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CASE STUDIES OF STATE SUPPORT FOR RENEWABLE ENERGY

Supporting Photovoltaics in Market-Rate Residential New Construction: A Summary of Programmatic Experience to Date and Lessons Learned

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Introduction

As a market segment for solar photovoltaic (PV) adoption, new homes have a number of attractive attributes. Homebuyers can easily roll the cost of the PV system into their tax-deductible home mortgage and, with rebates and other financial incentives, potentially achieve an immediate net-positive cash flow from the investment.[1] New homes are amenable to building-integrated photovoltaics (BIPV), which are less susceptible to aesthetic concerns than traditional, rack-mounted systems. The performance of PV systems can be optimized on new homes by taking roof orientation and shading into account when designing the home.[2] Perhaps most importantly, subdivisions with PV systems installed on a large number of homes offer potential cost savings from volume purchases of modules and inverters and from scale economies in system design and installation.[3] Finally, the ability of builders to install PV as a standard

[1] PV systems installed on existing homes could be financed through a home equity loan or by refinancing the mortgage, in which case the interest would be tax-deductible. However, new homes would still have a financing advantage in that no *separate* transaction would be required, thereby greatly simplifying the process for the customer.

[2] Though more aesthetically pleasing, BIPV systems may operate at higher temperatures, and therefore lower conversion efficiencies, than standard rack-mounted systems.

[3] These sources of up-front cost savings may be most applicable when PV is installed as a standard feature on multiple homes in new developments and may be offset, to some extent, by other factors. For example, builders that install PV as a standard feature may tend to opt for smaller systems in order to minimize the impact on home prices or profits, which would tend to raise the unit cost per watt (KEMA-Xenergy 2004a and 2004b). Also, BIPV, which is often used in new construction, is generally more expensive on a dollar per watt basis than standard, rack-mounted PV (and may also have lower performance, as mentioned previously).

feature on multiple homes in new subdivisions offers an opportunity to circumvent the high transaction costs and information-related market barriers typically confronted when each individual homeowner must make a decision about installing PV.

Builders may benefit in several ways from incorporating PV into new homes. Builders may gain greater market differentiation, enhanced media exposure, and less community or political opposition to development projects. Additionally, if homebuyers place a high value on PV, builders may be able to earn additional profits, just as they would on granite countertops or other high-value home features.[4] Although the impact of PV on the original sale price of new homes has not yet been rigorously examined, some limited empirical evidence does suggest that PV and energy efficient features may have a positive effect on *resale* value.[5]

Along with its unique advantages, residential new construction also faces unique barriers to PV adoption. Most fundamentally, perhaps, is the general aversion to technology risk within the building industry, particularly in "hot" housing markets where builders face little difficulty selling homes. Builders may also be concerned about the up-front cost of PV and its impact on new home prices and profits. The potential for project delays associated with PV module availability, installation scheduling, utility interconnection agreements, building inspections, permit processing, or other factors, may also be of great concern. Finally, many builders may believe that most homebuyers are not particularly interested in PV, given its cost, and that some may even be opposed based on concerns about aesthetics, maintenance, or reliability.

In this paper, prepared on behalf of the Clean Energy States Alliance (CESA), we describe early efforts by state clean energy funds to support the deployment of PV in new, market-rate homes.[6] (Other recent reports prepared for CESA describe experiences with programs targeting affordable housing.[7]) We focus on the activities of clean energy funds in nine states that have funded specific projects and/or have offered targeted programs for PV in market-rate residential new construction. We also include in our review several other state or local organizations whose efforts are particularly noteworthy or have some direct bearing on the efforts of clean energy funds in the same state – however, we do not attempt to comprehensively review the activities of entities other than state clean energy funds.[8]

[4] Homebuyers may value PV for various reasons, including improved environmental benefits, reduced utility costs, improved power quality, or provision of back-up power.

[5] Coburn *et al*. (2004) compared the increase in value of 10 homes in Shea Homes' zero-energy home development in Scripps Highlands (San Diego) that were bought and re-sold between April 2001 and February 2004 to the increase in value of 6 homes in a comparison community that were bought and resold during the same period. On average, the "zero-energy homes" (all of which had high efficiency features and some of which had PV) increased in value by a higher percentage than the comparison homes. Though the sample size for this study was too small to draw more general conclusions, other research has shown that energy efficiency measures can have a significant positive impact on home resale values (Nevin and Watson 1998, Nevin *et al.* 1999).

[6] Clean energy funds have been established in approximately fifteen states, to provide support for clean energy technologies and markets. CESA is a nonprofit organization that provides information and technical services to state clean energy funds. Currently, sixteen funds from twelve states are members of CESA.

[7] State clean energy fund support for PV and other clean energy projects in affordable housing are described by Peregrine Energy Group (2006) and by Fitzgerald *et al*. (2004). For information about state clean energy fund support for customer-sited PV more generally, see Bolinger and Wiser (2002, 2003).

[8] One notable initiative falling outside the direct scope of this report is the U.S. Department of Energy (DOE)'s *Zero Energy Buildings Program*. Through this program, DOE has provided funding and other assistance to four teams to develop zero-energy home designs and recruit large production homebuilders around the country to incorporate these designs into new housing developments. For discussions of experiences with this program, see Farhar *et al.* (2002, 2004) and Springer and Hammon (2004).

The overall objectives of this paper are to (1) briefly describe efforts to date to support PV in market-rate residential new construction, and (2) identify key issues and lessons learned that have emerged from these experiences. Information about these topics was obtained through interviews with program managers and from publicly available documentation describing program design and results. Although experience with PV in this market segment remains too limited at this time to provide a comprehensive design guide, our hope is that this report will help clean energy fund administrators and others in their efforts to modify existing programs or develop new programs to encourage adoption of PV in market-rate residential new construction.

The remainder of the paper is organized as follows. In the next section, we present a brief overview of the general types of strategies that state clean energy funds have pursued to support PV in new, market-rate homes. We then describe the specific programs and experiences in nine states where clean energy funds (and others) have provided targeted support for this market segment. Drawing on the experiences in these nine states, we then identify key issues for initiatives aimed at supporting PV in market-rate residential construction, and discuss how program administrators have sought to address them. Finally, we conclude with a set of recommendations for clean energy funds or other organizations seeking to grow the residential new construction market for PV.

Overview of State Support for PV in Market-Rate New Homes

In this paper, we describe the efforts of clean energy funds (and a select number of other organizations) in nine states, each of which has provided support *specifically* for PV in market-rate residential new construction (see Table 1).

Much of this support has occurred through programs aimed at broader categories of clean energy technologies and markets, which have provided funding for individual projects involving PV on market-rate new homes. These broader programs include:

- *Buy-down programs* for PV or for customer-sited renewable energy technologies more generally;[9]
- *Green building or clean energy solicitations* offering grants or other forms of financial support for feasibility studies, design, or construction of green building or clean energy demonstration projects; and
- *Research and development (R&D) solicitations* for clean energy technologies or markets.

On a more limited basis, a number of state funds have offered *targeted* support for PV in new, market-rate homes. They have done so either through distinct programs targeted to this segment, or through special provisions within broader programs that differentially support PV in new residential construction. These forms of targeted support include:

- *Higher buy-down incentives* for BIPV systems or for PV systems installed on high-efficiency homes;[10]
- *Buy-down program rules or administrative procedures* that explicitly or implicitly accommodate the unique features of residential new construction;
- *Solicitations for demonstration projects of high-efficiency new homes with PV*, that offer funding for PV systems, building design, development of innovative business models, marketing, or other related activities;
- *Bulk purchases* of PV modules and inverters on behalf of builders or assistance with procurement provided to builders;
- *Outreach and training for residential building industry professionals*, often conducted

[9] Many state clean energy funds have developed buy-down programs for PV, but we included only those programs that provide some form of targeted support for market-rate residential new construction.

[10] BIPV systems and systems installed on high-efficiency homes are often installed during construction, thus we consider higher incentives for these types of applications to be an implicit or indirect form of differential support for PV on new homes.

in support of, or in coordination with, buy-down programs or demonstration projects; and

• *Publicity and recognition for builders* who incorporate PV into residential new construction.

In the following section, we describe the specific programs and experiences of clean energy funds (and several other organizations) in the nine states listed in Table 1. Text Box 1 briefly describes other general types of strategies that have (or potentially could) be used to support PV in market-rate new homes.

Table 1. State Clean Energy Fund Support for PV in Market-Rate New Homes

	California	Massachusetts	Minnesota	New Jersey	New York	Oregon	Pennsylvania	Rhode Island	Wisconsin
Broader Programs That Have Supported Specific Projects Involving PV on New, Market-Rate Homes									
Buy-down programs for customer-sited PV	●	●	●	●	●	●	●	●	●
Green building or clean energy solicitations		●					●		
Research and Development (R&D) solicitations	●	●							●
Targeted Support for PV on Market-Rate New Homes									
Higher buy-down incentives for BIPV and/or for PV on high-efficiency new homes		●		●	●				●
Buy-down program rules or administrative procedures that accommodate new homes	**E**	**E**	**I**	**I**	**I**	**I**	**I**		**I**
Solicitations for demonstration projects of high-efficiency new homes with PV	●				●				
Bulk purchase of modules or technical assistance with bulk module procurement	●								
Outreach and training for residential building industry professionals	●				●	●			●
Publicity and recognition for builders or for new residential developments with PV	●				●				

Notes:

(1) The table refers to activities conducted by the clean energy fund(s) in each state and by several other organizations, including the Sacramento Municipal Utility District (California), the Minnesota State Energy Office, the Pennsylvania Department of Environmental Protection, and the Pennsylvania Energy Development Authority.

