FEBRUARY 2017

Standards and Requirements for Solar Equipment, Installation, and Licensing and Certification

A Guide for States and Municipalities

Beren Argetsinger, Keyes & Fox LLP • Benjamin Inskeep, EQ Research LLC

SUSTAINABLE SOLAR EDUCATION PROJECT

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ABOUT THIS GUIDE AND THE SUSTAINABLE SOLAR EDUCATION PROJECT

Standards and Requirements for Solar Equipment, Installation, and Licensing and Certification: A Guide for States and Municipalities is one of six program guides being produced by the Clean Energy States Alliance (CESA) as part of its Sustainable Solar Education Project. The project aims to provide information and educational resources to help states and municipalities ensure that distributed solar electricity remains consumer friendly and its benefits are accessible to low- and moderate-income households. In addition to publishing guides, the Sustainable Solar Education Project will produce webinars, an online course, a monthly newsletter, and in-person training on topics related to strengthening solar accessibility and affordability, improving consumer information, and implementing consumer protection measures regarding solar photovoltaic (PV) systems. More information about the project, including a link to sign up to receive notices about the project's activities, can be found at *www.cesa.org/projects/sustainable-solar*.

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ACKNOWLEDGMENTS

This work is based upon work supported by the U.S. Department of Energy SunShot Initiative, under Award Number No. DE-EE0007321. The authors would like to thank the following individuals for their contribution to this guide: Matt Piantedosi of The Cadmus Group; Elizabeth Hutchison of the California Energy Commission; Michael Forrester at the City of Cincinnati; Jeff Lyng and Tom Plant of the Center for the New Energy Economy; Isabelle Hazlewood, Edward Kranich, and Selya Price of the Connecticut Green Bank; Jeni Hall of Energy Trust of Oregon; Tim Lindl and Joseph Wiedman (formerly) of Keyes & Fox; Andrew Belden and Elizabeth Youngblood of the Massachusetts Clean Energy Center; Stacy Miller of the Minnesota Department of Commerce; Travis Lowder of the National Renewable Energy Laboratory; Max Joel and Frank Mace of the New York State Energy Research & Development Authority; Shauna Beland of the Rhode Island Office of Energy Resources; Ryan Barnett and Danielle Bentz of SolarCity; and Evelyn Butler of the Solar Energy Industries Association all provided guidance and input in the development of this guide. The following CESA staff also provided valuable review of the guide: Maria Blais Costello, Diana Chace, Warren Leon, and Nate Hausman.

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SECTION 1
Introduction

This guide is intended as a starting point for program managers in states or municipalities who are developing or revising standards and requirements for installation, licensing and certification, equipment, and warranties for solar photovoltaic (PV) equipment and systems. It discusses a selection of programs and rules in these areas to highlight various means by which states and municipalities have addressed these topics and how they impact the implementation of solar policy goals. The guide develops recommendations and considerations for each topic area based upon review of numerous state and local solar programs and in consultation with program managers, solar installers, consultants, and non-governmental organizations.

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SECTION 2

Installation

The installation of rooftop solar PV systems raises issues related to building, fire, and electrical codes. Because rooftop solar is a relatively new technology and often added to a building after it is constructed, some code provisions may need to be modified to ensure that solar PV systems can be accommodated while achieving the goals of the codes. Some primary code issues that impact rooftop PV installations include:

- Restrictive or ambiguous language written into the codes;
- Lag time between the release of updated model codes and new PV industry best practices and the widespread adoption of the codes and best practices;
- Variation across jurisdictions in which code editions and amendments are adopted; and
- Inconsistent, inefficient, or improper enforcement of codes.

Building, fire, and electrical codes are adopted at the state level in some states and at the local level in others. State-level code adoption can provide a level of consistency and uniformity to the industry that reduces costs, in comparison to a state where there are inconsistencies between various municipalities. On the other hand, codes adopted at the state level may restrict a local government's ability to update codes to reflect new information or best practices or to make modifications to suit its unique needs and conditions.[1] In "Dillon's Rule" states, the state retains all powers except those that are explicitly delegated to the local jurisdictions. In "Home Rule" states, the local jurisdictions are delegated all powers except those explicitly retained by the state.[2]

Authorities having jurisdiction (AHJs) may have different, and in some cases overlapping, powers and responsibilities over the solar installation process. For example, AHJs responsible for implementing building and fire codes may include state fire marshals, county building and health departments, and local development authorities and fire departments. In Dillon's Rule states that have adopted statewide codes, local governments are typically restricted to applying the state code.[3] In Home Rule states, code adoption may be controlled at either the state or the local level.

Code enforcement is essential to ensuring that rules are followed and properly implemented. Even well designed and unambiguous codes can fail to achieve their purpose if building inspectors, permitting staff, fire marshals, and other personnel lack the training and other support to correctly and consistently apply code standards. In many states, regardless of whether code adoption is a state-level function (i.e., a Dillon's Rule state) or a local jurisdiction-level function (i.e., a Home Rule state), code enforcement is performed by local jurisdictions.

Although local authority leverages local expertise and provides local governments with flexibility, variation across jurisdictions can add complexity and additional permitting and other compliance costs for solar installers, as well as inconsistencies in PV inspections. These issues are of particular concern to solar installers who work in multiple jurisdictions, as well as state-level program administrators tasked with overseeing statewide solar implementation programs. State-level policymakers and solar program administrators can help address these issues by providing local jurisdictions guidance and other support resources to foster greater consistency in code adoption and enforcement as it pertains to PV installation.

Several model codes have been developed to promote minimum standards and uniformity across AHJs. Most notably, the International Code Council, a membership association that supports building safety and fire prevention, updates its model codes every three years. Model codes from the International Code Council, including the International Building Code, International Residential Code, and International Fire Code, have been widely adopted, with state and local modifications, across the U.S.[4]

A National Renewable Energy Laboratory (NREL) report, *Clean Energy in City Codes: A Baseline Analysis of Municipal Codification across the United States*, released in December 2016, found that in a sample of 1,266 U.S. municipalities, 45 percent referenced solar in their municipal codes. In four selected states—California, Florida, Maryland, and Minnesota—30 percent of all solar references in municipal codes relate to development and design standards. The report notes that "often, these references exclude solar installations from building height requirements, require screening of solar equipment from public view, require systems to conform to the Uniform Solar Energy Code or other fire and safety codes, address setback requirements, or require other aesthetic, landscape, or building orientation changes among a myriad of other design-related stipulations."

BUILDING CODES

Building codes set minimum standards for structures and buildings to protect public health, safety, and welfare. Building code requirements related to installation, materials, wind resistance, and fire classification can help ensure the safe installation and operation of PV systems. AHJs typically require a PV system to pass a permitting and inspection process prior to commissioning. Inconsistency across AHJs in building code adoption and amendments can create challenges for solar installers and contractors. The permitting and inspection process can be lengthy, costly, and uncertain in some jurisdictions.

Model building codes assist AHJs in creating uniformity in their building codes. Often, AHJs will adopt amendments or modifications to model building codes to meet local preferences or circumstances. Building codes in most states and local jurisdictions in the U.S. are based on various editions of the International Code Council's model building and residential codes. The International Residential Code, which applies to detached one- and two-family dwellings and townhouses three stories or less, and the International Building Code, which applies to buildings and structures not covered by the International Residential Code, have been widely adopted. Still, there is significant variation across jurisdictions in how quickly updated editions of the model codes are adopted.


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The current versions of the International Residential Code and the International Building Code require rack-mounted rooftop PV systems to be installed according to the manufac-turer's instructions, the National Electrical Code, and Underwriters Laboratories product safety standards [such as UL 1703 (PV modules) and UL 1741 (Inverters)], which are design requirements and testing specifications for PV-related equipment safety (see Equipment Standards below).[5]

The International Residential Code also requires that:

- The roof be structurally capable of supporting the load of the modules and racking;
- The modules and racking be non-combustible; and
- Roof or wall penetrations (such as to attach the racking to the roof) be flashed and sealed to prevent water, rodents, or insects from entry.

The International Building Code also:

- Requires that rooftop solar systems have the same fire classification as the roof assembly;[6] and
- Establishes criteria for calculating the minimum design loads for rooftop solar PV systems, including guidance on wind load engineering calculations.[7]

These model codes are updated every three years to integrate emerging industry best practices, although states vary in how quickly or even if they adopt updated codes. In addition to timely review and adoption of updated versions of model codes, officials can create innovative policies that go above and beyond the solar-related provisions in the model codes, to further encourage and streamline solar installations. Importantly, ambiguous or overly restrictive provisions in building codes can create unintended barriers for solar installations without

AN EXAMPLE IN PRACTICE

Oregon Solar Installation Code and Structural Specialty Code

In 2010, Oregon enacted the Oregon Solar Installation Specialty Code, the nation's first statewide solar code. This statewide solar code has been included in the Oregon Structural Specialty Code and is applied in conjunction with Oregon's Electrical Specialty Code. Together, Oregon's solar installation code and electrical code standardize requirements for the installation, repair, and maintenance of residential and commercial PV systems.

Oregon Department of Consumer and Business Services. "Oregon Solar Installation Specialty Code." October 1, 2010.

providing additional benefits. The increasing popularity of rooftop PV installations and the pace at which solar technologies evolve mean that officials may need to evaluate building code provisions specific to rooftop solar periodically.

In 2010, Oregon enacted the first statewide solar code in the nation.[8] The Oregon Solar Installation Specialty Code has been included in the Oregon Structural Specialty Code and is applied in conjunction with Oregon's Electrical Specialty Code. Together, Oregon's solar installation code and electrical code standardize requirements for the installation, repair, or maintenance of residential and commercial PV systems. The code includes:[9]

- A prescriptive pathway to expedite permitting for installations that meet requirements relating to:
  - Building type, roof structure, and material requirements;
  - Loading requirements (not to exceed 4.5 pounds per square foot);
  - Height restrictions (not to exceed 18 inches above the roof); and
  - Positive attachment to the roof structure (rather than ballasted systems);
- Minimum structural requirements for the installation of PV components and support systems; and
- Guidance for how AHJs should process building permit applications and determine fees, including a flat fee for prescriptive pathway applications.

The Building Code Division within the Oregon Department of Consumer and Business Services created a *checklist* for installers to easily determine eligibility for the prescriptive pathway.[10]

By expansively covering topics related to PV installation, Oregon's solar installation code and structural code reduce uncertainty and inconsistency in the review and enforcement of technical installation requirements and the procedural permitting processes. The stability and standardization afforded by such an approach can foster solar market growth and development.

Solar Ready Buildings

Local governments can encourage homebuilders and developers to design and erect buildings that make it easy to add a rooftop solar PV system in the future. A "solar ready" building can offer substantial cost savings compared to retrofitting a building for a PV system. The 2015 IRC includes "Solar-Ready Provisions" in an optional Appendix U that AHJs can elect to adopt.[11]

Incorporating a few key design considerations in new or significantly modified buildings goes a long way in reducing costs associated with installing a PV system. Elements in building codes that can facilitate future rooftop PV installations include requirements to:

- Minimize rooftop equipment, or group it on a building's north side,[12] to leave ample contiguous space for a future rooftop PV system;
- Designate a section of the roof as a "Solar-Ready Zone" or "Solar-Ready Roof" that is reserved for a future solar PV system;
- Orient the building in a north-south manner to the extent possible and avoid siting the building or landscaping in a manner that results in significant rooftop shading;
- Plan for and document the interconnection pathways to clearly delineate the routing of conduit for a future rooftop PV system to the electrical service panel; and,
- Include detailed roof specifications in building plans so solar installers can confirm the roof can structurally support a PV system without additional (and often expensive) engineering studies.

