Clean Power Plan's "outside the fence" approach is uncertain,[111] if the final rule resembles the proposed rule and is upheld in court, states will likely seek innovative ways to comply. Local solar building standards offer exactly the type of innovative solution that states may need. By significantly increasing installations of distributed solar power, solar building standards reduce demand for carbon-intensive power, helping states reduce carbon emissions and comply with the Clean Power Plan. The Clean Power Plan may also motivate states to implement policies that will help local governments adopt and implement solar building standards.

E. SOLAR BUILDING STANDARDS WILL REDUCE SOFT COSTS

Developing cost-competitive solar power by 2020 is a priority for the U.S. Department of Energy. The SunShot Initiative aims to achieve this goal by reducing the installed price of solar power to roughly six cents per kilowatt hour ($0.06/kWh), or one dollar per watt ($1/W).[112] Hardware costs are already declining swiftly, but the remaining non-hardware, or "soft," costs are not declining as swiftly.[113] Soft costs include customer acquisition, financing, permitting, inspections, interconnection fees, taxes, installation, and maintenance. Currently, soft costs can account for nearly two-thirds of the end price of solar power.[114] As such, reducing soft costs is a priority for the United States as a whole and for many states and cities as well. Solar building standards can help reduce every category of soft costs, as this report explores more fully below.

Solar building standards can simultaneously reduce costs and offer states tools to comply with new environmental regulations.

F. SOLAR BUILDING STANDARDS WILL BENEFIT FROM EXISTING POLICIES IN THE SHORT TERM, BUT MAY REDUCE LONG-TERM NEED FOR SUBSIDIES.

In the short term, solar building standards will likely be most successful in jurisdictions that already have robust policy frameworks that have been proven to drive thriving solar markets. The National Renewable Energy Laboratory (NREL) recently issued a report analyzing which policies have enabled the growth of the largest state solar markets.[115] NREL found that the falling price of solar power had an uneven effect among states, suggesting that "solar development depends, at least to some extent, on other policy and contextual factors."[116] More specifically, NREL found that net metering and streamlined interconnection policies are "foundational for distributed generation market growth."[117]

Solar building standards will be most effective if policies promote swift connection to the power grid.

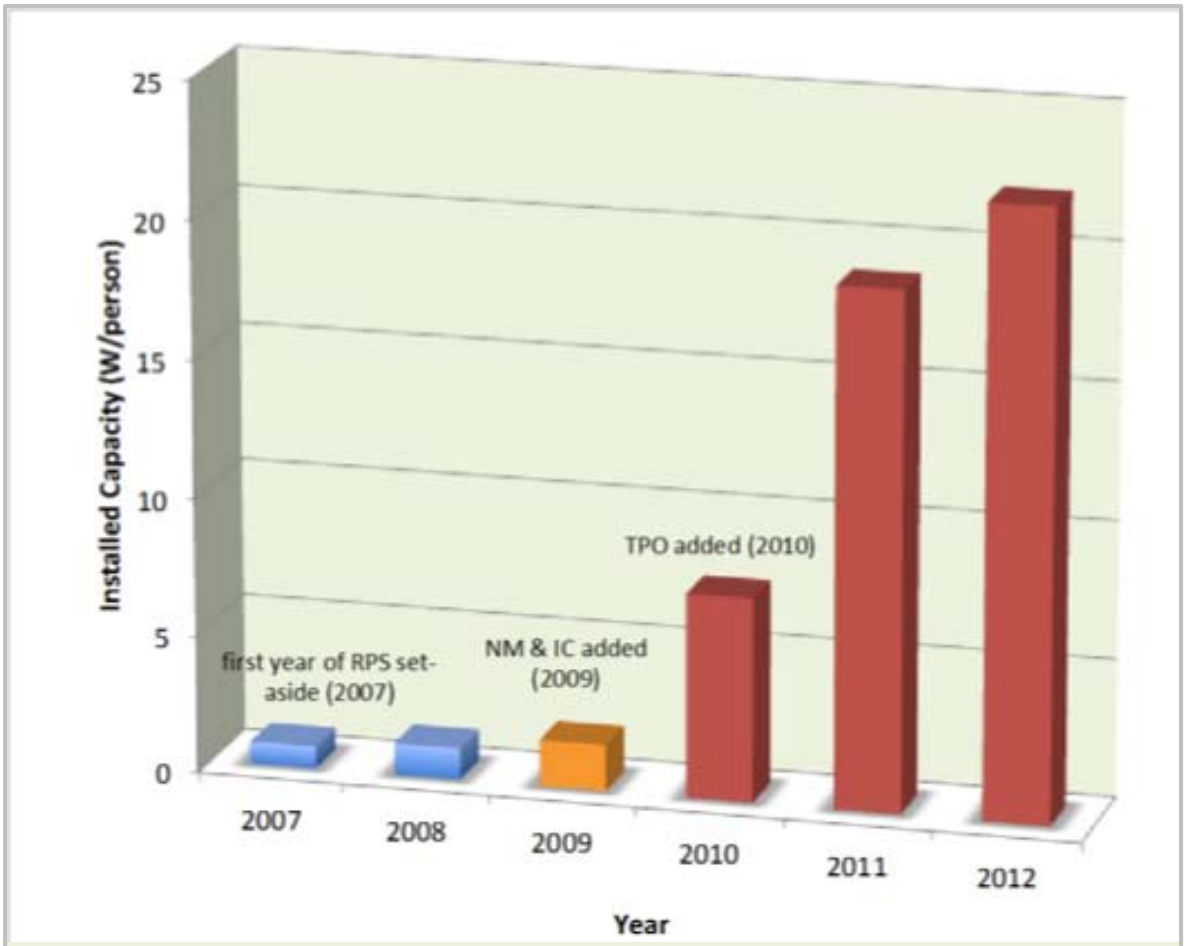
Similarly, NREL found that policies enabling third-party ownership and leasing of solar arrays can significantly boost solar markets.[118] However, NREL stressed the importance of the foundational policies of net metering and streamlined interconnection, noting that third-party leasing is "far less effective in spurring market development" where these policies are lacking.[119]

NREL also evaluated the impact of solar carve-outs in Renewable Portfolio Standards, finding that they are most effective at driving solar markets when they build on the foundational policies of net metering and streamlined interconnection.[120] In states that add either a solar carve-out or third-party leasing to these foundational policies, "installed capacity generally increases rapidly."[121] However, "[s]tates without the foundational policies do not typically see such increases."[122]

In the short term, solar building standards will likely prove most effective in jurisdictions that feature the foundational policies that NREL described. Strong interconnection policies will be essential; a solar building standard will be far less successful if the resulting solar arrays cannot easily connect to the electricity grid. Similarly, robust net metering policies will likely make solar building standards more politically popular, and thus more successful, by increasing the financial productivity of solar arrays. Third-party ownership, meanwhile, could facilitate the success of a solar building standard by enabling the installation of solar arrays at no upfront cost to property owners.

Solar building standards are akin to solar carve-outs in Renewable Portfolio Standards in that both policies reflect government requirements for the development of solar power. NREL described how a solar carve-out in Washington, D.C.'s RPS became increasingly effective once net metering, interconnection, and third-party leasing policies were adopted.[123] Similarly, where these foundational policies are in place, solar building standards will likely be more effective, for the reasons described above.

However, in the long term, solar building standards will likely reduce the costs of installing solar power, as described in detail below. In the long term, these cost reductions may reduce the industry's reliance on existing subsidies for solar power. Robust interconnection policies will likely remain essential, but as costs decline solar power will become increasingly cost-competitive in its own right. Once installation costs decline to the point of unsubsidized competition with other energy sources, financial incentives for solar power may no longer be necessary.



National Renewable Energy Laboratory, *The Effect of State Policy Suites on the Development of Solar Markets*, at 8.

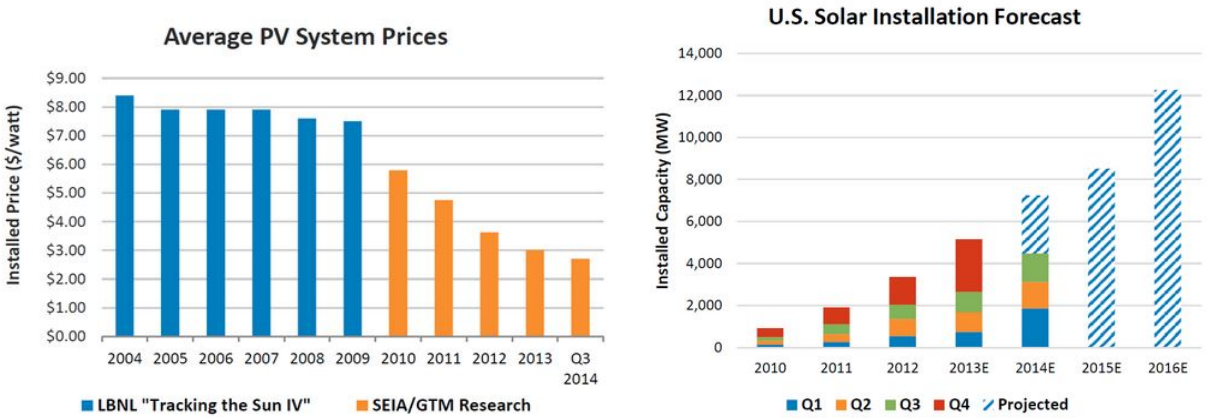
Washington, D.C.'s Renewable Portfolio Standard became much more effective after passage of fundamental policies of net metering and third-party leasing.

IV. IMPACTS OF SOLAR BUILDING STANDARDS

Well-designed solar building standards likely offer benefits to property owners, local governments, the solar industry, the electricity grid, and ultimately the global climate. However, if designed carelessly, solar building standards could also have negative impacts, such as erosion of utility profits or increased difficulty of grid management. This section explores potential impacts of solar building standards on various energy market stakeholders.

Some of the impacts described below are clear and proven. For example, solar-powered homes enjoy lower, more stable power bills than exclusively grid-powered homes.[124] Moreover, as the cost of solar power continues its swift decline, the pace of rooftop solar deployment is accelerating remarkably.[125] In fact, the U.S. solar industry has broken records for each of the last five years.[126] Nevertheless, solar power still meets only a very small portion of U.S. energy demand. Even in Hawaii, which has the most solar power per capita, only 12% of single-family homes use solar power.[127] Nationwide, solar power produces only 0.25% of U.S. energy.[128] Against this backdrop, solar building standards make sense as a way for local governments to promote increasingly cost-effective solar power.

