Solar Ready: An Overview of Implementation Practices

Andrea Watson, Linda Giudice, Lars Lisell, Liz Doris, and Sarah Busche

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Technical Report
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January 2012

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NATIONAL RENEWABLE ENERGY LABORATORY

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Introduction

According to the U.S. Census Bureau and U.S. Department of Housing and Urban Development's January 19, 2011, report on new residential construction, 7.8 million new, privately-owned housing units were completed in 2010.[1] These homes, if not compatible with solar technology, represent a large barrier to widespread solar deployment. Once a structure is built, structural and solar access issues can prevent a solar project from being cost effective, and, in some cases, can make it entirely infeasible. Currently, when developers and solar installers assess buildings as potential solar sites, they sometimes dismiss buildings that are incompatible with a solar installation. While solar could be pursued, the potential solar production is significantly reduced, making payback periods longer and financing less appealing. Homes and commercial buildings built "solar ready" offer a solution to overcoming this installation barrier to renewable energy.

A solar ready building is engineered and designed for solar installation, even if the solar installation does not happen at the time of construction. The solar ready design features, if considered early in the design process, are typically low or no cost. Attention to building orientation, available roof space, roof type, and other features is key to designing solar ready buildings. The *Solar Ready Buildings Planning Guide*, published by the National Renewable Energy Laboratory (NREL) in 2009, details the technical processes for making buildings solar ready.[2] In cases in which it is not cost effective or feasible to install a solar system at the time of construction, creating a solar ready structure improves the cost effectiveness of solar when pursued at a later date. This eliminates barriers to future solar applications and facilitates market growth.

Solar ready design is important if photovoltaic (PV) or solar hot water (SHW) technologies are to be installed on a building at any time during the building's lifespan. Solar ready also allows owners to take advantage of a changing energy market. The economics for installing solar on a new building are not always compelling, but, in the future, that picture could change with rising electricity prices and/or falling solar technology costs. In some locations, installing SHW is now cost effective for new construction projects. Building a home or commercial building that is not solar ready exposes owners to the risk of not being able to take full advantage of future economic scenarios for solar electricity and hot water. Instead, the building owners have no option but to continue to buy conventional power or pursue solar with a lower return on investment due to the structural or solar access barriers on their buildings. While installing solar at the time of construction is encouraged, when this option is cost prohibitive, solar ready could be a standard and common alternative.

It is important to recognize that solar ready itself does not reduce energy use or replace conventional energy with green energy. Solar ready does not contribute toward carbon emissions reduction until actual solar capacity is installed. Instead, solar ready has the potential to act as a

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[1] Economics and Statistics Administration. New Residential Construction Report. http://www.esa.doc.gov/sites/default/files/ei/documents/2011/January/new_residential_construction_december_2010.pdf. Accessed April 2011.

[2] L. Lisell, T. Tetreault, and A. Watson. *The Solar Ready Buildings Planning Guide*. NREL/TP-7A2-46078. Golden, CO: National Renewable Energy Laboratory, December 2009. Available online at http://www.nrel.gov/docs/fy10osti/46078.pdf.

catalyst for future installations and market expansion by reducing balance of system costs at the time of installation. In order to see this benefit, solar ready must become a widespread practice.

This report will explore three mechanisms for encouraging solar ready design and construction: solar ready legislation, certification programs for solar ready design and construction, and stakeholder education. These methods are not mutually exclusive, and all, if implemented well, could contribute to more solar ready construction.

Solar ready legislation is a way to mandate the uptake of solar ready practices. The Solar Ready Legislation and Policy section of this report describes the pros and cons of such an approach and discusses potential interactions with other policies. Appendix B includes sample solar ready legislation.

Certifying solar ready may occur through a solar ready certification program or through integrating solar ready into existing programs, such as the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) ENERGY STAR program[3] or the U.S. Green Buildings Council (USGBC) Leadership in Energy and Environmental Design (LEED)[4] program. Certifying a building or home as solar ready can work toward the long-term goal of reducing costs and carbon emissions over time. Certification helps the building owner advertise solar ready status and signifies the potential of the structure to take advantage of solar technologies later in the building's life. In addition, certification helps raise awareness among property owners who may otherwise not have considered solar at all. However, certifying solar ready offers a reward for a measure that does not save energy, produce clean energy, or reduce emissions.

Education of stakeholders can occur in conjunction with solar ready legislation or certification or as a standalone effort. Education of stakeholders will be an important step in widespread adoption of solar ready practices.

This report is intended for local, state, and federal decision makers as an overview and discussion of tools and methods for promoting widespread solar ready building practices.

[3] ENERGY STAR. http://www.energystar.gov/. See "Certification"/"Designed for EnergyStar." Accessed April 2011.
[4] LEED Homes Rating System. http://www.usgbc.org/DisplayPage.aspx?CategoryID=19. Accessed April 2011.

Solar Ready and Costs

When a building owner attempts to install solar on an existing building that is not solar ready, the owner may experience the following:

- Structural or solar access barriers that prevent installing solar due to insurmountable costs
- A less attractive financial picture due to reduced solar production
- An increase in cost to make the building compatible with solar.

All of these scenarios may slow or stop the rate of solar installations, and all can be avoided through solar ready building practices. This section explores the costs of solar ready, which can be used as background information for discussing the methodologies of promoting solar ready throughout this report.

Cost Prohibitive Scenario

In some cases, installing solar on a pre-existing building is cost prohibitive. Structural barriers or solar access issues can create a scenario where it is not feasible to install solar. Table 1 highlights these issues, as well as the cost scenarios that could make a project infeasible, the potential fix with solar ready design, and additional comments.

Table 1. Cost Prohibitive Scenario

Structural or Solar Access Issue	Potential Cost	Solar Ready Fix	Comments
Roofs unable to accept added load of PV or SHW system, especially if ballast system is only option	A cost-intensive roof reinforcement may be the only option, making a solar project cost prohibitive.	Design roofs for anticipated loads associated with a future solar installation during the initial building construction.	This varies by location and may be more common where roofs are not designed for snow loads or where wind loading is especially high.
Significant* number of roof obstructions	Roof obstructions may be numerous enough that the added cost of building around them or moving them, along with the loss of solar production, makes the project infeasible.	Group roof equipment on the north side of the roof or locate vents and other equipment to utilize non-rooftop space.	This will more likely make a project infeasible in the commercial sector. A third-party financier—crucial to making many commercial solar projects move forward—may dismiss projects lacking sufficient continuous roof space.
Significant* shading	Many things, including architectural features, other buildings, and vegetation, can cause significant shading. When the shading is very extensive and unavoidable, the economic case for solar is difficult to justify.	During the design phase, ensure that architectural features and the building's position on the site minimize shading. Consider landscape architecture that does not shade the roof in the future.	Shading may be more common in highly vegetated areas or places with high-density buildings, such as large cities. The effect of shading on PV power production is greater than that to SHW thermal production.

* The actual value of "significant" will vary by region, sector, or technology.

An entity that could take advantage of a production-based local incentive would be more affected by production losses than one that could take advantage of an installed capacity-based incentive, although some installed capacity-based incentives do consider potential production.

Reduced Production Scenario

In many cases, a building with structural or solar access barriers to solar can still be compatible with solar. However, the structural or solar access issues can increase up-front system costs or reduce system output. Structural issues such as roof load limitations require the need for structural reinforcement, in turn increasing up-front costs and total system size. Daily or semi-annual shading and roof obstructions that either shade or reduce the available roof space for solar can reduce the output of a solar system. Likewise, a non-ideal building orientation reduces system output. The example below highlights the difference in production when roof orientation is less than ideal.

Example: Effect of Orientation on PV

A 10-kilowatt (kW) PV array in Golden, Colorado, facing south and tilted 25° can be expected to produce 14,304 kW hours (AC) per year with an annual energy value of $1,201.00. (The state average electricity price is 8.4¢ per kW hour.) The same system facing east will produce 11,997 kW hours (AC) per year with an annual energy value of $1007.75. A west-facing system will produce 10,999 kW hours (AC) per year with an annual energy value of $923.92. This represents a 16% to 23% reduction in PV production and cost savings when oriented 90° away from south. Table 2 presents a simplified financial analysis of this example.

