
Supporting Photovoltaics in Market-Rate Residential New Construction:

A Summary of Programmatic Experience to Date and Lessons Learned

Galen Barbose, Ryan Wiser, and Mark Bolinger

Lawrence Berkeley National Laboratory

February 2006

Report Overview

Objective: Describe efforts to date to support PV in market-rate residential new construction, and identify key issues and lessons learned that have emerged from these experiences.

Approach: Case studies of clean energy funds and other organizations in 9 states: CA, MA, MN, NJ, NY, OR, PA, RI, WI

Report Structure

1. Introduction
2. Overview of State Support for PV in Market-Rate New Homes
3. Details on Specific Support Mechanisms
4. Key Issues and Findings
5. Summary and Recommendations

Why Focus on PV in New Homes?

Residential new construction has a number of ***potential*** advantages as a market segment for PV:

- ✓ **Can easily roll the cost of PV into the home mortgage**
- ✓ **Better performance** (e.g., proper orientation, no shading; but BIPV may degrade)
- ✓ **Amenable to BIPV** (better aesthetics)
- ✓ **Lower up-front costs** (e.g., bulk purchases, standardization)
- ✓ **Can install PV as a *standard feature* in new housing developments**

But it also faces unique barriers:

- ✓ **Builders often risk averse toward new technologies**
- ✓ **Builders have specific concerns about PV:**
 - Impact on home prices/profits
 - Potential scheduling delays/complications
 - Perceived lack of interest (or even aversion) among homebuyers

Case Study Approach

We reviewed publicly-available information and interviewed staff at the following organizations, to identify their efforts to support PV in market-rate new homes and to characterize issues and lessons learned:

CEC	California Energy Commission
ETO	Energy Trust of Oregon
LADWP	Los Angeles Department of Water and Power
LIPA	Long Island Power Authority
MSEO	Minnesota State Energy Office
MTC	Massachusetts Technology Collaborative
NJCEP	New Jersey Clean Energy Program
NYSERDA	New York State Energy Research and Development Authority
PEDA	Pennsylvania Energy Development Authority
RIREF	Rhode Island Renewable Energy Fund
SDF	Sustainable Development Fund (Pennsylvania)
SMUD	Sacramento Municipal Utility District
WFE	Wisconsin Focus on Energy

Support Mechanisms for PV in Market-Rate New Homes

Support for PV in new homes has been provided through a combination of:

- 1) Broader programs applicable to a wide range of technologies/markets
- 2) Targeted programs aimed more narrowly at PV in new homes

	CA	MA	MN	NJ	NY	OR	PA	RI	WI
Broader Programs That Have Supported <i>Specific Projects</i> Involving PV on Market-Rate New 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
Funding specifically 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	•				•				

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.

Support for PV in New, Market-Rate Homes via *Broader* Programs

Standard PV Buy-Down Programs

Buy-down programs for PV (or customer-sited renewables more generally) are ubiquitous, and in many states are the primary source of direct financial support for PV in new homes.

- **The CEC's *Emerging Renewables Program* in California has had, by far, the largest impact on the new home market:**
 - >2,700 PV systems on market-rate new homes funded (installed or approved) as of May 2005 (~15% of all systems funded)
 - Most (~1,900) are large groups of homes in new developments
- **Other buy-down programs have had only a modest impact:**
 - Most have funded no more than 10-20 PV systems on new homes per year (typically ~5-15% of all residential PV systems)
 - Many are individual, custom new homes (not large developments)

CEC Buy-Down Program Experience: PV Costs Less in Large Residential Developments

- **Separate LBNL study analyzed CEC project cost data from 1998-2005, controlling for a wide variety of factors**
 - *Wiser et al., 2006, “Letting the Sun Shine on Solar Costs: An Empirical Investigation of Photovoltaic Cost Trends in California.”* <http://eetd.lbl.gov/ea/emp/reports/59282.pdf>
- **Found significantly lower average installed costs for PV in large clusters of new homes – but *not* for individual or small clusters of new homes**

Installation Type	Status as of May 2005	Number of PV Systems	Percent of All Systems <30 kW	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

General Solicitations for Large Clean Energy or Green Building Projects

These are a common funding mechanism for larger, less-standardized projects, and *in some cases* may be applicable for PV on multi-family or groups of single-family homes.