Other likely impacts described below have yet to be empirically proven. For example, this paper describes likely impacts on some contentious issues, such as of net metering's effect on lower-income ratepayers or the effect of high levels of distributed generation on utility profits. Similarly, neither Lancaster nor Sebastopol has attempted to rigorously track or evaluate the policy's impacts on the solar market, which makes it difficult to quantify likely cost reductions.[129] Nevertheless, there are good reasons to believe that the impacts described below will manifest from adoption of solar building standards.



Source: Solar Energy Industries Association and GreenTech Media.

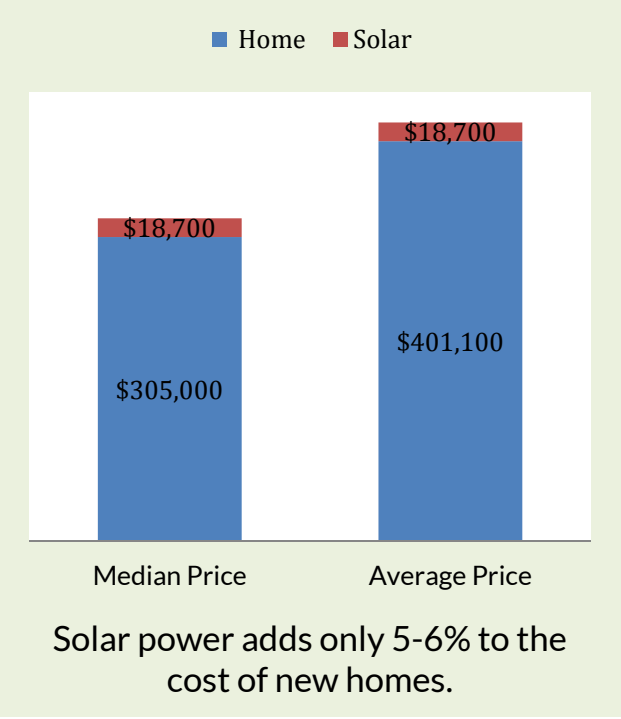
As solar prices continue to plunge, solar installations are on the rise.

A. IMPACTS ON PROPERTY OWNERS

Solar building standards will have their most conspicuous impacts on the builders and owners of new or renovated buildings. Requiring installation of solar power will increase construction costs but will also increase property values. Additionally, the cost of installing solar power during construction will likely prove significantly lower than the cost of installing solar panels later. Furthermore, the owners of solar-powered buildings will enjoy lower, more stable electricity bills.

1. Increased Construction Costs and Reduced Installation Costs

Installing solar power may increase the price of constructing or renovating buildings that would otherwise not have solar power facilities, although installing solar during construction is significantly less costly than installing solar on completed structures. New homes offer an easy example. According to the Solar Energy Industries Association, in the second quarter of 2014, the average price of a residential solar array was $3.74 per watt.[130] (This figure is likely high, because it includes data from post-construction projects.) Thus, a 5 kilowatt system would cost $18,700. According to the U.S. census, in October 2014, the median price of a new home was $305,000, and the average price was $401,100.[131] Thus, installing solar when building a new home could increase the median cost by 6.1% and increase the average cost by 4.7%.



However, these figures do not account for cost-savings from integrating solar into larger construction projects. For example, NREL reports that solar projects during new construction are less expensive by $0.75/W.[132] Installing solar during larger renovation projects may incur similar cost reductions from streamlined permitting and inspection. Thus, solar building standards may significantly reduce the overall costs of solar installation.

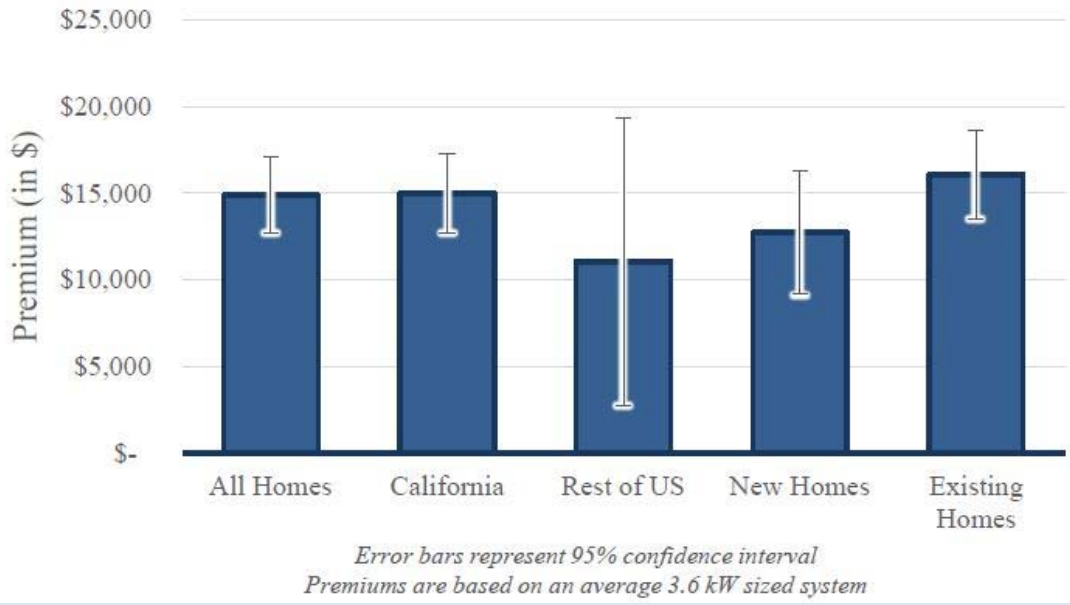
Furthermore, neither builders nor buyers of buildings would necessarily pay full prices. The federal Investment Tax Credit is worth 30% of a solar array's cost, and even if Congress allows it to dwindle in 2017, it will still be worth 10% of a solar array's cost.[133] Many states also have tax credits or rebates that will drive down costs even further.[134] Thus, in most states, the added cost is likely to be less than that calculated above. Moreover, in some states, builders and buyers may avoid upfront costs altogether. If a solar building standard enabled third-parties or utilities to own solar arrays, then the lessor or utility would bear the installation costs.

2. Increased Property Values

Solar building standards would increase property values. Homes with solar power sell more quickly and for more money. A 2013 study by Lawrence Berkeley National Laboratory (LBNL) of home sales in California showed that each kilowatt of rooftop solar capacity led to an average premium of $5,911, although the premium diminished as PV systems aged.[135] A similar study from Colorado found a smaller premium of $1,400 to $2,600 per kilowatt of solar capacity, but strongly reinforced the conclusion that solar power "almost always" helps homes sell more quickly.[136] A study by LBNL from January 2015 is the most comprehensive, analyzing data from eight states from 2002 through 2013.[137] That study found an average premium for solar homes of $4/W, or $15,000 for a 3.6kW system.[138]

Notably, if these figures apply to other jurisdictions, solar building standards could increase property values by as much as—or more than—the price of installing solar panels. As described above, a 5kW solar array now costs $18,700. The premium in California, following LBNL's 2015 figures, would be $20,000. However, the premium according to Colorado's figures would only be as great as $13,000. Still, even that lower premium would significantly defray initial installation costs.

Moreover, solar power can often increase property values and boost home sales without incurring increased property tax liability. Most states exempt renewable energy facilities from property taxes,[139] which generally means that consumers who install solar power enjoy higher property values without the burden of higher property taxes.



LBNL, *Selling Into the Sun: Price-Premium Analysis of a Multi-State Dataset of Solar Homes*, at 30.

Solar arrays add more than $10,000 to the resale value of homes.

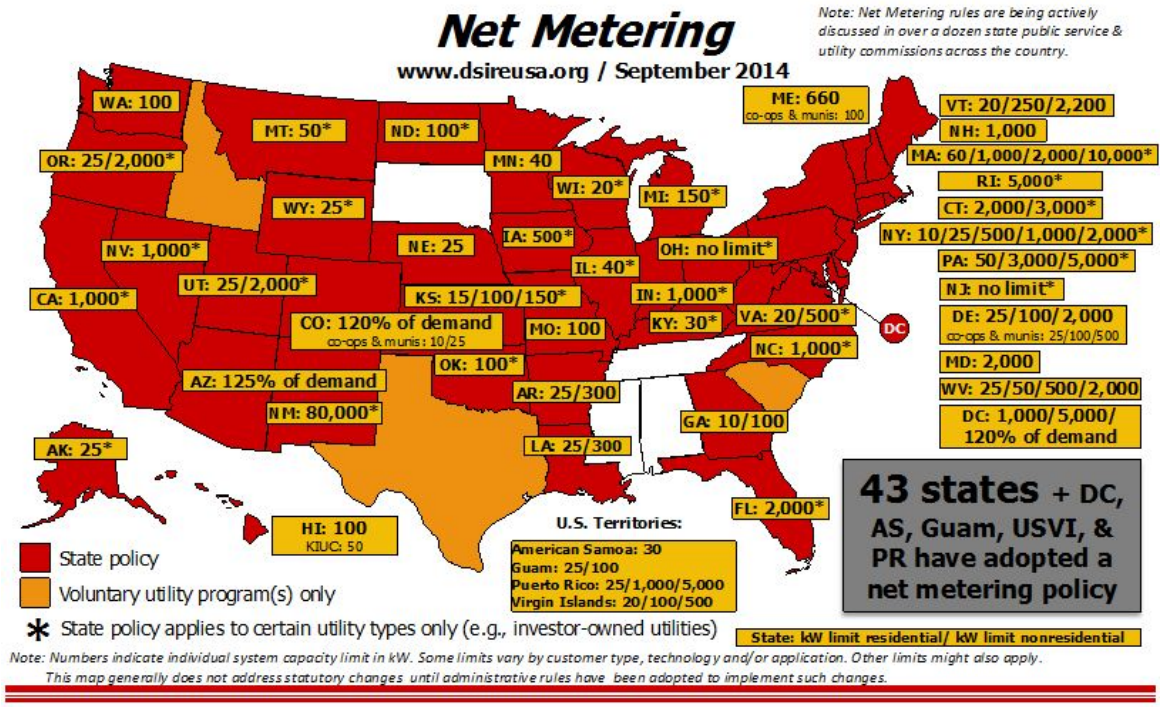
3. Lower Power Bills

Solar building standards would likely reduce power bills in two significant ways. First, most installations under a solar building standard would likely be net metered, allowing property owners to earn bill credits for the energy they generate. And second, by providing power locally and cooling urban heat islands, solar building standards would reduce overall energy demand.

a. Bill Credits

Solar building standards should lower power bills for properties they apply to. Buildings with solar arrays have lower electricity bills due to on-site energy generation. In most states, net metering policies give consumers with distributed solar arrays monthly bill credits for power they generate.[140] NREL describes net metering as a "foundational" policy for thriving solar markets.[141] Net metering is present in 44 states (see map[142]); in 2013, 95% of distributed solar installations took advantage of net metering policies.[143]

In most jurisdictions, monthly bill credits can offset increased energy usage in less-sunny months.[144] Net metering sometimes allows solar consumers to avoid utility bills altogether by earning bill credits that offset all their energy use.[145] Even in the few jurisdictions that lack net metering, or where consumers opt out of net metering programs, distributed solar arrays may still reduce energy use and thus lower energy bills. Solar building standards would allow more consumers to enjoy lower energy bills.



dsire.org

Most states feature net metering policies, although details differ.