AN EXAMPLE IN PRACTICE

Tucson Solar-Ready Buildings

In 2008, the City of Tucson, Arizona passed a "solar ready" ordinance that requires developers of new single-family homes or duplexes to plan for solar PV systems and solar water heating systems in order to receive a permit. The Site Plan must detail where the solar systems could be located, ensure adequate roof structure design to accommodate the additional loading of modules and racking, show minimum PV electrical load entry on the Service Load Calculation, and have an Electrical Panel Schedule with a 240-Volt circuit breaker space reserved for PV.

City of Tucson Planning and Development Services Department. "Residential Plan Review: Solar Ready Ordinance, Ordinance No. 10549."

AHJs can take many policy approaches to encourage developers to make solar-ready buildings, such as rebates or other cash incentives, streamlined permitting, "green building" certification, or acknowledgement for solar-ready buildings. Solar-ready building features can also be required for certain types of new housing or commercial property development.

Some local jurisdictions have gone even further by *requiring* PV installation on some buildings. The California cities of Lancaster, Santa Monica, San Francisco, and Sebastopol have all adopted ordinances requiring certain new buildings to install PV systems.[13]

Permitting and Inspection

Most local governments require a building permit prior to the installation of a PV system to ensure the system meets engineering and safety standards. After installation of a PV system is completed and prior to it being energized, a system inspection is often required to ensure code compliance. Rooftop system inspections are often performed at the local government level by building inspectors. It is worth noting that permitting and inspection have limitations. The permitting and inspection process usually does not consider whether the system is designed and installed to maximize performance. A system located in the shade may not produce any energy, but still pass code inspection, for example.

Although solar permitting and inspection help ensure a minimum level of safety, lengthy or overly complicated permitting processes can impede solar deployment. Permitting fees that exceed the administrative cost of processing a solar permit can unfairly penalize new PV systems.

A streamlined permitting process can be established for small rooftop PV systems or those meeting a standard set of design criteria. Establishing standard design criteria allows installers to know in advance that a PV system will be approved if it is designed to code, thereby reducing the uncertainty, time, and costs associated with additional engineering studies or re-doing an incomplete or incorrect permit application. Standard design criteria can also help AHJs that do not have extensive experience with solar to understand whether a system meets basic minimum code requirements.[14]

Often, a good place for AHJs to start is by explicitly identifying their current solar permitting and inspection process in detail, including each step of the process, who reviews various elements of the permit application, and which departments are involved. By making this internal process explicit, officials can identify where administrative efficiency can be improved and prepare staff for when a permit application is submitted. It may prove fruitful to implement improvements, such as online permitting, not only for PV systems but globally across all areas of the AHJ's permitting authority. Generally, AHJs should adhere to the following guidelines:

- Provide clear, publicly available, easily accessible information about solar permitting and inspection processes and make these materials available online;

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- Standardize and consider reducing application fees, particularly for more uniform system applications, such as rooftop PV systems; and
- Reduce the time period between permit application and approval, and project completion and inspection, and/or establish a standard processing window to increase process certainty for contractors.

The Interstate Renewable Energy Council (IREC) has published an overview of permitting and inspection best practices. IREC recommends policymakers consider the following best practices when adopting residential solar permitting rules:[15]

1. Post requirements online
2. Implement an expedited permit process
3. Enable online permit processing
4. Require fast turnaround time
5. Implement reasonable permitting fees
6. Do not require community-specific licenses
7. Offer a narrow inspection appointment window
8. Eliminate excessive inspections
9. Train permitting staff in solar

AN EXAMPLE IN PRACTICE

Streamlined Permitting in California

California's Expedited Solar Permitting Act (AB 2188), which went into effect in 2015, requires California AHJs to provide an expedited solar permitting process for residential rooftop PV systems. The law requires substantial conformance by local governments with the Governor's Office of Planning and Research's *California Solar Permitting Guidebook*. The guidebook provides recommendations and best practices to local governments relating to the installation and permitting of small solar PV and solar water heating systems. By requiring local governments to take specific actions, the law has increased awareness among AHJs of solar permitting and inspection issues.

Center for Sustainable Energy "Solar Permitting Guidebook California: AB 2188 Implementation." Accessed October 14, 2016.

Several states, including California,[16] Connecticut,[17] Massachusetts,[18] New Hampshire,[19] and New York,[20] have developed PV permitting guides and other related resources.

California's *Expedited Solar Permitting Act* requires California AHJs to provide an expedited solar permitting process for residential rooftop PV systems.[21] The law, which went into effect in 2015, requires substantial conformance by local governments with the *California Solar Permitting Guidebook*. The guidebook, issued by the Governor's Office of Planning and Research, provides recommendations and best practices to local governments relating to the installation and permitting of small solar PV and solar water heating systems. Although only recently implemented, solar installers have already reported that the Expedited Solar Permitting Act has led to substantial improvements in uniformity in permitting timelines and costs for small rooftop PV systems across many local jurisdictions. By requiring local governments to take specific actions, the law has increased awareness among AHJs of solar permitting and inspection issues. Key resources related to AB 2188 include:

AN EXAMPLE IN PRACTICE

Connecticut Green Bank Resources for AHJs

Connecticut has a statewide building code, but it is enforced at the local level. Through a Department of Energy SunShot Initiative Rooftop Solar Challenge grant, the Connecticut Green Bank, a quasi-public agency, provided outreach, training, and resources to AHJs on reducing the "soft costs" of going solar (e.g., permitting, inspection, labor, and other non-hardware costs). The Connecticut Green Bank has published a comprehensive guide to streamline solar permitting and inspections. The Connecticut Green Bank's guide includes resources on permitting recommendations, online permitting, determining a fair permit fee, standardized permitting instructions, structural review, and code compliance and inspection recommendations.

Energize Connecticut. "Sun Rise New England." Accessed December 12, 2016.

- *Draft AB 2188 Model Ordinance*
- *AB 2188: Implementation of the Solar Rights Act at the Local Level*
- *AB 2188 Implementation Report* (July 2016)

FIRE CODES

Rooftop PV systems present special considerations for firefighters and first responders. Potential system hazards include tripping, structural collapse due to extra weight from the system, fire spread (depending on the materials used), inhalation exposure to toxic materials, electrical shock, and other hazards if battery energy storage systems are also present.[22] Fire codes are designed to minimize the risk of fire, protect public health and safety, and safeguard firefighters and other emergency responders.

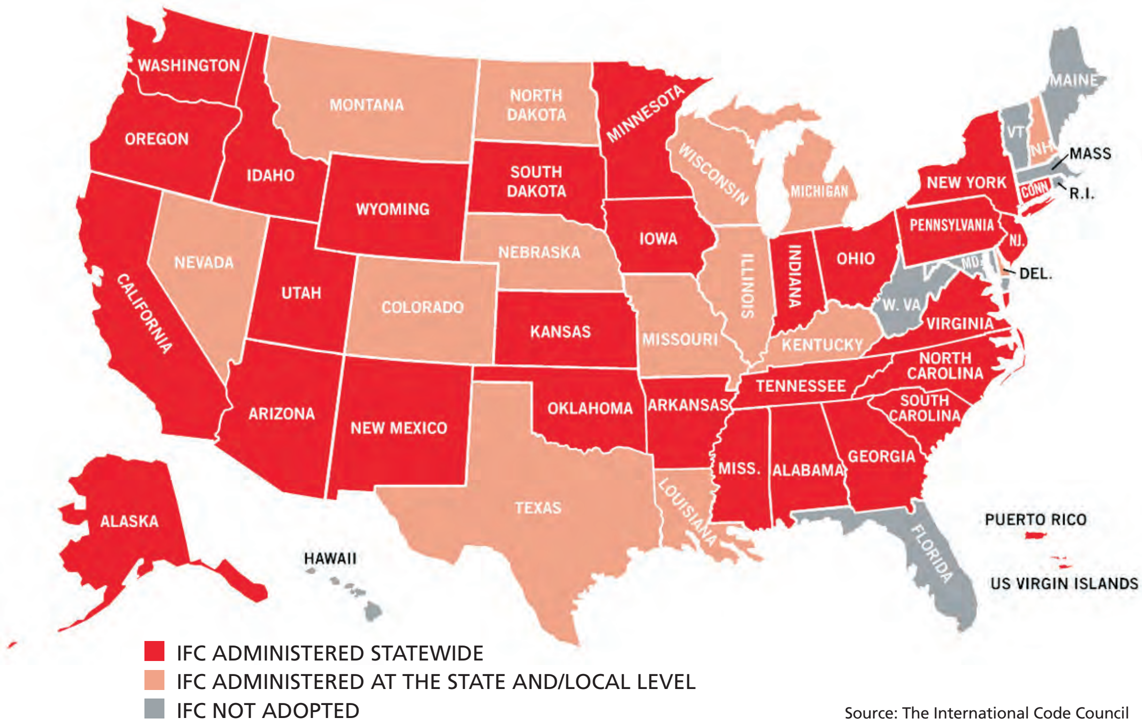
In addition to the International Fire Code (IFC), the National Fire Protection Association (NFPA) produces the NFPA 1 Fire Code. Both codes have been adopted by AHJs in the United States. Ideally, fire codes should strike a careful balance of ensuring firefighters can effectively and safely do their jobs while at the same time allowing consumers to maximize their solar PV potential. Various versions of the IFC have been adopted or are in use by AHJs in 42 states and the District of Columbia (see Figure 1, page 13). Both the Clean Energy States Alliance[23] and the International Association of Fire Fighters in conjunction with the Interstate Renewable Energy Council,[24] among others, offer online PV fire training resources for first responders.

Recent versions of the IFC include sections specific to PV systems and their electrical components, as well as more generic requirements that apply to these systems. The 2015 IFC requires that PV systems obtain a permit and be installed according to the International Building Code or International Residential Code and the National Electrical Code (NFPA 70).[25] Provisions within the National Electrical Code are particularly critical to first responder safety and are provided in greater detail in the following section.

Pathways, Spacing, and Setbacks

Fire codes can address the location of rooftop PV systems, in order to minimize tripping and electrocution hazards and to provide first responders access to roof space. Firefighters can require access to the roof during a fire, especially for the purpose of vertical ventilation (i.e., making a hole in the roof in order to allow heated gas and smoke to escape from the building). The IFC provides an exception to roof ridge clearance requirements where an alternative ventilation method approved by the fire chief is provided or where the fire chief determines that vertical ventilation techniques would not be required.[26]

FIGURE 1: **International Fire Code Adoption Map**



The IFC is in use or adopted in 42 states, the District of Columbia, New York City, Guam, and Puerto Rico.

Section 605.11 of the 2015 IFC details design specifications for rooftop PV systems. Provisions relating to roof access and pathways can significantly limit available roof space for a PV system. Some jurisdictions have modified these provisions or created certain exceptions to them after collaborative stakeholder engagement with the solar industry and firefighting professionals.

In Colorado, codes are generally adopted and enforced at the local level.[27] After conducting an inclusive stakeholder process that involved solar installers and firefighters, the City of Boulder in 2013 adopted several amendments to the 2012 International Fire Code that allowed more rooftop space to be used for PV systems while at the same time providing access pathways for firefighting operations.

