



Customer-Sited PV: A Survey of Clean Energy Fund Support

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Generating electricity from the sun’s rays without motion, sound, or exhaust, photovoltaic (PV) systems are perhaps the quintessential renewable energy technology. PV’s widespread popularity, along with its high up-front cost and resulting need for support, have made it a prime target of state clean energy funds – virtually all funds currently in operation provide some form of support for customer-sited PV.

There is less agreement among funds, however, about the most effective means of providing such support. Many funds have implemented what are commonly known as “buy-down” programs, where funds are distributed as grants to subsidize or “buy down” the initial cost of the system.¹ Other funds have taken different approaches, soliciting proposals for specific projects, offering pre-development grants, developing infrastructure and distribution channels, or investing seed capital in budding PV manufacturers. At least one fund has considered (but not implemented) a leasing program.

This report surveys the different experiences of funds trying to support customer-sited PV. The first section describes experience with buy-down programs, while the second section examines alternatives to, or variations on, buy-downs.

This report also proposes further joint activity through the Clean Energy Funds Network (CEFN) to improve upon existing and future PV programs.

¹ Often, buy-down programs are not limited to PV, but will also fund small wind turbines, solar thermal applications, and even fuel cells. While the focus of this case study is limited to PV, much of the discussion is applicable to these other technologies as well, particularly small wind.

I. BUY-DOWN PROGRAMS

Program Characteristics

Six different clean energy funds currently offer PV buy-downs as a major programmatic effort; details of these programs are summarized in Table 1.

PV: Take Away Points

- ☼ **Popular:** Buy-down programs have proven popular among state funds for a variety of reasons: they are relatively straightforward to implement, directly engage the public, impose minimal transactions costs on the system owner, and have the potential to provide quick and tangible results.
- ☼ **24 MW Funded:** With incentive levels ranging from roughly \$2/W to as high as \$6/W, roughly 24 MW of PV has been installed or reserved under buy-down programs to date.
- ☼ **Cost-Effective?** Experience has shown that buy-down programs are often expensive on a \$/W basis, and may receive a limited response in the absence of strong marketing and consumer education campaigns, or widespread media coverage surrounding a crisis event. Some fund managers have also questioned whether buy-down programs will lead to a sustainable demand for PV such that the technology – and the industry that manufactures and installs it – can stand on its own once the subsidy disappears.
- ☼ **Sticks and Carrots:** Some of the newer buy-down programs are partially performance-based, employing both carrots (incentives) and sticks (penalties) to encourage a high level of performance.
- ☼ **Alternatives:** Productive alternatives to buy-down programs have proven elusive (e.g., system leasing), or will take some time to bear fruit (e.g., equity investments, building distribution channels), making them difficult to evaluate.
- ☼ **Still Early:** It is too early to draw conclusions about the relative successes of buy-down programs versus other forms of support. Prior to California’s electricity crisis, for example, the state’s buy-down program was performing at less-than-expected levels, but few would offer that judgment today in the face of phenomenal growth during 2001.

CEFN ACTIVITIES: This report suggests that there are at least four broad areas where state clean energy funds interested in supporting PV could benefit from joint work: education and infrastructure building, project coordination, joint research, and information sharing. For more information, please turn to page 16.