(2) Although the table shows little program activity for Rhode Island, the clean energy fund in that state has recently considered several strategies for targeting the residential new construction market for PV, discussed in the following section of this paper.

(3) **E** = buy-down program has provisions that *explicitly* accommodate residential new construction; **I** = buy-down program has provisions that *implicitly* accommodate residential new construction, or the program administrator has the flexibility to grant variances to normal program rules to accommodate new construction, if warranted.

Text Box 1. Other Potential Strategies for Encouraging PV in New Homes

Various other strategies, in addition to those listed in Table 1, could be used to support PV in new, market-rate homes. Some could be implemented directly by clean energy funds, while some would require action by other entities. Here, we briefly mention a few of these general strategies. For additional information, see KEMA-Xenergy (2004a, 2004b).

Builder mandates. These could take on various forms, including requirements that builders install PV on new homes, that they offer it as an option, or that they construct new homes to be "PV-ready" (e.g., with proper roof orientation and pitch, or with the required conduit and wiring for PV pre-installed). Understandably, mandates typically face resistance from the building industry. To our knowledge, no state has yet adopted any PV-related builder mandate, although several bills introduced in the California legislature over the past several years would have established some form of statewide requirement. Builder mandates have been adopted in several cases at the local level. The master developer of Ladera Ranch, a planned community in Southern California, required that builders offer PV and incorporate green building features in the development's Evergreen "village". Also, the city of Winters, California requires builders to include PV on a minimum percentage of homes in all new developments; the exact percentage has ranged from 10% to approximately 30% and is established on a project-by-project basis while negotiating a Development Agreement (McCabe 2005).

Financing strategies. Various financing strategies, targeting either homebuyers or developers, could be employed to encourage PV on new homes. One type of consumer financing strategy is to offer increased loan eligibility limits for buyers of homes with PV, on the basis of their lower monthly utility costs. This approach has been attempted through energy efficient mortgages that cover PV, but such programs have generated limited interest given that the total loan amount is typically capped at a relatively low level for many housing markets and given that the benefit offered (a larger loan) is not a particularly compelling incentive (KEMA-Xenergy 2004a). Most other consumer financing strategies focus on reducing the financing costs. Several clean energy funds and other organizations have used public funding to offer low-interest loans for PV, but these are not particularly well-suited to new construction, since they require that the homebuyer take out a separate loan in addition to their mortgage. In theory, a similar program could be developed to buy-down the interest rate on the mortgage itself. However, this type of approach may be a less-efficient use of public dollars than an equivalent buy-down incentive (KEMA-Xenergy 2004a and 2004b). An alternative, which would require considerably less public funding but could face significant institutional barriers, is to use the value of a large number of PV homebuyers in need of a mortgage to recruit lenders willing to offer lower interest loans or point reductions in exchange for PV homebuyer leads. A variant on this approach has been implemented in Japan, where a prominent manufacturer of modular homes has negotiated an agreement with a bank to provide reduced interest rate home loans (as much as 1.7% below the bank's standard fixed-rate mortgage) to buyers of the manufacturer's "zero-utility-cost" homes with PV (Sekisui 2005). Similar arrangements could perhaps be organized by a public agency or clean energy fund, and Community Reinvestment Act credits could potentially be offered to induce lenders to participate, as is currently done for energy efficient mortgages (KEMA-Xenergy 2004a and 2004b).

Financing strategies could also be targeted to residential developers. For example, the Reinvestment Fund (the Pennsylvania Sustainable Development Fund's parent organization) has considered offering low- or no-interest pre-development loans for new construction projects (affordable housing) that incorporate PV, for the specific purpose of addressing developers' concerns about the financing costs resulting from any project delays associated with PV (Clark 2005). Similarly, state public financing authorities could offer developers low-interest construction loans, or loan guarantees, for large residential developments with PV.

Entitlements. Local permitting and planning authorities can support PV on new homes by offering entitlements, such as shorter wait times, higher density allowances, or reduced permitting and inspection fees. The city of San Diego has pursued this approach, offering expedited permit processing for projects that meet the city's "sustainable buildings" definition, including residential projects that provide 50% of their projected energy use through renewable resources. Entitlements such as these can potentially be of great financial value to developers; however, it is unclear how large of a role they ultimately might play. Through interviews with local government personnel and builders, KEMA-Xenergy (2004a, 2004b) concluded that the resource constraints of many municipal agencies, particularly in regions with a large amount of development, would likely limit their ability to offer expedited processing or other entitlements. Moreover, unless state legislatures required that local governments offer entitlements for residential PV, each locale would have to make the decision individually, entailing considerable time and effort to achieve broad application.

Bulk purchases by groups of builders. Cost savings can potentially be realized through bulk purchases of modules or other system components. As described further in the section of this report describing efforts undertaken in California, the Sacramento Municipal Utility District (SMUD) directly purchased PV modules and inverters in bulk and resold the equipment to builders, as part of its *Solar Advantage Home Program*. Similarly, homebuilders could band together without a middle-man to negotiate bulk purchases with PV equipment manufacturers – perhaps with organizational support or technical assistance from trade organizations, clean energy funds, or other entities. The California Solar Energy Industry Association and California Building Industry Association have reportedly considered such an approach (KEMA-Xenergy 2004a, 2004b). Because large production builders typically already purchase equipment in relatively large volumes, the cost savings from this type of strategy are likely to be greatest for smaller builders.

Table 2. Market-Rate New Home Projects Funded by the CEC's ZENH RFP

Project Name	Contractor	Award	Key Elements of Business Model
Commercializing Zero Energy New Home Communities	Powerlight	$2,730,283	The PV systems will be purchased by a third-party and the cost recovered from the homeowner through the equivalent of an ongoing utility bill.
Utility-Focused Market Model for Zero Energy New Homes	Architectural Energy Corporation	$2,904,938	The proposal seeks to "explore the benefits of ZENH for the electric utility and to develop a market model in which the utility can serve as a major driver for reducing the cost to the homeowner."

Case Study Details

In this section, we describe the specific activities to support PV in market-rate residential new construction conducted by clean energy funds (and several other organizations) in nine states, highlighting program design, market impacts, and issues or lessons learned. We begin with the three states with arguably the most substantial efforts to date – California, New York, and Massachusetts – and then describe the activities of clean energy funds in New Jersey, Minnesota, Oregon, Pennsylvania, Rhode Island, and Wisconsin.

California

California has, by far, the most significant experience of any state with PV in market-rate residential new construction. This market segment has grown, and continues to grow, based on a variety of programs and initiatives.

The California Energy Commission (CEC) has supported PV in new, market-rate homes through a number of programs and related activities. To date, its largest program directed *specifically* at PV in new homes has been an RFP, issued in 2004 through the Public Interest Energy Research (PIER) Program, for *Research, Development, and Demonstration Projects Focused on Zero-Energy New Homes (ZENH)*.

The solicitation offered a total of $10 million in funding for up to seven projects. Each proposal was required to incorporate: a large-scale (>75-unit) demonstration project involving ZENH designs meeting specified cost and performance goals;[11] an innovative business model to reduce the upfront cost of PV to homeowners and address other key market barriers; and activities to facilitate the long-term sustainability of the ZENH market (e.g., creating ongoing partnerships or disseminating information). Prior to issuing the solicitation, the CEC convened a stakeholder workshop to identify and refine a set of candidate business models that bidders could incorporate into their proposals.

As of December 2005, two proposals targeting market-rate, single-family homes had been awarded (see Table 2) and one other was under consideration.[12] According to CEC staff, one of the two market-rate ZEH projects that has already been funded has experienced setbacks, because the original builder included in the project team dropped out after the proposal was awarded (Peterson 2005).

The CEC's *Emerging Renewable Energy Program*, which provides buy-down incentives for small (<30 kW), customer-sited renewable energy technologies, has been the primary source of financial support for PV on new homes in California. In addition to providing buy-down incentives through the program, the

[11] Specifically, ZENH designs were required to exceed California's Title 24 energy efficiency standards by 25%, have a peak demand of 1 kW or less, and have an incremental first cost to the homeowner of $5,000 or less (after rebates and other financial incentives).

[12] Brief descriptions of these two proposals are at http://www.energy.ca.gov/pier/buildings/projects/500-04-022-0.html and http://www.energy.ca.gov/pier/buildings/projects/500-04-024-0.html. Also, see Springer and McCabe (2004).

CEC has also organized media events and provided other forms of free publicity for participating builders.

Though the program as a whole is not specifically targeted to PV in new homes, the CEC has added a number of provisions to the guidebook for the *Emerging Renewable Energy Program* to accommodate residential new construction.[13] These include the following:

- All new construction projects are allowed an 18-month reservation period rather than the standard 9-month period, to accommodate the lengthier development timeframe for new construction.
- For new subdivisions where PV will be installed on multiple units, a master building permit for the development may be included in the incentive application, in lieu of individual building permits for each site.
- For new subdivisions with at least 30 kW of PV in aggregate, developers can include in their application a *single* reservation request and a *single* utility inspection sign off or interconnection agreement for *all* addresses with PV, rather than separate documentation for each individual address.
- Developers who plan to offer PV as an optional feature on homes in new subdivisions may obtain reservations for 10% of the lots in advance, without identifying the specific lots, provided that the developer commits to installing PV on at least one model home in the subdivision. As of October 2005, no developers had availed themselves of this option.

As of May 2005, more than 2,700 PV systems on new market-rate homes had been installed or approved for funding through the CEC's *Emerging Renewable Energy Program*, representing roughly 15% of all systems less than 30 kW in size installed or approved since program inception in 1998.