NET METERING UNDER ATTACK:

Perhaps because net metering has very successfully driven solar development, it has recently come under fire from utilities in several states. Utilities argue net metering is unfair in two chief ways. First, by allowing some customers to avoid electricity bills altogether, net metering arguably allows solar customers who still use the grid to avoid paying for its management.[146] Second, utilities argue that the result of net-metered customers not paying for grid management is that those costs become concentrated on lower-income ratepayers, those who could not afford to install their own solar arrays.[147]

The merits of this argument are a matter of debate. For example, Crossborder Energy analyzed the costs and benefits of distributed generation in Arizona and found that "benefits exceed the costs by more than 50%."[148] Crossborder concluded that "new DG resources will not impose a burden on [the local utility's] ratepayers."[149] On the other side of the debate, the American Legislative Exchange Council argues that "net metering policies are doubly regressive," but does not itself quantify the allegedly regressive impacts.[150]

To resolve these alleged problems, utilities have proposed increasing the fixed charges for all ratepayers, as well as imposing new charges on solar customers.[151] Perhaps because the debate's merits are unclear, results have been mixed in various states. In November 2013, the Arizona Corporation Commission approved a charge of 70 cents per kilowatt of capacity, or roughly $5 per month for an average solar array, for net-metered utility customers.[152] Roughly a year later, the Wisconsin Public Service Commission approved an increased fixed charge for all customers and a reduction in net metering payments.[153] Also in 2014, Massachusetts approved a new minimum-billing system for net-metered customers, allowing bill credits to reduce energy bills only to a certain level.[154] Minnesota responded by allowing utilities to offer a "value of solar tariff" instead of net metering payments, but the new tariff is actually higher than the net metering rate.[155]

The net metering debate may prove important to the value of solar building standards. Solar building standards are likely to be more popular in areas with strong net metering policies, because these policies increase the financial benefit from solar arrays. Conversely, solar building standards may also be important to the net metering debate. Solar building standards could mitigate concerns about shifting costs to lower-income communities by requiring the installation of solar power in lower-income areas. However, if solar building standards simply focus on new single-family homes, they could exacerbate any cost-shifting by further concentrating solar power in more affluent communities. Local governments should be sure to consider these issues as they design solar building standards.

b. Reduced Energy Demand

Solar building standards will also likely reduce energy bills by mitigating air conditioning costs and cooling urban heat islands. Currently, air conditioning constitutes 8% of overall U.S. energy demand and costs consumers roughly $15 billion annually.[156] This energy use is especially pronounced in cities, due to an effect known as the urban heat island. According to the EPA, cities with over a million residents can be between 1.8 and 5.4 degrees warmer than surrounding rural areas during the day.[157] Because cities retain more heat than rural areas, urban heat islands are more pronounced at night, with cities being as much as 22 degrees warmer.[158] Urban heat islands increase summer peak energy demand and inflate air conditioning costs.[159]

Solar building standards can mitigate urban heat islands in two ways. Most obviously, solar building standards would increase the concentration of rooftop solar arrays, which generate low-cost energy at peak hours for air conditioning. Less intuitively, rooftop solar panels actually cool cities. A recent study in Paris found that "reasonably high" solar deployment could reduce the demand for air conditioning by 12%.[160] In the United States, 87% of households have air conditioning systems.[161] Both by reducing urban heat islands and by generating energy at the time when most air conditioners are running, solar building standards could help defray the significant costs associated with air conditioning for the vast majority of American homes.

4. More Stable Electricity Rates

In addition to lowering electricity bills, solar building standards could stabilize them as well. The dominant business model for distributed solar power is third-party leasing.[162] Led by companies such as SolarCity and SunRun, third-party leasing allows building owners to enjoy rooftop solar power at no up-front cost, with the lessor owning the array.[163] Customers engage in a long-term contract to buy solar power from their own roofs at rates below those charged by utilities.[164] Because prices under these contracts are fixed for long periods, while utility electricity rates rise regularly, customers in third-party leasing arrangements pay more stable, long-term electricity rates.[165] The National Renewable Energy Laboratory reports that third-party ownership can be a very effective driver of thriving solar markets.[166]

Solar building standards could easily take advantage of third-party leasing by allowing either a builder or buyer to enter into a contract with a third-party lessor. This arrangement could provide solar installations at no up-front cost to buyers or developers; in short, this arrangement could attain the benefits of a solar building standard without increasing the costs of new buildings.

Additionally, solar building standards could stabilize utility bills even in jurisdictions without third-party leasing. Unlike fossil fuel-fired generating assets, solar panels require no fuel and thus generate energy at a fixed cost. By increasing the share of fixed-cost generating assets in a utility's portfolio, solar building standards could provide greater stability for utility bills.

5. Expanded Access to Solar Power

Finally, solar building standards could expand access to solar power for lower-income communities and tenants, two groups that have historically been unable to take advantage of solar power. Generally, lower-income households have not installed solar power because they either cannot afford their own solar arrays or lack the credit ratings necessary to attract a third-party lease.[167] Tenants have not been able to adopt solar power because they lack an incentive to finance improvements of property they do not own, while landlords lack incentive because they do not pay for the power their tenants consume. So far, the main consumers of solar power have been middle-class homeowners who are sufficiently wealthy to afford high up-front costs or sufficiently credit-worthy to enter into a third-party lease.[168]

However, a solar building standard that required solar power on all new or renovated buildings would by necessity include multi-family housing and affordable housing. By doing so, a solar building standard would guarantee that tenants and lower-income communities would begin to enjoy the benefits of solar power. Expanded access to solar power is especially good policy because tenants and lower-income communities are the demographics most in need of the lower, fixed power prices that solar building standards can provide. As described above, jurisdictions can design solar building standards to facilitate this progress by providing subsidies for projects on multi-family housing or in lower-income areas paid for by in-lieu fees from projects in wealthier areas.

Virtual Net Metering Enables Tenants to Enjoy Solar Power

Virtual net metering is a policy that allows multiple consumers to receive bill credits from a shared solar array.[169] This policy can allow tenants to share the benefits of solar power generated from a common array on the roof of a multi-family residential building. Virtual net metering has prompted some developers of multi-family buildings to install solar power: "When [virtual net metering] became available, we jumped right in," said one San Diego developer.[170] Currently, virtual net metering exists in 11 states.[171] Solar building standards will be most successful at spreading solar power to historically underserved communities in areas with virtual net metering.

Virtual net metering can expand solar power to multi-family housing.

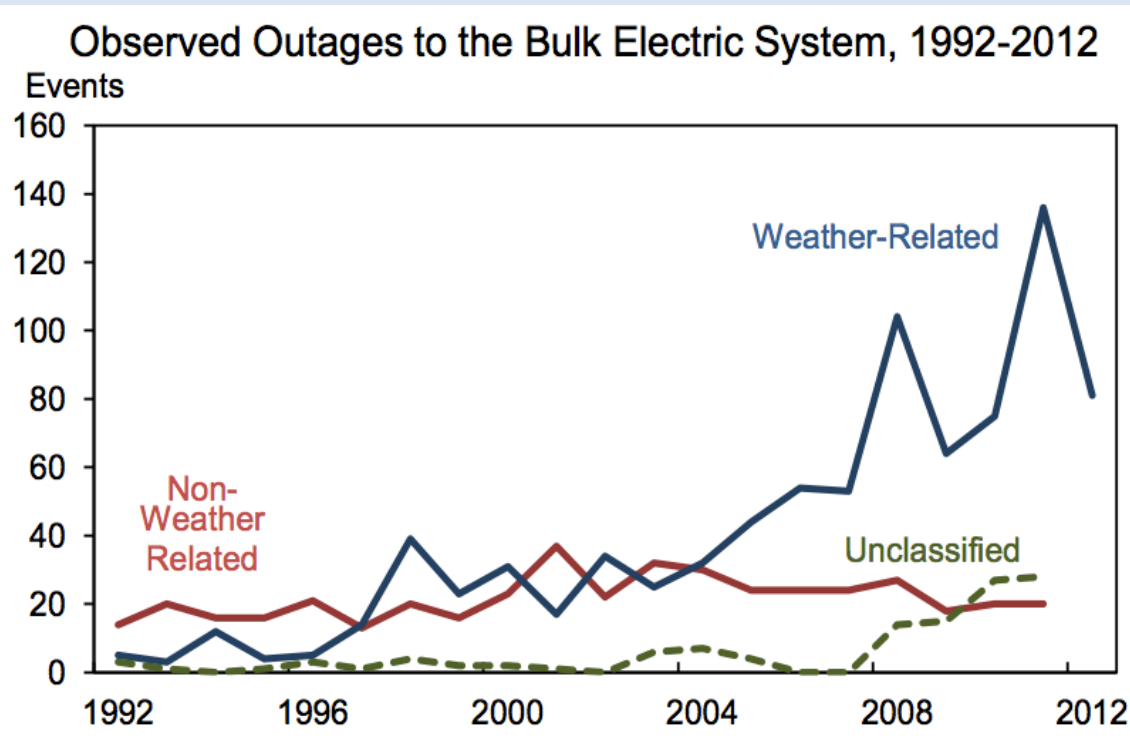
B. IMPACTS ON LOCAL GOVERNMENTS

Solar building standards should benefit local governments by improving the resiliency of the power grid and helping to prepare for natural disasters. Moreover, solar building standards operate at low cost to local governments. Finally, solar building standards also provide an opportunity and motivation for local governments to engage with states in comprehensive planning to minimize costs and maximize benefits from solar power.