Table 1. PV Buy-Down Programs

State	System Size Limit*	Buy-Down Level (\$/W up to % of system cost)	Maximum Funding Per System	System Requirements	Installation Requirements**	Warranty	Performance Guarantee	Grid Connect
CA	None Specified	\$4.50/W up to 50%	\$2,500,000	Must have appropriate UL listings CEC provides list of eligible components that are UL-listed	Contractor must hold appropriate licenses (though owner can install system without using a contractor)	Full 5-yr on entire system if installed by a licensed contractor, limited 5-yr if installed by owner	Warranty must protect against degradation in electrical output of > 10%*** Random audits	Required
IL	0.5-2 kW ≥2 kW	\$6/W up to 60% \$6/W up to 60%	\$5,000 \$300,000	UL-listed or 1 yr of field testing	None specified	None required	None, though system may be inspected	Not Specified
NJ	≤10 kW 10-100 kW >100 kW	\$5/W up to 60% \$4/W up to 60% \$3/W up to 60%	None	UL-listed Specifics listed in technical worksheet	Must be installed such that output exceeds a minimum percentage of optimal output. Specifics listed in technical worksheet.	Full 5-yr on entire system	Program administrators will inspect 100% of the eligible installations in the first yr prior to issuing the rebate incentive	Not Required
NY (LIPA)	≤10 kW	\$6/W installed by 7/31/02 \$4/W installed after 7/31/02	\$60,000	None	None specified	None required	System may be inspected before rebate issued	Required
PA (PECO)	1-5 kW	\$3/W (owner) upfront \$1/kWh (owner) after 1 yr 10¢/kWh (installer) after 1 yr	\$6,000 \$2,000 \$250	Systems must be FSEC-approved or components must be CEC-approved, or else must meet a series of IEEE, UL, and other standards	Installers must be pre-certified System must be sited such that it can produce ≥ 70% of optimal output	Full parts and labor for 2 yrs, limited parts for additional 3 yrs	1-yr anniversary payment to owner and installer based on system performance	Preferred
RI	None Specified	\$3/W up to 50%	None	None	None specified	None required	None	Not Specified

* In addition to these limits, all programs require eligible customer-sited PV systems to be sized such that output does not exceed historic on-site load.

** In addition to meeting all applicable national, state, and local codes.

*** Note that this is 10% degradation from PVUSA Test Conditions (PTC), which already include the degradation that commonly occurs when PV systems are first installed.

In addition to the six programs listed in Table 1, several other states have either implemented small buy-down programs, or are contemplating buy-downs in the future.²

- The northeast portion of **Wisconsin** has a small buy-down program that offers PV systems \$1 per projected annual kWh of generation up to 25% of project costs, with awards ranging from \$5,000³ to \$50,000. While at first glance this appears to be a 1-year production incentive, the fact that it is tied to *projected* rather than *actual* kWh production means that only efficient siting is incented. Assuming a 20% capacity factor, \$1/kWh works out to about \$1.75/Watt – a low incentive relative to that offered by other funds, yet consistent with Wisconsin’s focus on infrastructure development and market transformation rather than project development. Roughly a dozen PV systems have been funded to date.
- In 1998, the **New York State Research Development Authority (NYSERDA)** funded three PV manufacturers/installers to develop distribution channels to residential customers (discussed later), and one of the recipients – SunWize Technologies – developed a buy-down program offering \$3/Watt up to the lesser of 50% of system costs or \$7500/system. The Solar Connect New York program is targeting the installation of 40-60 systems, and after 2 years has shipped 21 systems and installed 8. Utility interconnection

² While many municipal utilities, particularly in California, also offer PV buy-down programs, this report does not cover those programs.

³ Systems whose annual production is not expected to exceed 5000 kWh – which includes most systems under 3 kW, assuming a 20% capacity factor – must be aggregated with other projects in order to exceed the \$5,000 minimum grant threshold.

approvals have reportedly caused many delays. SunWize trains authorized dealers, and systems are monitored for performance (though the incentive is not tied to performance).