Table 2: Effect of Orientation on Finances for a 10-kW PV Array in Colorado

Orientation	Installed cost	Annual solar energy production value (8.4¢)	Cost after utility rebate program of $2/watt (this rebate based on installed capacity, not production)	Approximate cost after incentive mix, about 45% of cost (e.g., income tax credit, accelerated depreciation)	Simple payback period
South	$60,000	$1,201.00	$40,000	$22,000	18.3 years
East	$60,000	$1,007.75	$40,000	$22,000	21.8 years
West	$60,000	$ 923.92	$40,000	$22,000	23.8 years

The example above illustrates that orienting a building to maximize solar production can shave years off the payback period for a solar installation. In the example, the utility rebate program is based on installed capacity, not system production. Some rebate programs degrade incentive levels for systems that are not optimally configured, but this degradation was not considered here. An incentive program based on production would further increase the simple payback periods for installations facing away from south. Similar calculations can be made to account for reduced array size due to roof obstacles or reduced production due to shading; however, these scenarios will vary greatly from site to site.

When confronted with a scenario in which expected solar production is reduced, some building owners may choose to pursue solar despite the less attractive economics, while others may choose not to proceed at all. Designing a solar ready building can prevent the production losses that negatively affect solar installation economics later in a building's life. Solar ready buildings designed with continuous roof space uninterrupted by roof equipment, minimal roof shading throughout the year, and a roof oriented on an east-west horizontal axis can increase production and shorten simple payback periods.

Incremental Cost of Solar Retrofit

There is always a cost associated with retrofitting a building to accommodate solar. With the proper solar ready preparations, these measures may cost less if done at the time of building construction. The examples below consider cost differences between preparing a building for solar during initial construction and after initial construction. Quantifying these incremental costs is difficult because of site variations. The scenarios below are examples of cost reduction scenarios, but these examples cannot be extended to every situation.

Example: PV System

In this example, the costs are calculated for making a residential building solar ready for a 10-kW PV system. For this example, there are three main measures associated with making the building solar ready that can increase the cost of construction. They include upsizing the electrical panel, installing conduit and wire from the roof to the electrical panel, and installing a combiner box on the roof in which to combine the wiring for the panels. The costs for these measures were estimated using the 2011 edition of *RS Means Construction Databook*. By these calculations, the building can be made PV ready for $1,729 at the time of construction. See Table 3 for the cost breakdown of the measures.

If there were no solar ready preparations made at the time of construction, the same preparations would cost $4,373 at the time of solar installation. The measures would be more costly after construction for a number of reasons. Installing the measures during construction could be completed by a general contractor already on the site instead of requiring a team of solar contractors to travel to the site. This results in a 75% savings in the labor costs due to reduced travel time. In this example, vent relocation and inhibited roof exposure require the solar panels to be installed on multiple pitches. Both of these additions result in additional expenditures. The cost of the materials was assumed to be the same whether the work is done during or after construction. In this example, the measures completed during construction saved $2,644.

Table 3: Cost to Make a Building Solar Ready[5]

	During Construction			After Construction		
Measures	**Equipment**	**Labor**	**Total**	**Equipment**	**Labor**	**Total**
Increase size of electrical panel	$459	$480	$ 939	$459	$1,200	$1,659
Run conduit	$374	$416	$ 790	$374	$1,040	$1,414
Relocate vents	n/a	n/a	n/a	-	$ 300	$ 300
Install panels on multiple pitches	n/a	n/a	n/a	-	$1,000	$1,000
Total	**$833**	**$896**	**$1,729**	**$833**	**$3,540**	**$4,373**

In this example, implementing the solar ready measures during building construction costs 60% less than the measures would cost after construction.

[5] Waier, P.R., ed. *Green Building Cost Data.* RSMeans, 1st Annual Edition, Norwell, MA: RSMeans, 2010.

Example: Solar Hot Water System

In this example, the costs are calculated for making a residential building solar ready for a three-panel, 96-ft^2, closed-loop solar thermal system. It is assumed that the system utilizes .75-inch tubing, and that the existing hot water system requires the addition of "stub-outs" in order to allow the SHW system to be incorporated without depressurizing the domestic hot water system. For this system, there are three main measures that will increase the cost of the building construction. They include installing copper pipes from the roof to the utility room, adding tee joints to the existing system where the SHW system can be plumbed in, and adding SHW mounting hardware on the roof of the building. By implementing these measures during construction, the building can be made SHW ready for $1,588.

Table 4 shows the cost breakdown of the measures. If there were no solar ready preparations made at the time of construction, the same preparations would cost $4,645 as a retrofit. The measures would be more costly after construction for a number of reasons. Installing the measures during construction could be completed by a general contractor already on the site instead of requiring a team of solar contractors to travel to the site. In this example, the result is a 72% savings in the labor costs due to reduced travel time. In this scenario, there are vents that need to be relocated and roof exposure that cannot be optimized, resulting in panels that need to be installed on multiple pitches. Both of these additions require additional expenditure.[6] The cost of the materials was assumed to be the same whether the work is done during or after construction. In this example, the measures completed during construction saved $3,057.

Table 4: Cost to Make a Building SHW Ready[7]

	During Construction			After Construction		
Measures	**Equipment**	**Labor**	**Total**	**Equipment**	**Labor**	**Total**
Add mounting hardware SHW	$8.00	$20.00	$28.00	$8.00	$50.00	$58.00
Pipes to roof	$407.00	$1,109.00	$1,516.00	$407.00	$2,773.00	$3,180.00
Stub-out pipes	$2.00	$43.00	$45.00	$2.00	$ 106.00	$ 108.00
Relocate Vents	n/a	n/a	n/a	–	$ 300.00	$ 300.00
Install panels on multiple pitches	n/a	n/a	n/a	–	$1,000.00	$1,000.00
Total	**$417.00**	**$1,172.00**	**$1,589.00**	**$417.00**	**$4,229.00**	**$4,646.00**

In this example, implementing the solar ready measures during building construction costs 66% less than the measures would cost after construction.

[6] Waier, P.R., ed. *Facilities Maintenance & Repair Cost Data.* RSMeans, 18th Annual Edition, Norwell, MA: RSMeans, 2010.
[7] Waier, P.R., ed. *Green Building Cost Data.* RSMeans, 1st Annual Edition, Norwell, MA: RSMeans, 2010.

Solar Ready Legislation and Policy

This section discusses solar ready legislation or policy tools that may be useful in promoting solar ready. In preparing the sample legislation in Appendix B, NREL worked with Keyes and Fox, LLP, to evaluate a variety of different approaches that have been taken by states and municipalities in requiring new building construction to be solar ready. Keyes and Fox, LLP, drafted the sample legislation in Appendix B to provide a starting point for jurisdictions interested in creating solar ready legislation.

There are a number of policies that could be considered when designing solar ready legislation and several that can act as standalone policies to promote solar ready. The following solar ready legislation discussion explains some of the choices reflected in the sample presented in Appendix B. This section also highlights some complementary policies and options that could strengthen the effectiveness of solar ready legislation.

Requiring solar ready construction through legislative or regulatory mechanisms has certain advantages, but may work best when combined with some of the other tools discussed below, such as certification programs or education strategies. One of the biggest challenges of legislation is the ability to craft stringent rules requiring buildings to be solar ready while also allowing developers to achieve established requirements in a manner well suited to a particular building type and a developer's design goals. Working in coordination with developers and builders helps make legislation more politically feasible. It is also important that legislation enables the use of the most cost- and resource-efficient technologies as they evolve.

Currently, several jurisdictions have put in place some sort of policy that promotes solar ready construction (see Appendix C). However, there is currently little data on the effectiveness of these policies by metrics. More data, such as the number of new solar ready structures as a result of policy or the increase in the number of solar installations, needs to be collected on existing policies. Future policies should also plan for data collection and verification of policy effectiveness.