1. Resilience and Disaster Preparedness

Power outages are increasingly common and severe. A 2013 white paper prepared by the President's Council of Economic Advisers reports that power outages cost the United States an average of $18 billion to $33 billion each year.[172] The Congressional Research Service reports similar findings, with average annual costs of power outages ranging from $27 billion to $70 billion.[173] The leading cause of power outages is severe weather.[174] Both severe weather and resulting power outages are occurring with greater regularity.[175]

Although power outages have aggregate economic consequences that trouble the entire U.S. economy, outages wreak their havoc locally. By disrupting power to hospitals, 911 call centers, fire stations, and other critical facilities, outages can prevent local governments from providing essential services during emergencies.[176] And while many critical facilities are equipped with backup diesel generators, those generators often fail, either because they rely on



The White House, *Economic Benefits of Increasing Electric Grid Resilience to Weather Outages*, at 8.

Power outages from severe weather are increasingly common.

deliveries of fuel that are cut off during disasters or because they are poorly maintained.[177] The Clean Energy Group reports that during Hurricane Sandy, more than 60% of diesel generators failed, "leading to loss of life, hospital evacuations, and billions in damages."[178] Moreover, lower-income communities tend to be harmed most severely by power outages; the damages tend to fall on those who can least afford them.[179]

Solar power offers a good way to prepare for natural disasters and mitigate their impacts. For example, power outages from Hurricane Sandy affected 8.5 million people and even led to 50 deaths,[180] but solar arrays weathered the storm admirably.[181] Mobile solar generators even helped some residents recover from the storm's aftermath.[182] However, most solar facilities—even though undamaged by the hurricane—had to shut off during outages to protect utility workers from potential electrocution.[183]

But that was 2012. Today, inverter technology has progressed to the point that solar panels can produce emergency power even when the grid is down.[184] Similarly, batteries have become more affordable, allowing storage-equipped solar arrays to operate during outages. This new technology enables distributed solar arrays to provide reliable sources of power during emergencies.

Solar Power Could Help Prepare the Pacific Northwest for Strong Earthquakes

The Cascadia fault off the shore of the Pacific Northwest produces very strong earthquakes. Experts warn that an earthquake of magnitude 9.0 or greater is "inevitable," but the timing is difficult to predict.[185] Such a large earthquake would likely disrupt essential services, including the electricity grid. However, experts also predict that newer buildings will lose utility services but will not collapse.[186] Solar building standards can help the region prepare for these inevitable, devastating earthquakes by guaranteeing that new buildings, those least likely to collapse, host solar power capable of providing emergency electrical service. Governments in the Pacific Northwest should strongly consider solar building standards.

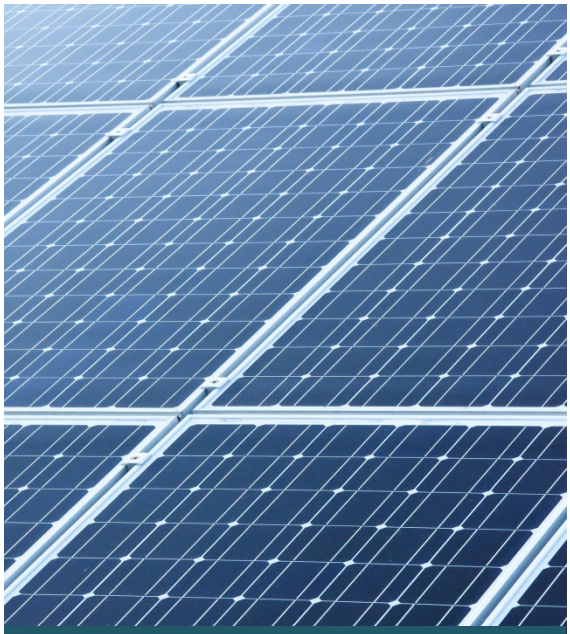
Solar building standards can help prepare communities for natural disasters by fostering resilient backup power. Solar building standards should require arrays to include inverters capable of providing power during grid outages. Solar building standards should also require essential buildings, such as hospitals, to include batteries to store solar power for emergencies. These measures could substantially reduce impacts from severe weather and power outages. Local governments, especially in disaster-prone areas, should give solar building standards strong consideration.

2. Low Cost to Local Government

Local governments should also consider that solar building standards will likely operate at little cost to local government.[187] By incorporating solar power into the standard procedure for issuing building permits, solar building standards may streamline the permitting process. In contrast to jurisdictions where solar power requires several permits, a building standard that incorporates solar permits into the building permit itself will likely face lower overall costs. The same trend should prove true for inspections, suggesting that solar building standards will not impose significant administrative costs on local governments.

3. Opportunity for Comprehensive Solar Policy Development

Enacting a solar building standard also offers local governments an opportunity to help create comprehensive policies to enable solar development with the greatest capacity and least cost. Local governments should take this opportunity to engage with states to implement certain policies that are crucial to thriving solar markets, including solar access laws, third-party leasing, net metering, and virtual net metering.



Cities and states should work together to craft and implement supportive policies.

Solar access laws are a critical part of any comprehensive solar development policy. Solar access laws seek to guarantee that existing solar panels will have continuous access to necessary sunlight without being shaded by subsequent development. Some jurisdictions, such as Portland, Oregon, have already developed solar access rules other jurisdictions can look to for guidance.[188] Additionally, solar access laws have been the topic of a great deal of scholarly work.[189] Strong solar access rules will likely be a critical underpinning of the most effective solar building standards; without a guarantee of ongoing solar access, installing solar power on new buildings is a risky investment. Fortunately, the body of existing solar access laws and scholarship on the subject should make it fairly easy for a jurisdiction to incorporate these rules into a solar building standard.

Solar building standards also create a motive for local governments to engage with states to enable third-party leasing. As discussed above, third-party leasing is now the dominant business model for distributed solar installations, but major third-party lessors operate only in a limited number of states.[190] Policies that enable third-party leasing include net metering, tax credits, and viable markets for renewable energy credits. Although many of these policies are beyond the control of local governments, the adoption of solar building standards at the local level may make it more likely that states will open their markets to third-party lessors that can accomplish a standard's objectives at no upfront cost to consumers.

Similarly, solar building standards may motivate local governments to engage with state governments to adopt virtual net metering policies. Virtual net metering, which currently exists in only a few states, allows a group of consumers to share bill credits from a larger solar array. This policy is likely essential for the success of a solar building standard that applies to multi-family housing; without virtual net metering, it is difficult for tenants to share the benefits of a common rooftop array. The adoption of local solar building standards may motivate states to address these issues by enacting policies that enable local standards to function well.

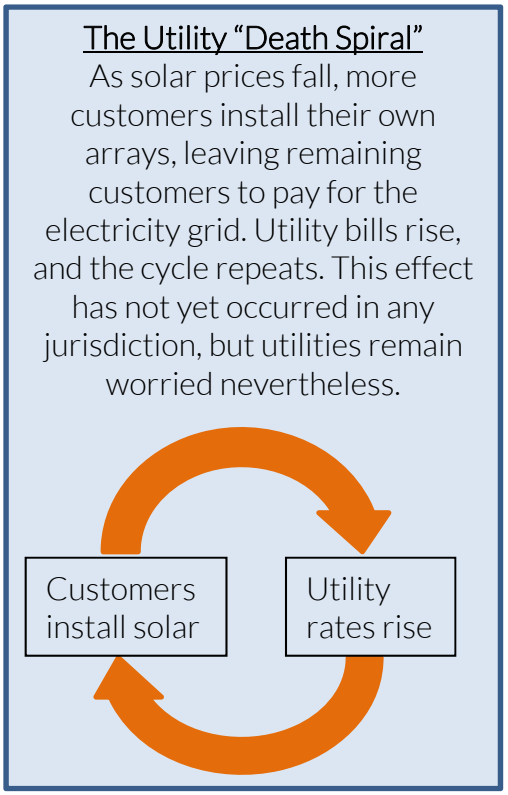
C. IMPACTS ON UTILITIES AND THE ELECTRICITY GRID

Solar building standards may have significant impacts on utilities and the electricity grid. Depending on their design, solar building standards could undermine utility profits or help utilities transition to new business models that better accommodate renewable energy. Similarly, depending on their design, solar building standards could either create difficulties for the electricity grid or could help make it more efficient and reliable. Local governments should consider these issues closely as they design solar building standards.

1. Depending On Design, Solar Building Standards May Harm Or Help Utilities.

Although distributed solar power currently meets only a minuscule portion of U.S. energy demand, electric utilities are already quite concerned about the potential threat that solar power poses to their bottom lines. For example, a 2013 report from the Edison Electric Institute, the trade organization for electric utilities, characterized solar power as a "disruptive threat" to traditional electric utility business models.[191] That report cautioned that distributed solar power could pose the same kind of challenge for utilities that cell phones posed for copper-wire telephone companies.[192] The utilities' basic fear is that decreasing costs of solar power and increasing utility bills will drive ever-greater deployment of distributed solar, reducing customer numbers and threatening utilities' bottom lines.

Whether solar power will actually disrupt utilities is open to debate. One pundit opines that high credit ratings for utilities suggest that they are not facing a serious threat.[193] Another notes that famed investor Warren Buffett is looking for opportunities to buy more utilities, suggesting that they continue to be a good investment.[194] The American Council for an Energy Efficient Economy notes that the threats to utilities largely result from ratemaking policies and can thus be solved by regulatory reforms.[195] On the other hand, the experiences of European utilities, some of which declined very substantially in value as penetrations of renewable energy have increased,[196] suggest that utilities may have some valid concerns.



LBNL issued a rigorous report on the financial impacts of solar power on electric utilities in September 2014.[197] That study

examined scenarios in which solar power accounted for 2.5% or 10% of total retail electricity sales. The 2.5% scenario mirrors deployment levels in utility jurisdictions with the greatest solar penetration (excluding Hawaii, a special case), while the 10% scenario far exceeds current deployment. The study quantified impacts of these levels of solar deployment on two model utilities: one vertically integrated utility typical of the Southwest; and one "wire-only" utility typical of the Northeast (which owns only the distribution grid, and not the transmission grid or generation assets).[198]

The study found that while ratepayer impacts would be modest—raising electricity rates by less than 3%—impacts on utility earnings and shareholders could be severe. For example, increased solar deployment could reduce both model utilities' returns on equity by between 8% and 15%.[199] More dramatically, 10% solar deployment could reduce the Northeastern model utility's earnings by up to 41%,[200] an outcome that resembles the current plight of some European utilities.