- In late 2001, **Xcel Energy’s** Renewable Development Fund awarded a \$1.15 million grant to the Minnesota Department of Commerce to implement a statewide PV buy-down program. Early indications are that the 4-year program will fund systems up to 4 kW with a \$2/Watt incentive, and will target a total of 400 kW installed (i.e., a minimum of 100 systems).
- **Delaware’s** “Energy Alternatives Program” just got underway in January 2002. For PV, the program offers rebates of 35% of eligible system costs, up to \$10,500 for residential systems and \$250,000 for non-residential systems. Eligible system costs, which include all components, labor, and permit or construction fees, are capped at \$12/Watt. All systems must carry a full 5-year warranty against component failure, malfunction, and premature output degradation, and modules and inverters must be UL-certified.
- **Massachusetts** has recently announced a multi-faceted program that would combine up-front buy-downs with performance incentives extending over three years. One facet would target clustered installations in an effort to reduce costs and perhaps shore up areas with constrained distribution system infrastructure, while a second facet would target new construction (but would also be available to existing buildings).

Among all implemented or proposed programs covered in this report, buy-down

levels currently range from roughly \$2/W to \$6/W, with most states limiting total expenditures per system to 50% or 60% of total system costs and/or some absolute dollar amount. Only the Long Island Power Authority (LIPA), Minnesota, and Pennsylvania⁴ limit system size, though all three will fund larger systems outside of their structured buy-down programs.

Technical and performance requirements vary widely among programs, with Illinois, LIPA, and Rhode Island imposing few requirements, while California, New Jersey, and in particular Pennsylvania are much more stringent.

Innovative Buy-Down Features

As one of the first states to implement an SBC-funded buy-down program, California has set the standard for other states to follow, while also providing valuable real-time experience upon which other states have drawn in designing their own programs.

For example, New Jersey closely modeled its program after California's, yet set a higher buy-down level following the modest response to California's initial \$3/W offer.⁵ Similarly, Pennsylvania draws upon the technical system requirements imposed in California, yet also ties a portion of the incentive to the performance of the system, in part as a response to the discovery that some of the systems installed in California were performing from one quarter to one third below expectations. In other words,

the newer programs – i.e., New Jersey and Pennsylvania, as well as Massachusetts' proposed program – have benefited the most from the experience of other programs, and have tended to innovate in response to perceived problems.

Specific innovations (in these and other programs) include:

- *Performance-Based Incentives:* While Pennsylvania's initial \$3/W buy-down is at the low end of the range, a second payment of \$1/kWh (up to \$2,000) is made to the system owner at the end of the first year of production.⁶ At the same time, the system installer is paid \$0.10/kWh (up to \$250). These delayed, performance-based payments incent both the owner and installer to ensure that the system is operating at high levels.⁷ Massachusetts has also announced a performance-based buy-down, where 70% of a \$5/Watt incentive will be paid up-front, with the remaining 30% paid down over three years based on system performance.
- *Performance-Based Penalties:* In addition to offering a "carrot" to encourage peak performance, Pennsylvania also employs a "stick": to be eligible for the program, the placement and orientation of PV modules must enable the system to produce not less than 70% of the annual output achieved by an optimally placed and oriented system. New Jersey employs a similar mechanism, with

⁴ Throughout this case study, "Pennsylvania" refers to the Sustainable Development Fund (SDF) in PECO's service territory. SDF is the only one of Pennsylvania's four clean energy funds that currently offers a customer-sited PV program.

⁵ California increased its buy-down level from \$3/W to \$4.50/W in April 2001 (made retroactive to February 8, 2001).

⁶ For a 2 kW system, the \$1/kWh one-year production incentive (capped at \$2,000) roughly equates to an extra \$1/W up-front incentive.

⁷ Note that performance-based incentives (as well as system monitoring) require that the system be metered separately from the building, rather than through the building's existing meter, as is common practice with net-metered applications.

different minimum percentages for westerly oriented systems (60%), building-integrated photovoltaics (40%), and all other orientations (75%).

California requires retailers to warrant against degradation in system output by more than 10% from originally rated output (as measured per PVUSA Test Conditions, which already includes the typical initial degradation).