[13] The current program guidebook is at: http://www.energy.ca.gov/2006publications/CEC-300-2006-001/CEC-300-2006-001-ED6F.PDF

The large number of systems funded through this program offers an unprecedented opportunity to examine the hypothesis that PV systems installed on new homes are less costly on an up-front basis than retrofits. Wiser *et al.* (2006) analyzed project cost data for systems funded through the program (i.e., completed projects and projects approved but not yet installed) as of May 2005, controlling for a variety of factors, such as system size and time of project approval (see Table 3).[14] Looking only at completed projects, PV systems installed in large new residential developments cost, on average, $1.70/W less than comparable retrofit systems, while those installed on individual or small clusters of new homes were slightly more expensive (+$0.32/W) than comparable retrofits. The higher cost of PV on individual or small clusters of new homes may reflect the combination of a potentially higher incidence of BIPV among such homes and the absence of scale economies realized in larger housing developments. Among the larger population of projects that have either been completed or approved (but not yet completed), PV systems in large new residential developments averaged $1.20/W less than comparable retrofit systems, suggesting a possible narrowing of the cost advantage over time, and PV systems installed on individual or small clusters of new homes remained slightly more expensive than comparable retrofits (an additional $0.18/W, on average).

In addition to the two programs discussed above, the CEC has supported PV on new homes on at least three other fronts. They have funded PV-related training and outreach for the building industry, through the *Renewable Energy Consumer Education Program*. Through the PIER program, the CEC has funded several

[14] Several important caveats should be made. First, the data provide a comparison of up-front costs. To compare the cost of energy would require information about system performance over time, which is unavailable. Second, the cost data for new home construction may not include any mark-up charged by the builder, and thus may not represent the full cost to the homebuyer.

Table 3. Relative Cost of PV on New Residential Construction Compared to Retrofits among Projects Funded through the CEC's *Emerging Renewables Program*

Installation Type	Status as of May 2005	Number	Percent of All Systems < 30kW	Difference in Avg. Cost Relative to Retrofit Systems of Similar Size
Large New Residential Developments	Completed	710	6%	- $1.70/W
	Completed or Approved	1946	11%	- $1.20/W
Single or Small Clusters of New Homes	Completed	242	2%	+ $0.32/W
	Completed or Approved	771	4%	+ $0.18/W

R&D projects targeting BIPV technologies and markets. Finally, the CEC is in the process of adopting changes to the state's 2008 building energy efficiency standards and is considering establishing an optional "Tier II" standard for high efficiency homes with PV, which would serve as a benchmark for state or utility programs seeking to promote such homes.

The Sacramento Municipal Utility District (SMUD), one of many municipal utilities in California that has offered funding for residential PV systems, stands out for its targeted support of PV in new homes. From 2001 to 2003, SMUD offered its *Solar Advantage Homes Program*, whereby the utility purchased BIPV systems and inverters in bulk quantities directly from a manufacturer, and sold these systems to production homebuilders at a discount.[15] The BIPV manufacturer also provided installation training and system design services for builders, as part of its contract with SMUD. Eight builders participated in the program, installing PV on model homes and offering it as an optional feature on other homes in new subdivisions. In total, the program resulted in the installation of approximately 220 PV systems on new homes in 21 different subdivisions (Keesee 2005a).

SMUD's current program for PV in new homes is a joint effort with the U.S. Department of Energy (DOE)'s *Zero Energy Homes* (ZEH) *Program*.[16] DOE's contractor provides technical assistance with ZEH home design and marketing, and SMUD offers participating builders buy-down incentives for PV and energy efficiency measures. SMUD provides additional funds to the builders for marketing activities, as well as informal technical assistance with PV module procurement. As of December 2005, three subdivisions with a total of 139 PV systems had received funding through this program. In one of these developments, PV was installed as a standard feature on 12 of the 120 homes and was offered as an optional feature on the other homes, although no homebuyers opted to have it installed. In the other two developments, with 95 and 32 homes each, PV was (or will be) installed as a standard feature on all homes. According to SMUD staff, the main challenge to expanding this program further (other than lack of funding) has been recruiting interested builders (Keesee 2005b).

Lastly, California Governor Arnold Schwarzenegger has put forth a broad policy proposal, dubbed the *Million Solar Roofs Initiative* (MSRI), which seeks to install 3,000 MW of PV by the end of 2017 and to build half of all new homes with PV by that year. Several pieces of legislation to implement this policy have been proposed but have not passed. The most recent bill, SB1, would have required builders of large developments to offer PV as an option and would have extended the state's buy-down programs for an additional ten years.

[15] SMUD financed the discounts through PV buy-down incentives for municipal utilities provided by the state. When the state discontinued these buy-down incentives in 2003, SMUD cancelled its *Solar Advantage Homes Program* (Keesee 2004).

[16] See footnote 8 for additional information about DOE's ZEH program.

The CEC and the California Public Utilities Commission (CPUC) have investigated potential regulatory strategies for meeting the MSRI goal, and in January 2006 the CPUC finalized the broad outlines of its programs under the *California Solar Initiative (CSI)*; the CEC is expected to do the same later in 2006. As part of these efforts, staff at the two agencies proposed an overall program design that would restructure the state's current PV buy-down programs and extend the funding for PV incentives by 10 years.[17] The most recent proposal recommends creating two statewide PV programs: one for commercial systems and residential retrofits, administered under the oversight of the CPUC, and a second program specifically for residential new construction, administered by the CEC (CEC and CPUC 2005).[18]

The proposed program for residential new construction includes the following key elements:

- The program would be allocated $350 million for the initial five-year period (2007-2011).[19]
- The staff proposal recommends adopting a performance-based incentive (PBI) for the commercial and residential retrofit program, to encourage effective design and installation, but opts for an up-front, capacity-based incentive for residential new construction, on the grounds that it "is more consistent with a new construction setting" (CEC and CPUC 2005).[20] However, in order to encourage quality design and installation in new construction, the proposal recommends adjusting the up-front payment, based on factors that affect system performance and that can be verified through site inspection, such as insolation, shading, orientation, and installation quality.
- The proposal does not identify a specific rebate level for residential new construction, but it does suggest that it reflect the differential costs between new construction and retrofit applications.
- Applicants would be required to participate in the utility energy efficiency programs for new construction (e.g., Energy Star Homes) or achieve equivalent efficiency levels relative to state building efficiency standards. Projects that exceed these efficiency levels could be offered higher incentives.[21]
- Applicants would be required to install advanced metering to enable enrollment in time-of-use or critical peak pricing rates, which, when combined with net metering, provide a higher credit to the homeowner for PV system output than traditional, flat residential rates, which do not require advanced meters. The advanced metering systems would also be required to provide information to the utility about system performance.
- The program would incorporate a significant training and outreach element for large production homebuilders, and program marketing would be coordinated with the marketing of energy efficiency programs for new homes.

Though the CEC has not yet finalized this design formally, it is expected to create the

[17] Two separate statewide PV buy-down programs are currently offered in California: the CEC's *Emerging Renewables Program* and the Self-Generation Incentive Program, which is overseen by the CPUC and targets systems of at least 30 kW.

[18] As of January 2006, the CPUC had formally adopted the program for commercial and residential retrofit systems, but the CEC has not yet done so for the residential new construction program.

[19] The five-year funding duration reflects the fact that the program would be funded through the state's public goods charge, which is scheduled to expire in 2011. However, the proposal assumes that funding will be provided to the program for ten years.

[20] Rather than an up-front incentive based on system size, a performance-based incentive (PBI) is paid over a period of time based on measured electrical output.

[21] The San Diego Regional Energy Office offered a similar suggestion in their comments on the draft proposal, with the additional requirement that the PV system be installed as a standard feature (SDREO 2005).

nation's (if not the world's) most aggressive attempt to specifically target the new residential construction market for PV.

Massachusetts

The Massachusetts Technology Collaborative (MTC) has provided support for PV in market-rate, residential new construction through a combination of broader programs administered under the auspices of MTC's Renewable Energy Trust (RET). These include a series of two buy-down programs and several competitive solicitations to fund feasibility studies, design, and construction of large green building or clean energy projects (see Table 4 for a list of relevant projects funded through these programs).[22]

It is important to note that MTC has focused much of its effort in the area of residential new construction on affordable housing, reflecting the organization's charter as an economic development agency. However, affordable housing projects in Massachusetts may include a significant fraction of market-rate units, and, as such, MTC has funded several projects involving PV on new, mixed-income affordable housing projects.

MTC's initial buy-down program, the *Solar to Market Initiative* (SMI), did not directly fund individual residential PV systems, but rather, provided funding to solar contractors or other organizations for groups of residential PV installations. Two projects funded through SMI, comprising a total of 48 PV systems, consisted solely of market-rate, single-family new homes.[23] The recipient of both awards was Conservation Services Group (CSG), the administrator of the EPA's Energy Star Homes program in Massachusetts, which provides a variety of services for builders and homebuyers (e.g., information and training, plan evaluation, home energy rating, marketing assistance) to help promote the construction of Energy Star Homes in the state.[24] CSG used the funds from one of their awards to integrate rebates for PV on Energy Star Homes into the package of services offered through the Energy Star Homes program. Funding from the other award was used for PV installations on standard efficiency (non-Energy Star) new homes.