LBNL also examined several policy options to mitigate these utility impacts. Notably, utility ownership of even only 10% of distributed solar arrays could significantly reduce negative impacts on utility profits.[201] However, the potential impact of utility ownership is much more significant in the Northeast, where the model utility does not otherwise own generation, than in the Southwest, where the model utility does. Nevertheless, even in the Southwest, utility ownership of distributed solar arrays can offset negative impacts on utilities. Perhaps the single most important conclusion from the LBNL study is that these impacts are likely to take time, giving utilities and regulators the opportunity to adapt. According to LBNL, "utilities, policymakers, and solar stakeholders likely have sufficient time to address these concerns in a measured and deliberate manner."[202]

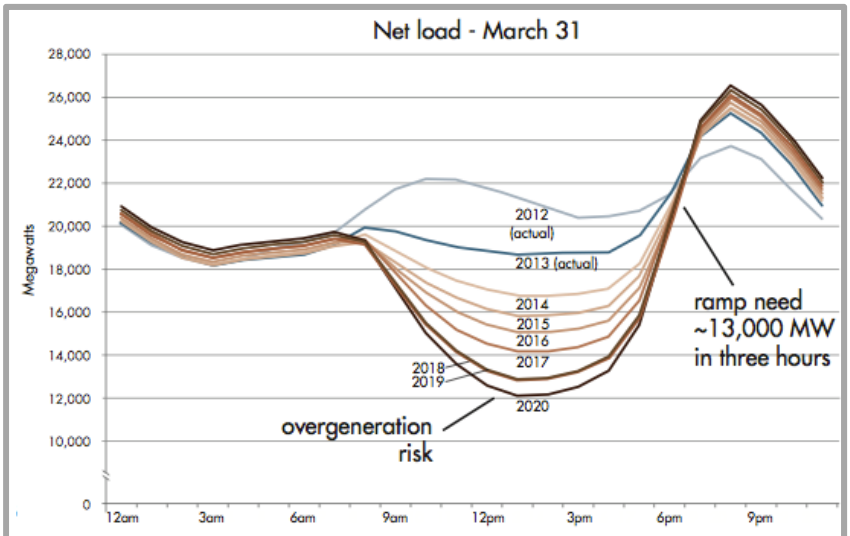
Solar building standards could either exacerbate or ameliorate the impacts of increased solar deployment on utilities. Solar building standards that allow only property owners or third-party lessors to own arrays could erode utilities' customer bases and thus negatively impact their profits and shareholders. However, solar building standards may allow utilities to own some new arrays, which would likely significantly offset any negative utility impacts. By doing so, solar building standards could help utilities develop new business models as owners and operators of distributed solar power, which could help utilities adapt to increasingly affordable and widespread solar power. However, because utilities generally require permission from state public utility commissions to own new assets, local governments may lack authority to allow utility ownership of new arrays.

When designing solar building standards, local governments should work with utilities and public utility commissions to assess the likely impacts of these new policies on utility profits and to design the proper level of utility ownership of new arrays to help mitigate those effects.

Solar building standards could help utilities develop new business models as owners and operators of distributed solar power, allowing them to thrive as providers of clean energy.

2. Solar Building Standards Could Impair or Improve Grid Management.

Solar panels produce their power at peak hours, when energy demand and energy prices are at their highest. Although this effect can be helpful to the energy grid, if solar power reduces peak demand very substantially, it can also pose challenges. For example, the California Independent System Operator (CAISO) projects that as solar power becomes more common, it could reduce peak demand to the point of over-supply—meaning that solar power will generate more energy than the grid actually needs.[203] As a result, the grid operator will need to curtail generation from other sources, either idling other power plants or shutting them off altogether.[204] Another significant challenge for grid operators could be ramping other power plants back up to meet demand as night falls and solar arrays stop generating power.[205] CAISO issued a graph of this issue, called the "duck curve" because it (vaguely) resembles a duck:

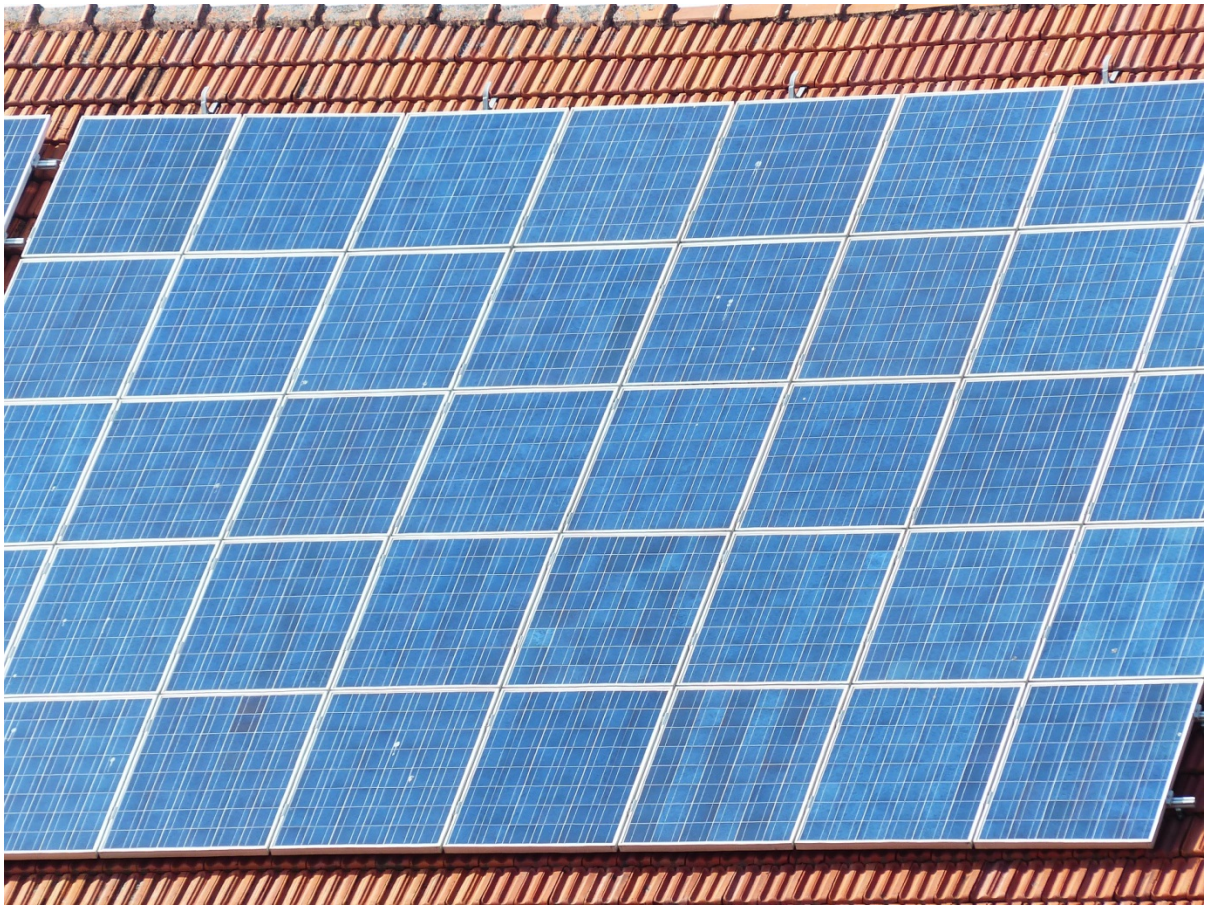


California Independent System Operator, *What the Duck Curve Tells Us About Managing a Green Grid*, at 1.

The duck curve illustrates a potential negative impact in the late-afternoon, when south-facing solar panels become less productive. Arguably, as energy demand continues and solar production ebbs, utilities may face difficulties ramping up energy production to meet demand.

The Regulatory Assistance Project (RAP) published a white paper with solutions to the duck curve's potential problems, called "*Teaching the Duck to Fly*."[206] Among RAP's strategies is a simple change: "Orient fixed-axis solar panels to the west."[207] Orienting some solar panels to face west will allow solar power to continue meeting demand later in the day.[208] The problem is that existing policies promote maximization of energy production from solar panels, which encourages south-facing arrays.

Solar building standards offer an easy solution to the problems illustrated by the duck curve. Local governments can simply require a certain percentage of new solar panels to be installed facing west. Because west-facing solar panels tend to be somewhat less productive, this percentage of installations will likely face some economic disadvantages. However, solar building standards can offset these disadvantages as well. For example, a solar building standard that requires some panels to face west could provide those projects with reduced-cost permitting and inspection, or a local property tax reduction, or another offsetting financial incentive. By doing so, a solar building standard could help remove a significant obstacle to increased solar development.



D. IMPACTS ON THE SOLAR INDUSTRY

The solar industry would very likely benefit from solar building standards. Prior experience with solar carve-outs in Renewable Portfolio Standards confirms that government requirements for solar power successfully drive solar markets. There is no reason to doubt that local solar building standards would do the same.

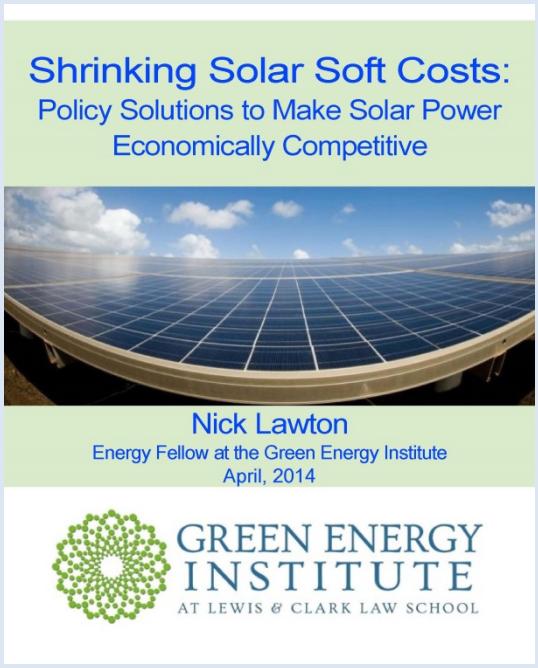
1. Stable Foundation for Market Growth

Solar building standards would provide a level of predictability and certainty that the solar industry has not yet enjoyed. Under a solar building standard, new or renovated buildings must install solar power. Thus, the solar industry could predict the likely number of installations in a given year from the foreseeable level of construction. Of course, linking the solar industry to the construction industry would also expose the solar industry to risks associated with downturns in the housing or construction market. Still, increased predictability would very likely be a significant boon for the solar industry. Among other benefits, increased predictability would help to lower costs.

2. Reductions in Solar Soft Costs

Solar building standards should also benefit the solar industry by reducing the cost of solar power. Although the price of solar panels has plunged dramatically in the last decade, non-hardware, or "soft," costs have not declined nearly as swiftly.[209] Soft costs include customer acquisition, financing, permitting, inspections, interconnection fees, taxes, installation, and maintenance. High soft costs are a principal obstacle to solar power becoming competitive with other forms of energy on a purely economic basis. Indeed, soft costs account for over 50% of the end price of rooftop solar.[210] Reducing soft costs is thus essential to meeting the U.S. Department of Energy's goal for the development of cost-competitive solar power by 2020.