- *Qualified Installers:* While California requires PV installers to carry the appropriate contractor licenses (though system owners are allowed to install their own systems without being licensed), Pennsylvania (and SunWize in New York) goes one step further and requires the use of a participating contractor from a pre-certified list.
- *Warranties:* California, Delaware, New Jersey, and Pennsylvania all require systems to carry 5-year warranties, of varying comprehensiveness. Such requirements have forced manufacturers to strengthen and lengthen their product warranties, providing a good example of how SBC-funded PV programs are pushing the PV industry towards maturity.⁸
- *Leveraging of Funds:* Illinois' program often teams up with two other funds in the Chicago area – controlled by the City of Chicago and ComEd – to fund 100% of the cost of PV systems on public buildings in the metropolitan area. This cooperation has resulted in large

⁸ Prior to California's buy-down program, PV modules (i.e., panels) routinely carried 10- to 20-year warranties, but balance of system components – which often make up half the cost of a complete system – were rarely covered. See Thomas J. Starrs and Vincent Schwent, "Government Buydowns for the Residential Market", prepared for the Renewable Energy Policy Project.

amounts of PV being installed – more than 400 kW to date on a dozen museums and schools, as well as several community centers and commercial buildings – and also provides considerable demonstration value.

- *Seeking Value-Added Markets for PV Power:* The SDF in Pennsylvania has investigated the possibility of offering an innovative "PV pricing" program through retail electricity service providers, where the electricity provider pays PV system owners premium prices for their systems' generation in exchange for the right to claim that it is supplying PV power to the grid. Customers benefit because the premium prices are higher than a customer can earn through net metering. Retailers benefit by procuring relatively cheap PV power and reaping the public relations benefits of supporting local green power projects.

The Energy Cooperative Association of Pennsylvania (ECAP) has recently announced such a program: ECAP customers who install SDF-qualifying PV systems and meet 100% of their gross usage with ECAP's all-green product offering will be paid \$0.20/kWh for their PV production. ECAP estimates that this program could reduce system payback times by as much as 30%.

Outcomes

Buy-down programs have had mixed success over time. Prior to the electricity crisis of 2000/2001, customer-sited PV programs were generally considered to be performing below expectations. For example, even after two-and-a-half years, California had not attracted enough interest in its emerging renewables buy-down

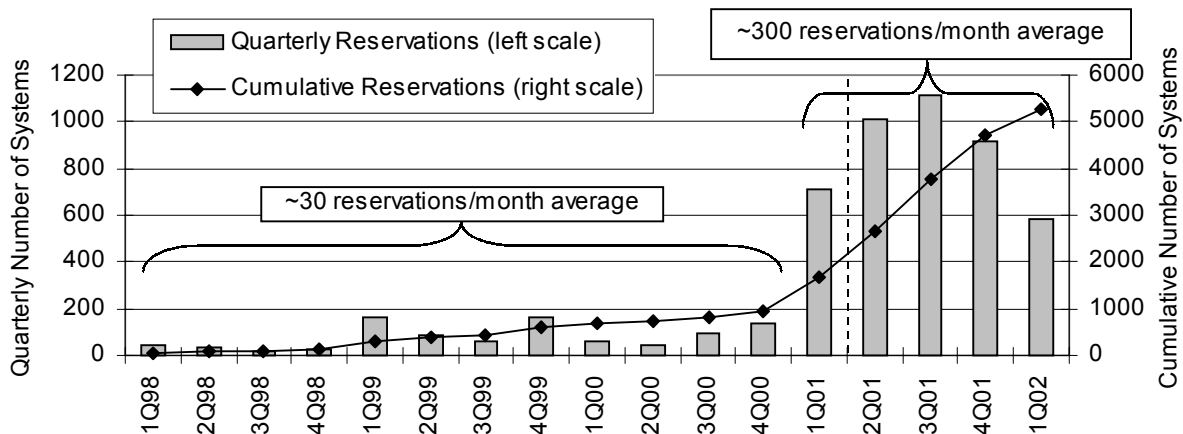
program to exhaust even 20% of the funds available for small (< 10 kW) systems. Rhode Island, offering a less-appealing solar resource and an incentive half as large as California's, had also met with disappointing results, and in early 2001 doubled its buy-down incentive to \$3/Watt in an effort to boost program participation. In New York, LIPA gave away 31 free PV systems to kick off its Solar Pioneer program back in November 1999, but after funding only 20 or so systems (at \$3/Watt) in the following two years, doubled its buy-down level in December 2001 to \$6/Watt and announced a second lottery of 30 free systems.