MTC's current buy-down program, the *Small Renewables Initiative* (SRI), provides rebates for individual PV systems smaller than 10 kW in size. The program was launched in April 2005, and as of September 2005, funding has been awarded for PV systems on 13 new, market-rate homes, all of which are individual, custom homes. Based on reported project data, these systems cost $1.11/W more, on average, than the 69 retrofit systems funded through SRI as of the same date (Abe 2005). The program guidelines for SRI specify that only homeowners can apply for rebates. Thus, builders who plan to install PV on new spec homes (e.g., as a standard feature in new housing developments) would not be eligible for funding through SRI, since the commitment to install these systems would typically occur prior to home sale.[25] As described further below, builders who are planning to install groups of PV systems (with more than 10 kW combined capacity) in new market-rate housing developments can apply for funding through MTC's *Large Onsite Renewable Initiative*; and builders planning to install large groups of PV systems in new

[22] Project data in Table 4 is based on MTC's publicly-accessible database of projects it has funded (at http://www.mtpc.org/Project_Srch.asp); data on the number of new construction projects funded through the *Small Renewables Initiative* was provided to LBNL by MTC staff (Abe *et al.* 2005). We do not include in the table projects involving PV on affordable housing with no market-rate units, such as the $20K provided through MTC's *Green Building Initiative* for a feasibility study to determine the potential for integrating PV into a new 40-unit Energy Star affordable housing project (Trolley Square).

[23] According to MTC staff, a number of these installations had not been completed by the end of the program timeline, but may receive funding through one of MTC's newer programs (Abe *et al.* 2005).

[24] See http://www.energystarhomes.com/ESHController.aspx?home

[25] MTC recently decided to grant exceptions to this rule on a case-by-case basis for affordable housing projects only (Abe *et al.* 2005).

Table 4. MTC-Funded Projects Involving PV on Market-Rate or Mixed-Income Residential New Construction

Program	Project	Funding	Project Description
Small Renewables Initiative	Various individual applications	$150K	As of October 2005, the program had awarded rebates for 13 PV systems on individual, market-rate new homes.
Solar to Market Initiative	Conservation Services Group: Energy Star Homes	$397K	Design and installation of 38 PV systems on homes in new energy efficient subdivisions.
	Conservation Services Group: New Homes	$118K	Design and installation of 10 PV systems on new custom homes and model homes in new subdivisions.
Commercial, Industrial, and Institutional Initiative	Cranberry Court Development	$405K	Feasibility study, design, and construction of BIPV system (74 kW total) and other green building components on a new, market-rate, 48-unit Energy Star condominium complex.
Green Buildings Initiative	Maverick Gardens	$498K	Feasibility study, design, and construction of PV systems (41 kW total) and other green building components on a new, LEED-certified, 396-unit mixed-income housing complex.
	Egleston Crossing	$520K	Feasibility study, design, and construction of PV systems (63 kW total) and other green building components on a new, LEED-certified, 64-unit mixed-income housing complex.
	Greentech Housing	$20K	Feasibility study, by manufacturer of modular homes, to determine the potential for integrating PV and advanced energy efficiency measures into its construction process, including construction of a group of test homes.

affordable housing projects (which may include a significant fraction of market-rate units) can apply for funding through the *Green Affordable Housing Initiative*.

Several other provisions of MTC's buy-down programs have had special significance for residential new construction. SMI offered a lower incentive rate for PV installed in new construction ($4/W maximum, compared to $5/W maximum for PV on existing buildings), presumably based on the assumption that systems installed on new construction would not need as sizable an incentive due to inherent cost advantages.[26] SRI did not retain this provision and, to the contrary, effectively provides a differentially *higher* level of support for residential new construction, by offering a bonus incentive for BIPV (an additional $1/W) and for PV on high-efficiency homes (an additional $0.50/W for Energy Star homes or an additional $1.50/W for LEED-certified homes). SRI also provides some additional level of support for new construction by granting such projects a 2-year reservation period, compared to the standard 9-month period.

Another important issue for new construction has been MTC's use of performance-based incentives (PBI) in its buy-down programs. In the past, the PBI reportedly has been somewhat problematic because of the time and effort required of participants to periodically collect and submit data on PV system output (Abe *et al.* 2005). The issue has been particularly acute for new construction projects where the builder serves as the program applicant (and is therefore the recipient of the PBI), because builders do not want to continue to be involved with the program after the homes have sold. MTC has tried to lessen the significance of this issue by shortening the payment period from three years to one year (for all types of projects, not just new construction), and is trying to encourage installation of telemetry to automate reporting of PV energy production data.

[26] Solicitation No. 2003-SMI-01, p.6.

In addition to its buy-down programs, MTC has supported PV on new market-rate homes through a number of other programs structured as competitive solicitations for large clean energy or green building projects. Two previous programs, the *Commercial, Industrial, and Institutional Initiative* and the *Green Buildings Initiative*, both funded feasibility studies for, and the design and construction of, new, multi-family residential buildings with PV (see Table 4). Several of these projects either consisted entirely of market-rate units or were a mixture of market-rate and affordable units. In addition, the *Green Buildings Initiative* provided funding to a manufacturer of modular homes, to study the feasibility of integrating PV and advanced energy efficiency measures into its construction process. These two initiatives have since been succeeded by a new program, the *Large Onsite Renewables Initiative*, which offers funding though competitive solicitations for customer-sited renewable energy projects larger than 10 kW in size. No awards have yet been made, but the program is open to builders or developers seeking funding for large groups of PV systems in new, market-rate housing developments.

Finally, MTC recently launched its *Green Affordable Housing Initiative*, which, as its title indicates, is focused on affordable housing. However, as already mentioned, a project need only include a minimum number or percentage of affordable units to qualify as affordable housing, thus the program could provide support for PV on new market-rate homes.[27] Thus far, the *Green Affordable Housing Initiative* has provided funding for two partnerships, both of which are currently in the early stages of implementation. The first of these is a collaborative program with MassHousing and the Enterprise Foundation/Enterprise Social Investment Corporation, to encourage the construction of green affordable housing across the state. Through this program, dubbed *Massachusetts Green Communities*, MTC will provide $8.5 million in grants to fund feasibility studies for and the design and construction of onsite renewable energy systems integrated into green affordable housing projects.[28] The second partnership is with the Massachusetts Energy Star Homes program. Through this partnership, MTC will provide $1.5 million for rebates (at the same level as offered through SRI) for PV on Energy Star affordable housing.

New York

The New York State Energy Research and Development Authority (NYSERDA) has sponsored a number of programs and initiatives to support PV in new, market-rate homes. The program most directly targeted to this market segment was an RFP issued in 2002, the *Photovoltaic System and New York Energy Star-Labeled Home Demonstration Project (RFP 655-01)*. The solicitation offered up to $650,000 per proposal for a variety of activities to be conducted in coordination with the construction of six Energy Star subdivisions, each with PV installed on one or more home. As part of the award, NYSERDA offered to pay 100% of the cost of the first PV system in each development, 75% of the second, and 60% of the third.[29] The remaining portion of the award was designated for: PV system design and installation services; marketing activities; training of building code officials, realtors, and appraisers; and surveys of various market participants (homebuyers, builders, home energy raters, bankers, appraisers, realtors, and local building code officials). An additional $135,000 for each proposal was available to provide additional incentives to builders and consumers (e.g., a $5,000 incentive was offered to builders for each model home with PV kept open for at least 60 days). The training activities funded through this solicitation were primarily for education about Energy Star homes. A separate solicitation, *Renewable Energy Technologies:*

[27] The affordable housing requirement is described at http://www.mtpc.org/renewableenergy/afford_housing.htm

[28] For additional information, see http://www.greencommunitiesonline.org/Massachusetts.

[29] Buy-down incentives for additional PV systems in each subdivision could be obtained through NYSERDA's standard PV buy-down program, the *Solar Electric PV Incentive Program*, which capped the rebate at 60% of project cost.

Technical Training, Education, Outreach, and Market Support (PON 590-01), provided funding for an accompanying set of training seminars that offered information about PV-related topics (e.g., system costs, benefits, financing options, impact on home valuation and resale, etc.) to residential building industry professionals.[30]

Two proposals were awarded through the *Photovoltaic System and New York Energy Star-Labeled Home Demonstration Project*, each involving the construction of six subdivisions. PV systems were installed on one model home in each subdivision, as required, and three additional homebuyers in two separate subdivisions opted to have PV installed. According to NYSERDA staff, the average cost of these 15 PV systems was $8.18/W (Ferranti 2005). NYSERDA staff identified a number of issues and lessons learned from this project (Ferranti and Peterson 2005). First, many of the builders initially included in the winning proposals dropped out of the project after the awards were granted, and a significant amount of time was spent trying to recruit new homebuilders. (It is interesting to note the similar experience by the CEC, with its zero-energy home solicitation.) Second, the participating builders seemed generally unenthusiastic about PV, citing the small profit opportunity and the potential for project delays. NYSERDA staff indicated that additional outreach to inform potential homebuyers about the benefits of PV may have helped to generate more interest in PV where offered as an optional feature in new homes.

NYSERDA has also provided support for PV in market-rate new homes through a series of two PV buy-down programs.[31] Their current buy-down program, the *Solar Electric PV Incentive Program (PON 716-02)*, has several features with particular relevance to residential new construction. First, the program offers a higher incentive rate (an additional $0.50/W) for PV systems installed on Energy Star Homes.[32] Second, the program has a 90-day reservation period within which the equipment must be delivered to the customer site. This requirement could be challenging for large housing developments with long project lead times; however, NYSERDA staff indicated that they are able to consider extensions for new construction on a case-by-case basis. Lastly, as with many buy-down programs, NYSERDA requires a copy of the interconnection agreement from the utility. NYSERDA staff have found that, for new construction projects, it has often been difficult to get the interconnection documentation from the utilities in the timeframe needed to process the application (Ferranti and Peterson 2005).