The Green Energy Institute has suggested five strategies for reducing solar soft costs: streamlined permitting; new business and financing models; standardized designs; swift interconnection policies; and solar building standards. See go.lclark.edu/law/gei

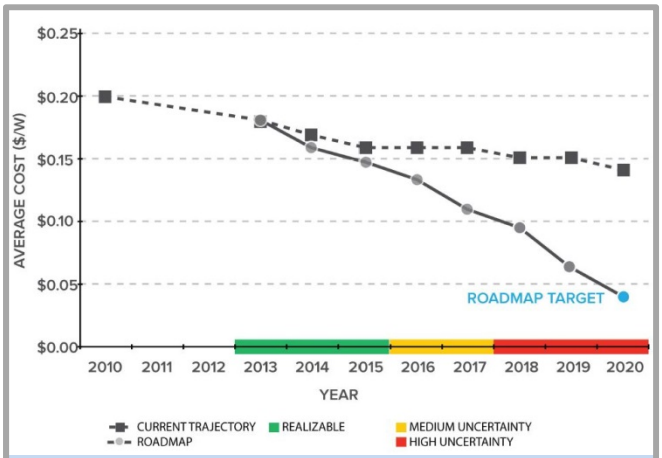


Solar building standards should help reduce each category of soft costs. Most clearly, solar building standards would reduce customer acquisition costs by guaranteeing that each new or renovated building becomes a solar customer. Additionally, solar building standards may reduce project design costs by requiring that new buildings be structurally prepared to support solar panels. Preparing and wiring buildings to support solar panels achieves a significant cost reduction on its own; according to the National Renewable Energy Laboratory, "solar-ready" buildings reduce costs by as much as 60%.[211] Because reducing customer acquisition costs will otherwise require "highly uncertain market penetrations" of site assessment and preparation strategies,[212] cost reduction from solar readiness could be particularly helpful for the industry.

Solar building standards should also help reduce financing costs. Loans for privately owned solar arrays face an average 10% cost of capital, and financing for third-party lessors can face up to a 14% cost of capital.[213] To become cost-competitive, solar financing will need to reach a 3% cost of capital.[214] Solar building standards can help achieve this goal by including the financing for a solar array in a traditional mortgage, which generally faces a low cost of capital of between 3% and 4%.[215]

Solar building standards can also help reduce permitting and inspection costs, which are not currently on track to meet the Department of Energy's goals for cost-competitive solar power.[216] A solar building standard would streamline the permitting and inspection of solar arrays by including that process within the existing permitting and inspection scheme for new and renovated buildings. Moreover, solar building standards could promote

standardized array designs, which could be easier to inspect. Streamlining permitting and inspections would reduce overall project costs. Lancaster is already streamlining permitting with over-the-counter permits for solar arrays.[217]



NREL, Soft Costs Roadmap, at 23.

Permitting, Inspection, and Interconnection costs are not on track to meet targets.

Solar building standards may also reduce the cost of interconnecting a solar array to the electricity grid. Currently, interconnection to the grid can add thousands of dollars to a project's overall costs.[218] The "last-in" problem inflates costs further: once an electricity distribution network has a certain level of distributed generation, adding more distributed solar power can trigger the need for supplemental studies of grid safety and reliability, which the "last-in" generator must pay for.[219] According to NREL, these supplemental studies can cost up to $25,000.[220] Solar building standards can help solve this problem by giving utilities a predictable schedule for the addition of solar power based on projected building development. Utilities that can predict the need for supplemental grid studies may be able to distribute the costs of those studies more evenly among ratepayers, rather than putting the entire cost on a single solar project. This cost spreading would reduce a disincentive to develop solar arrays in already solar-intensive areas.

Finally, solar building standards may reduce soft costs by allowing project developers to achieve economies of scale. If solar installers can more accurately predict the amount of upcoming projects, based on building development trends, they may be able to purchase materials in bulk at lower prices or negotiate longer-term, lower-cost labor contracts. These economies of scale could help distributed solar power achieve significant cost savings.

E. IMPACT ON THE GLOBAL ENVIRONMENT

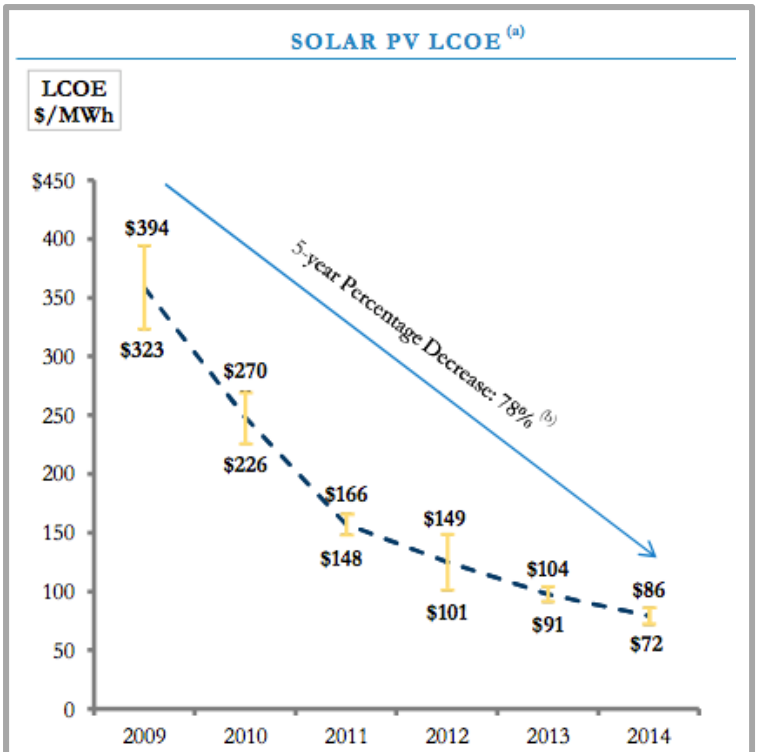
Mitigating and adapting to global climate change is another significant benefit of solar building standards. Cities contribute quite dramatically to global greenhouse gas emissions. In 2009, Los Angeles emitted as much carbon dioxide as Sweden.[221] By one estimate, the U.S. Conference of Mayors Climate Protection Agreement, which commits signatories to meeting the targets of the Kyoto Protocol, could reduce overall U.S. emissions 7% by 2020.[222] U.S. cities thus have significant potential cumulative impacts that can contribute to national greenhouse gas emission reduction goals.[223] Moreover, solar power can help U.S. cities adapt to climate change by offering them a source of energy that is more resilient to increasingly common severe weather.[224] Similarly, solar power helps cities adapt to climate change by reducing energy demand as the climate warms.[225] By substantially increasing the amount of solar power in U.S. cities, solar building standards offer a way for local governments to contribute meaningfully to global climate change mitigation and adaptation.

V. POTENTIAL OBSTACLES TO SOLAR BUILDING STANDARDS

The impacts described above are generally positive, which might lead one to wonder why solar building standards remain rare. This section offers a series of reasons why solar building standards have not yet been adopted in many cities. First, solar power has been dauntingly expensive until recent years. Second, many local governments actually create significant obstacles for solar power—even for voluntary adoption of solar power—due to a perception that solar panels are unsightly and reduce property values. Third, some critics decry government mandates as contrary to the free market. Finally, potential legal obstacles at the state and federal level may have daunted local governments. However, these obstacles to solar building standards have dwindling validity, suggesting that solar building standards may become increasingly appealing to local governments and thus increasingly widespread in coming years.

A. THE COST OF SOLAR POWER

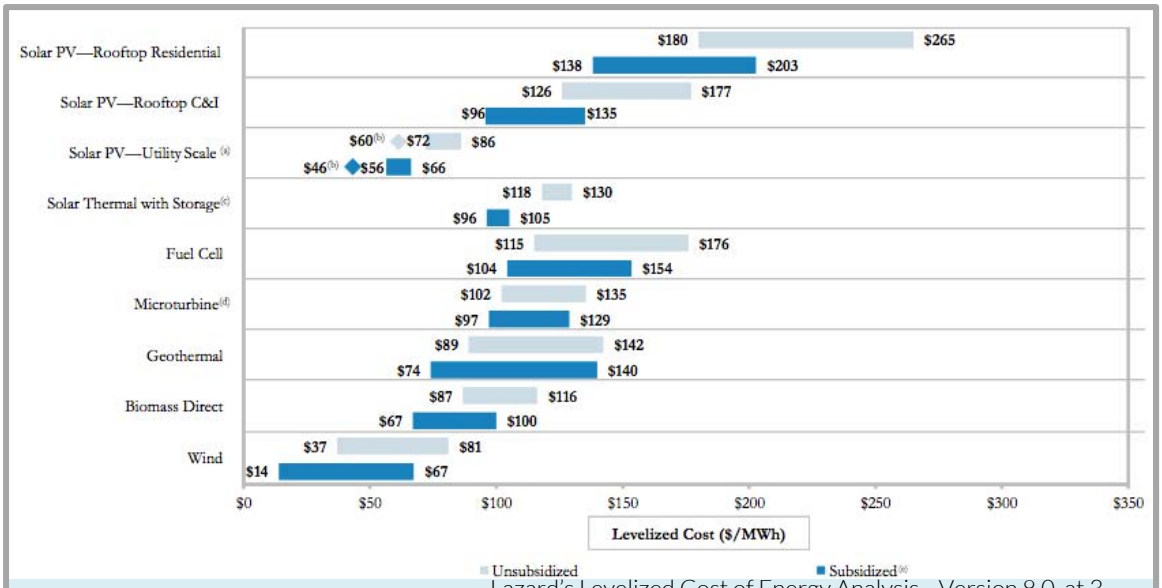
In recent years, the cost of solar power at all scales has declined dramatically. The U.S. Energy Information Administration (EIA) regularly issues calculations of the "levelized cost of energy" (LCOE) from different sources. In 2011, the EIA reported that the LCOE of solar photovoltaic power was $210.70 per megawatt-hour ($210.70/MWh).[226] In 2014, the EIA reported that the LCOE for solar power had fallen to $118.60/MWh.[227] Thus, the EIA found a 44% decline in the price of solar photovoltaic power over a span of only three years. Other sources calculate a similar decline in prices; for example, Lazard's most recent LCOE report reveals a 78% decline in the LCOE of solar photovoltaic power from 2009 to 2014.[228] In sum, solar power is rapidly becoming more affordable.



Lazard's Levelized Cost of Energy Analysis—Version 8.0, at 9.