These modest early results were perhaps due to a combination of factors, including low consumer awareness, interconnection barriers, and low buy-down levels in some states relative to the high up-front costs of PV. The electricity crisis has reversed these circumstances, at least in some states, and has had a profound effect on some of the PV programs, dramatically increasing consumer awareness, prompting increases in buy-down levels, and stimulating increased interest in and installation of PV systems.

This is particularly true in California, where the severity of the crisis, the extensive media coverage given to distributed generation solutions, state consumer awareness campaigns, and the mid-year increase in the buy-down level from \$3 to \$4.5/Watt spurred a ten-fold increase in sales of small wind and PV systems during 2001.

According to the California Energy Commission (CEC), PV system installations in California occurred at a rate of 1 system per month prior to the inception of the buy-down program in 1998. Under the buy-down program, reservations had been running at about 30 systems per month on average from 1998 through 2000 (i.e., prior to the electricity crisis). Since the beginning of 2001, however, system reservations have jumped to more than 300 systems per month on average.

Figure 1 depicts the surge in activity on a quarterly basis; note that the retroactive \$1.50/W increase in the buy-down level did not occur until April 2001 (as depicted by the dashed vertical line), and therefore did not contribute to the sharp increase in reservations during the first quarter of 2001.



Source: CEC Quarterly Reports to Legislature

Figure 1. Quarterly Reservation Activity Within California's Buy-Down Program

It remains to be seen whether or not the recent demand surge in California is sustainable. In the wake of a summer of unusually low wholesale electricity prices and no rolling blackouts, as well as the events of September 11, California's electricity crisis has largely dropped out of the public eye, and the dip in reservations over the last two quarters depicted in Figure 1 at least hints at the beginnings of a parallel tapering off of demand for PV in California.

To date, approximately 21 MW of PV have been installed or reserved under California's buy-down program.⁹ Illinois' fund is estimated to have supported roughly 700 kW of PV installations since its inception in 1999, the bulk of it co-funded by two other funds in the Chicago area that routinely collaborate to fully fund PV installations on Chicago museums, public schools, and commercial buildings. In the first year of New Jersey's customer-sited program, utilities (and the Board of Public Utilities) have approved 62 PV project applications totaling more than 1.9 MW. In New York, LIPA's Solar Pioneer program has installed 18 systems totaling 54 kW (not counting either lottery) with another 114 kW reserved, while SunWize's Solar Connect program has supported roughly 30-40 kW (including systems shipped but not yet installed). Rhode Island's buy-down program has funded approximately 20-30 kW, and Wisconsin's program has supported roughly 15 kW. Programs in Pennsylvania and Delaware only became operational in December 2001 and January 2002, respectively, while Minnesota's program will likely be implemented later in 2002.

⁹ This number reflects only the CEC buy-down program, and does not include capacity reserved under the CPUC's newly implemented buy-down program.

*In aggregate, roughly 24 MW of PV has been installed or reserved under clean energy fund buy-down programs to date.*¹⁰

To put the roughly 24 MW of PV supported by buy-down programs to date in perspective, roughly 300 MW of PV was installed globally in the year 2000, bringing total installed capacity worldwide to more than 1,000 MW. Japan, home to the world's largest PV market, installed almost 110 MW in 2000, bringing cumulative PV capacity in that country to nearly 320 MW. Germany, on track to surpass the US as the world's second largest market, installed 45 MW in 2000, bringing total installed PV capacity to more than 110 MW. The U.S. installed roughly 20 MW in 2000, bringing total installed capacity to roughly 140 MW.