The IFC requires three-foot-wide access pathways from the eave to the ridge of a roof. Through a stakeholder process, the City of Boulder approved exceptions to this. Although Boulder's exceptions depend upon roofing design, they generally allow access pathways of 18 inches along the sides of sloped roof "hips" when PV modules are located on both sides, and 12 inches along the sides of horizontal ridges, when the PV module area is 1,000 square feet or less in size and there is no continuous section of PV panels larger than 150 feet. PV systems are also not required to comply with International Fire Code access pathway requirements in cases where the total combined area of the solar PV system does not exceed 33 percent of the total roof area.

AN EXAMPLE IN PRACTICE

Stakeholder Engagement in Boulder, Colorado

In 2013, the City of Boulder adopted several amendments to the 2012 International Fire Code that allowed more rooftop space to be used for PV systems while at the same time providing access pathways for firefighting operations. Through a stakeholder process, the City approved exceptions to the International Fire Code's three-foot-wide roof access provision. PV systems were also not required to comply with International Fire Code access pathway requirements in cases where the total combined area of the solar PV system does not exceed 33 percent of the total roof area. The City's fire code regulations both increase rooftop solar PV potential and address key fire safety issues.

Rebecca Cantwell. "Boulder Compromise on PV Setbacks in 2012 International Fire Code."

ELECTRICAL CODES

The National Electrical Code (NEC) provides comprehensive electrical safety design, installation, and inspection requirements for electrical conductors, equipment, and raceways related to a solar PV system. The NEC, also called the NFPA 70, is developed by the National Fire Protection Association (NFPA) and updated every three years. The NEC 2014 has been adopted by 35 states as of October 2016.[28] In some states, however, local jurisdictions have primary or complete authority over electrical code adoption.[29]

The NEC devotes two of its articles to addressing solar PV systems: Article 690 (Solar Electric Systems) and Article 705 (Interconnected Electrical Power Production Sources). These articles are key to the safe installation and operation of PV systems. The NEC requires that "qualified" individuals install solar panels, but it does not define the criteria for vetting installers, resulting in differing state and local government interpretation (see Licensing and Certification, page 21). Revisions in the past several code cycles have contained important updates designed to protect firefighters, contractors, installers, and homeowners. For example, in 2011, the NEC was amended to expand labeling requirements for all PV systems.[30] Rapid shutdown and disconnection device provisions have been a major topic of discussion in the 2014 and 2017 NEC updates.

Signage and Labeling

Signage and labeling requirements are important safety elements because they alert firefighters to electrocution hazards from PV system equipment. Even when all the circuit breakers have been shut off and a rooftop disconnect has been used, electricity can flow from the panels through DC wiring, creating an electrocution risk. Identification, signage and labeling requirements are specified in detail in the NEC. The IFC requires that systems comply with the National Electrical Code. Electrical components connected to a PV system must meet requirements that detail where, when, and how labels are applied.[31] The main service panel should be clearly labeled to alert firefighters to the presence of a PV system. Systems should have a dedicated, clearly labeled breaker for the inverter, in addition to DC (direct current) conduit runs and other electrical wiring and components.

Rapid Shutdown and Disconnect Devices

When responding to a fire, firefighters reduce electrical shock risk by opening an AC (alternating current) service disconnect, thereby shutting off power flowing from the grid to the building. With a rooftop PV system, mitigating the risk of electrical shock becomes substantially more challenging since opening an AC service disconnect does not address the DC flowing from the PV modules to the inverter. Moreover, a DC disconnect device, while stopping the flow of current, would generally not provide voltage isolation, as lethal voltages can still occur on PV system output circuits for five minutes after disconnect due to energy stored in DC capacitors.[32] Thus, a DC disconnect device can provide a false sense of security to firefighters since the shock hazard would not have been completely mitigated in the panels and DC wiring, while adding a substantial additional expense to the cost of a PV system. Consequently, the solar industry has been working to help develop codes and standards related to rapid shutdown to address the electrical shock hazard to emergency responders.

An important addition to the NEC 2014 essentially requires rooftop PV systems to have the ability to very quickly reduce voltage to non-lethal levels in the event of an emergency.[33] This rapid shutdown provision represents a substantial safety improvement for firefighters and first responders by mitigating the risk of electrical shock when responding to emergency situations.[34] The NEC 2014 also requires that when a rooftop DC disconnect device is used, it contain warning labels indicating the presence of a shock hazard even when in the open (i.e., "off") position.

While some stakeholders initially sought to add rapid shutdown provisions at the level of individual PV modules during the drafting of the NEC 2014, that provision was modified following collaborative stakeholder input. The NEC 2014 as adopted includes a provision requiring array-level-only rapid shutdown capabilities, which can be achieved through a variety of system designs and technologies. This modification stemmed from concerns the solar industry expressed related to the availability of equipment compliant with the proposed requirement.[35] Some technologies such as DC optimizers and microinverters comply with the NEC 2014 rapid shutdown requirements, whereas systems with conventional string inverters need additional equipment to comply.[36]

Some states elected not to adopt the rapid shutdown requirements when adopting updated electrical codes.[37] Moreover, some AHJ inspectors in states adopting the 2014 NEC rapid shut down provisions have not consistently enforced the provisions.[38] Similarly, some AHJs responded to changes to the NEC 2011 regarding arc-fault requirements,[39] which are designed to protect against arcing faults (a high-power discharge that could start an electrical fire) in PV system components and wiring through use of a protective device, by waiving or delaying enforcement of the provision to allow time for devices to comply with the applicable product safety standard.

The NEC 2017 was issued by NFPA in August 2016. As of January 1, 2017, it has been adopted by Massachusetts, with 23 other states in the process of adopting it.[40] It includes compromise provisions on rapid shutdown requirements,[41] including a delayed effective date of January 1, 2019, to allow for the industry to develop product safety standards. The NEC 2017 will also allow three different compliance options for rapid shutdown.[42] Other changes to the NEC 2017 are aimed at reducing confusion among PV installers and inspectors, improving overall safety, eliminating superfluous warning signage requirements, cutting provisions on center-fed panelboards that resulted in unnecessary expenses (as implemented

AN EXAMPLE IN PRACTICE

Massachusetts Electrical Code

The Board of Fire Prevention is charged with promulgating the state electrical code in Massachusetts.[1] Effective January 1, 2017, the NEC 2017, with revisions, was adopted as the state electrical code, making Massachusetts the first state to enact the updated edition.[2] Massachusetts was also the first state to adopt the NEC 2014. One Massachusetts amendment to the NEC 2014 specified that the rapid-shutdown requirement would not be enforced until January 1, 2017. Massachusetts also adopted an amendment to the NEC 2014 to create an alternative pathway for equipment to be eligible for meeting the rapid shutdown requirement prior to the January 1, 2017, enforcement date.

1 M.G.L. c. 143, § 3L

2 *Electrical Code Coalition. "NEC in Effect, 1/1/2017." Accessed January 11, 2017.*

by some AHJs), and substantially improving accuracy in calculations that allow for better sizing of system components.[43]

These examples underscore how code requirements can push technological innovation to improve safety. Ongoing discussions regarding provisions such as rapid shutdown requirements, however, also demonstrate that implementing code provisions can be challenging and costly. Collaborative and transparent code adoption processes can help alert officials to both industry and first responder concerns and create a forum where both innovation and compromise are possible.

PLANNING AND ZONING FOR SOLAR

Zoning regulations can significantly impact where and how solar development can occur in a community. Critical components of zoning regulations related to rooftop PV systems include height restrictions and setbacks, applicability of these restrictions to PV systems, and whether additional permits or zoning variances are needed to install a PV system. Zoning ordinances and building codes often require that structures meet specific minimum setbacks from property lines or that rooftop equipment (such as PV panels) be set back from the edge of the roof. Similarly, building height regulations restrict the height of development for specific types of buildings and structures. Some of these ordinances may unnecessarily apply to PV installations and impose unintended burdens on solar development goals. To over-come these hurdles, officials can consider:

- Explicitly waiving building height restrictions for otherwise compliant buildings where the addition of a rooftop PV system would cause the building to exceed its height restriction;
- Incorporating appropriate exemptions or modifications to setback and height restrictions or ordinances specifically for PV systems;
- Waiving side and rear property line setbacks for PV systems to remove barriers for solar development on portions of the property not facing public view;
- Amending other barriers in the zoning code related to a parcel, such as yard requirements or impervious coverage requirements; and
- Providing a streamlined variance or waiver process specific to PV installations.

It is also often appropriate for most types of rooftop PV systems to be expressly listed as a permitted accessory use. This classification means installers avoid what can be a lengthy and costly process of obtaining a separate zoning permit or variance prior to installing a PV system. While solar development on certain buildings or planning areas, such as historic buildings and historic districts, could warrant separate treatment, policymakers can provide rooftop PV installations a presumption of permitting approval. This can be accomplished through local zoning code amendments,[44] such as the following:

- Expressly defining solar energy systems in the "definitions" section of the zoning code, providing definitions for the energy system type (e.g., rooftop, ground-mounted, and building-integrated), identifying where the energy is used (onsite, off-site, or both), and detailing the physical size, shape, and energy capacity (e.g., small, medium, and large systems based on kW nameplate capacity);
- Adding the defined solar energy systems to appropriate zoning districts (e.g., residential, agricultural, commercial, industrial, and mixed-use districts); and
- Specifying whether each defined solar energy system is allowed as a principal use or accessory use on the parcel, and other classifications that might apply to the area (e.g., special use). A rooftop PV system is generally classified as an "accessory use" because it is subordinate and incidental to the principal use of the property.

Solar Access and Rights

Solar access and rights provisions are found in state statutes and local ordinances, and they protect property owners' rights to access sunlight on their property.[45] Solar rights specified by statute or ordinance can prohibit building codes, neighborhood covenants, and homeowners associations (HOA) from banning or implementing certain restrictions on rooftop PV systems. Restrictive HOA rules, for example, have been used to prevent homeowners in some neighborhoods from installing PV systems.[46]

NREL's *Clean Energy in City Codes* report found that of all solar references in a sample of municipal codes (CA, FL, MD, and MN), 23 percent related to solar access. The report notes, "Many of the references in this sample prohibit new buildings from limiting an abutting property's solar access, require landscaping plans to minimize or mitigate solar access impacts, or include solar access as a consideration when addressing zoning variance requests."

Solar easements are legal agreements protecting a solar customer's access to sunlight on her property and preventing shading created by obstructions from an adjacent property. State or local governments can adopt a solar access permit structure in which a solar easement is created when a solar customer receives a permit to install a PV system. This arrangement gives assurance to the customer that a new obstruction that would shade the solar system will not be added to an adjacent property for a specified period of time.

SECTION 2

Recommendations & Considerations

Officials should consider how rooftop solar PV systems fit within their building, fire, and electrical codes and zoning regulations, as well as how these regulations are applied and enforced in their community. Each community has different circumstances and goals, but all can encourage smart, sustainable solar development by adopting codes and ordinances that are prudent, but not prohibitive. Safety considerations in the installation of rooftop PV systems should be addressed, but it is also possible to remove some barriers to rooftop PV deployment by engaging stakeholders, streamlining certain processes, and training and educating staff and first responders about PV.

Some of the issues that arise related to rooftop PV in building, fire, and electrical codes can be addressed through increased training and education of officials charged with adopting and enforcing the codes. Program managers can help by coordinating solar-specific training for code officials and first responders and by providing technical assistance or other resources on solar code issues. Several recommendations and considerations for program managers are provided below.