- MTC has provided funding for several large multi-family residential construction projects with PV and other green building features
- PEDDA has also provided funding for two zero-energy home developments through recent “clean energy” solicitations

Market-Rate or Mixed-Income Residential New Construction Projects with PV

MTC	<ul style="list-style-type: none">▪ 48-unit, market-rate Energy Star condo complex with 74 kW BIPV system▪ 396-unit, mixed-income, LEED-certified housing complex w/ a 41 kW PV system▪ 64-unit, mixed-income, LEED-certified housing complex w/ a 63 kW PV system
PEDA	<ul style="list-style-type: none">▪ 75 zero-energy single-family homes as part of a larger brownfield redevelopment project▪ 38 zero-energy townhomes

General Renewable Energy R&D Solicitations

Several clean energy funds have supported projects *particularly relevant* to PV on new homes through general solicitations for renewable energy R&D projects.

R&D Projects Relevant to PV on New Homes

CEC	Has funded the development of various new BIPV products
MTC	Awarded funding to a manufacturer of modular homes to conduct a feasibility study to determine the potential for integrating PV and advanced energy efficiency measures into their homes
WFE	Awarded a grant for the development of a free software tool to aid Wisconsin architects and engineers in the design of zero-energy buildings

Targeted Support for PV in New, Market-Rate Homes

Higher Buy-Down Incentives for BIPV or for PV on High-Efficiency Homes

Some buy-down programs offer (or have offered) higher incentives for specific types of PV projects, including BIPV and PV on high-efficiency homes, both of which are particularly applicable to new homes.

Incremental Buy-Down Incentives Above Standard Rebates

	BIPV	Energy Star Homes	LEED-Certified Homes
LADWP Solar Incentive Program	+\$0.75- \$1.00/W [†]		
MTC Small Renewables Initiative	+\$1.00/W	+\$0.50/W	+\$1.50/W
NJCEP Customer Onsite Renewables Program	–	+\$0.25/W	–
NYSERDA Solar Electric PV Incentive Program	+\$0.50/W*	+\$0.50/W	–
WFE Cash Back Rewards Program**	–	+\$1.00/kWh-yr	–

[†] LADWP offered a \$1.00/W BIPV bonus incentive for systems <30 kW, and \$0.75/W for systems >30 kW. Changes to the program's incentive structure are currently being considered for implementation in mid-2006.

* NYSERDA's bonus incentive for BIPV is currently available only for nonresidential projects, due to limited funding.

** WFE ceased offering this extra incentive in 2006.

Accommodations within Buy-Down Programs for PV on New Homes

Many buy-down program administrators make accommodations for residential new construction projects, formally or informally.

➤ Longer reservation periods

- The CEC and MTC both offer a longer reservation period for all new construction projects: 18 and 24 months, respectively, compared to standard 9-month period
- NJCEP offers a 12-month reservation period for all projects >10 kW compared to standard 6-month period (beneficial for new residential developments)

➤ The CEC makes several other accommodations for PV in new residential developments

- Simplified documentation requirements (e.g., related to building permits, application forms, interconnection agreements)
- Builders planning to offer PV as an option can reserve rebates for 10% of lots in advance, without specifying locations

➤ Other buy-down program administrators are able to make accommodations on a case-by-case basis, even if not formally specified in program rules

Demonstration Programs for High-Efficiency New Homes with PV

CEC solicitation for *RD&D Projects Focused on Zero-Energy New Homes (2004)*

- Grant funding for projects incorporating several components:
 - Development of a new ZENH design
 - Development of an innovative business model
 - Construction of a new residential development with at least 75 ZENH
 - Activities to facilitate long-term sustainability of ZENH market
- Funding is *in addition* to PV buy-down incentive
- Awards made for 2 market-rate (~\$3M each) and 1 affordable housing project (not yet underway)

NYSERDA's *PV and Energy Star Home Demonstration Program (2002)*

- Grant funding for projects consisting of:
 - Construction of 6 new subdivisions with Energy Star homes
 - PV installed on model home and offered as option on other homes
- Funding used for:
 - Higher-than-normal buy-down incentives for three PV systems per subdivision
 - Surveys and training of residential building industry professionals
 - Various financial incentives for builders and consumers
- Awards made for two projects (12 new subdivisions)
- Only three PV systems installed other than those on model homes

SMUD and DOE Programs for PV on New Homes

SMUD's Solar Advantage Homes Program (2001-2003)

- SMUD purchased BIPV systems in bulk and sold at a discount (using buy-down incentives from the state) to large production homebuilders. Manufacturer also provided design assistance and installation training for builders.
- Program impact: 113 PV systems installed on model homes and as an optional upgrade on other homes in 21 subdivisions

SMUD's Zero Energy Homes Program (2004-current)