Mandating Solar Ready Buildings or a Solar Ready Option

It is important to highlight the difference between solar ready legislation that *mandates* solar ready versus legislation that requires a solar ready *option*. A number of states have required that the option of solar readiness be expressly given to homebuyers at the time of construction. [8,9,10] Instead of imposing a requirement on new construction to be solar ready, this option focuses on educating the homeowner about solar technologies, providing them with the information to decide if the added cost of building solar ready is of value to them when they consider how future energy costs will impact their budget. Conversely, the sample legislation in Appendix B has been drafted to require that new residential and commercial construction be solar ready. One of the limitations of the "option" approach is that relatively few homes and commercial buildings

[8] New Jersey AB 1558. http://www.njleg.state.nj.us/2008/Bills/PL09/33_.PDF. Accessed April 2011.

[9] General Assembly of the State of Colorado: Section 1, Article 35.7 of title 38, Colorado Revised Statutes. http://www.leg.state.co.us/clics/clics2009a/csl.nsf/fsbillcont3/56DAD78B9D26BD5187257539006E7FF9?open&file=1149_enr.pdf. Accessed April 2011.

[10] Online Code and Environment Advocacy Network (Ocean). http://bcap-ocean.org/state-country/colorado. Accessed April 2011.

are constructed with the ultimate buyer in mind. Unless the developer or builder will be the ultimate owner of a structure, choosing the solar ready option may not be appealing. Consideration of the variety of owners of a building over its usable lifetime increases the appeal of solar ready construction so that a long-term tenant or future owner could easily install solar.

Colorado HB 1149

In Colorado, HB 1149 was enacted in May 2009, requiring builders of single-family homes to offer solar as a standard feature to all prospective homebuyers. Builders are required to give the buyer the option to either have a PV system or a SHW system installed on the new home, or to have all the necessary wiring and/or plumbing installed so that the homeowner can easily add a solar system at a later date. The builder must also provide the buyer with a list, maintained by the Governor's Energy Office, of every solar installer in the area so the buyer can obtain expert help in determining if the home's location is suitable for solar and what the estimated cost savings would be (General Assembly of the State of Colorado: Section 1, Article 35.7 of title 38, Colorado Revised Statutes).

Installing a solar system on a solar ready building can be more cost effective than installing solar on a building that is not designed to accommodate solar. Some features, such as orientation or shading, may not be reasonable to modify at a later date (see "Solar Ready and Costs" section). In addition, requiring a building to be constructed solar ready from the start may provide additional motivation for initial building owners to look more seriously at solar options in connection with the initial investment in constructing a residential or commercial building.

Along with mandating solar readiness for new construction, it may be effective to also require that future building owners be informed of options for having a solar system installed at the time a building is first constructed. Colorado and New Jersey have instituted requirements of this sort.[11,12] Software tools, such as In My Backyard,[13] can provide information to an owner/developer on what a building's exposed surface area could produce with a PV array installed. Likewise, the NREL SolOpt[14] tool can be used to determine if solar hot water or PV makes more sense for a given amount of roof space on a particular building. Developers could be required to provide such information to educate buyers on the potential benefits of installing a solar system.

Solar Ready Sample Legislation

The sample legislation in Appendix B has been drafted such that state or local agencies have the opportunity to consider local conditions and policy appetite in promulgating detailed regulations for solar ready building requirements. Although detailed requirements could simply be included in statutory language itself, there are a number of advantages to having the detailed

[11] General Assembly of the State of Colorado: Section 1, Article 35.7 of title 38, Colorado Revised Statutes. www.leg.state.co.us/clics/clics2009a/csl.nsf/fsbillcont3/56DAD78B9D26BD5187257539006E7FF9?open&file=1149_enr.pdf. Accessed April 2011.
[12] New Jersey AB 1558. www.njleg.state.nj.us/2008/Bills/PL09/33_.PDF. Accessed April 2011.
[13] NREL. In My Backyard. www.nrel.gov/eis/imby/. Accessed April 2011.
[14] SolOpt Optimization Tool, available at the Solar America Communities website. http://solaramericacommunities.energy.gov/Publications.aspx. Accessed April 2011.

specifications included in regulations. Principally, regulations are generally easier to update and modify over time. Given that technologies change, the ability to update technical requirements without action from the legislature is important to providing necessary flexibility. However, legislators can include more prescriptive language about technical requirements in the legislation if preferred. The technical requirements that NREL currently recommends have been provided in footnotes to the sample legislation for further guidance to implementing agencies.

If time and resources are not available at an implementing agency level, an effective solar ready statute can be drafted that avoids the need for further regulatory action by including specific requirements directly in a statute itself.

Commercial and Residential Considerations

The sample legislation in Appendix B applies to both commercial and residential construction. Although many of the existing solar ready mandates adopted in the United States only apply to single-family residential buildings, there are similar cost challenges associated with modifying commercial construction that make extension of these mandates to such buildings a sensible approach. In particular, commercial buildings often have flat roofs that require ballast-mounted systems. Commercial building roofs need to be designed to withstand the added weight of solar systems. The varied nature of commercial buildings requires more detailed regulations to be adopted to accommodate a range of building types. States may also want to consider whether multi-family residential and multi-unit commercial buildings warrant separate regulatory guidance.

Sample Legislation and Incentives

The sample legislation in Appendix B includes a provision to make it clear that compliance with solar ready mandates is not required for homes constructed prior to the statute to access any available incentives for solar installations. A new building that complies with the statute should also be able to access incentives under the theory that the costs of installation will be less.

Green Building Codes

Solar ready requirements can be a low-cost and effective addition to existing green building codes. Jurisdictions with green building codes using a points-based system may consider assigning points for aspects of solar ready construction, while providing additional points for homes that have actual solar systems installed. The text box highlights the residential rating system used in Pima County, Arizona. While this program is designed to promote solar ready and ultimately increase the number of solar installations, preliminary data needs to be collected on whether this program is effective or if most developers choose not to comply.

Pima County Regional Residential Rating System – Tucson, Arizona[15]

The Pima County Regional Residential Rating System was developed to promote the construction of sustainable homes specifically designed for Pima County. Homes are rated and awarded points for environmentally responsible criteria including location, lot design, and development as well as resource and energy efficiency. Solar ready (SHW and PV stub-outs) qualifies for points within this system. There are four levels of certification available that range from Bronze (75–100 points) to Emerald (over 160 points). This voluntary, no-cost program is combined with the permit and inspection process. The procedure for obtaining the rating includes looking at site development and resource, energy, and water efficiency. Once one completes the procedure of complying with the requirements of the program, the building receives a certificate indicating the award level and becomes eligible to receive a building plaque to commemorate the achievement. For more information, see www.pimaxpress.com/green.

Homeowners' Associations

Jurisdictions may consider including language that addresses how solar ready requirements interact with limitations imposed by homeowners' associations or common interest communities (CICs) rules. Although homeowners' associations cannot trump requirements imposed by state law, homeowners' associations that adopt rules directly or indirectly prohibiting the installation of solar equipment may undermine the intent of requirements that buildings be constructed solar ready. For example, states and localities include provisions that explicitly prohibit homeowners' associations from implementing restrictions that prevent homeowners from installing solar energy equipment on their own property (e.g., Arizona[16]). In this case, jurisdictions may consider expressly preempting homeowners' associations from prohibiting solar installations when enacting solar ready legislation. In Colorado, HB 08-1270 revised an existing law so that installation of renewable energy or energy efficiency equipment cannot be prohibited.[17] The bill prevents CICs from making rules that would explicitly prevent the installation of such equipment; however, the bill allows reasonable restrictions based on aesthetic considerations, safety requirements, and—in the case of wind-electric generators—noise.[18]

[15] Pima County Regional Residential Rating System, Tucson, Ariz. http://www.pimaxpress.com/green. Accessed April 2011.
[16] Database of State Incentives for Renewables & Efficiency (DSIRE). Arizona: Solar Rights http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=AZ07R&re=1&ee=1. Accessed April 2011.
[17] Colorado General Assembly. House Bill 08-120. www.leg.state.co.us/clics/clics2008a/csl.nsf/fsbillcont3/3F45E0C88F60DD39872573680059F7E2?open&file=1270_enr.pdf. Accessed April 2011.
[18] Colorado General Assembly. Digest of Bills. www.state.co.us/gov_dir/leg_dir/olls/digest2008a/PROPERTY.htm#08-1270. Accessed April 2011.