Strengthen awareness among building officials, permitting staff, firefighters, and fire marshals about rooftop PV systems in your community.

- In locations where solar deployment has not become commonplace, proactively engaging AHJs on solar issues can help identify and address potential problems in code adoption and enforcement before they arise.
- Increasing firefighter awareness of PV systems, including providing information on where PV systems are located, if possible, can help ensure safety as well as acceptance for this new technology.

Offer training, education, and outreach to firefighters and building officials.

- Make training accessible, such as by offering night and weekend training options for volunteer firefighters who may not be available during weekdays.
- When possible, provide incentives to attend trainings. Possible incentives include continuing education credits, no-cost training, and food and refreshments.
- If state or local solar program staff or third-party representatives conduct on-site inspections (e.g., as part of the program's quality assurance/quality control process), offer building officials, electrical inspectors, and other government agency staff the opportunity to observe and participate.

– Tap networks to find instructors who are well-respected by both industry and government attendees.

– Offer training in geographically diverse locations across a state.

– Actively recruit training attendees and publicize through professional organizations or related networks.

Create an inclusive stakeholder process when adopting or updating codes.

– Actively solicit solar stakeholder participation, widely distribute notices of intent to change codes, and allow ample time for public comment.

– Create opportunities for constructive dialogue. Foster an open conversation between solar stakeholders, code enforcers, and other relevant parties (e.g., firefighters) to help all parties become more educated about the concerns of the others.

As discussed above, provisions within building, fire, and electrical codes involve many interested parties, including government agencies, local officials and first responders, consumer protection organizations, and the solar industry. Providing a well-publicized forum for these parties to collaborate on code updates prior to their adoption can allow code issues to be addressed before they create problems or unintended outcomes. Model codes discussed below are developed by experts and offer a useful starting point when discussing code adoption. They can be amended, added to, or otherwise revised to address local circumstances or concerns about certain provisions.

Use model codes as a starting point when considering adopting new or updated building, fire, and electrical codes, recognizing that local conditions and stakeholder input can create beneficial alternatives to some provisions.

– Explicitly address PV systems in codes.

– Adopt a process for updating codes when new model code editions are released.

– Consider including a transparent and expedited process for obtaining variances from certain provisions of codes as they relate to PV systems.

Provide clear and consistent enforcement of codes and a transparent process for appealing an enforcement action.

– Inconsistent or improper code enforcement can create frustration among solar contractors, inspectors, and customers.

– Lack of code enforcement can pose a risk to property and safety.

– Transparent and consistent enforcement of codes established though a fair and collaborative process can maximize the opportunity of creating positive outcomes for everyone involved.

Encourage desirable solar development by integrating solar into zoning ordinances and protecting property owner access to sunlight.

– In zoning ordinances, clearly articulate the conditions under which it is permissible or desirable to the community to have solar. This will help ensure solar deployment conforms with the goals and preferences of the community.

– Protecting property rights and enabling access to sunlight will likewise provide opportunities and minimize risk to those electing to adopt PV.

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SECTION 3

Licensing and Certification

State and local jurisdictions typically establish standards for electrical work and the qualifications required of contractors and individuals to perform electrical work. Most states adopt the National Electrical Code (discussed in the previous section), often with state or local modifications, as the standard for electrical installations.[47] Because PV systems contain numerous electrical components and usually connect to the electric grid, many states or localities require qualified electric professionals to perform many aspects of PV installation.[48]

The National Electrical Code defines a "qualified person" as "one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved."[49] The interpretation of "qualified person" varies by state and local jurisdictions according to state licensing and/or certification laws and standards.

Licensing and certification are the credentialing tools that states and local jurisdictions use to ensure that solar installers possess the qualifications, competence, and expertise to provide solar installation services—in other words, that the installer is a "qualified person." Most rules governing who is qualified to perform electrical work and the standards to which the work must be performed are adopted at the state level; however, local jurisdictions in some states establish electrician licensing standards and requirements. A license is a grant of legal authority to those individuals who demonstrate the necessary degree of knowledge, experience, and skill to safely and competently engage in the profession. Licensing is typically a mandatory requirement administered at the state level, and in some states at the municipal level. Certification is typically a voluntary credential that is administered by third-party, non-governmental organizations.[50] As discussed further below, state or local government administered solar programs will often incorporate third-party certification requirements into program rules.

Variations in state licensing and certification requirements can be significant and these differences have important implications for PV installations. Some important areas where licensing requirements may differ include:

- Whether the licensing function is administered at the state or local level;
- The type or level of license needed to perform PV installations;[51]

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- The components of a PV installation which are defined as electrical work and therefore require a licensed electrician to perform or supervise;
- The number of licensed electrical workers required to oversee non-licensed workers who also perform electrical work.

Many states require a general electrician license as a minimum credential to perform or oversee electrical work on PV installations. Others, however, allow individuals to obtain a limited license to perform electrical work but with specified limitations, such as limiting the size of the system or narrowing the components that can be installed with a limited license. In addition to licensure, some state or municipal agencies tasked with implementing solar incentive programs require solar contractors to hold a third-party certification in order for the system to be eligible for the incentive. Utilities that offer solar incentives may also require that licensed professionals perform the PV installation in order for the customer to qualify for the incentive, including licensed general contractors and/or licensed electrical contractors.

Licensing and certification requirements are important considerations for states and local jurisdictions because these requirements directly impact:

- The implementation of solar policy goals, including local or in-state investment;
- Pathways to employment in the state; and
- Labor costs associated with deploying PV.

Licensing standards are important aspects of PV installations. The level of training required, the allowable ratio of licensed electrician to apprentice, and the definition of "electrical" work are each important factors in establishing licensing standards. A state's ability to achieve their solar goals depends on the availability of qualified labor and consumer confidence in the safety and quality of the workmanship. Additionally, third-party certification offers installers a means by which to distinguish themselves from competition. Third-party certification also offers states and localities an additional tool to leverage in developing solar programs to ensure that participating installers have solar-specific training and qualifications independent of the state or localities licensing requirements. Third-party certification is especially useful for agencies or localities that do not possess licensing authority but want to condition access to certain program incentives upon an installer having achieved minimum-level, PV-specific training.

This section highlights three variations of licensing and certification regimes employed by states and localities to illustrate different licensing models for rooftop solar installers: general electric licensing, limited electric licensing, and third-party certification.

GENERAL ELECTRIC LICENSING

In states and localities where electrical work is a licensed trade and limited electric licensing options do not exist, PV installations must be completed and/or overseen by a licensed electrician, often referred to as a "journeyman license."[52] To operate as an electrical contractor, a company must hire a licensed "master electrician." An important distinguishing characteristic, regardless of the name given to the license, is that a journeyman license grants an individual the right to work as an electrician, while the master's license grants the firm or business the right to hire journeymen and other workers and to hold itself out to conduct business as an electrical contractor.[53] The education and on-the-job training requirements are generally not specific to any particular area of electrical specialty, such as PV, and vary by state.[54]

An important distinguishing factor between these examples is the allowed ratio of licensed electrician to non-licensed apprentices. The practical impact of the ratio requirement can be significantly compounded depending on whether all aspects of a PV installation are considered

TABLE 1: **General Electrician Licensing in Selected States: Training and Ratio Requirements**

State	License Type	Minimum Training Required	Ratio of licensed electrician to non-licensed apprentice
Idaho[55]	Journeyman	Classroom: 576 credit hours (4 years); On-the-job training: 8,000 hours (4 years)	1:3
Massachusetts[56]	Journeyman	Classroom: 600 credit hours; On-the-job-training: 8,000 hours (4 years)	1:1
Minnesota[57]	Journeyman	On-the-job training: 8,000 hours (4 years)	1:2
Wisconsin[58]	Journeyman	Classroom: no minimum requirement (but educational experience may be claimed toward required experience; On-the-job experience: 8,000 hours (4 years)	1:1

Examples of the general electric license and the ratio of licensed to non-licensed apprentice requirements for PV installation in some states.

"electrical" and therefore must be performed or supervised by a licensed electrician (e.g., Massachusetts) or if some aspects are non-electrical and do not require the licensed electrician (e.g., Wisconsin). A very low (e.g., 1:1) ratio requirement for PV installations means that a higher number of licensed electricians may be required per installation.

There are tradeoffs that should be considered when setting ratio requirements and defining which aspects of a PV installation are "electrical" work. For instance, if all aspects of a PV installation are defined as "electrical," a licensed electrician and supervisee must perform all aspects of the installation. This ensures that trained electricians perform the entire installation; however, this also increases the labor cost compared to an installation where a licensed electrician performs only some aspect of the installation. The definition of "electrical" work as it pertains to a PV installation therefore has important implications. There are similar tradeoffs associated with the ratio requirement, for larger PV installations in particular.

The ratio and definition of electrical work considerations directly influence the individuals qualified to perform certain aspects of PV installations and the available labor force. Policymakers and solar program developers are encouraged to take these considerations into account when developing new or assessing existing PV programs.

Massachusetts law requires that a person, firm, or corporation in the business of installing wires, conduits, apparatus, devices, fixtures, or other appliances for carrying or using electricity carry the appropriate electrical license.[59] For the installation of PV systems, the Massachusetts Board of Electrical Examiners interprets this to mean that a "solar PV system . . . and associated apparatus such as, but not limited to, frames, racks, rails and modules must be assembled and installed by a licensed electrician."[60] A licensed electrician in Massachusetts is either a journeyman, "Class B" license holder, or a master, Class A license holder. To apply for a journeyman license, the applicant must have completed 600 hours of classroom instruction and 8,000 hours of electrical work experience. To apply for a master license, the applicant must complete 150 hours of classroom instruction and have one year of active electric experience as a licensed journeyman.[61]

The effect of the Massachusetts Board of Electrical Examiners' determination that most aspects of a solar installation constitute "electrical work" means that nearly all aspects of a PV installation must either be completed by a licensed electrician or by a person under the supervision of a licensed electrician.[62] Massachusetts has adopted the National Electrical Code recommendation that a licensed electrician may supervise only one non-licensed apprentice.[63]

AN EXAMPLE IN PRACTICE

Massachusetts' Licensed Electrician Requirement

In Massachusetts, any person, firm, or corporation in the business of installing wires, conduits, apparatus, devices, fixtures, or other appliances for carrying or using electricity must have the appropriate electrical license. The Massachusetts Board of Electrical Examiners' determination that most aspects of a solar installation constitute "electrical work" means that nearly all aspects of a solar install must either be completed by a licensed electrician or by a person under the supervision of a licensed electrician. Massachusetts does not preclude contractors that do not hold an electrician's license from advertising or bidding on solar PV projects, and performing a number of the tasks associated with those projects. The non-electrician licensed contractor, however, must sub-contract with a licensed firm or electrician to perform the electrical aspects of the actual PV installation.

1 M.G.L. c 141 § 1A.

LIMITED ELECTRIC LICENSING


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As used in this guide, a limited license describes a license obtained by a person or firm that allows that person to perform a discrete and often narrow scope of work in a specified electric field, such as solar PV. This is distinct from a specialty license, which is obtained in addition to general electrician's license to either comply with additional licensing requirements or highlight a particular area of expertise, such as PV.[64] Some states provide limited electriclicensing for particular sub-fields of electric work.