NYSERDA does not track whether PV systems funded through the *Solar Electric PV Incentive Program* are on existing or new homes, thus precise information about the program's impact on the residential new construction market is unavailable. As of September 2005, funding had been approved for a total of more than 265 residential PV systems. Forty of these projects received the higher incentive for Energy Star Homes, approximately half of which were installed (or are expected to be installed) during the construction phase on individual, custom homes (Ferranti and Peterson 2005). NYSERDA staff attributes the apparently slow uptake of PV in the new construction market, in part, to a lack of technical and business capabilities among PV installers and builders in the state. In their view, the local installers do not possess the sophistication required by large production homebuilders, and the installers perceive that new construction projects are too involved given their already-narrow profit margin.

[30] PON 590-01 has funded various other training and outreach activities for renewable energy technology and green power markets, but none that directly relate to residential new construction.

[31] NYSERDA has also offered programs for green buildings and several solicitations for renewables R&D, but we could not verify whether any of these activities have funded projects that relate specifically to PV in new, market-rate homes.

[32] The program also offers a bonus incentive for BIPV, but it is currently available only for commercial systems.

Elsewhere in New York, the Long Island Power Authority (LIPA) offers buy-down incentives for PV through its *Solar Pioneers Program*. The program guidelines indicate that the only eligible participants are residential customers with an active account at the location at which the PV system is to be installed. If strictly applied, this would preclude builders from receiving rebates for installing PV on spec homes. However, LIPA has the discretion to grant exceptions to this rule and allow the builder to serve as the applicant. Although the program thus far has not funded many PV systems on new homes, LIPA program staff indicated that they are anticipating a growing interest in PV among residential builders in their territory. Accordingly, they have recently started to discuss internally any issues that might emerge, e.g., whether new homebuyers may have difficulty producing the necessary documentation to claim the New York state tax credit for PV (Zaweski 2005).

Minnesota

The Xcel Energy Renewable Development Fund (XERDF) has issued two RFPs for renewable energy projects. Funding was provided through the first solicitation to the Minnesota State Energy Office (MSEO) for the *Solar Electric Rebate Program*, a buy-down program for small PV systems. The program has provided funding to one builder who installed PV systems on eight spec homes (two separate developments with four townhomes each).

MSEO has made several revisions to the program rules in recent years to make the program more amenable to participation by homebuilders. First, it extended the reservation period from 6 to 9 months, although the program manager indicated that he is quite flexible in granting extensions if need be (Taylor 2005). Second, it now allows up to five rebates to be paid to any one applicant or for any one location, rather than the previous restriction of one rebate per applicant. Builders planning to install PV systems on multiple homes can *reserve* more than five rebates on behalf of future homeowners, but cannot be directly *paid* more than five without written approval by homebuyers.

New Jersey

The New Jersey Clean Energy Program (NJCEP) offers a large buy-down program for customer-sited renewable energy systems, the *Customer On-Site Renewable Energy (CORE) Program*, making New Jersey the home of the second largest PV market in the United States, after California. Although the CORE program administrator does not explicitly track whether PV systems funded through the program are on new homes, the program manager indicated that the program has funded numerous PV systems on individual new homes but thus far no groups of homes in new housing developments (Hunter 2005).

The program has a number of provisions with potential significance for residential new construction. Starting in 2006, the CORE program began offering a bonus incentive of $0.25/kW for PV systems installed on homes that are also participating in the New Jersey Home Performance with Energy Star Program. This incentive is available only for projects smaller than 10 kW in size.

Also, the New Jersey Board of Public Utilities (BPU), which administers the program, recently changed the definition of an individual project so that it is based on contiguous or adjacent property under common ownership, rather than on each meter. Thus, a group of PV installations throughout a new residential subdivision would be considered a single project (Hunter 2005). This provision has several significant implications. First, the buy-down incentives in the CORE program are based on a tiered rebate structure, whereby the first 10 kW for each project receives a relatively high incentive rate and additional blocks of capacity receive progressively lower incentive rates.[33] Thus, groups of PV installations in a new development

[33] The program's current rebate levels are $4.95/kW for the first 10 kW, $3.70/W for the next 30 kW, $3.20/kW for the next 60 kW, and $3.05 for all additional installed capacity.

with a combined capacity greater than 10 kW would receive a lower average incentive rate than systems installed on individual (new or existing) homes. In addition, large groups of PV installations in new residential developments are not eligible for the bonus incentive for systems on Energy Star homes. Last, and more positively for the new-home PV market, projects over 10 kW in size are allowed a reservation period of 12 months, compared to 6 months for smaller projects, ensuring that new developments with PV systems on multiple homes will have additional time to accommodate the lengthy development process typically associated with such projects.

Oregon

The Energy Trust of Oregon (ETO)'s primary source of support for PV in residential new construction is its general PV buy-down program, the *Solar Photovoltaic Market Assistance Program*. To date, very few PV systems on new homes have been funded through the program, which ETO staff attributes largely to a lack of familiarity with PV among builders (Brockman 2005).

The program has two elements with particular bearing on residential new construction. First, in order to manage the program budget, ETO will pay the standard incentive amount for up to 10 homes in a single subdivision (subject to change), but beyond that number of systems, they will negotiate a lower incentive for the entire development. Second, as a general rule, ETO limits the number of uncompleted reservations any one applicant can have outstanding at a time, in order to avoid tying up the limited funds. However, recognizing the potential for delays in new construction projects, ETO does grant exceptions for new construction and other projects requiring local design review (West *et al.* 2004).

ETO has recently started to target the new home market for PV through several other activities. First, ETO has started providing information about PV to builders participating in their Energy Star homes program, and has tried to coordinate the two programs to present them as a single face to the builder (Brockman 2005). Second, ETO plans to begin conducting educational seminars for homebuilders at industry conferences, to provide information about PV and their buy-down program.

Pennsylvania

The Sustainable Development Fund (SDF) has supported PV in new, market-rate homes through its *Solar PV Grant Program*, a buy-down program for small PV systems.[34] To date, the program has awarded funding for a total of approximately 220 PV systems, which includes 19 systems on new, market-rate, single-family homes and 11 systems on a new, market-rate, multi-family residential building. One of the single-family homes is a model home in a new residential subdivision where PV was offered as an option on about 60 other homes, although few or none of the homebuyers appear to have opted for PV (Clark 2005, Celentano 2005).

The *Solar PV Grant Program* has several provisions with particular relevance to residential new construction. First, the program splits the total incentive into an up-front rebate and a performance-based incentive (PBI). SDF staff indicated that the PBI has been problematic for new construction projects where the incentive is paid to the builder or developer, presumably for the same types of reasons discussed in connection with MTC's buy-down program. SDF has dealt with the issue either by simply not including the PBI at all or by rolling it into the up-front payment (Celentano 2005). The program also has a number of provisions related to documentation requirements (e.g., that a customer signature be included in the application), which could be problematic for PV installations on spec homes. However, SDF staff indicated that they are quite flexible in their

[34] To our knowledge, the other four Pennsylvania clean energy funds – Metropolitan Edison Sustainable Energy Fund, Pennsylvania Electric Company Sustainable Energy Fund, Sustainable Energy Fund of Central Eastern Pennsylvania, and West Penn Power Sustainable Energy Fund – have not undertaken activities to target PV specifically in new, market-rate homes.

Table 5. PEDA-Funded Projects Involving PV on Market-Rate Residential New Construction

Awardee	Funding	Project Description
EQA Landmark Communities	$413K	A 300-acre brownfield redevelopment project with commercial and residential new construction, including 75 zero-energy single-family homes.
Solar Strategies Development Corp.	$130K	A neighborhood redevelopment project consisting of 38 zero-energy townhomes.

review process and are willing to grant variances to these types of requirements when necessary.

SDF has considered making several changes to the program specifically for new construction. They have considered allowing builders who install PV on multiple homes in a development to submit a single application for all of the systems in the development. They have also considered reducing the rebate level for new construction, particularly for projects receiving additional financial support from other sources (such as the Pennsylvania Department of Environmental Protection, as described below).

The Pennsylvania Energy Development Authority (PEDA), a public financing authority administered by the Pennsylvania Department of Environmental Protection's Office of Energy and Technology Development, has offered grants and other forms of financial assistance for a wide variety of clean energy projects.[35] Two of the projects that have received funding though these solicitations include market-rate, zero-energy new home developments with PV (see Table 5).[36] The builder for both projects indicated that he has a third project in the pipeline (for which he has not yet obtained any public funding), consisting of 15 market-rate, single-family, zero-energy new homes (Bradley 2006).

Rhode Island

The Rhode Island Renewable Energy Fund (RIREF) offers the *Residential and Small Commercial Solar and Wind Incentive Program*, a buy-down program for residential PV systems on existing or new homes and is in the process of developing a new program, the *Solar Ready Homes Program*, to specifically target PV in new residential construction.

As of December 2005, details of the latter program have not been made public, but the RIREF Advisory Board has considered several potential program components.[37] The Board considered providing a small amount of funding to conduct advocacy for changing building codes to require new homes to be constructed with proper roof orientation, but decided against this on the basis of potential resistance from builders. They have also considered offering an incentive of $1,500 per home to encourage construction of new Energy Star homes with the proper roof orientation for PV; this incentive would be provided in addition to the buy-down incentive for the PV system.

Wisconsin

Wisconsin Focus on Energy (WFE) offers the *Cash-Back Rewards Program*, a buy-down program for small, customer-sited renewable energy systems. Of particular importance for residential new construction, in 2005, the

[35] The Pennsylvania Department of Environmental Protection has also offered grants for smaller clean energy projects through its *Energy Harvest* program. Thus far, the program has not funded any market-rate residential new construction PV projects, though it did provide funding for an Energy Star affordable housing project with 11 PV systems (which also received funding through SDF's *Solar PV Grant Program*).