Session Laws of Colorado 2008, Second Regular Session, 66th General Assembly

Concerning the removal of restrictions on the use of energy efficiency* measures in connection with real property.

38-30-168. Unreasonable restrictions on renewable energy generation devices - definitions. (1)(a) A covenant, restriction, or condition contained in any deed, contract, security instrument, or other instrument affecting the transfer or sale of, or any interest in, real property that effectively prohibits or restricts the installation or use of a renewable energy generation device is void and unenforceable.

Historic Structures

The sample legislation in Appendix B only applies to new construction, so it is not likely to impact existing historic structures. However, new construction within a designated historic district may be under restrictions that inhibit the ability of a developer, or eventual owner, to install a solar system. As with homeowners' associations, it may be wise to consider expressly preempting any such restrictions or to provide for an exemption for particular circumstances.

Solar Access Laws

Another potential companion provision may be the creation or enhancement of solar access rights. There is an exception from compliance in the sample in Appendix B for buildings that do not have sufficient solar resources to warrant the addition of solar readiness at the time of construction; however, this exception does not protect a building that may have sufficient solar resources at the time of construction from future obstructions that may diminish access to solar resources. To ensure that initial investment in solar ready construction maintains its value over time, it may be worth considering companion provisions to enact solar access protections.

Nearly 80% of the states and a number of localities have implemented some type of a solar access law. As these policies are designed to meet the unique needs of the constituents, they vary greatly. For example, some of these policies allow parties to voluntarily enter into an agreement to protect the solar easement rights of either or both parties (e.g., Georgia[19]). Other policies require that solar access is not impeded (e.g., the City of Sebastopol, California[20], can place restrictions on vegetation and building construction if it impedes on solar easements).

Like many solar ready policies, data is needed on the effectiveness of these laws to protect solar access and encourage solar installation.

Roof Warranties

The requirements outlined in Appendix B require that roofs be designed to accommodate installations of solar PV systems and/or SWH systems. In light of this, it is important that roof warranties accommodate the ultimate installation of a solar system without the fear of a warranty being voided by the installation of a system. Jurisdictions adopting solar ready mandates may

[19] Database of State Incentives for Renewables & Efficiency (DSIRE). Georgia: Solar Easements http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=GA01R&re=1&ee=1. Accessed April 2011.
[20] Database of State Incentives for Renewables & Efficiency (DSIRE). California: City of Sebastopol Solar Access http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA33R&re=1&ee=1. Accessed April 2011.
*The Colorado law uses the term energy efficiency, which includes renewable energy like solar.

want to consider including requirements that will ensure that roof warranties are compatible with, and not voided by, the proper installation of a solar system.

Sample of Solar Ready Requirements or Practices by Jurisdiction

Appendix C summarizes the jurisdictions that have adopted solar ready into existing legislation, codes, or ordinances. The DSIRE website was a primary source for these excerpted entries.[21] A few others were obtained through direct e-mail or telephone contact with various jurisdictions. Of the examples cited, most require measures related to PV and SHW systems. Technical requirements range from SHW stub-outs to full PV site/situational plans (see Tucson, Arizona). It should be noted that there appear to be a number of jurisdictions where elements of solar ready are practiced, but not mandated (see the City of Boulder or Aspen/Pitkin County).

Data on the effectiveness of these different approaches to solar ready would be useful for other jurisdictions looking to adopt similar policies. While outside of the scope of this report, compiling information on participation, increased number of solar ready structures, and increased number of solar installations as a result of these policies would help jurisdictions choose the most appropriate policy for their area. Similarly, new policies put in place should consider how to evaluate the effectiveness of those policies in promoting solar ready and solar installations.

Incentives

Incentives are a mechanism used by governments for the purpose of encouraging the use of technologies considered to have public benefits. These can be financial incentives that reduce the cost of clean energy technologies, which are typically advanced, higher-cost technologies. Examples of financial incentives include tax credits or deductions, rebates, and reduced interest rates on loans. These increase access to clean energy technologies into broader markets. Alternatively, incentives can be non-financial, in which a benefit other than money is used to encourage the use of technologies. Examples of non-financial incentives are expedited permitting and “density bonuses,” which allow developers to increase the maximum allowable development on a property in exchange for acting in the public good.[22] While both types of incentives could be used to promote solar ready building, neither is currently used to do so. A literature review found no current incentives for solar ready construction.

Making incentives available could raise the profile of building solar ready as well as encourage developers to do so. Such incentives would need to be carefully structured. Creating financial incentives for solar ready buildings is complicated because the buildings result in a potential for clean energy development, not actual clean energy production. Therefore, calculating the expected public good resulting from solar ready development is challenging. Non-financial incentives may be more straightforward, as they result in little direct cost to the government, so justification for the implementation of the incentive may be more politically palatable.

[21] Database of State Incentives for Renewables & Efficiency (DSIRE). See “State Incentives/Policies for Solar.” www.dsireusa.org/solar/.

[22] University of Wisconsin Center for Land Use Education. 2005. “Planning Implementation Tools: Density Bonus.” www.uwsp.edu/cnr/landcenter/pdffiles/implementation/densitybonus.pdf. Accessed April 2011.

Conclusion

Legislating solar ready construction is one method for promoting solar energy deployment. As opposed to the other methods discussed next, this method effectively requires developers to consider solar ready design. Pursuing solar ready through legislation should take into account a diverse group of stakeholders. Combined with training and educational tools, solar ready legislation could effectively increase solar ready design practices. Other methods for implementing solar ready may prove faster to initiate and offer more flexibility to stakeholders.

Solar Ready Certification

Certification Programs

This section discusses the use of certification programs as an option for advancing solar ready implementation. Solar ready certification could act as a standalone program or be integrated into existing programs such as ENERGY STAR and LEED. This section will discuss both approaches.

Solar Ready Certification's Potential Benefits

In general, certification is used in green building to promote a standard and ensure desirable characteristics such as design, quality, environmental friendliness, safety, reliability, efficiency, and interchangeability.

If it is not cost-effective or feasible to install solar at the time of construction or retrofit, creating a solar ready structure will save money and time when solar is pursued at a later date. This would eliminate barriers to future solar applications and facilitate market growth. In addition, certifying a building or home as solar ready helps the building owner advertise solar ready status and signifies the potential of the structure to take advantage of solar technologies later in the building's life. Lastly, it helps raise awareness among property owners who may otherwise not have considered solar from the outset.

To summarize the potential benefits, certification of solar ready:

- Ensures a certain level of quality. Currently, any property could be advertised as solar ready, but the lack of a standard definition or technical requirements prevents this claim from carrying any weight.
- Signifies the opportunity to take advantage of changing electricity and solar markets.
- Allows building owners an easy avenue for advertising the status of their properties or homes.
- Provides a measurable metric.
- Is voluntary and may be more palatable to building owners or developers than legislation.
- Can serve as a form of communication, awareness, and education on solar.
- May promote solar ready as a catalyst for market expansion by overcoming barriers that prevent solar projects from going forward.

Challenges of Solar Ready Certification

One of the clear disadvantages of a solar ready certification program is that it does not guarantee installation of solar systems. If this becomes the norm, then the perceived value of solar ready programs could be diminished. Furthermore, solar ready itself does not reduce energy use or replace conventional energy with green energy, which raises the question as to whether solar ready should even be rewarded with a certification.

When certification schemes are adopted, they regularly cite statistics regarding improved standards, benefits, and financial savings. Yet, sometimes they can fail to reach their potential. For certification schemes to work, they require proper design and management to achieve the intended results.[23]

A Solar Ready Certification Label

Similar to the ENERGY STAR or LEED label, guidelines could be established for achieving a solar ready label that stands separate from these existing programs.[24] An easy way to make sure a building is solar ready would be to find out if it has been solar ready certified. This label could be government based like ENERGY STAR or nonprofit backed like LEED. Local jurisdictions could also consider creating a solar ready certification and label. Any building may be able to earn a solar ready certification label if the building meets the established requirements.