The concept of limited electric licensing is widely applied in the electric field for non-solar electrical work. For instance, numerous states offer limited licenses for the installation and servicing of certain electric systems such as fire alarms, electric security devices, and other discrete electrical applications. The limited license requires focused training in the field, requiring less time to complete than a general electrician's license. It enables the license holder to perform a defined scope of electrical work limited to the particular subfield.

One potential benefit of creating a limited license class for PV is a lower labor cost associated with a limited license holder as compared to the general license holder due to the narrowed scope of electrical training. Examples of states that offer "limited" electric licenses for non-solar applications are listed in Table 2. Examples of states that offer limited licenses for solar applications are listed in Table 3.

TABLE 2: **Examples of Non-Solar "Limited" Electric Licenses and Training Requirements**

State	License Type	Minimum Training Required
Oklahoma[65]	Alarm Endorsement Registration	Electrical Apprentice Registration
Nebraska[66]	Fire Alarm Installer	2 years experience in planning, laying out, and installing fire alarm systems

TABLE 3: **Examples of Solar "Limited" Electric Licenses and Training Requirements**

State	Name/License Type	Minimum Training Required
California[67]	C-46 Solar Contractor	Classroom: no minimum; On-the-job-training: 4 years of solar experience (apprenticeship training and advanced education is credited, but 1 year of practical experience required
Connecticut[68]	PV-1 – Limited Solar Electric Contractor	Classroom: 144 hours; On-the-job training: 4,000 apprentice hours (2 years)
Oregon[69]	Limited Renewable Energy Technician	Classroom: 144 hours; On-the-job training: 4,000 apprentice hours (2 years)

AN EXAMPLE IN PRACTICE

Oregon's Limited Renewable Energy Technician and Contractor Licenses

Oregon offers many license classifications, including limited electric licenses. While licensed electric contractors and journeymen are authorized to oversee and perform all electrical work necessary for the installation of PV systems, Oregon law also allows the holder of a Limited Renewable Energy Technician's license to oversee and perform most aspects of a rooftop solar installation. While the Limited Renewable Energy Technician license restricts the scope of the electrical work a licensee may perform and the size of the system that the licensee may install, it provides an avenue for achieving licensure to supervise the work on most residential and some small commercial solar systems in much less time than required to earn a journeyman or electric contractor license.

Oregon SEIA, Solar Installation and Program Information and Educational Opportunities

The state of Oregon offers many different electric license classifications, including limited electric licenses. Examples include Electrical Contractor, Supervising Electrician (General and Limited), Journeyman (General and Limited), Electrical Apprentice, Limited Renewable Energy Contractor, and Limited Renewable Energy Technician.

While licensed electric contractors and journeymen are authorized to oversee and perform all electrical work necessary for the installation of PV systems, Oregon law also allows the holder of a Limited Renewable Energy Technician's license to oversee and perform most aspects of a rooftop solar installation. While the Limited Renewable Energy Technician license restricts the scope of the electrical work a licensee may perform and the size of the system that the licensee may install, it provides an avenue for achieving licensure to supervise the work on most residential and some small commercial solar systems in much less time than required to earn a journeyman or electric contractor license.[70]

Oregon's Limited Renewable Energy Contractor license allows the holder to employ a Limited Renewable Energy Technician and contract for electrical work that may be performed by a Limited Renewable Energy Technician.[71] The Limited Renewable Energy Technician license permits the holder to perform rooftop solar installation for systems up to 25 kW. The Limited Renewable Energy Technician license permits the holder, as the employee of a licensed electrical contractor, or limited renewable energy contractor, to install, maintain, replace or repair electrical wiring and electrical products on renewable electrical energy systems up to 25 kW.[72] For PV systems, this allows the Limited Renewable Energy Technician to complete nearly the entire installation, including installing the inverter. A fully licensed electrician, however, must perform the grid interconnection.[73]

THIRD-PARTY CERTIFICATION

Third-party certification programs are typically administered by non-government organizations such as nonprofit organizations, professional associations, or industry trade organizations. The nonprofit North American Board of Certified Energy Practitioners (NABCEP) provides the most well-known PV certification program for solar industry professionals, although other the organizations such as Electrical Training Alliance[74] and Underwriters Laboratory (UL)[75] offer solar-specific certification as well.[76] NABCEP offers a "Photovoltaic Associate" (formerly called "Entry Level") certification and a "PV Installation Professional" certification. The Associate certification allows entry-level individuals to demonstrate basic knowledge and skills.

Candidates for the PV Installation Professional certification must have the requisite field experience,[77] a minimum of 58 hours of advanced PV training,[78] and an Occupational Safety and Health Administration (OSHA) 10-hour construction industry card or equivalent and continuing education.[79]

Professional certificates attest to the certificate holder's competence, skill and knowledge of the trade pursuant to the standards and requirements of the certifying body. While certification is a means by which industry professionals may obtain additional training or specialization, some jurisdictions also use third-party certification to establish eligibility to participate in solar incentive programs (e.g., Maine, Wisconsin, and New York). Many states also have statewide licensing requirements. In these states, third-party certification is either voluntary or supplemental to the statewide licensing requirement, or in some cases, such as Connecticut, an additional credential necessary to access state incentives. The Energy Trust of Oregon has adopted an independent certification system for program eligibility.

Some examples of three state programs and a municipal program that rely on existing third-party certification for program eligibility, as well as the Energy Trust of Oregon with its own Solar Trade Ally certification program, are featured on pages 28 and 29.

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Examples of Programs that Include Certification for Solar Contractors

NYSERDA Participating Contractor List

New York has a robust solar market, ranking seventh nationally with respect to total installed solar electric capacity.[80] New York, however, does not have a statewide electric licensing requirement. While some municipalities in New York have electrician licensing requirements, others do not require a license to perform electrical work, including PV installations. The vast majority of customers with rooftop solar installations in New York, however, receive incentive funding from the New York State Energy Research & Development Authority (NYSERDA). To qualify to work on an installation for which the contractor receives NYSERDA incentives on behalf of the customer, the project installer must be registered with NYSERDA as a "Participating Contractor."[81] To qualify as a NYSERDA participating contractor, a contractor must have a valid third-party certification. Accrediting organizations accepted by NYSERDA include NABCEP, Underwriters Laboratory, and the Building Performance Institute (BPI).[82]

While the absence of a statewide licensing requirement is a significant departure from most other states, and NYSERDA does not have authority to institute licensing requirements for solar installers, third-party credentialing allows NYSERDA to require minimum standards of competence that solar contractors must demonstrate to be eligible for its incentive programs.[83]

Other states and local jurisdictions similarly tie installer eligibility for state-funded programs to third-party certifications but certification is typically voluntary and supplemental to the statewide licensing requirement and in some cases an additional requirement to access state incentives.

Rhode Island's Renewable Energy Professionals License

Prior to 2014, only businesses with licensed electrical contractors on staff were permitted to advertise and contract for solar PV installation work. This restriction meant that companies were barred from advertising and operating as a general contractor for a solar installation. In 2014, the Rhode Island legislature sought to relieve this problem and created a "Renewable Energy Professional Certificate." This new licensing category allows Rhode Island-certified Renewable Energy Professionals[84] to advertise themselves as a PV installation company and perform "ancillary non-electrical" work associated with the development of a "renewable energy system" (including solar).[85] Under the new law, one person in a company must hold a Renewable Energy Professional Certificate to qualify the company to contract for renewable energy service work. To qualify, the person must receive a third-party "certification from a nationally recognized, equivalent, renewable energy certification training program." Rhode Island accepts various third-party certifications, including NABCEP certification.[86]

It is important to distinguish Rhode Island's Renewable Energy Professional Certificate from "limited license" programs, such as Oregon's Limited Renewable Energy Technician license. While the Limited Renewable Energy Technician license allows the license holder to perform specified electrical work, the Renewable Energy Professional Certificate is not a form of electrician's license; it instead allows a Renewable Energy Professional Certificate holder to advertise and bid for renewable energy jobs that entail electrical work.[87] The Renewable Energy Professional Certificate holder must subcontract all aspect of electrical work to a licensed electrician.

The Renewable Energy Professional Certificate program was developed to address an issue specific to Rhode Island; that general contractors were not able to advertise and contract for PV installation work. Additionally, by requiring the contractors to have solar training and certification, the Rhode Island program helps to ensure that solar installations meet the most up-to-date industry standards and power output expectations.

Cincinnati's Solarize Program

In Ohio, contractors who perform electrical work, including PV installations, must obtain an electrician's license from the Ohio Construction Industry Licensing Board.[88] Local jurisdictions require electrical contractors to register with the city prior to operating within the jurisdiction, but do not have the authority to issue, condition, or revoke electrician licenses.[89] Local jurisdictions do, however, have the authority to design and adopt solar incentive programs to meet local energy goals and can require solar installers to obtain third-party certifications as a condition to participating in the program.

The City of Cincinnati has adopted an innovative model for advancing the city's clean energy goals through a partnership with the Greater Cincinnati Energy Alliance, a non-profit, non-governmental entity.[90] The Alliance is a third-party administrator tasked with designing and implementing clean energy programs for Cincinnati, including the "Solarize Cincy" program. Solarize Cincy offers lower prices for solar panels through bulk purchasing opportunities and a $250 per kW rebate up to $2,000 per household for participants.[91] Participating customers must have their system installed by one of four approved solar installers. Approved installers must hold NABCEP certification. While the Cincinnati model is similar to the NYSERDA model in that it ties incentive program eligibility to third-party certification, Cincinnati's program was initiated at the local government level and is administered by a non-governmental entity, not a state entity. It demonstrates how local municipalities, acting within their statutory authority, can leverage third-party partnerships and third-party certification requirements to accelerate PV development goals and maintain installation quality by means other than traditional licensing.

Energy Trust of Oregon's Solar Trade Ally Program

Energy Trust of Oregon is an independent non-profit organization selected by the Oregon Public Utility Commission to provide low-cost, clean energy solutions in Oregon and Washington.[92] Energy Trust is funded by a percentage charge on the utility bills of Portland General Electric, Pacific Power, NW Natural, and Cascade Natural Gas customers, and it provides cash incentives and services to help utility customers make improvements to save energy, generate renewable power, and manage costs in their homes, businesses, and communities.[93]

Unlike other state programs that rely on third-party certification systems, the Energy Trust of Oregon has created its own certification system. The Energy Trust of Oregon's Solar Trade Ally Program is a unique certification program that ensures that participating contractors receive training in the Energy Trust's standards, quality control requirements, and incentives. Trade Ally partners agree to perform work in accordance with program requirements and are eligible for benefits provided by Energy Trust, which include access to specialized training resources, technical assistance, and the right to perform installations for customers that receive Energy Trust incentives.[94] The motivation to become a Solar Trade Ally contractor is strong, as non-participating contractors are not eligible to offer or apply on a customer's behalf for the solar electric cash incentive. Beyond the cash incentive, solar trade ally contractors can take advantage of other programs administered by Energy Trust such as reimbursement for the cost of preapproved advertising, marketing, training, certification and business development opportunities.