[36] Based on information from Bradley (2006) and from PEDA press releases, available electronically at: http://www.dep.state.pa.us/dep/deputate/pollprev/PA_Energy/PAENERGY/PEDA_pressreleases.htm

[37] Information from Advisory Board meeting minutes and updates, http://www.riseo.state.ri.us/riref/aboutfund/meetings/spminutesjun05.pdf and http://www.riseo.state.ri.us/riref/aboutfund/meetings/minutesjul05.pdf

program offered a higher incentive rate for PV installed on new homes enrolled in WFE's *Wisconsin Energy Star Homes Program* ($3/kWh-yr, up to 50% of project cost, compared the standard incentive of $2/kWh-yr, up to 35% of project cost). The higher incentive was discontinued in 2006 because of a dramatic increase in PV system applications, the new Federal tax credit for residential PV, and limited program funds.

In 2005, the *Cash-Back Rewards Program* provided funding for a total of approximately 100 residential PV systems. WFE does not explicitly track whether PV systems funded through the program are on new or existing homes, thus precise information about the program's impact on the residential new construction market is unavailable. However, all eight of the PV systems that received the higher incentive for Wisconsin Energy Star Homes in 2005 were individual, custom new homes (Wolter 2005).[38]

WFE has also supported PV in residential new construction through two other types of activities. They have conducted outreach to the building industry (e.g., speaking about PV at builder conferences). WFE also previously offered funding for renewable energy R&D, and some of the funded projects were directly relevant to the new residential market for PV: for example, the development of a free software tool to aid Wisconsin architects and engineers in the design of zero-energy buildings.

Supporting PV in New, Market Rate Homes: Key Findings and Issues

Our review of program experiences and interviews with program managers highlighted a wide range of issues relevant to the residential new construction market for PV and for initiatives targeting this market segment.[39] In this section, we describe these issues and, where applicable, discuss how state funds have addressed them.

Limited Program Data and Experience

A fundamental challenge for organizations seeking to support PV in market-rate residential new construction is simply that there is very little experience with this market segment to draw upon. Outside of California, where thousands of PV systems on new homes have been funded through the CEC's and SMUD's programs, most states have seen fewer than a hundred installations on new, market-rate homes (see Table 6).[40] Furthermore, many of the installations outside of California have been on individual or small clusters of new homes, rather than bulk installations of PV systems on a large number of homes in new housing developments.

Compounding this issue is a lack of information about what little experience has been accumulated. PV buy-down program administrators can help to fill this void by tracking whether PV systems funded through their programs are installed on existing or new homes, and if the latter, whether the systems were installed on individual new homes or on multiple homes throughout a new subdivision, and whether they were installed as a standard or an optional feature. Performance tracking of PV systems installed at new homes, many of which are likely to be BIPV, would be helpful. And builder and customer experience with PV in new homes could be more comprehensively collected and analyzed, especially from the budding California market.

[38] One of the eight systems was BIPV, and the others were rack-mounted (Wolter 2005).

[39] For additional discussions of issues facing this market and lessons learned, see Farhar *et al.* (2004), Springer and Hammon (2004), and Keesee (2004, 2005a).

[40] The table summarizes PV systems on market-rate new homes that have been funded through the programs described in this report; it is not an exhaustive list of all PV systems installed or planned for installation on new, market-rate homes in these states.

Table 6. PV Systems Installed or Approved for Installation on New, Market-Rate Homes

State	Organization	Program Name	Number of PV Systems	Notes
California	CEC	Emerging Renewables Program	2717	1,946 PV systems on groups of new, market-rate homes in large housing developments and 771 systems on single or small clusters of new homes (projects approved or installed as of May 2005)
		Research Development & Demonstration Projects Focused on Zero-Energy New Homes	150	Two projects, with at least 75 market-rate homes each (projects awarded as of December 2005)
	SMUD	Solar Advantage Homes Program	~220	Installed on model homes or offered as optional feature in 21 new developments
		Zero Energy Homes Program	139	Installed as a standard feature in three new developments (projects approved or installed as of December 2005)
Massachusetts	MTC	Small Renewables Initiative	13	Individual, custom new homes (approved or installed as of October 2005)
		Solar to Market Initiative	<48	Funding approved for at least 48 systems, but some were not installed within the program timeframe and may be funded through subsequent programs
		Commercial, Industrial, and Institutional Initiative; and Green Buildings Initiative	3	Three large PV systems (approx. 175 kW total installed capacity) on multi-family residential buildings.
Minnesota	MSEO	Solar Electric Rebate Program	8	Installed by builder as a standard feature in two four-townhome developments
New Jersey	NJCEP	Customer Onsite Renewable Energy Program	Unknown	NJCEP does not track this information, but staff reports that the program has funded numerous systems on individual new homes
New York	NYSERDA	PV and Energy Star-Labeled Home Demonstration Project	15	PV installed on model homes and offered as an option on other homes in twelve new housing developments
		Solar Electric PV Incentive Program	~20	NYSERDA does not generally track this information. Of the 40 systems installed on Energy Star homes, about half were installed during construction phase.
Oregon	ETO	Solar Photovoltaic Market Assistance Program	Few	Few if any systems on new homes; exact number not provided
Pennsylvania	SDF	Solar PV Grant Program	~30	Approximately 19 custom, single-family new homes, and a new multi-family residential building with 11 PV systems.
	PEDA	Two solicitations for clean energy projects	113	Two ZEH developments with PV installed as a standard feature on all homes.
Wisconsin	WFE	Cash-Back Rewards Program	~8	WFE did not track this information. All eight projects receiving the bonus incentive for Energy Star or LEED-certified homes were on individual new homes.

Funding Levels and Duration

The amount and duration of program funding is particularly important to the development of the new home market for PV. Given the long project lead times and the start-up costs associated with training construction and sales staff, large production homebuilders may be reticent to make major changes to their business strategy if the program budget is small or the funding cycle is short. Thus, some threshold level and consistency of funding may be

required in order to "jump-start" the market (a process that may take some time). This may be one of the reasons that California – with a sizable and long-running incentive program – is the only state so far to have made real headway in this market segment.

PV as a Standard vs. Optional Feature

A handful of developers have recently built new residential subdivisions with PV installed as a standard feature on some or all homes. Other builders may be unwilling to take this route, but may be willing to offer PV as an optional feature in new developments, at least until they become comfortable with the technology and confident that it makes business sense.

The optional approach to PV sales in new homes has several distinct disadvantages from a PV deployment perspective. The most fundamental, perhaps, is that adoption of PV becomes contingent on each individual homebuyer making a separate decision about PV amidst all of the other decisions involved in buying a new home, most of which are much better understood. Additionally, sales staff must receive a much higher level of training so that they can explain the PV system and its benefits to potential homebuyers, and installation scheduling can become more complex and prone to delays. Farhar *et al.* (2004) have concluded that, as a result of the lower number of PV systems likely to be installed and the higher transaction costs, offering PV as an option ultimately may not be a profitable business model for large production homebuilders.

Comprehensive information has not yet been compiled on the adoption rate of PV in developments where it is offered as an option, although experiences with several developments have been documented and provide some benchmark for the potential homebuyer response. In several cases, very few (or no) homebuyers opted for PV. For example, among the twelve subdivisions supported through NYSERDA's *Photovoltaic System and New York Energy Star-Labeled Home Demonstration Project*, only three homebuyers opted for PV (Ferranti and Peterson 2005). In Morrison Homes' 120-home Lakeside subdivision in Sacramento, PV was pre-plotted on 10% of the homes and offered as an option on the others, but no homebuyers opted to have it installed (Keesee 2005a). Shea Homes' Scripps Highlands development in San Diego saw notably greater, although still relatively modest, uptake: 24 out of 164 homebuyers (15%) opted to have PV installed, and 8 out of 96 (8%) homebuyers with PV installed as a standard feature chose to upgrade to a larger system (Farhar *et al*. 2004). Finally, SMUD's previous experience with its *Solar Advantage Homes Program* indicates, at an aggregate level, that the optional approach can achieve a fairly substantial impact, having resulted in approximately 220 PV installations in 21 subdivisions where it was installed on model homes and offered as an optional feature on the others (Keesee 2005a).

Clearly, experience with selling PV as an option on new homes has been mixed, with several notable failures and some examples of mixed success. More work is needed to understand where optional sales strategies have and have not worked, and why. In the meantime, state funds may want to specifically encourage the incorporation of PV as a standard feature by offering differentially higher incentives to solar systems installed in that way. In cases where builders are only willing to offer PV as an option but not as a standard feature, state funds may want to focus some additional effort on ensuring that sales staff are sufficiently informed and motivated to sell the PV option to prospective homebuyers.

Differential Incentives

One direct way of providing targeted support to a specific market segment, such as PV in new homes, is to offer larger financial incentives. NYSERDA, MTC, NJCEP, and WFE have all provided a greater level of financial support for specific types of residential new construction PV projects – namely, those involving BIPV or high-efficiency homes – by offering higher standard buy-down incentives for these projects. Thus far, however, these bonus incentives do not appear to have spurred a significant number of

PV installations on new homes, although it is important to consider their impact in light of the overall size of the PV market in each region and the relatively short period of time that the higher incentives have been offered.

SMUD has also provided higher levels of financial support for PV on new homes through its current *ZEH Program* by offering additional funds for builder marketing materials.[41] Finally, both the CEC and NYSERDA have provided greater levels of financial support for PV on new homes through targeted solicitations for demonstration projects of new, high-efficiency residential subdivisions with PV. The CEC's solicitation provided incremental funding on top of the standard buy-down rebate; while a portion of the funding in NYSERDA's solicitation served as an alternative, higher buy-down incentive (offered only for the first few PV systems in each subdivision). Importantly, most or all of the funding provided through these solicitations was designated for activities other than the physical PV system (e.g., training and education, surveys, R&D focused on developing and demonstrating more sustainable business models).