There are several advantages of a standalone solar ready label that is specific to the achievement of being solar ready. If solar ready is incorporated into a more comprehensive green building program, making a structure solar ready would likely be one of several choices of green building measures one could choose from to obtain certification. This could inherently dilute the number of structures that become solar ready. A solar ready label would only be applied to buildings that were indeed solar ready. Furthermore, a standalone solar ready label would be positioned to gain brand recognition, raising awareness about solar installations and solar ready buildings. This brand could be developed into a sticker or plaque that could be put on infrastructure such as electrical panels that have room for solar interconnection, conduit, or pipes to signify solar ready status to future users.

A disadvantage of having solar ready as a standalone label as opposed to part of an existing certification program might be the more limited visibility and participation. However, it remains a good option for local jurisdictions or other entities wishing to emphasize the importance of solar ready. Additionally, too many certifications and label programs for this sector could complicate the market to the point where the solar ready label has little value.

Solar Ready Certification Status

ENERGY STAR

From a review of existing solar ready initiatives, there does not appear to be a certification program dedicated exclusively to solar ready practices in the United States. However, at this writing, actions have been taken to incorporate solar ready into ENERGY STAR and LEED certification programs.

ENERGY STAR is a DOE and EPA program focusing on improving energy performance in buildings as a method of reducing greenhouse gas emissions. ENERGY STAR recognition is available as an indicator of superior energy performance. Projects can alternatively achieve Designed to Earn ENERGY STAR to recognize architects' intent that buildings operate at

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[23] Peters, Katherine McIntire. "ENERGY STAR Program Comes Under Attack." March 30, 2010. http://www.govexec.com/dailyfed/0310/033010kp1.htm. Accessed April 2011.
[24] ENERGY STAR. "Apply for the ENERGY STAR for Your Buildings." http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager_intro. Accessed April 2011.

superior energy efficiency when built. Once the buildings are occupied and operating, they can earn the ENERGY STAR label.[25]

The EPA has developed renewable energy ready home specifications to incorporate into the ENERGY STAR Concept Home Version 4 program requirements (ENERGY STAR Version 3 will be fully adopted as the mandatory base program guidelines by January 1, 2012, followed by Version 4).[26] The content of Version 4 was rolled out before 2012, but it will be an optional guideline until it is completely phased into the program, replacing Version 3 (date of complete phase-in to be determined).[27] Currently, PV and solar thermal are the only two technologies addressed by the renewable ready home specifications.

In early 2012, the EPA plans to pre-release the renewable energy ready home specifications as an educational resource and to provide the opportunity for the ENERGY STAR builder community to give feedback. During the pre-release period, homes meeting the renewable energy ready specification would not be eligible as renewable energy ready homes for recognition under any ENERGY STAR program guidelines.

By incorporating renewable energy ready homes into ENERGY STAR, the EPA is maintaining a focus on energy efficiency while rewarding homes that are prepared to take the next step to solar energy. EPA designers of the solar ready guidelines see a large opportunity to educate both the home building community and homeowners through the solar ready addition. Homebuilders can learn simple design and building practices that make a home solar ready. Upon receiving information about their solar ready home, homeowners can then learn about the opportunity to install solar systems.

In the ENERGY STAR renewable energy ready home checklist, applicants will have to meet a number of requirements in the following categorical areas:

- Building Array/Site Assessment
- Structural and Safety Considerations: Photovoltaic (PV) or Solar Hot Water (SHW)
- Renewable Energy Ready Home Infrastructure
- Homeowner Education.

LEED

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System is a green building certification offered by the nonprofit U.S. Green Building Council (USGBC).[28] LEED is a building certification process that looks at various aspects of green building and gives recognition to structures that meet certain standards. LEED has recently developed a draft titled "EA Credit: Solar Ready Design" as part of its Homes Rating System with the designated intent

[25] ENERGY STAR. "Design to Achieve Energy Star." http://www.energystar.gov/index.cfm?c=cbd_guidebook.cbd_guidebook. Accessed April 2011.

[26] ENERGY STAR. "Renewable Energy Ready Homes (RERH)." http://www.energystar.gov/index.cfm?c=rerh.rerh_index. Accessed December 2011.

[27] ENERGY STAR: ENERGY STAR for Homes Version 3 Guidelines. http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_v3_guidelines. Accessed April 2011.

[28] U.S. Green Business Council. http://www.usgbc.org/DisplayPage.aspx?CMSPageID=283. Accessed April 2011.

to "reduce energy consumption and greenhouse gas emissions by designing to maximize opportunities for solar design." [29] The draft emphasizes the following areas for solar ready design:

- Infrastructure requirements (hardware, raceway for PV, plumbing for SHW)
- Design approval by a PV or SHW contractor
- Minimum roof space and orientation
- Informational material for occupant.

At this writing these draft changes to LEED Homes Rating System are in the public hearing phase and may be further modified before formally accepted into practice. A link to the document that was open for comment can be found at the USGBC website.[30]

Conclusion

Both ENERGY STAR and LEED programs promote green building practices by offering a reward for incorporating specified characteristics into a building. The reward, or certification, offers a value to the owner for a variety of reasons. This may be from an increased market value of the property or the ability of the owner to meet federal or local mandates, or because the certification may serve as a symbol of environmental responsibility.

As opposed to mandating solar ready buildings through legislation, certification programs or guidelines encourage building owners to adopt solar ready practices by offering a reward or recognition. A drawback of incorporating solar ready into certification schemes is that it rewards building owners for building attributes that don't reduce electricity consumption or generate green electricity. Nevertheless, a building stock of solar ready buildings would reduce installation barriers and likely increase solar production. Certification of solar ready buildings is a reasonable way to encourage solar ready design.

[29] LEED Rating System Draft. November 2010. www.usgbc.org/ShowFile.aspx?DocumentID=8186. Accessed April 2011 (This draft is no longer available to the public).
[30] U.S. Green Building Council. http://www.usgbc.org/. Accessed April 2011.

Stakeholder Education and Communication Methods

Stakeholder education represents a critical component of expanding the implementation of solar ready building practices. Whether in conjunction with solar ready legislation or certification programs, or as a standalone entity, education around solar ready is important to promoting widespread solar ready buildings. Solar ready buildings themselves further serve as conduits for solar education. This section explores multiple approaches to providing solar ready education.

Audience

Owners and real estate developers are the stakeholder groups most likely to benefit from a solar ready home or building. An owner with a solar ready home is positioned to take advantage of falling prices of solar technologies. At some point in the future, an owner can install a solar array to hedge against rising electricity prices. Likewise, real estate developers can advertise solar ready homes as a green investment in the future. Owners and developers ultimately decide how a building is designed and built. Education programs should emphasize the merits of equipping a house for solar at the time of construction as a best practice. However, in situations when solar installation at the time of construction is not feasible or is cost prohibitive, solar ready should be presented as the next best option.

Engineers and architects must understand the simple principles of solar ready design. Often, these principles can be applied without changing the cost or quality of the building design and should be considered good building practices. Solar ready is an added-value feature that engineers and architects can offer owners in their design that requires little up-front cost. Furthermore, knowledge of solar ready principles prepares architects and engineers to design buildings that meet mandates or certification requirements.

Methods of Delivering Education

Considering the large number of homes built in the United States each year, solar ready education of key stakeholders could have a significant impact on the future of solar in this country. Education and communication strategies must reach a large number of people in diverse fields. The discussion below explores several methods for reaching target audiences. Local governments, federal agencies, or nonprofit organizations could implement these methods.

Education Combined with Legislation or Policy

A strong approach for promoting solar ready is the combination of solar ready policy with an educational campaign. In this approach, the mandate requires developers, architects, and engineers to consider solar ready, while the educational campaign ensures they understand the best practices. Pairing education with a mandate motivates stakeholders to participate in education or training programs or to use available educational tools. Designing an education program in parallel to developing mandates may also help make mandates more palatable to the groups most affected.