OTHER ISSUES: INSTALLER DATABASES AND CONTRACTOR LISTS

Many states provide various types of PV installer or contractor lists. Often a state agency will provide a directory for consumers to identify solar contractors or installers in their area. Directory-style lists typically are not intended as an endorsement of particular contractors and the agency does not provide background screening of listed installers. In other cases, agencies provide lists that are intended to provide consumers with information about whether an installer meets certain state requirements—often related to whether the listed entity qualifies for state or municipal incentive programs. Below are several examples of solar contractor lists:

- The California "*Solar Installers Database*" is a directory-style list. The California Energy Commission provides the list for informational purposes only and does not endorse any of the listed entities.
- The NYSERDA "*Participating Contractor*" list identifies those installers that meet NYSERDA's requirements to participate in state-based incentive programs (as discussed above, one requirement for participation is obtaining a NYSERDA-approved, third-party certification).
- The Connecticut GoSolarCT "*Eligible Contractor*" list identifies contractors that are eligible for the Connecticut Green Bank solar incentive program.
- Energy Trust of Oregon's "*Trade Ally Contractors*" list, discussed above, identifies contractors that are eligible for the Energy Trust administered funds. Trade Ally Contractors receive training and support from Energy Trust. In February 2017, Energy Trust of Oregon will launch a rating system for solar contractors. The rating system will evaluate solar contractors based on program service, quality service, and customer service. Solar customers will be able to view the ratings of individual Oregon Solar Trade Allies.[95]

The usefulness of installer lists depends on the underlying purpose of the list and whether the criteria for inclusion are clear and easily understood by consumers and installers alike. If a state chooses to pursue an installer rating list similar to the Solar Trade Ally rating system the Energy Trust of Oregon is developing, collaboration with solar program staff, industry, installers, consumer advocacy organizations, and state and local system inspectors will be especially important to allow for fair and transparent evaluation criteria and ranking protocol.

SECTION 3

Recommendations & Considerations

Solar PV development goals and circumstances vary by state and there is no "one-size-fits-all" licensing or certification standard. The following recommendations and considerations are offered for policymakers and solar program officials to consider when reviewing, adopting or revising licensing and certification standards for their state or local jurisdiction. Some may be more applicable than others, depending upon the goals and circumstances of the individual state, local jurisdiction, or agency charged with development and implementation.

Identify whether state or local circumstances, or technological advancements, warrant modification of National Electrical Code licensing recommendations for PV.

Some factors to consider with respect to licensed electrician-to-non-licensed worker (apprentice) ratios include:

– The number of licensed electricians in the state and existing non-solar related demand for those individuals.

– The anticipated labor force required to meet solar installation demand.

– The various aspects of solar installation that require a licensed electrician under existing statutes and rules.

– Whether there are elements of electrical work currently required to be performed by a licensed electrician that can safely be performed by a non-licensed electrician.

– Whether the ratio requirement that applies to non-PV work is equally applicable to PV installations or whether a different ratio should apply.

– The change in installation costs that would result from a different ratio requirement or changes to the definition of "electrical work" related to PV installations.

– Whether technological advancements in solar panels, inverters, racking and mounting equipment, electrical systems, and other equipment in conjunction with current licensing requirements necessitate modifications to licensing requirements, such as the definition of "electrical work" or ratio requirements.

A review of these and other considerations can help a state or local jurisdiction identify whether modifications are warranted:

– Provided additional guidance and clarity on the scope of solar installation work that must be performed or supervised by a licensed electrician.

- Revised the scope of work that must be completed or supervised by licensed electricians to allow skilled construction trade laborers to perform non-electrical (e.g. structural) aspects of PV installations.
- Increased the ratio of non-licensed apprentices that a licensed electrician is allowed to supervise.
- Developed "limited electrician" licenses specific to PV installations that allow an individual or contractor to meet training and work experience requirements specific to, and limited to, PV installations.
- Provided clear guidance and updates on enforcement priorities to solar installers, electrical inspectors, and consumers.
- Allowed skilled construction trades and laborers (or simply licensed general contractors) to perform the structural aspects of solar with electricians performing all wiring and traditional electrical work.

Clearly define licensing and certification standards to help contractors and consumers understand the credentials necessary to perform various aspects of a PV installation and qualify for state or municipal incentive programs, and to help contractors more accurately bid projects.

A survey of existing licensing requirements may reveal areas in the licensing code that warrant modification with respect to installations to ensure that an adequate and qualified labor force is available without compromising safety or quality of work. State and municipalities should consider:

- Reviewing enforcement guidelines to ensure that contractors and installers understand code enforcement and system performance expectations and requirements; and
- Disseminating and making available online updates in code enforcement priorities and guidelines.

Third-party certifications can be a useful mechanism for entities at the state or local level that implement solar programs but lack licensing authority. Third-party certification can be used in conjunction with other programs to require solar installers to meet minimum solar-specific training requirements. This is especially important in the solar field to keep installers abreast of technology advances that can outpace changes in regulatory regimes. Program developers and administrators can leverage third-party certifications as part of solar incentive programs and other state or locally administered solar programs by:

- Integrating third-party certification requirements into other areas in which the agency or locality has control (such as the development and implementation of local solarize campaigns, incentive funding, and other solar programs or other mechanisms within the authority's jurisdiction).

- Setting clear guidelines and enforcement priorities in solar program rules for third-party certification requirements.
- Exploring partnerships between state or local jurisdictions and third-party non-government administrators to provide additional flexibility in program implementation and enforcement, and program review and modification.

Provide clear and transparent solar installer contractor lists or databases to reflect information, education, and rating goals

Solar installer databases can assist customers in identifying, evaluating, and selecting solar installers. When developing solar installer lists and databases, officials should consider the following to enhance the usefulness of these tools for both consumers and installers:

- Make the purpose of the list or database prominent, clear, and transparent.
- If the list is simply a directory of all available installers, or participating installers for a particular state or municipal program, clarify whether the list indicates an endorsement of listed installers or not.
- Encourage consumers to conduct their own review and due diligence before selecting an installer.
- When specific credentials are required to become a "participating installer" for state or local solar programs, include information about the additional training required and screening or evaluation metrics used to distinguish a "participating installer" from a non-participating installer.
- For "contractor rating" portals, clearly identify and explain the rating criteria, evaluation standards, and other elements of the portal, including periodic updates, and avenues and opportunities for contractors to address poor ratings or delisting.
- Work with industry, contractors, consumer advocacy groups, and state and local inspectors to develop portal rating criteria, evaluation standards, and other rating program design elements.

Identify and address implementation hurdles related to licensing and certification standards when developing solar programs and policies.

Numerous state and local agency directives are invoked when solar development goals are implemented. For example, an agency tasked with administering an incentive program may discover that a separate agency enforcing electrical licensing requirements has statutory mandates that conflict with solar development implementation goals and expectations. It is desirable to collaborate with "stakeholder" agencies and utilities to identify and address potential implementation conflicts early in the planning and program development phase.

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To facilitate this process:

- Appoint a solar implementation lead to identify and convene stakeholder agencies (state and local) and participating utilities early on in order to get buy in from those entities to work together to develop and implement the solar policy goals.
- Identify and appoint a solar implementation "champion" within each stakeholder agency.
- Work with the respective agencies and utilities to revise rules or guidance as needed.

SECTION 4

Equipment Standards and Warranties

Innovation in solar equipment has helped reduce the median installed cost of residential PV systems from approximately $8 per watt in 2009 to $4.10 per watt in 2015.[96] Today's solar equipment has higher equipment durability factors, increased conversion efficiencies, better inverter functionality and enhanced interoperability between customer-sited solar systems and the grid. These advances did not occur, and will not continue to occur, without lengthy premarket equipment testing. With new and modified products, all facets of long-term product performance and durability cannot be known in the early development stages. These are important consumer protection considerations that can be addressed by implementing clear and transparent rules and guidelines for industry.

A typical residential PV system requires a significant investment. Installer and manufacturer warranties, third-party-developed equipment standards, and state-based equipment legal standards are essential tools for consumers to rely on when selecting installers and choosing between equipment types and brands.

EQUIPMENT STANDARDS

Equipment standards ensure product safety, help set consumer expectations, and drive industry innovation and investor confidence. State and local governments play an important role in developing and applying these standards. Whereas codes provide legally-binding requirements, equipment standards relating to PV systems have typically set eligibility criteria under government-administered incentive programs, or government-led purchasing programs, or served as utility-enforced prerequisites for interconnecting to the electric grid.

The equipment standards developed by the California Energy Commission (CEC) in 2007 are the most widely adopted and applicable equipment standards in the country. Many states apply the CEC's standards. Other states have adopted different equipment standards. This section discusses the most commonly used third-party and state PV-equipment elements that provide benefits to consumers and industry, as well as those that could be improved.

Third-Party Equipment Standards

Several third-party-developed equipment standards have been widely adopted across the country. The Underwriters Laboratories (UL), an independent safety science company, develops standards, product requirements, testing, and certification processes for ensuring various products meet safety standards. In addition to certifying PV installers as described above, UL tests and certifies solar PV modules in accordance with the National Electrical Code and Model Building Codes.[97] UL 1703 provides a process for testing minimum safety and performance standards for PV modules, ensuring the equipment mitigates mechanical, electrical, and fire hazards, and performs according to minimum standards. For example, the testing process includes several environmental tests to make sure the module does not break or degrade under typical operating conditions. UL has also developed processes to test PV components, including electrical components, inverters, interconnection equipment, rack mounting systems[98] and trackers (used in some large-scale PV systems).[99] UL 1741 provides UL's process for testing standards for inverters, converters, controllers, and PV interconnection system equipment. These standards are published under the American National Standards Institute's (ANSI) accredited process for Standards Development Organizations.

The Institute of Electrical and Electronics Engineers (IEEE), a professional society, develops industry-driven consensus standards on equipment, including PV system grid integration and energy storage devices. IEEE 1547 articulates the widely adopted standard for interconnecting a rooftop PV system to the electric grid.[100] Key provisions in IEEE 1547 include voltage and frequency trip thresholds, disconnection, grounding, monitoring, and islanding requirements—in short, the technical standards that provide safety and performance assurances so grid-connected PV systems do not create safety or reliability problems for grid operators or consumers. The *Energy Policy Act of 2005* set IEEE 1547 as the national standard for interconnecting rooftop solar PV systems (and other distributed generation resources) to the grid, and many states and utilities have adopted IEEE 1547 as part of their interconnections standards.

Third-party equipment standards, including UL 1703, UL 1741, and IEEE 1547, are applied in conjunction with and as a complement to one another and electrical and fire codes. For example, UL 1741 is intended to be jointly used with IEEE 1547, and the products covered by UL 1703 and UL 1741 are intended to comply with the National Electrical Code, NFPA 70.

State-Mandated Equipment Standards

State equipment standards can support consumer and investor confidence in products, as well as provide assurances that tax dollars used in government-sponsored solar programs or incentives are supporting deployment of quality equipment. Depending on how they are implemented, state-mandated equipment requirements could also impose unintended additional costs or restrictions on PV systems or be of limited value if the standards fail to ensure that only quality products are used. When creating or modifying equipment standards, officials should consider:

- The strengths and weaknesses of equipment standards commonly used by other states, including the extent to which they address equipment safety, performance, and testing;
- Actively soliciting diverse stakeholder feedback early in the development of the standards;

- The additional burden or cost the standards could impose on manufacturers, installers, or contractors that may be passed on to consumers;
- How the standards could reinforce or detract from important policy goals on consumer protection, investor confidence, responsible use of taxpayer dollars, renewable energy market development, carbon and other pollution mitigation, and other energy, social, or environmental goals; and
- The additional protections or assurances that the equipment standards would provide above and beyond what other codes and standards require.