The higher levels of financial support offered through these programs may reflect a view that growing the new residential construction market, the BIPV market, or the market for PV in high-efficiency homes is important for the long-term success of the PV market, in general, or that it provides a higher value to the state commensurate with the higher incentive. Alternatively, at least in the case of BIPV, the intent may simply be to level the playing field with lower-cost applications.

Several clean energy funds have taken the opposite approach, offering *lower* incentives for all or certain types of projects involving PV in residential new construction. The broadest and most explicit example is MTC's initial buy-down program, which offered a reduced incentive rate for all new construction projects. ETO has adopted a narrower approach, offering lower incentives specifically for large groups of PV installations (currently, 10 or more) in new residential developments. Lastly, NJCEP offers lower buy-down incentives for all projects larger than 10 kW, including those involving multiple PV systems installed as a standard feature throughout a new housing development. In all of these cases, the lower incentive likely reflects some belief that the cost of PV in these markets is likely to be lower than in other segments, along with a corresponding interest in stretching program budgets and/or leveling the playing field with higher-cost retrofit projects.

These different approaches reflect the inherent difficulty of trying to provide direct and differential support to a market segment that offers potentially lower costs.[42] They also suggest that, while higher incentives may be appropriate in the near term in order to "jump start" the new construction market (which may take a considerable amount of time for large production homebuilders), over time a more appropriate approach may be to focus differential support on applications that provide the state fund with some additional value beyond that provided by a standard PV installation on a new home.

Such high-value applications to which targeted incentives might be provided include:

- Systems installed on energy-efficient homes;
- BIPV systems that overcome aesthetic concerns;
- New innovative business models; and

[41] Builders participating in SMUD's program also receive valuable, non-financial forms of support, in particular, the technical assistance (e.g., ZEH design and installation training) provided through SMUD's partnership with DOE.

[42] As cited previously in this report, Wiser *et al.* (2006) analyzed project cost data from the CEC's *Emerging Renewables Program* and found that large groups of PV systems installed in new housing developments cost significantly less, on average, than comparable retrofits. However, PV systems installed on individual or small clusters of new homes were actually slightly more expensive than comparable retrofits. No other buy-down programs have been subject to a similarly rigorous statistical analysis, and few have generated enough market activity to support such an analysis.

- Systems sold as a standard feature, and not as a buyer's option.

Buy-Down Program Provisions

Given their prevalence, buy-down programs are clearly an important potential source of support for PV in market-rate residential new construction. Yet, many buy-down programs have specific features or provisions that could potentially pose barriers for residential new construction, particularly for projects where PV is installed as a standard feature on multiple homes in a new development. Many program managers are able to mitigate these barriers simply by dealing with any issues that might arise on a case-by-case basis and, if warranted, granting variances to standard program rules that pose an unreasonable barrier. In addition, several buy-down program administrators (e.g., CEC and MTC) have adopted provisions applicable specifically to residential new construction, to accommodate unique features of this market segment.

Below, we identify specific buy-down program provisions that may have particular significance for residential new construction, and briefly describe how different program administrators have addressed any issues that have arisen.

- *Limits on the Number of Rebates or Total Funding per Applicant or per Site*. In the interest of managing program budgets or ensuring an equitable distribution of incentive funds, some programs (e.g., MSEO's *Solar Electric Rebate Program*) limit the number of rebates or total funding that can be reserved by or paid to any one applicant or for projects at any one site. Provisions such as these can potentially pose barriers for projects involving PV systems pre-plotted on multiple homes in a new subdivision, because a single entity (e.g., the builder or installation subcontractor) would typically serve as the applicant for all of the PV systems, and depending on the program rules, the entire development may be counted as a single project.

- *Participant Eligibility Requirements*. Some buy-down programs restrict participation to only individual utility customers.[43] If strictly applied, this would render ineligible projects involving PV installations on spec homes, since typically no customer would be associated with the project at the time of application submittal. However, administrators of programs with this provision (e.g., ETO) are generally willing to grant a variance in this situation, and allow the builder or installer to serve as the project applicant.

- *Reservation Period*. Most buy-down programs specify a reservation period within which applicants must install their PV system or else "lose their place in line." To accommodate the longer lead times typically required for new construction projects, especially those involving multiple homes constructed in staggered phases, many buy-down programs allow new construction projects a longer reservation period. The CEC and MTC both offer longer reservation periods for all new construction projects. NJCEP offers longer reservation periods for all projects larger than 10 kW, including new construction and retrofit. Other program administrators simply deal with these situations on a case-by-case basis and grant extensions when needed.

- *Documentation Requirements*. A wide range of documents are typically required at different stages in the application process, including standard application forms, building permits, utility interconnection

[43] A similar type of restriction is that some buy-down programs (e.g., NYSERDA and SDF) require that only installers from a specified list be used. The rationale for such a requirement is to ensure that the installations are of an acceptable quality. However, these requirements may pose a barrier for large production homebuilders, some of whom reportedly prefer to use their existing roofing or electrical subcontractors, rather than a specialized PV installer. SDF staff indicated that they have been flexible in these cases and have allowed others to install the system, provided that one of the contractors on their list oversees the installation (Celentano 2005).

agreements, purchase orders, installation labor contracts, and others. In some circumstances, requirements related to the type and timing of documentation to be provided can pose difficulties for new construction projects. For example, utility interconnection agreements may be difficult to obtain if the home does not yet have a meter. The CEC has sought to address many of these documentation-related issues by adopting a separate set of requirements specifically for residential new construction. A number of other program managers indicated, again, that they would simply deal with these issues on a case-by-case basis as they arise.

- *Installation Commitment*. Most buy-down programs require that applicants make some type of good faith commitment to install a PV system at a specific location, in order to reserve a rebate. The rationale is that program administrators do not want to tie up limited funds for projects that are not likely to occur. However, these requirements may pose a barrier for builders that would like to offer PV as an option in new developments, but are wary of incurring start-up costs (e.g., related to training or marketing) if they are uncertain about whether incentive funds will continue to be available throughout the (possibly multi-year) sales cycle. The CEC has sought to remedy this issue by adding a provision to its *Emerging Renewables Program* which allows builders who plan to offer PV as an option in new developments to reserve rebates for up to 10% of the lots, provided that they commit to installing PV on at least one model home.

- *Performance-Based Incentives*. Some buy-down programs provide some or all of the payment in the form of a performance-based incentive (PBI), which is paid out over time based on the measured output of the PV system. The rationale for such an incentive structure is to encourage proper system design and installation, as well as ongoing maintenance. However, for several reasons, PBIs may be a poor match for residential new construction, particularly for builders who would like to install PV in new spec homes. The most general issue is that PBI payments do not address builders' concerns about the impact of PV on the up-front cost of new homes. A second issue is that builders who serve as the program applicant and are therefore the recipient of the PBI may be deterred by the prospect of ongoing involvement with the program after the homes are sold, e.g., by periodically collecting and submitting performance data in order to receive their PBI payments.

  MTC and SDF provide a portion of the total payment in their buy-down programs in the form of a PBI, and both have experienced difficulties with the PBI in situations involving new construction. MTC has sought to minimize the issue by shortening the performance period and encouraging automated data submission, while SDF has (in some cases) opted to eliminate the PBI altogether and to instead provide the entire incentive as an up-front rebate.[44] Recognizing the mismatch between PBIs and residential new construction, the recent CPUC/CEC proposal for a 10-year California solar initiative recommended moving toward a PBI for commercial systems and residential retrofits, while retaining an up-front, capacity-based incentive for residential new construction (CEC and CPUC 2005). However, to encourage appropriate PV design and installation in residential new construction, the proposal recommends adjusting the up-front rebate based on factors affecting system performance that can be verified through a site inspection (e.g., orientation and shading).

[44] One option for addressing builders' reservations about continued involvement with the programs would be to allow them to transfer the PBI and any associated responsibilities to the homeowner upon home sale. However, doing so could undermine the basic rationale for structuring the rebate as a PBI in the first place, as it is unclear what incentive the PBI would then provide to the builder to ensure that the system is designed and installed properly.

- *Pass-Through of Incentives to the Customer*. Many programs require that the incentive payment be passed through in full to the customer if initially issued to some other entity, in order to advance the goal of making PV more affordable to consumers. These requirements do not pose a barrier, *per se*, for new construction projects. However, where PV systems are installed as a standard feature on a spec home, incentive pass-through requirements may not be particularly meaningful, since the homebuyer is not charged for the PV system separately from the purchase of the rest of the home, and therefore the net cost of the system to the consumer cannot be directly observed or precisely defined.

Integrating Energy Efficiency with PV

Several natural synergies may exist between PV and energy efficiency in new homes. First, to stretch program budgets, PV program administrators may have an interest in ensuring that cost-effective energy efficiency upgrades are made prior to, or in conjunction, with PV installations, in order to reduce the size of those PV systems. New homes are relatively well suited to this objective, compared to existing homes, given the greater degree of standardization in the building characteristics of new homes and the lower incremental cost of upgrading building envelope components during the construction phase. Second, integrating PV and energy efficiency in new homes creates a marketing opportunity to offer "zero energy" or "green" new homes. Third, builders that have experience with or interest in energy efficient home construction may be prime candidates for early adopters of PV within the building community.