Solar power prices have plunged by more than 75% in the last five years. Experts predict that solar power will be cost-competitive with other energy sources by 2020.

These cost reductions are important, but the same reports reveal that rooftop solar power continues to be more expensive than competing energy sources in many areas. For example, according to EIA's most recent LCOE estimates, solar photovoltaic power remains among the most expensive of all energy sources.[229] Lazard's analysis agrees.[230]



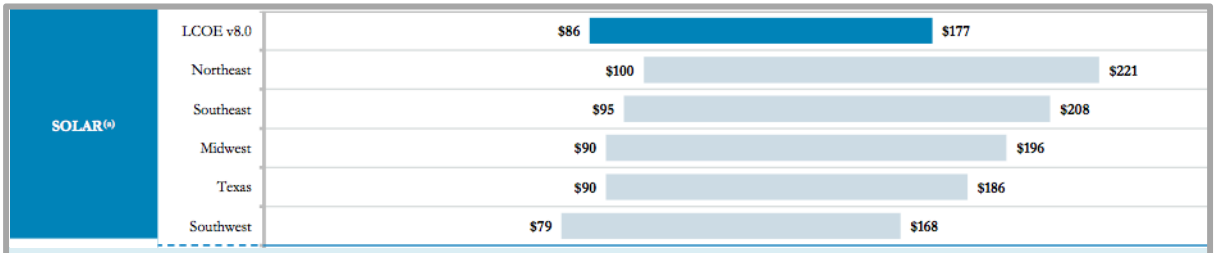
Lazard's Levelized Cost of Energy Analysis—Version 8.0, at 3.

Solar power remains more costly than other energy sources.

The high cost of rooftop solar power in comparison to competing energy sources is one likely reason that solar building standards are not widespread. Certainly, high prices are one reason that some utilities, such as Florida Power & Light, cite for their opposition to state-level policies that encourage rooftop solar power.[231] Local governments may reasonably have hesitated to require development of an energy source they perceive to be costlier than other options.

However, solar power prices have fallen far more quickly than industry analysts anticipated. On the basis of these surprising cost reductions, the International Energy Agency (IEA) found in 2014 that solar power could economically satisfy a substantially greater share of the world's energy needs than the agency had estimated only four years earlier.[232] Although module prices may be stabilizing as a result of international trade disputes,[233] the U.S. Department of Energy is spearheading the SunShot Initiative to reduce solar soft costs and attain economically competitive solar power by 2020.[234] Many industry analysts believe that U.S. markets will attain the SunShot Initiative's goal.[235]

Facing these swiftly and substantially declining costs, local governments should give solar building standards increasing consideration. Given the rapid price reductions, it is crucial that local governments review the latest cost figures. A recent study from Bloomberg New Energy Finance reveals that "[o]utdated numbers are still widely disseminated to governments, regulators and investors," putting solar power at a disadvantage.[236] Local governments should review the latest cost data as they consider whether solar



Lazard's Levelized Cost of Energy Analysis—Version 8.0, at 8.

Solar power exhibits significant regional price variations.

building standards are a good solution for their jurisdictions.

Local governments should also consider local price differences. The costs of rooftop solar power vary significantly by region. For example, the EIA's LCOE estimates display a wide range of regional values, from roughly $100/MWh at the low end to nearly twice that sum at the high end.[237] Lazard's analysis shows a similar variation.[238]

In short, solar power is more affordable in some places than in others. Local governments should take stock of local energy prices and the local cost of solar power as they consider solar building standards.

Finally, local governments should be sure to value the benefits from rooftop solar that LCOE estimates fail to capture. Although LCOE calculations include such financial considerations as hardware, installation, and financing costs,[239] they tend not to capture such benefits as reductions in carbon emissions or other harmful pollution. Moreover, LCOE estimates do a poor job of identifying risks of price volatility for fossil-fuel-based electricity sources, failing to reveal that solar arrays provide power at stable, fixed prices over their lives. Similarly, LCOE estimates do not account for the disaster preparedness that solar power can provide. Local governments considering solar building standards should not rely on LCOE alone, but should be sure to consider all the benefits of solar power.

In sum, the high price of solar power is one likely reason that solar building standards remain rare. However, the price of solar power has plunged more quickly than many industry analysts foresaw, and this precipitous downward trend is likely to continue. In the near future, rooftop solar power is likely to be purely economically competitive with other forms of energy generation, even without considering the resiliency of solar power or its reductions in carbon emissions. As the price of solar power continues to decline, local governments should give increasing consideration to solar building standards.

B. LOCAL RESTRICTIONS ON SOLAR POWER

Local political opposition to distributed renewable energy is another important reason solar building standards remain rare. Far from requiring solar panels, many jurisdictions instead impose restrictions in zoning and planning rules. Professor Troy Rule reported in 2010 that "[e]ven municipalities that have embraced green building standards and other sustainable land use practices often disfavor local policies that promote distributed renewable energy."[240] Professor Sara Bronin reported in 2008 that policies disfavoring solar power appear in "the vast majority of localities."[241]

Local restrictions on solar panels are generally based on aesthetic concerns and a misguided belief that solar panels reduce property values.[242] Both concerns seem to be historical artifacts with little current validity. Aesthetic opposition—basically the belief that solar panels are ugly—could date back to the 1970s, when solar panels were much larger and generally relied on free-standing metal frames.[243] Today's solar panels are much smaller and sleeker and can be unobtrusively sited on rooftops. Nevertheless, distaste for solar panels seems to persist, as reflected by the fact that "aesthetic review boards and historic preservation boards, which typically govern structures visible from a public way, regularly reject their installation."[244]

The belief that solar panels reduce property values may once have been valid, but is no longer true. Instead, studies have shown the opposite: Homes with solar panels sell more quickly and for more money.[245] Nevertheless, the mistaken belief that solar panels harm property values appears to persist, leading local governments and homeowner associations to restrict solar development.

BELLE MEADE AND AL GORE'S SOLAR PANELS

In 2007, Al Gore tried to install solar panels on his home in Belle Meade, an affluent community in Nashville, Tennessee, only to find that the town did not allow rooftop solar panels.[246] *In reaction to a proliferation of noisy, diesel-powered generators, the town had required all generators to be sited on the ground (where they are presumably less of a nuisance), and the town interpreted this restriction to apply to solar panels as well. Perhaps in response to pressure from the former Vice President, the town eventually amended its ordinance to allow solar panels, but took over a year to do so and still imposed a significant restriction: solar panels are allowed only "so long as they are not visible from the street or from any adjoining property."*[247] *This restriction illustrates the obstacles that local governments sometimes impose to installing solar power.*

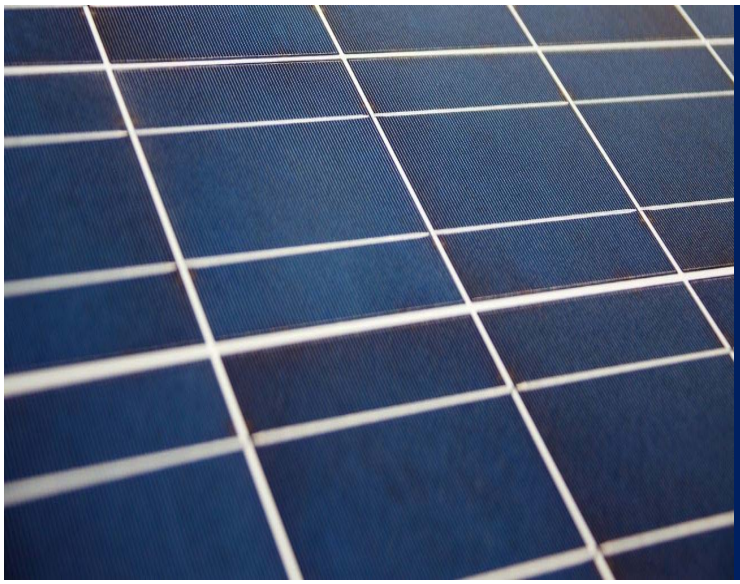
Jurisdictions that perceive these local costs from solar power are unlikely to embrace climate change as a reason to promote solar, much less require it. Instead, local governments tend to favor policies that confer local, rather than global, benefits.[248] Accordingly, local governments are likely to adopt solar building standards only if they become aware that outdated perceptions of solar power as ugly and costly are no longer accurate. If local governments take stock of the current state of solar power—observing both the aesthetic progress in panel design and siting and the demonstrable fact that solar power increases property values—then solar building standards are likely to become more common.

C. "FREE-MARKET" OPPOSITION TO RENEWABLES REQUIREMENTS

Policies from any level of government that encourage renewable energy come under fire from some critics as violations of the free market. For example, some critics claim that Renewable Portfolio Standards inappropriately "pick winners and losers."[249] Similarly, net metering receives some criticism as being untrue to the spirit of the free market.[250] Solar building standards would likely receive the same kind of criticism.

The problem with free market arguments about energy policy is that, as Professor Melissa Powers has stated, "free market principles have never applied to the electricity system."[251] For most of the history of electricity, states granted utilities monopoly status based on the belief that competition in the electricity sector would not be economically efficient.[252] Since the 1970s, federal and state governments have promoted some competition in electricity generation,[253] but electric utilities still enjoy significant benefits as a result of their regulated monopoly status.[254] The electricity sector has always been a creature of government regulation rather than free competition: "The electricity system itself is not a free market, so market principles have very little applicability."[255] In short, free-market arguments about renewable energy policies have more superficial charm than intellectual honesty or rigor.

Purportedly free-market arguments should not deter local governments from considering or adopting solar building standards. The electricity market has never been free, nor is it likely to become free. Instead, energy policy at all levels reflects attempts by governments to ensure abundant and affordable electricity. As the costs of pollution and climate change have become increasingly clear, governments have increasingly prioritized carbon-free energy sources such as solar power. Solar building standards offer local governments a way to achieve all these goals and other significant local benefits at the same time. Local governments should consider solar building standards on their merits, undaunted by spurious "free-market" arguments.



"The electricity system itself is not a free market, so market principles have very little applicability."

D. POTENTIAL STATE AND FEDERAL LEGAL OBSTACLES TO SOLAR BUILDING STANDARDS

Some legal obstacles at the federal and state level may have deterred local governments from enacting solar building standards. First, at the federal level, potential constitutional arguments could impede solar building standards. Second, states may preempt local efforts to require solar power. However, the constitutional arguments are unlikely to succeed, and only a few states actually preempt local solar building standards. Accordingly, most jurisdictions are likely free to enact a solar building standard.