- Partnership with DOE's Zero Energy Home program
- SMUD provides PV buy-down incentives (\$3/W), funding for builder marketing materials, and incentives for energy efficiency measures; also informally helps builders with PV procurement
- Program impacts to date: two ZEH subdivisions with PV installed as a standard feature on all homes (95 and 32 units each) and one with PV pre-plotted on 12 lots

DOE's Zero Energy Home Program

- Funded six teams to design ZEHs and recruit large production homebuilders to install PV as a standard feature in new developments or offer it as an option:
- Program impacts thru 2004: ~ 30 projects completed or nearly completed (>700 ZEHs)
 - Some builders have integrated ZEH concept into their business strategy (e.g., one Northern Calif. builder only does ZEH now); others decided it wasn't for them

Outreach to Residential Building Industry Professionals

A number of state clean energy funds have funded or directly conducted various forms of outreach to professionals in the residential building industry.

- In support of its *PV on Energy Star Homes* demonstration program, NYSERDA funded training for builders, lenders, appraisers, local building inspectors
- The CEC's ZENH RD&D program includes a “market sustainability” element, which can be fulfilled through outreach and training activities
- ETO and WFE have both conducted outreach in support of their buy-down programs (e.g., by hosting seminars at building trade events)

Other Potential Approaches for Encouraging PV in New Homes

Various other strategies could be employed to support PV in market-rate new homes – some could be implemented directly by state clean energy funds, while others would require action by other entities.

1. Builder mandates

- Require builders to offer PV as a standard feature or an option, or to build homes to be “PV ready”
- Could be adopted at state or local level (e.g., Ladera Ranch; Winters, CA; San Luis Obispo, CA)

2. Financing strategies

- Typical financing programs are not necessarily appropriate/effective for new home market
- An alternative: recruit lenders to offer low-interest mortgages in exchange for aggregations of PV customers and/or Community Reinvestment Act credits
- Low/no-interest construction loans for developers (to address concerns about cost of financing and potential PV-related construction delays)

3. Entitlements granted through local planning/permitting agencies

- Shorter wait times for plan check and inspection, higher density allowances, waived permitting fees

4. Bulk purchases by builders

- Coordinated bulk purchase by groups of builders, with organizational and/or financial support from clean energy fund or trade organizations

Key Findings and Issues

1. Limited Experience and Data

- Most states (outside of CA) have seen relatively few PV projects on new market-rate homes
- Many of the systems have been installed on single new custom homes
- There is also a lack of information about what little experience has been accumulated

Number of PV Systems on New Market-Rate Homes Funded Through Each Program Type

State / Organization		Standard PV Buy-Down Programs	General Solicitation for Clean Energy or Green Buildings Projects	Targeted Demonstration or Deployment Programs for PV on New Homes
CA	CEC	2717	-	150
	SMUD	Few	-	252
MA	MTC	13*	3**	-
MN	MSEO	8	-	-
NJ	NJCEP	Unknown	-	-
NY	LIPA	Few	-	-
	NYSERDA	20*	Unknown	15
OR	ETO	Few	-	-
PA	SDF	30	-	-
	PEDA	-	113	-
WI	WFE	8*	-	-

* The only PV systems on new homes that could be identified were those that received a higher incentive for BIPV or Energy Star homes, thus the value shown here is a lower bound.

** All are large PV installations on new multi-family buildings

Key Findings and Issues

2. PV as a Standard vs. Optional Feature

- **Some large production homebuilders may be unwilling to install PV as a *standard* feature in new developments, but may be willing to offer it as an *option***
- **When offered as an option, builder faces higher transaction costs (training of sales staff, more complex procurement and installation scheduling)**
- **Experience with offering PV as an option is mixed:**
 - Few or no homebuyers in some cases (e.g., NYSERDA demonstration program)
 - Modest uptake in other cases (e.g., 113 PV systems in SMUD's *Solar Advantage Homes Program*)
- **States may want to offer higher buy-downs for systems installed as a standard feature**

3. Integrating Energy Efficiency with PV

- **New homes offer potential synergies between PV and energy efficiency (EE)**
 - Greater potential for EE upgrades in new homes allows for smaller PV system
 - Marketing opportunities for “zero energy homes”
- **State clean energy funds have harnessed these synergies through:**
 - Integrated programs that specifically target PV in high-efficiency homes
 - EE requirements as a precondition for new home participation in the PV buy-down program
 - Higher buy-down incentives for PV on Energy Star Homes
 - Coordinated program delivery between PV and EE programs for new homes