Solar Ready Training – Boston, Massachusetts

The City of Boston's Department of Neighborhood Development (DND) [31] has developed design standards for new construction and the rehabilitation of existing buildings. These ensure that all projects conform to current applicable regulations and promote cost effective, environmentally responsible quality design. DND requires that applicants for subsidized funding for building development be solar ready. DND has worked with the Solar Boston Initiative to incorporate solar into the housing portfolio through the Green Affordable Housing Program (GAHP). In conjunction with the solar ready requirement, the Green Affordable Housing Program offers specialized training sessions on Integrated Design and Renewable Energy and Energy Efficiency to help developers meet the solar ready and other green building requirements.

Education Combined with Certification

A certification program promotes solar ready building practices by offering a label or certificate and accompanying educational aspects. These aspects may include training programs, robust websites, and public awareness campaigns.

The EPA and USGBC have both had success promoting their respective certification programs, ENERGY STAR and LEED. USGBC has a robust education program that parallels their certification program. Education is designed for those who are implementing LEED projects or seeking LEED certification.

USGBC provides a curriculum that is taught through a wide network of education providers. Through this infrastructure, USGBC is able to offer hundreds of courses worldwide. Achieving LEED certification requires an educated workforce. In turn, USGBC provides training to the workforce that completes LEED projects. The projects themselves then act as an educational opportunity to the public that works or lives in high-performance green buildings. In the LEED Home Rating System draft, providing information about solar ready to the occupant is required.

Likewise, the EPA has recognized the educational potential of introducing the renewable energy ready home concept into ENERGY STAR. Ultimately, the EPA plans to incorporate the renewable energy ready home into the ENERGY STAR Concept Home Version 4. Because the Concept Home Version 4 will likely not be available for several years, the EPA plans to pre-release the renewable energy ready homes standard. This allows it to be available as an educational tool and resource for ENERGY STAR builders while encouraging the community to provide feedback on the specifications.

While the EPA recognizes that it will be difficult to track how many renewable energy ready homes actually result in installed renewable energy projects, the program nonetheless serves as an opportunity to educate homeowners about renewable energy. Like ENERGY STAR or LEED, local or standalone solar ready certification programs or labels can be conduits for education and communication about solar ready. Incorporated in ENERGY STAR or LEED, solar ready will

[31] City of Boston Department of Neighborhood Development (DND). www.cityofboston.gov/dnd/d_green_housing.asp. Accessed April 2011.

reach a wider audience. A potential drawback of this approach is the dilution of the concept by couching it with other green building measures. On the other hand, this emphasizes the importance of pursuing energy efficiency concepts in parallel with renewable energy.

Education Combined with Incentives

One approach may be to make educational training mandatory in order to receive an incentive or benefit. This benefit could be monetary, access to a streamlined process, or eligibility for a certification.

Stakeholder Education

Appendix A lists organizations that can act as conduits for educating the stakeholders on solar ready construction. These organizations often sponsor conferences, workshops, robust websites, and newsletters, and many have a database of stakeholders. Promoting solar ready concepts through these organizations may be an effective way to reach front-end decision makers who can pave the way for solar development.

Guidelines

Some jurisdictions have taken an approach to promoting solar ready that neither mandates compliance nor rewards participants with a label or certification. Solar ready guidelines fall into this third category. Solar ready guidelines offer specific information and even specifications that can be used to educate stakeholders about solar ready and aid stakeholders in implementation. Solar ready guidelines provide the information needed to construct solar ready buildings for those who are self-motivated to do so. When promoted by a visible entity or program, guidelines can encourage stakeholders to consider building solar ready when they might not have otherwise.[32] Likewise, the Twin Cities of Minneapolis and St. Paul, Minnesota, have pursued a solar ready building program based on location-specific guidelines and specifications.

[32] As technical assistance to the City of Boston, NREL designed solar ready guidelines that the city can use as an educational document to inform stakeholders. See Solar Ready Buildings Planning Guide, http://www.nrel.gov/docs/fy10osti/46078.pdf.

Solar Ready Guidelines – The Twin Cities, Minnesota[33]

The Twin Cities, Minnesota, have released two location-specific documents for use by public agencies, community organizations, the nonprofit and for-profit development communities, and owners, architects, builders, and contractors. The Solar Ready Building Design Guidelines explain solar ready and outline guidance for designing and building a solar ready structure. The Solar Ready Construction Specification provides an implementation methodology for achieving solar ready buildings. The guidelines, released by the Twin Cities Solar America Cities Program in 2010, " … address specific site planning, building form, space planning, roofing, and mechanical and electrical issues to be considered in the design of solar ready buildings." The accompanying specification document " … establishes responsibilities and procedures for implementing these requirements during the construction phase of the building process." Both of these documents represent comprehensive education on solar ready building principles for a targeted audience in a targeted location. Supported by the city through the Solar America Cities Initiative, these documents will help overcome "major barriers to the installation of solar energy systems [which] is the traditional design of [the] building stock" in the Twin Cities.

[33] Lunning Wende Associates, Inc. *Solar Ready Building Design Guidelines for the Twin Cities, Minnesota*. September 2010. www.state.mn.us/mn/externalDocs/Commerce/Solar_Ready_Building_Design_Guidelines_020211042659_SolarBuildingDesignGuidelines.pdf. Accessed April 2011.

Conclusion

Solar ready itself does not reduce energy use or create clean energy. Nevertheless, solar ready building practices are needed to reach the full potential of solar deployment. Without forethought on incorporating solar into design, buildings may be incompatible with solar due to roof structure or excessive shading. In these cases, retrofitting the roof or removing shading elements is cost prohibitive. Furthermore, higher up-front costs due to structural adaptations and production losses caused by less than optimal roof orientation, roof equipment, or shading will lengthen payback periods, making solar more expensive. With millions of new buildings constructed each year in the United States, solar ready can remove installation barriers and increase the potential for widespread solar adoption.

There are many approaches to promoting solar ready, including solar ready legislation, certification programs, and education of stakeholders. Federal, state, and local governments have the potential to implement programs that encourage solar ready and in turn reduce barriers to solar deployment. With the guidance in this document and the examples of jurisdictions and organizations already working to promote solar ready building practices, federal, state, and local governments can guide the market toward solar ready implementation.

Appendix A – Trade Organization Resources

American Institute of Architects (AIA)

The AIA Board of Directors recognizes the need to prepare their members to respond to the challenge and opportunity facing the profession in environmentally responsible projects. The AIA offers a number of forums and programs by which industry professionals can learn about the latest developments. The AIA offers a continuing education program dedicated to sustainability in which solar ready modules may be incorporated.

American Solar Energy Society (ASES)

The American Solar Energy Society provides a conduit to integrate solar ready into solar energy education and communication. While the membership is often focused on solar installation, an additional emphasis on solar ready helps ensure that opportunities to make buildings solar ready will be cost effective into the future.

National Association for Industrial and Office Properties (NAIOP)

NAIOP, the Commercial Real Estate Development Association, is the leading organization for developers, owners, and related professionals in office, industrial, and mixed-use real estate. NAIOP provides industry networking and education, and advocates for effective legislation on behalf of its members. NAIOP advances responsible, sustainable development that creates jobs and benefits the communities in which members work and live. The NAIOP Center for Education is the principal learning resource for the commercial real estate professional. It is organized as a system of continuing education, which includes webinars, courses, certificate programs, and chapter education partnership.

National Association of Home Builders (NAHB)

The National Association of Home Builders (NAHB) is one of the largest trade associations in the United States, with more than 800 state and local associations. About one-third of NAHB's more than 175,000 members are home builders and/or remodelers. The home builder members of NAHB construct approximately 80% of new homes each year in the United States. The various NAHB groups analyze policy issues and economic and consumer trends as well as educate and communicate industry news to the public. The NAHB organizes the International Builders' Show, which is one of the largest conventions in North America for the residential and light commercial construction industry. NAHB publishes *Nation's Building News*, a free weekly e-newspaper distributed to nearly 200,000 recipients. The NAHB hosts educational seminars at the International Builders' Show, which offered 900 courses to 6,000 conference participants in 2008.

U.S. Green Building Council (USGBC)

The USGBC has diverse resources and multiple formats for LEED and green building education and knowledge. Solar ready could potentially be adapted within existing programs. The USGBC offers a number of educational forums, including:

- USGBC's LEED curriculum and workshops
- Reference guides
- Study guides
- Podcasts
- USGBC live chats
- Private LEED workshops.