1. Constitutional Arguments against Solar Building Standards Are Weak.

Local solar building standards may face constitutional challenges, but are likely to weather them. There are two principal challenges that an opponent of a solar building standard could mount. First, a challenger could argue that a local solar building standard unconstitutionally takes private property. And second, a challenger could argue that a local solar building standard violates the dormant Commerce Clause by unreasonably burdening interstate commerce. This section briefly describes the challenges and offers a few reasons why those challenges might fail. However, a full discussion of these legal issues is beyond the scope of this report.

a. Takings

The Fourteenth Amendment of the U.S. Constitution forbids states from taking private property without paying just compensation.[256] Some takings are obvious, such as government condemnation of private property, but it is also possible for government regulations to take private property without actually taking possession of land.[257] For example, in *Lucas v. South Carolina Coastal Council*, the Supreme Court held that just compensation is necessary when a regulation deprives a landowner of all economically viable use of her land.[258] The rule from *Lucas* is one of only a few bright lines in the realm of regulatory takings. Generally, however, when a challenger alleges a regulatory taking, courts examine three factors, known as the *Penn Central* factors: (1) the character of the government action; (2) the economic impact on the challenger; and (3) whether the

regulation interferes with distinct investment-backed expectations.[259]

There are two potential takings arguments against a local solar building standard, but neither is strong. First, a property owner could argue that a solar building standard works a regulatory taking by depriving property of economic use. Second, a neighbor could argue that a solar

building standard that guards access to sunlight works a taking by restricting her right to build in a way that would shade existing solar panels.

A local solar building standard is unlikely to be a regulatory taking requiring just compensation. Solar building standards are basically like other green building requirements, such as requirements for energy efficient windows or insulation. One scholar, Professor Keith Hirokawa, has noted that "takings claims against green building laws may not be recognized as viable per se."[260] It should be "difficult for property owners to make a convincing demonstration that the imposition of green building standards interferes with property rights, much less economic value of the property."[261] Indeed, green building requirements, including solar building standards, actually confer economic benefits; as described above, solar panels reduce energy bills and increase property values.[262] Accordingly, it should be impossible to make the argument that a solar building standard works a taking by depriving property of economic value, either under *Lucas* or the *Penn Central* factors. Thus, this type of potential takings claim is not a good reason for local governments to balk at enacting a solar building standard.

Additionally, a solar building standard that includes solar access rights could face a takings claim from a neighbor, but that challenge would be likely to fail as well. The basis for the challenge would be the fact that a rule protecting one building's solar access could restrict a neighbor from building in a way that would cut off that solar access. Because the rule would thus impose restrictions on a neighbor's use of her property, that neighbor might bring a takings claim.

However, the takings analysis inquires into distinct, investment-backed expectations.[263] Because the enactment of a solar building standard with solar access protections would put potential investors on notice of this restriction on development, it would likely prove impossible to show that the restriction violated any realistic, investment-backed expectations for building in a way that would shade neighboring solar panels. Because the solar building standard would predate most such development plans, neighbors would generally lack a valid takings claim.

In fact, the only potential challengers with seemingly legitimate claims would be neighbors who had lined up investments for development that would shade neighboring solar panels *before* the solar standard went into effect. This pool of challengers would likely be quite limited. Additionally, it would be fairly easy for a local government to create exceptions to a general policy in order to avoid costly legal battles. For example, if a neighbor has a credible takings based on demonstrable, investment-backed expectations, the government could allow the property subject to the solar building standard to comply through the payment of an in-lieu fee or participation in a larger, off-site array. Both because the pool of potential takings claimants would be small and because exemptions that would avoid litigation would be easy to craft, potential takings claims are not a strong reason for local governments to hesitate in enacting a solar building standard.

b. The Dormant Commerce Clause

Because the Commerce Clause of the U.S. Constitution specifically empowers Congress to regulate interstate commerce,[264] the Supreme Court has developed a doctrine known as the "dormant Commerce Clause," generally holding that states cannot unduly burden interstate commerce.[265] The basic goal of the dormant Commerce Clause is to prevent economic protectionism, or states favoring in-state business over out-of-state business.[266] Laws that discriminate against interstate commerce face strict scrutiny and generally fail, while laws that do not so discriminate face a balancing test weighing burdens on interstate commerce against legitimate local benefits.[267]

Although a legal challenge to solar building standards under the dormant Commerce Clause is possible, a challenger would be unlikely to prevail. The challenge would argue that a solar building standard favors in-state energy and displaces out-of-state energy, unconstitutionally favoring in-state business.[268]

However, in the context of solar building standards, this argument seems specious. Solar building standards do not facially discriminate against out-of-state commerce, because they do not act as a bar to purchasing electricity from another state. Thus, a court would likely weigh the standard's impacts on out-of-state commerce against its local benefits. Although rooftop solar power may reduce demand for out-of-state electricity, a solar building standard is not economic protectionism. Instead, solar building standards create significant local benefits to the electricity grid without regard to local business interests. As described above, rooftop solar power has a plethora of benefits, including reduction of peak energy demand, promotion of a resilient power grid, stabilization of power prices, reduction of carbon emissions, and avoidance of significant costs of energy transmission and distribution.[269] All of these benefits are legitimate governmental aims that do not constitute economic protectionism.

Additionally, distributed generation systems are often themselves commodities in interstate commerce. Solar panels are a globally traded commodity, as are other components of a rooftop solar array such as racking or inverters. A solar building standard, far from preventing interstate commerce, actually invites transactions in these globally traded commodities. Moreover, the majority of rooftop solar arrays installed today are leased from third-party owners, which tend to be companies operating in multiple states. These third-party owners of rooftop solar arrays participate in interstate commerce when they install and own distributed solar arrays in different states. Thus, solar building standards seem to actually invite interstate commerce. As such, the dormant Commerce Clause should not be a barrier to local solar building standards.

The many local benefits from solar building standards likely outweigh any negative impacts on interstate commerce.

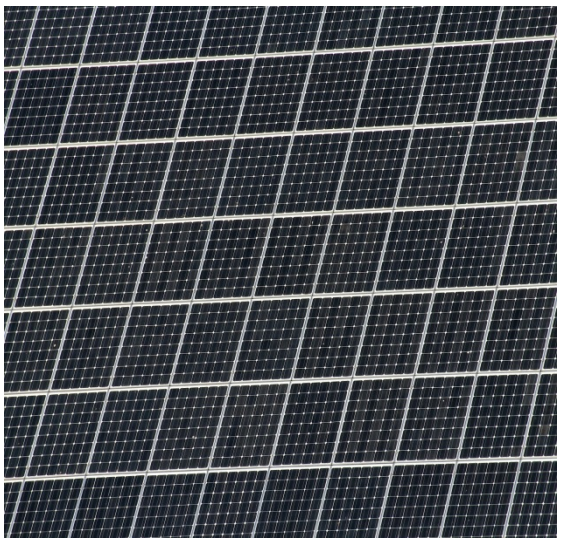
2. Most State Building Codes Do Not Preempt Local Solar Building Standards.

Generally, state law should not pose a significant obstacle to local governments that want to enact solar building standards. While many states have enacted building codes, "few states entirely preempt local codes, although a number set regulatory floors."[270] Moreover, states "often do not adopt comprehensive codes, leaving gaps for local regulation."[271] In other words, states generally impose floors rather than ceilings, leaving local governments free to impose more rigorous requirements.

Some states even encourage local governments to promote distributed renewable energy such as solar power. For example, Pennsylvania and Connecticut have "enacted statutes that generically instruct localities to accommodate distributed renewables."[272] Notably, California's requirement for offering solar power to new homebuyers expressly contemplates local solar building standards, allowing the state rule to give way to local regulation.[273] California also prohibits local governments from restricting solar power by invalidating "enforcement of any covenant, restriction, or deed in connection with the transfer of real property that effectively prohibits or restricts the installation or use of a solar energy system."[274] Several states have similar policies, including Florida, Delaware, Indiana, Nevada, New Hampshire, Vermont, and Wisconsin.[275]

Only a few states prevent local governments from going beyond the requirements in state building codes. For example, Oregon has had a preemptive state-wide building code since the 1970s.[276] Oregon's statewide code does include some measures that promote solar power. For example, the Energy Efficiency Specialty Code allows for the installation of solar panels as one path toward compliance.[277] Similarly, Oregon's statewide Solar Installation Specialty Code imposes certain requirements about the engineering and placement of solar arrays.[278] Additionally, Oregon has a voluntary REACH Code that allows developers to attain a certification by taking certain measures, which can include installing solar power.[279] However, local governments in Oregon may not impose requirements that go beyond Oregon's statewide provisions.[280] Thus, a city in Oregon could not enact a solar building standard unless the state altered its building code, the city obtained an exemption, or the city was willing to engage in a legal battle with an uncertain outcome. In states such as Oregon, local solar building standards are thus unlikely to be adopted.

Local governments contemplating solar building standards should be sure to check with state regulators to ensure that state law does not restrict their efforts. The fact that most states do not preempt local building codes, even where statewide codes impose a regulatory floor, suggests that most local governments will likely find themselves free to enact a solar building standard.



VI. CONCLUSION

Solar building standards are currently at the vanguard of renewable energy policy but may become more common in the near future. The likely impacts of solar building standards are generally positive, conferring benefits to property owners, local governments, grid managers, and the global climate. Moreover, solar building standards offer solutions to some vexing problems with increasing penetrations of solar power, such as the possible effects on utility profits or the potential to shift burdens to lower-income communities. If designed properly, solar building standards can allow many different stakeholders to thrive, safeguarding utility shareholders and lower-income communities alike. Moreover, because solar building standards confer significant local benefits without incurring significant costs to local government, they are likely to appeal to an increasing number of cities.

Some current political trends also suggest that solar building standards may soon become more common. Local governments have pledged significant action to curb climate change, and solar building standards seem to offer a good way to achieve this goal. State policies that would support the most effective solar building standards are spreading. And the federal Clean Power Plan may prompt states to seek innovative ways to reduce carbon emissions, a goal to which solar building standards could contribute significantly.

Finally, the increasingly strong economic case for solar power suggests that more cities may adopt solar building standards. The cost of solar power has plunged in recent years and continues to decline. The solar industry will likely achieve the U.S. Department of Energy's goal of having solar power become cost competitive with all other forms of energy by 2020. Moreover, as solar development continues to accelerate, the benefits of solar power for reducing energy costs and mitigating climate change become increasingly clear. A 2015 study from the University of North Carolina reveals that in 42 of the largest 50 cities in the United States, an average solar array costs less in the long-term than purchasing energy from a local utility.[281] As the economics of solar power continue to improve, an increasing number of cities should give serious consideration to solar building standards.

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