California Equipment Eligibility List

With the passage of SB 1 in 2007, the California Energy Commission was directed to establish rating and compliance standards for solar equipment, components, and systems.[101] As of 2015, at least 16 states (including California), representing 70 percent of the U.S. solar market, used the California Energy Commission (CEC) equipment standards list to calculate upfront incentives, project future costs for performance-based incentives, or determine whether PV equipment is eligible for the state's solar tax credits or other incentives. Industry and other organizations, including utilities, project developers, and research institutions use the list for numerous purposes. The National Renewable Energy Laboratory (NREL), which

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has used the list to develop location-based performance estimates for specific PV systems, dubbed the list the "de facto national eligible equipment list."[102]

Equipment, components, and systems must be on the Energy Commission's eligible equipment list to qualify for ratepayer-funded solar incentives in California. To qualify for the CEC's list of eligible PV modules, safety certification from a Nationally Recognized Testing Laboratory and third-party-tested electrical characterization data must be provided. Importantly, the CEC notes that inclusion on its list "does not demonstrate equipment quality, performance over time, reliability, or durability." The CEC also does not remove discontinued equipment (although some models have been removed after manufacturers failed to honor their warranties). Manufacturers of PV modules and inverters must offer a minimum 10-year warranty on the equipment, protecting customers from defects and undue degradation. Currently, there are approximately 17,000 types of equipment on the list.

Florida Solar Energy Standards Act

Florida adopted its solar equipment standard through the Solar Energy Standards Act of 1976. Under the Energy Standards Act, the Florida Solar Energy Center is responsible for certifying all PV systems and modules sold or manufactured in Florida.[103] To qualify for the list, manufacturers apply and request that the Florida Solar Energy Center test equipment samples. Testing is conducted in accordance with Florida Solar Energy Center standards. Once a system successfully completes the process and has been accepted, the Florida Solar Energy Center issues the manufacturer a certificate. The Florida Solar Energy Center accepts power-rating tests for PV modules conducted by other labs if the tests are administered in accordance with Florida Solar Energy Center standards.[104] Revocation of approval may be initiated by the supplier or the Florida Solar Energy Center. The Florida Solar Energy Center may revoke or suspend an approval for grid-connected PV systems under any of the following circumstances:

- Deliberate misrepresentation of documentation submitted in the application for design review and approval;
- Claiming that one PV system approval applies to another system which has not been approved;
- Failure to comply with a condition of approval or product labeling; or
- Failure to correct a discrepancy that is detected by the Florida Solar Energy Center after initial approval. The supplier is given 30 days in which to make corrections.[105]

MANUFACTURER AND WORKMANSHIP WARRANTIES

Solar product manufacturers and PV system installers can offer consumers warranties on system components and installation. Some states and local governments use these warranties as a means to establish equipment or contractor eligibility for state solar incentive programs. Tying solar incentives to manufacturer and contractor warranties is a significant motivation for manufacturers and contractors to guarantee their products and services.

Manufacturer Warranties

Manufacturer warranties protect consumers against product failures due to manufacturing defects, premature material degradation, and other issues that may arise during the warranty period. Solar panel manufacturers, for instance, warrant their panels' power production as a percentage of original output over specified time intervals.

As PV system components have improved, standard warranty lengths have increased. Today, many PV module manufacturers offer a 10- to 12-year product warranty from the date of installation, protecting against manufacturing defects, and a 25-year performance warranty, guaranteeing the PV module will not lose more than 20 percent of its output capacity during that time.[106] Inverters, which transform the electricity generated by the module from direct current into alternating current so it can be used by customers, typically have shorter warranties than PV modules. For example, conventional string inverters typically come with 5- to 10-year manufacturers' warranties. At least one microinverter manufacturer offers a 25-year warranty.[107]

Workmanship Warranties

Workmanship warranties offered by solar installers or contractors protect consumers against labor-related defects and materials and equipment not covered by separate manufacturer warranties. A workmanship warranty gives the consumer a level of protection and assurance that the PV system has been designed, assembled, and installed correctly, and will operate and perform as expected. Should a workmanship issue arise, workmanship warranties typically specify that the contractor will fix the problem for free.

Like manufacturer warranties, workmanship warranties are common requirements in state and local incentive programs and are offered by many installers outside of the context of incentive programs as well. Workmanship warranties lasting 5 to 10 years are typical, although they range from none at all to 25 years.

Production Guarantees

Solar installers usually provide an estimate to potential rooftop PV customers showing how much energy a system is expected to produce. Some installers offer production guarantees that a system will generate a certain amount of energy. A production guaranty is most common for third-party-owned PV systems (i.e., leases and power purchase agreements). In the event that an underlying problem caused the system to fail to generate as much electricity as promised, a production guarantee will require the installer to fix the problem or compensate the customer for the amount of energy that was promised, but not produced. This can provide customers with a way to enforce promises made by solar installers during the sales process. Production guarantees can include specific clauses or tables specifying how the customer will be compensated if the system produces less energy than estimated.

SOLARIZE CINCINNATI WARRANTIES

The City of Cincinnati partnered with third-party administrator Greater Cincinnati Energy Alliance to offer the *Solarize Cincy* program, which combined the benefits of lower costs from solar bulk-purchasing with a cash rebate incentive. The Greater Cincinnati Energy

Alliance set equipment standards and manufacturer warranty provisions as requirements for solar contractor eligibility in the programs. Using a third-party administrator offered several advantages, including providing greater flexibility to adapt to changing circumstances, vet qualified installers and contractors, and address issues in the event that a solar contractor failed to comply with program requirements. To be eligible for the *Solarize* program and cash rebates, solar contractors were required to use UL-certified equipment with minimum warranties of 10 years for inverters and 25 years on all PV panels, in addition to complying with U.S.-made solar panel and component provisions. Contractors were also required to offer a minimum two-year workmanship warranty.

ENERGY TRUST OF OREGON'S WARRANTY REQUIREMENTS

For a customer to qualify for Energy Trust solar electric incentives, the solar system must be installed by a Solar Trade Ally contractor (see Section 3), the design and installation must meet all program requirements, adhere to Energy Trust guidelines for contractor warranties, and use products that meet Energy Trust manufacturer warranty requirements. Energy Trust minimum warranty requirements are:

- PV modules must carry a 20-year warranty against performance degradation below 80% of original output.
- Inverters must carry a 5-year warranty against manufacturer's defects.
- Mounts and roofing material must carry at least 10 years of useful life remaining to ensure that it won't need repair or replacement early in the system's operational life.
- Solar Trade Ally contractors must provide a two-year system warranty that covers all labor for any repairs to defective equipment or workmanship.

Although Energy Trust does not require Solar Trade Allies to provide customers with a production guarantee, it does provide some assurances to customers regarding PV system output. As part of the incentive application process, Solar Trade Allies give Energy Trust detailed information on the PV system components, design, and shade analysis, which Energy Trust uses to calculate conservative production estimates on PV system output that is visible to customers on the application. While this estimate is not a guarantee, customers are provided with an additional level of assurance knowing the estimate is calculated in a standardized manner by an independent nonprofit rather than the solar installer, who may be motivated to overestimate production in order to make a sale.[108]

SECTION 4

Recommendations & Considerations

Solar warranties, guarantees, and equipment standards help customers feel secure in going solar. States and municipalities can adopt solar equipment policies that protect consumers without creating unnecessary hurdles for industry. Adhering to the following recommendations will help states and municipalities craft and implement sound solar equipment policies.

Provide clear information in program documents on equipment standards and warranty requirements.

Regardless of which equipment standards and warranty requirements are adopted, providing clear, easy-to-find, explicit information is important. Information can be conveyed on program websites, in guidelines, instructions, or on application forms, as well as expressly in rules, regulations, or statutes. Providing clarity on applicable standards and requirements can improve the experience of customers and solar contractors, mitigate the potential for inadvertent noncompliance, and reduce staff time spent answering inquiries.

When developing or updating policies related to equipment standards:

- Identify existing equipment standards already in place or widely used in practice in the jurisdiction.
- Consider the strengths and weaknesses of widely-adopted, existing third-party and state-developed equipment standards.
- Actively solicit participation, collaboration, and feedback from relevant stakeholders, including the solar manufacturers, contractors, and trade associations, consumer protection agencies and organizations, other relevant government agencies, and electric utilities.

When developing or updating policies related to equipment warranties or guarantees:

- Identify warranty and guarantee terms already commonly provided by solar manufacturers, installers, and contractors.
- Actively solicit participation, collaboration, and feedback from relevant stakeholders, including solar manufacturers, contractors, and trade associations; consumer protection agencies and organizations; and relevant government agencies.
- Find an appropriate balance to address consumer protection issues without stifling solar deployment.

SECTION 5

Conclusion

Building, fire, electric, and other solar installation codes, licensing and certification requirements, and equipment standards and warranties are critical components of sustainable solar markets. States and localities around the country have adopted regulations, programs, and incentives to meet solar-related public policy goals and to protect consumers, contractors, and the general public. Reviewing and updating existing codes and standards at the both the state and local government level in light of solar policy goals can help ensure a jurisdiction's goals are met. Well-crafted codes, rules, and standards are an important policy lever for improving the customer experience, promoting safety, and ensuring that rooftop PV development meets the goals, priorities, and expectations of officials and program managers.

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SECTION 6

Additional Resources

Installation

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Other

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Endnotes

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51 Common categories of licensed individuals or firms include electrical contractors (often "master electrician") and individual electricians (often "journeyperson"). The names and level of training required to achieve licensure for various license levels may vary by state or jurisdiction.

52 While this guide does not focus on general contractor (i.e., non-electric) licensing, it is important to note that some states require a company to be licensed as a general contractor to work on certain aspects of PV where the structural considerations of solar installation are part of safety and quality assurance considerations. For example, building structure, wind and other load calculations, flashing, and system assembly require construction skills. In these states, composite crews made up of skilled labor and licensed electricians work side-by-side to complete a solar installation. For instance, the wiring is typically considered electrical work in these states and requires a licensed electrician working for a licensed electrical contractor to complete these aspects of PV installation.

53 Some states require a company be licensed as a general contractor to work on certain aspects of solar PV or advertise their services. General contractor licensing considerations are not explored in this guide.

54 Some states offer special categories of licensure that reflect a person's specialization in a particular area. A specialty license is generally understood to be a credential that one can earn in addition to a general electrician licensing. A specialty license can help a licensed electrician highlight specialized knowledge and experience in a particular area, such as solar PV installations, to distinguish themselves from others without that specialization. A specialization in PV installations held by a licensed electrician should be distinguished from limited electrical licensing programs that limit the scope of a licensee's work to, for instance, rooftop PV installations. Limited licensure is discussed further in this section.

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56 M.G.L. c 141 § 1A.

57 Minnesota Department of Labor and Industry, "Personal Power Limited Technical and Electrical Licensing," *www.dli.mn.gov/ccld/LicElectricalPersonal.asp.*

58 Wisconsin Department of Safety and Professional Services, "Instructions for Journeyman Electrician Application," *http://dsps.wi.gov/Documents/Credentialing%20Forms/Trades%20Application%20Forms/fm3106.pdf.*

59 M.G.L. c 141 § 1A.

60 State Board of Electrical Examiners, Guidance Memo 13-01, *www.mass.gov/ocabr/licensee/dpl-boards/el/regulations/board-policies/guidance-memo-pv-installation.html.*

61 237 CMR 13.00 et seq.