Appendix B – Sample Solar Ready Legislation

1. Definitions – As used in the [name of act or chapter],
   A. "New Construction" includes any newly constructed residential or commercial building that requires a building permit to proceed.
   B. "Developer" means any person or company who constructs residential or commercial buildings.
   C. "Department" means [name of state agency who will undertake tasks identified below].
   D. "Solar Energy System" means any system that uses solar energy to provide all or a portion of the electrical needs of a residential or commercial building.
   E. "Solar Hot Water Heater" means any system that uses solar energy to heat water for use in a residential or commercial building.
   F. "Substitute Renewable Energy System" means any system that uses renewable energy resources, including wind and geothermal heat, to provide for all or a portion of the electrical needs of a residential or commercial building.
   G. "Substitute Renewable Hot Water System" means any system that uses renewable energy resources, including geothermal heat, to provide for all or a portion of the hot water needs of a residential or commercial building.
2. New Construction Shall be Built Solar Ready

   All new construction shall be built to accommodate the installation of a solar energy system and solar hot water heater in accordance with regulations adopted by the Department and in accordance with the following sections.

3. Solar Energy System Readiness Standards
   A. The Department shall promulgate regulations by [date] that establish minimum standards that must be met for new construction to accommodate a solar energy system.
   B. In drafting the regulations, the Department shall take into account existing building code requirements and compliance costs. The Department shall also consult with scientists, engineers, professional societies, and government agencies with relevant expertise in solar energy systems and building construction.
   C. At a minimum, the Department shall include requirements for:
      i. Static load roof strength, with a requirement that roofing where solar equipment could be placed be capable of supporting a minimum of 6 lb/ft^2;

ii. Placement of non-solar related rooftop equipment, taking into account positioning that avoids shading of solar equipment and maximization of continuous roof space;[34]

iii. Sizing and/or provision of extra electrical panels to accommodate addition of an appropriately sized future solar energy system; [35] and

iv. Provision of space for a solar energy system DC-AC inverter in the utility room or on an outside wall.

D. The Department shall also consider including requirements for:

i. Roof orientation and angle;[36]

ii. Roof types that are compatible with a solar installation mounting strategy that will require minimal or no roof penetrations;[37] and

iii. A conduit for wiring from roof to electric panel.

E. To the extent necessary, the Department shall promulgate separate standards for residential and commercial construction.

4. Solar Hot Water Heater Readiness Standards

A. The Department shall promulgate regulations by [date] that establish minimum standards that must be met for new construction to accommodate a solar hot water heater.

B. In drafting the regulations, the Department shall take into account existing building code requirements and compliance costs. The Department shall also consult with scientists, engineers, professional societies, and government agencies with relevant expertise in solar hot water heating and building construction.

C. At a minimum, the Department shall include requirements for:

i. Roof strength, with a requirement that roofing where solar hot water heating equipment could be placed be capable of supporting a minimum of 6 lb/ft^2;

ii. Placement of non-solar-related rooftop equipment, taking into account positioning that avoids shading of solar equipment and maximization of continuous roof space;[38]

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[34] To optimize future solar energy and hot water systems, NREL recommends that there be at least 75% continuous roof space, unobstructed by HVAC equipment, vents, or any other objects, and that all such equipment be located on the north end of the solar ready roof. www.nrel.gov/docs/fy10osti/46078.pdf. Accessed April 2011.

[35] To optimize future solar energy and hot water systems, NREL recommends that residential electrical panels have an excess of 30% capacity and that space for an additional electric panel be provided in commercial buildings. www.nrel.gov/docs/fy10osti/46078.pdf. Accessed April 2011.

[36] To optimize future solar energy and hot water systems, NREL recommends that all buildings be oriented with a sky view within 15 feet of due south or be flat in order to be considered solar ready. www.nrel.gov/docs/fy10osti/46078.pdf. Accessed April 2011.

[37] To optimize future solar energy and hot water systems, for flat roofs NREL recommends fully adhered thermoplastic olefin or polyolefin (TPO) roofing. For slanted roofs, NREL recommends a structurally fastened standing seam roof. www.nrel.gov/docs/fy10osti/46078.pdf. Accessed April 2011.

iii. Provision of sufficient free space in utility rooms for solar hot water equipment at a minimum of one times the space required for the conventional water heating equipment;

iv. Plumbing that will allow solar hot water piping to be attached to a conventional system without requiring the building water system to be de-pressurized;[39]

v. Plan hot water distribution systems to accommodate SHW system integration;

vi. On-demand water heaters that can operate in conjunction with a SHW system or implement distributed domestic hot water tanks that are capable of being integrated with a SHW system; and

vii. Roof types that are compatible with a solar installation mounting strategy that will require minimal or no roof penetrations.[40]

D. The Department shall also consider including requirements for:

i. Plumbing installed from the utility room to the roof of the building and

ii. Metering of hot water load in commercial buildings.

E. To the extent necessary, the Department shall promulgate separate standards for residential and commercial construction.

5. Exemptions

A. Developers may seek an exemption from [building code official or the Department] from the solar system and/or solar hot water heater readiness requirements upon a sufficient showing that:

i. Accommodation of a solar energy system and/or a solar hot water heater would be impractical due to poor solar resources at a site of new construction;

ii. A substitute renewable energy system will be installed at the time of new construction; or

iii. A substitute renewable hot water system will be installed at the time of new construction.

B. The Department shall issue regulations that define what constitutes a sufficiently poor solar resource such that a building should be exempted. The Department shall also consider publishing a list of acceptable software tools that can be utilized to determine the available solar resources for a building.

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[38] NREL recommends that there be at least 75% continuous roof space, unobstructed by HVAC equipment, vents, or any other objects, and that all such equipment be located on the north end of the solar ready roof.
[39] NREL recommends requiring that T-joints and shut-off valves be required to accomplish this purpose.
[40] To optimize future solar energy and hot water systems, for flat roofs NREL recommends fully adhered thermoplastic olefin or polyolefin (TPO) roofing. For slanted roofs, NREL recommends a structurally fastened standing seam roof. www.nrel.gov/docs/fy10osti/46078.pdf. Accessed April 2011.

C. The Department shall publish regulations by [date] that clearly define the process for seeking an exemption.

6. Availability of Incentives

Compliance with the provisions of this [Act] shall not impair a pre-existing building's eligibility for any incentives, rebates, credits, or other programs in existence to encourage development of renewable resources.

7. Enforcement

A building permit for new construction may not be granted without a showing that the building complies with the requirements of this [Act].

Appendix C – Sample of Solar Ready Requirements or Practice by Jurisdiction

1 Arizona

1.1 Tucson – Solar Design Requirement for Homes

1.1.1 Type of Technology

The requirement addresses photovoltaic (PV) and solar water heating systems.

1.1.2 Legislative Mandate/Option

Tucson adopted an ordinance in June 2008 that requires all new single-family homes and duplexes in Tucson to be solar ready. The ordinance requires all new homes either to have a PV and solar water heating system installed, or to have all the necessary hardware installed so that a system can easily be installed at a later date.

City of Tucson Energy Office
4004 S. Park Ave., Bldg. 1
Tucson, AZ 85714

Bruce Plenk
Phone: 520-791-5111
Email: bruce.plenk@tucsonaz.gov
Website: http://cms3.tucsonaz.gov/energy

Database of State Incentives for Renewables and Efficiency:
Arizona, City of Tucson – Solar Design Requirement for Homes
http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=AZ26R&re=1&ee=1

1.1.3 Technical Requirements

To comply with this requirement, new homes must either have a complete solar water heating system installed or comply with one of two solar stub-out options. Option one requires the installation of two insulated pipes and a suitably sized conduit (for two pairs of monitoring and control wires) that run from the water heater area through the roof and are capped. Option two does not require the installation of pipes, but it does require the installation of a sleeve or conduit of sufficient size to hold the two insulated pipes and wires. With option two there must be a straight line from the water heater area to the roof. Both options will greatly cut down on the cost of installing a system at a later date. To comply with the PV requirement, a site plan must indicate the best roof space for locating the PV panels, and provide a roof structure designed for the additional collector weight. The site plan must also illustrate the best space available for accommodating PV equipment (meter, inverter, disconnect), and it should be adjacent to the electrical service panel or on a wall near the proposed location of the panels. There must also be a minimum 3,800-volt-ampere PV electrical load entry on the service load calculation, and an Electrical Panel Schedule with a 240-volt circuit breaker space labeled “reserved for photovoltaic.”