State clean energy funds have sought to capitalize on these potential synergies in at least four different ways:

- *Integrated Programs.* Several funds have offered programs specifically targeting PV in energy efficient new homes, for example, the CEC's and NYSERDA's demonstration programs for zero-energy homes (or Energy Star Homes with PV), and SMUD's two programs for PV in high-efficiency/zero-energy homes. Similarly, MTC provided funds to the administrator of the Massachusetts Energy Star Homes program to integrate PV rebates into the package of services offered.
- *Energy Efficiency Requirements.* The recent CEC/CPUC staff proposal for a new program targeting PV in residential new construction recommends making participation in utility energy efficiency programs (or demonstration of equivalent energy efficiency levels) a requirement for receiving a PV rebate.
- *Energy Efficiency Incentives*. MTC, NYSERDA, and WFE have offered higher buy-down incentives for PV systems on Energy Star or LEED-certified homes.
- *Coordinated Program Delivery*. ETO has sought to coordinate the administration and marketing for their PV and energy efficiency programs to present the two programs as a single face to builders.

Installer Infrastructure Development

Given builders' concerns about potential installation scheduling delays and reliability problems, cultivating a capable installer network is especially important for the development of the residential new construction market for PV. In addition to requiring a basic level of technical competency, large production homebuilders may also have unique requirements or needs from their PV installer that differ from those of other market segments. For example, in order to simplify the process as much as possible for the builder, installers may need to provide a comprehensive suite of related services (e.g., obtaining utility interconnection agreements, applying for rebates, etc.). Also, some large production homebuilders reportedly prefer to use their own roofing or electrical sub-contractors for PV installation, rather than specialized PV installers (Keesee 2004). Those that are willing to use specialized installers are likely to require a level of professionalism and experience not possessed by the "mom and pop" shops that predominate the installer network in many regions (Ferranti and Peterson 2005).

Several state clean energy funds have taken active steps to develop the PV installer infrastructure in their region. NYSERDA has perhaps been the most aggressive in this respect, funding a wide range of training and certification activities for PV installers, and providing financial support to renewable energy companies (including installers) for business and professional development. An overarching objective of these efforts has been to cultivate more sustainable business models for PV installers, and NYSERDA has sought specifically to expand the base of PV installers to encompass a wider range of businesses, such as HVAC contractors (Ferranti and Peterson 2005). SMUD also conducted a limited form of support for installer infrastructure development through its previous *Solar Advantage Homes Program*, by partnering with a PV module manufacturer that provided installation training to the sub-contractors used by builders participating in the program.

Lack of Knowledge about PV within the Residential Building Industry

A number of program managers cited the lack of knowledge about PV among builders as a critical impediment to the development of the residential new construction market for PV (Brockman 2005, Ferranti and Peterson 2005). The residential building industry includes a variety of other key market participants (realtors, lenders, appraisers, building inspectors, etc.) who also are typically unfamiliar with PV systems, which can also undermine market development. For example, lack of knowledge about PV among building inspectors or building permit officials can lead to delays in the project schedule, potentially entailing large financial costs and risks for the builder.

Several state clean energy funds have taken steps to foster greater familiarity with PV among key participants in the residential building industry. For example, NYSERDA has sponsored a number of informational seminars about PV for residential building professionals and provided funding for training of local building code officials in conjunction with its *PV and Energy-Star Labeled Home Demonstration Project*. ETO, CEC, and WFE have both conducted education and outreach with homebuilders in their state, by holding seminars at trade shows and conferences to explain PV technology and the available financial incentives.

Federal and State Tax Credit Issues

Residential new construction projects face several unique issues related to the federal and state tax credits for PV. A threshold question is whether the builder or the homebuyer should claim the tax credits. In some situations, it may seem that the builder is in a better position to utilize tax credits, and would presumably be eligible for the potentially more lucrative commercial federal tax credit, which has no dollar cap. However, federal and state tax incentives are often "recaptured," in part or in whole, if the system is sold within five years after its in service date.[45]

As a result, in the vast majority of situations, it will make more sense for the homebuyer to claim available tax incentives. In this case, it is important that the builder provide the homebuyer with whatever documentation is needed to claim the tax credit, including information on the cost of the PV system. However, it may not always be immediately clear how to define the cost of the system to the homeowner. In particular, if the PV system is installed as a standard feature on a spec home, or if it is included in the general contractor's fixed fee contract (as opposed to a time and materials contract) for the entire project, then the cost of the PV system to the homeowner (and therefore the tax credit amount) may not be well-defined. The cost charged to the builder could be used as a proxy, as is apparently done in some cases, but this neglects any mark-up by the builder, resulting in a lower tax credit for the homeowner.

[45] Federal commercial solar tax credits vest at a rate of 20% per year after the in service date (SEIA 2006). Thus, if the system were sold after one year, 80% of the tax credit would be recaptured.

Finally, residential new construction projects face a specific issue related to the "placed in service" date used to determine eligibility for the Federal residential solar tax credit. As described in the recently-released *Guide to Federal Tax Credits for Solar Energy*, published by the Solar Energy Industries Association (SEIA), "If the installed property is included as part of construction of a new house, then the 'placed in service' date is when the taxpayer takes residence of the house" (SEIA 2006). Thus, for spec homes built with PV already installed, the homebuyer is eligible to claim the Federal Tax credit only if occupancy begins in calendar years 2006 or 2007 (unless the residential solar tax credit is extended).

Summary and Recommendations

Residential new construction offers a variety of attractive features as a market segment for PV, but has thus far been slower to develop than other market segments. To date, broader programs, particularly buy-down programs, have been the primary source of support for PV in new residential construction by state clean energy funds. On a more limited basis, state funds have also supported the development of this market segment through targeted program offerings, such as demonstration projects for zero energy homes, and specialized provisions in broader programs, such as higher buy-down incentives.

Efforts to encourage PV adoption in market-rate, residential new construction face a variety of unique issues. Our discussions with program staff and review of the literature on experiences with this market point to a number of basic lessons for how state clean energy funds and other organizations can address these issues and more successfully tap the residential new construction market for PV:

- *Do no harm*. At a minimum, broader programs aimed at PV or customer-sited renewable energy systems should not inadvertently disadvantage the new construction market. Program administrators with a great degree of flexibility and discretion can often address any issue as it comes. In other cases, some explicit modifications or accommodations may be required, particularly for projects involving PV systems installed as a standard feature on multiple homes in new developments.

- *Track key information about PV installations on new homes*. Incorporating basic information about residential new construction projects into standard application forms and program databases (e.g., whether the system was installed "on spec" or offered as an option and whether it was an individual installation or part of a larger cluster) may be useful for future program design and market assessment.

- *Ensure sufficient funding*. Given the long project lead times and the start-up costs associated with training construction and sales staff, a sizeable and long-term effort may be required to generate widespread interest in PV among large production homebuilders.

- *Consider a higher incentive level*. Higher incentives or other forms of differential support for residential new construction may be appropriate in order to jump start this market. Given concerns about the effectiveness of offering PV as an option in new homes, if higher incentives are offered, states might consider doing so only for systems installed as a standard feature. Additionally, states may want to focus differential support on projects and activities that provide value beyond standard PV installations on new homes (e.g., BIPV, PV on high-efficiency homes, or the creation of innovative business models).

- *Coordinate PV and energy efficiency programs for residential new construction*. State clean energy funds can capitalize on natural synergies between energy efficiency and PV in new homes by integrating or coordinating PV and energy efficiency initiatives for residential new construction. At a minimum, creating the appearance of a

single program to the builder ("one-stop shopping") can help to simplify participation and reduce transaction costs.

- *Cultivate the installer infrastructure*. Efforts to develop the installer network are particularly important for the residential new construction market and should consider any specific needs of large production homebuilders, such as the quality and types of services needed.

- *Educate and train key professionals in the residential building industry*. Staff at several clean energy funds echoed similar sentiments about the importance of conducting outreach and education to provide basic information about PV, its benefits, and related programs to various types of residential building industry professionals (builders, realtors, lenders, appraisers, inspectors, etc.). Such efforts are critical not only to creating interest in and support for PV, but also for overcoming specific barriers, such as project delays associated with obtaining permit approval or building inspection sign-off.

- *Engage the building community*. Given the conservative nature of the residential construction industry as a whole, it is important to enlist leaders and champions within the building community to demonstrate the technical viability and market acceptance of new homes with PV. Also, engaging builders early on in program development can help to forestall potential program design issues and create a sense of buy-in from the building community. Though developing this market segment for PV may take time and effort, the rewards for doing so may be significant.

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ABOUT THIS CASE STUDY SERIES

A number of U.S. states have established clean energy funds to support renewable and clean forms of electricity production. This represents a new trend towards aggressive state support for clean energy, but few efforts have been made to report and share the early experiences of these funds.

This paper is part of a series of clean energy fund case studies prepared by Lawrence Berkeley National Laboratory and the Clean Energy States Alliance. The primary purpose of this case study series is to report on the innovative programs and administrative practices of state (and some international) clean energy funds, to highlight additional sources of information, and to identify contacts. Our hope is that these case studies will be useful for clean energy funds and other stakeholders that are interested in learning about the pioneering renewable energy efforts of newly established clean energy funds. To access or download all the case studies, see: http://eetd.lbl.gov/ea/ems/cases/ or http://www.cleanenergystates.org/

ABOUT THE CLEAN ENERGY STATES ALLIANCE

The Clean Energy States Alliance (CESA) is a non-profit initiative funded by members and foundations to support the state clean energy funds. CESA collects and disseminates information and analysis, conducts original research, and helps to coordinate activities of the state funds. The main purpose of CESA is to help states increase the quality and quantity of clean energy investments and to expand the clean energy market. The Clean Energy Group manages CESA, while Berkeley Lab provides CESA with analytic support.

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