62 Massachusetts does not preclude contractors that do not hold an electrician's license from advertising or bidding on solar PV projects, and performing a number of the tasks associated with those projects. The non-electrician licensed contractor, however, must sub-contract with a licensed firm or electrician to perform the electrical aspects of the actual solar PV installation.

63 237 CMR § 13.00 et seq.

64 Specialty licenses are not discussed in this Guide.

65 OAC 158:40-1-2.

66 R.R.S. Neb.§ 81-2112.02.

67 16 CCR § 832.46; California State Licensing Board, Before Applying for the Examination, *www.cslb.ca.gov/Contractors/Applicants/Contractors_License/Exam_Application/Before_Applying_For_License.aspx;* California State Licensing Board, Qualifying Experience for the Examination, *www.cslb.ca.gov/Contractors/Applicants/Contractors_License/Exam_Application/Experience_For_Exam.aspx.*

68 Connecticut Department of Consumer Protection, Solar Trade Licenses and Scope of Work, *www.ct.gov/dcp/cwp/view.asp?a=1624&q=461646.*

69 Oregon Apprenticeship and Training Division, Limited Renewable Energy Technician, *www.oregon.gov/BOLI/ATD/Pages/A_Ctrades_RenewableEgyTech.aspx.*

70 Oregon SEIA, Solar Installation and Program Information and Educational Opportunities.

71 ORS § 479.630 (16).

72 ORS § 479.910.

73 ORS § 479.630 (16).

74 Electrical Training Alliance, previously called NJATC, is a joint training program between the National Electrical Contractors Association (NECA) and the International Brotherhood of Electrical Workers (IBEW). Electrical Training Alliance, in partnership with Underwriter's Laboratories (UL), offers a photovoltaics proficiency certification for a journey-level workers and apprentices. See *http://electricaltrainingalliance.org/training/SolarPvCertification.*

75 UL offers a PV System Installer Certification, which is designed for electrician and electrical professionals with significant hands-on PV experience. See *http://lms.ulknowledgeservices.com/common/ncsresponse.aspx?Rendertext=certification.*

76 The Interstate Renewable Energy Council (IREC) offer accreditation of third-party solar training programs. See, e.g., Interstate Renewable Energy Council, "Accreditation," *www.irecusa.org/credentialing/accreditation.*

77 This includes providing documentation of up to five solar installations in which the candidate acted in the role of contractor, lead installer, foreman, supervisor, or journeyman.

78 A minimum of 40 of the 58 hours must cover advanced solar PV installation and design principles and be offered by a NABCEP approved provider.

79 NABCEP, PV Installer Professional, *www.nabcep.org/certification/pv-installer-certification.* Additional information about other certification programs is provided in the Appendix of this report.

80 Solar Energy Industries Association, "State Solar Policy, New York Solar," *www.seia.org/state-solar-policy/new-york.*

81 NYSERDA, "Find a Contractor," *https://www.nyserda.ny.gov/Contractors/Find-a-Contractor.*

82 NYSERDA, Clean Energy Certifications and Accredidation Incentives, Program Opportunity Notice PON 2397.

83 NYSERDA, "Become a Participating Contractor for Residential/Small Commercial MW Block," *https://www.nyserda.ny.gov/All-Programs/Programs/NY-Sun/Project-Developers/Residential-Small-Commercial-MW-Block/Become-a-Participating-Contractor-for-Residential-Small-Commercial-MW-Block.*

84 An Electrical contractor's license or a Certificate REP may be issued to a person, firm or corporation. See R.I. Gen. Laws § 5-6-8(a), (g).

85 This includes advertising services, distribution of materials to final installation location (i.e. mounting racks), and installing the ground and rooftop support brackets.

86 R.I. Gen. Laws § 5-6-11(e).

87 For solar installations in Rhode Island, electricians must complete the installation, connecting, testing, and servicing of all electrical wiring and mounting of modules and inverters. See *http://webserver.rilin.state.ri.us/Statutes/TITLE5/5-6/5-6-8.htm.*

88 Ohio Department of Commerce, "License Qualification Process," *www.com.ohio.gov/dico/ocilb/LicenseQualificationProcess.aspx.*

89 Cincinnati Municipal Code § 1106-21.

90 Greater Cincinnati Energy Alliance, *http://greatercea.org.*

91 Greater Cincinnati Energy Alliance, City of Cincinnati Solar Incentive, *http://greatercea.org/cincinnati-solar-incentive-2.*

92 Energy Trust of Oregon, "Who We Are," *http://energytrust.org/about/leadership.*

93 Energy Trust of Oregon serves customers in Oregon and Washington.

94 Energy Trust of Oregon, "Trade Ally, Benefits," *http://energytrust.org/trade-ally/join/benefits.*

95 A draft of the Energy Trust of Oregon's Solar Trade Ally Rating System is available at *https://energytrust.org/library/forms/Solar_Trade_Ally_Rating_System_DRAFT.pdf.*

96 Barbose, Galen L., and Naim R Darghouth, "Tracking the Sun IX," National Renewable Energy Laboratory, August 2016, *https://emp.lbl.gov/sites/all/files/tracking_the_sun_ix_report_0.pdf.*

97 UL 1703, *http://ulstandards.ul.com/standard/?id=1703.*

98 Rack mounting systems include the components that secure the PV panel to the roof, ground, or other surface.

99 See UL 1699, UL 1741, UL 2703, UL 3703, and UL 8703.

100 Basso, Thomas, "IEEE 1547 and 2030 Standards for Distributed Energy Resources Interconnection and Interoperability with the Electricity Grid," *National Renewable Energy Laboratory,* December 2014, *http://www.nrel.gov/docs/fy15osti/63157.pdf.*

101 SB 1, California Solar Initiative: Chapter 8.8, 25780(c).

102 Clean Energy States Alliance, "Clean Energy Champions: The Importance of State Programs and Policies," June 2015. *www.cesa.org/assets/2015-Files/Clean-Energy-Champions-LR.pdf.*

103 Florida Solar Energy Center, Photovoltaic System Certification, *www.floridaenergycenter.org/en/certification-testing/pv/PVsystems/index.htm.*

104 Florida Solar Energy Center Standard 201-10, *www.floridaenergycenter.org/en/publications/pdf/standards/FSECstd_201-10.pdf.*

105 Florida Solar Energy Center, "Procedures for Photovoltaic System Design Review and Approval, Florida Solar Energy Center Standard 203.10," January 2010, *http://www.floridaenergycenter.org/en/publications/pdf/standards/FSECstd_203-10.pdf.*

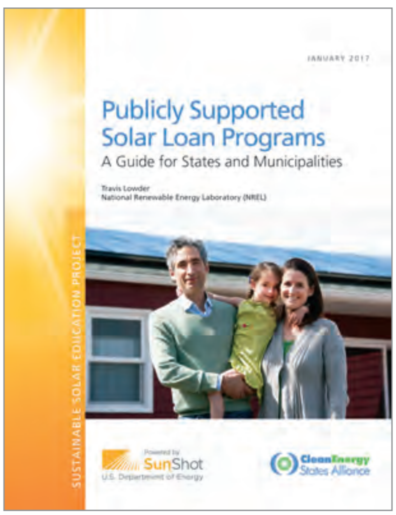
106 EnergySage, "What to Know about a Solar Panel Warranty," *http://news.energysage.com/shopping-solar-panels-pay-attention-to-solar-panels-warranty.*

107 Enphase, "Enphase Energy Microinverter 25-Year Limited Warranty," *www2.enphase.com/entrust/25-year-limited-warranty.*

108 Energy Trust of Oregon, "Request Proposals," *https://energytrust.org/solarbid/?a=Home* (accessed October 2016).

From CESA's Sustainable Solar Education Project

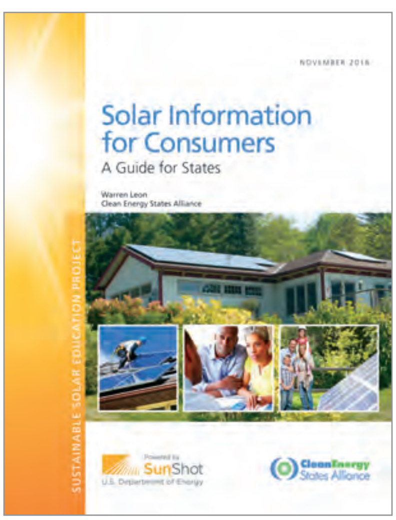
The Sustainable Solar Education Project provides timely information and educational resources to help states and municipalities ensure distributed solar electricity remains consumer friendly and benefits low- and moderate-income households. The project is developing program guides, webinars, online course material, and in-person training for government officials on topics related to strengthening solar equitability, improving consumer information, and implementing consumer protection measures. More information, including the resources listed below, can be found at *www.cesa.org/projects/sustainable-solar*. You can sign up to receive the Sustainable Solar Education Project's newsletter, reports, and webinar announcements at *http://cesa.org/projects/sustainable-solar/mailing-list*.



PUBLICLY SUPPORTED SOLAR LOAN PROGRAMS: A GUIDE FOR STATES AND MUNICIPALITIES

This guide describes general factors state and municipal governments should consider when assessing whether to launch a public solar loan program, explains various loan program design elements, and offers several case studies.

The accompanying webinar recording is available at *http://cesa.org/webinars/designing-publicly-supported-solar-loan-programs/?date=2017-01-12*.



SOLAR INFORMATION FOR CONSUMERS: A GUIDE FOR STATES AND MUNICIPALITIES

This guide explains why states should provide consumer information on solar, describes the types of information that can be useful, and points out existing educational efforts by states and other entities that provide models and useful resource information.

The accompanying webinar recording is available at *http://cesa.org/webinars/solar-consumer-protection/?date=2016-12-08*.

For more information about this project's activities, contact Nate Hausman, CESA Project Director, at *Nate@cleanegroup.org*.

ABOUT THE AUTHORS

Beren Argetsinger is an associate with Keyes & Fox LLP. Mr. Argetsinger's practice centers on advancing and defending policies that support the development and integration of distributed energy resources and other clean energy technologies through regulatory proceedings and other forums. Mr. Argetsinger received his Juris Doctor, magna cum laude, with a certificate in environmental law, from the Elisabeth Haub School of Law at Pace University and a Master of Environmental Management from the School of Forestry & Environmental Studies at Yale University.

Benjamin Inskeep is a research analyst with EQ Research LLC. Mr. Inskeep conducts research and analysis on rapidly evolving clean and distributed energy policies and markets for EQ Research's policy tracking and consulting services. Mr. Inskeep received his Master of Public Affairs and Master of Science in Environmental Science degrees from the School of Public and Environmental Affairs at Indiana University.




Clean Energy States Alliance
50 State Street, Suite 1
Montpelier, VT 05602
802.223.2554
cesa@cleanegroup.org
www.cesa.org

Clean Energy States Alliance (CESA) is a national, nonprofit coalition of public agencies and organizations working together to advance clean energy. CESA members—mostly state agencies—include many of the most innovative, successful, and influential public funders of clean energy initiatives in the country.

CESA works with state leaders, federal agencies, industry representatives, and other stakeholders to develop and promote clean energy technologies and markets. It supports effective state and local policies, programs, and innovation in the clean energy sector, with an emphasis on renewable energy, power generation, financing strategies, and economic development. CESA facilitates information sharing, provides technical assistance, coordinates multi-state collaborative projects, and communicates the views and achievements of its members.

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