1.1.4 Agency Responsible for Specifications

The ordinance was developed by a stakeholder group that included Technicians for Sustainability, the Tucson Association of Realtors, the Sierra Club, the Southern Arizona Homebuilders Association, architectural professionals, solar energy companies, and elements of the city government.

1.1.5 Exceptions

These requirements may be waived if it can be demonstrated to the building official that compliance is not practical due to shading, building orientation, construction constraints, or the configuration of the parcel of land.

2 California

2.1 California State Energy Code

2.1.1 Type of Technology

The requirement addresses PV and solar water heating systems.

2.1.2 Legislative Mandate/Option

California Green Building Standards Code (GBSC) (Title 24, Part 11). On page 60 (page 69 of the .pdf), there are residential voluntary measures for "space for future solar installation" (A4.211.3) and "future access for solar system" (A4.211.4).

2.1.3 Technical Requirements

On page 127 (page 136 of the .pdf), there are nonresidential voluntary measures for "prewiring for future solar" (A5.211.4) and "off-grid prewiring for future solar" (A5.211.4.1). Local jurisdictions may make portions of the GBSC mandatory, but there are no specifics. To view the text of the local ordinances go to:www.energy.ca.gov/title24/2008standards/ordinances/. Note that these local ordinances are primarily meant to exceed the California Energy Code (Title 24, Part 6) but may also contain additional elements, such as those from the GBSC.

California Energy Commission

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Database of State Incentives for Renewables and Efficiency:
California State Energy Code
http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA51R&re=1&ee=1

2.2 Marin County – Single-Family Dwelling Energy Efficiency Ordinance

2.2.1 Type of Technology

The requirement addresses PV and solar water heating systems.

2.2.2 Legislative Mandate/Option

Marin County Code 19.04.100.

2.2.3 Technical Requirements

New commercial buildings over 5,000 square feet and all new residential construction must include plumbing and electrical conduit specifically designed to accommodate the easy installation of solar water heaters and PV systems in the future. These systems can be used to comply with the building code, but they are not required by the building code.

Marin County Community Development Agency
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San Rafael, CA 94903-4157

Omar Pena
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Website:
http://www.co.marin.ca.us/depts/CD/main/comdev/ADVANCE/index.cfm

Database of State Incentives for Renewables and Efficiency:
Marin County – Green Building Requirements
http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA40R&re=1&ee=1

2.2.4 Agency Responsible for Specifications

The exact requirements for these solar ready additions will be adopted by the chief building inspector.

3 Colorado

3.1 Colorado Building Energy Code with Mandatory Solar Option

3.1.1 Type of Technology

The requirement addresses PV and solar water heating systems.

3.1.2 Legislative Mandate/Option

HB 1149, enacted in May 2009, requires builders of single-family homes to offer solar as a standard feature to all prospective homebuyers.

3.1.3 Technical Requirements

Builders are required to give the buyer the option to either have a PV system or a solar water heating system installed on their new home, or to have all the necessary wiring and/or plumbing installed so they can easily add a solar system at a later date. The builder must also provide the buyer with a list, maintained by the Governor's Energy Office, of every solar installer in the area, so the buyer can obtain expert help in determining if their home's location is suitable for solar and what the estimated cost savings would be.

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Database of State Incentives for Renewables and Efficiency:
Colorado Building Energy Code with Mandatory Solar Option
http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CO36R&re=1&ee=1

3.2 Boulder Green Points Building Program

3.2.1 Type of Technology

The requirement addresses PV and solar water heating systems.

3.2.2 Legislative Mandate/Option

There is no code or ordinance. But on page 127 (page 136 of the .pdf), there are nonresidential voluntary measures for “prewiring for future solar” (A5.211.4) and "off-grid prewiring for future solar" (A5.211.4.1).

City of Boulder, Department of Community Planning & Sustainability

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Database of State Incentives for Renewables and Efficiency:
City of Boulder – Green Points Building Program
http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CO06R&re=1&ee=1

3.3 Aspen & Pitkin County – Renewable Energy Mitigation Program

3.3.1 Type of Technology

The requirement addresses solar water heat, PV, and geothermal heat pumps.

3.3.1.1 Legislative Mandate/Option

Pitkin County does not require homes to be solar ready. It does, however, have a mandatory Efficient Building Program (EBP) that requires residences to score points by incorporating sustainable building measures in home construction. Solar ready measures are one of the ways the builder may choose to score points. The EBP is mandatory—a building permit cannot be issued without scoring enough points. To summarize, some homes in unincorporated Pitkin County are solar ready, but the percentage is very low.

Pitkin County

Tony Fusaro
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Website: www.aspenpitkin.com

Database of State Incentives for Renewables and Efficiency:

Aspen & Pitkin County – Renewable Energy Mitigation Program

http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CO16R&re=1&ee=1

4 Guam

4.1 Guam – Solar Ready Residential Building Requirement

4.1.1 Type of Technology

The requirement addresses solar hot water heaters.

4.1.1.1 Legislative Mandate/Option

The Guam Energy Code became effective in October 2000.

4.1.2 Technical Requirements

The requirement mandates that piping stub-outs be provided for water heaters installed in low-rise residential buildings to enable the future installation of solar collectors.

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Database of State Incentives for Renewables and Efficiency:
Guam – Solar-Ready Residential Building Requirement
http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=GU01R&re=1&ee=1

5 New Jersey

5.1 New Jersey Solar Energy Option Requirement for Residential Developments

5.1.1 Type of Technology

Broad definition could include passive as well as active solar elements.

5.1.1.1 Legislative Mandate/Option

In March 2009, New Jersey enacted legislation designed to support the integration of solar energy systems into new residential developments. The law requires that, whenever “technically feasible,” developers of residential developments with 25 or more dwelling units (i.e., single-family residences) offer to install or provide for the installation of a solar energy system on the unit during negotiations with a prospective purchaser. Developers are required to disclose this option in their advertising materials, which must include information on installation costs, environmental benefits, energy cost savings, and incentive programs for which the installation may qualify.

New Jersey Department of Community Affairs
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PO Box 802
Trenton, NJ 08625-0802

Darren Port
Division of Codes and Standards
Phone: 609-984-7607
Website:
http://www.state.nj.us/dca/divisions/codes/index.html

Database of State Incentives for Renewables and Efficiency:
New Jersey Solar Energy Option Requirement for Residential Developments
http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ18R&re=1&ee=1

5.1.2 Technical Requirements

NJ // P.L. 2009, CHAPTER 33 / 3 stipulates that the solar energy system is to be installed in conformance with the manufacturer's specifications and in compliance with all applicable electrical and building code standards.

5.1.3 Agency Responsible for Specifications

The Board of Public Utilities shall adopt orders, rules, or regulations that provide for solar energy systems installed in accordance with the provisions of P.L. 2009, c.33.

6 Massachusetts

6.1 City of Boston

6.1.1 Type of Technology

The requirement addresses PV systems.

6.1.1.1 Legislative Mandate/Option

The City of Boston Department of Neighborhood Development (DND) coordinates the construction of affordable housing units within the city. DND has worked with the Solar Boston Initiative to incorporate solar into the department housing portfolio through the Green Affordable Housing Program (GAHP) as part of a $1.8 million grant from the Massachusetts Clean Energy Center. The DND has required that all future affordable housing development in the city be built to solar ready guidelines.

City of Boston

Andrew Belden

Department of Neighborhood Development

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6.1.2 Technical Requirements

The solar ready guidelines, which were developed with the help of NREL, require new affordable housing developments to limit roof obstructions and to avoid roof designs that would complicate future solar installations. The solar ready standard has been in place since 2007 for all DND-developed affordable housing projects.