Key Findings and Issues

4. Funding Level and Duration

- Large production homebuilders face long project lead times and potentially large start-up costs associated with training construction and sales staff
- Some threshold level and consistency of program incentive funding may be required to “jump-start” the new home market
- Jump-starting the market may take time and staying power

5. Differential Incentives

- Higher incentives are one way to jump-start the market
- Disparate approaches illustrate the challenge of providing a higher level of support to a market segment that offers potentially lower costs
 - *Higher* buy-down incentives for BIPV or for PV on high-efficiency homes; additional incentives for builder marketing materials or design and installation services
 - *Lower* buy-down incentives for new construction or large projects
- **If higher incentives are offered for PV in new homes, it may make sense to focus on “high value” projects** (e.g., BIPV, PV on Energy Star homes, innovative new business models, PV installed as a standard feature in new developments)

Key Findings and Issues

6. Buy-Down Program Provisions

- **Many buy-down programs have features or provisions that could potentially pose barriers for PV in new homes (particularly when PV is installed as a standard feature throughout new housing developments):**
 - Short reservation periods
 - Limits on the number of rebates or funding per applicant/site
 - Participant eligibility limited to individual customers: builders can't serve as applicant
 - Documentation requirements may be inappropriate for large housing developments
 - Installation commitment as precondition for rebate reservation: uncertainty about future program funding may deter builders from offering PV as an option
 - Performance-based incentives: builders don't want to be involved with program after home sale
 - Requirements that incentive be passed through to customer: cost to homebuyer not observable if PV is installed as a standard feature
- **Buy-down program administrators can often deal with these types of issues on an *ad hoc*, case-by-case basis; others (e.g., the CEC and MTC) have adopted explicit rules to accommodate residential new construction projects**

Key Findings and Issues

7. Installer Infrastructure Development

- **Particularly important for new home market, given builder concerns about installation-related project delays**
- **Large production homebuilders may also have specific needs:**
 - A comprehensive set of services (e.g., obtaining rebates and utility interconnection)
 - Prefer to have roofing or electrical sub-contractors do PV installations
 - Higher level of professionalism than what may normally be acceptable
- **Strategies to cultivate installer infrastructure**
 - Grant funding for installer training, certification, and business development
 - Installer standards for PV buy-down program

8. Lack of Knowledge About PV Within the Building Industry

- **Various market participants play an important role in developing the new home market for PV: builders, realtors, lenders, appraisers, building inspectors, local permitting agencies**
- **State clean energy funds have taken some steps to foster greater knowledge about PV among these professionals**

Key Findings and Issues

9. Federal and State Solar Tax Credit Issues

- **Should builder or homebuyer claim the tax credit?**
 - Commercial federal tax credit has no dollar cap, and thus is potentially more lucrative.
 - However, tax incentives are often “recaptured” (in part or in whole) if the system is sold within five years after its in-service date; as such, homebuyer should generally take the credit
- **For the homebuyer to claim the credit, it is critical that the builder provide necessary documentation (e.g., information on equipment cost)**
- **In some situations, the cost of the system to the homebuyer is not directly observable or well-defined**
 - Situations where this can occur: PV is installed by the builder “on spec” (e.g., as a standard feature in a new development), or the builder of a custom new home includes the PV system within a fixed fee contract for the whole project
 - The builder’s cost could be used as a proxy, but this neglects any additional mark-up
- **The “in-service date” is based on when occupancy begins**
 - Thus, a new home with PV built in 2006 or 2007, but not occupied until 2008, would be ineligible for the federal tax credit (unless the tax credit is extended).

Recommendations

- ✓ **At the very least, “do no harm” through existing programs**
- ✓ **Track key information about PV installations on new homes**
- ✓ **Provide consistent funding over a sustained period**
- ✓ **Offer a higher incentive to jump-start the market, but focus incentives on achieving more than a “standard” PV installation**
- ✓ **Conduct outreach to building industry to educate about PV, and to receive input early on program development**
- ✓ **Engage champions within the building community to demonstrate technical feasibility and market acceptance**
- ✓ **Coordinate PV and energy efficiency programs for new homes**
- ✓ **Build up competent base of installers who meet professional standards required by large production home builders**

For More Information...

Download the full report from:

<http://eetd.lbl.gov/ea/emp/reports/59299.pdf>

Contact the authors:

Ryan Wiser, RHWiser@lbl.gov, 510-486-5474

Galen Barbose GLBarbose@lbl.gov 510-495-2593

Mark Bolinger, MABolinger@lbl.gov, 603-795-4937