In other words, within the relatively small domestic and worldwide PV markets, state clean energy fund support for PV has been significant – particularly so given the brief history of the programs that are in place.

Issues and Challenges

- *Buy-downs often need to be generous for grid-connected PV systems.* Based on early experience in California and elsewhere, generous buy-down incentive levels appear to be necessary, though perhaps not sufficient, to stimulate significant demand for grid-connected PV systems. Given the high level of support required, fund managers should have reasons other than near-term cost-effectiveness for supporting PV: even at the low end of the buy-down range, a \$3/W buy-down could completely fund a comparably sized small wind system and is triple the amount needed to

¹⁰ Note that not all projects that have reserved funds will be installed.

completely fund a utility-scale wind project.

- *Customer education and awareness appear to be vital to success.* Perhaps as or more important than the specific buy-down level is the level of customer education and awareness of distributed generation options.

Nowhere is this better illustrated than in California, where an otherwise attractive \$3/Watt incentive did not meet expectations for its initial two and a half years. During these initial years, the educational component of California's renewable energy program focused principally on green power marketing and very little on the buy-down program, in part explaining why only 14% of residential and 9% of business customers were aware of the buy-down program nearly two years after its launch.¹¹ Such low levels of program awareness perhaps partially account for the slow initial response to California's buy-down program.

In 2001, however, the threat of regular and sustained rolling blackouts and sharply higher retail prices, in combination with more focused educational efforts and considerable media attention paid to the state's electricity crisis, have significantly increased awareness of and interest in California's buy-down program (see Figure 1).

One could even argue that the crisis itself has been the true driver behind the surge in demand for PV in California,

raising awareness and spurring system sales more effectively than any education program could ever hope to. Two bits of information support such an argument: (1) the dip in reservation activity over the last two quarters, commensurate with the crisis fading from the public's memory, and (2) the fact that, despite national media attention focused on California's electricity woes, the surge in California buy-down activity has not been universally replicated elsewhere – e.g., programs in Rhode Island and New York (LIPA) did not see much of an increase in activity during 2001, perhaps because the electricity crisis never ultimately spread to those two states.

- *Anticipated reductions in residential system costs have not materialized.* The CEC's October 2000 preliminary evaluation of the first two years of California's buy-down program compared the installed costs of the first 300 small (< 10 kW) PV systems installed under the program against the costs of the latest 100 small systems and found virtually no reduction in costs over time.¹²

Fearing that the program's declining block structure, which reduces incentive levels as cumulative volume increases, would prove disastrous in the face of stable system costs, the CEC restructured the program in the summer of 2001 to award a constant \$4.50/W incentive to all systems over the next five years. In fact, there is some risk that total system costs could actually

¹¹ See *Renewable Energy Program Preliminary Evaluation: Overall Program Summary Report*, prepared for the California Energy Commission by Regional Economic Research, October 30, 2000.

¹² See *Renewable Energy Program Preliminary Evaluation: Emerging Renewable Resources Account (Volume IV)*, prepared for the Governor and the California State Legislature by Regional Economic Research, Inc., October 30, 2000.

increase as the surge in buy-down activity in 2001 taxes the existing manufacturing and installation infrastructure to its maximum capacity, leading to supply bottlenecks and higher costs. The CEC's investment plan indicates that it will remain vigilant to indications of increasing, rather than decreasing, costs, and will reevaluate the program if such signs emerge.¹³

- *Commercial system sales often fare better than residential system sales.* California has observed a brisk pace of fund reservations among larger commercial systems, as well as cost reductions. Most of the \$4.2 million earmarked for medium (10-100 kW) and large (> 100 kW) systems within the first funding block offered in 1998 (at \$3/Watt) was snapped up within the first few days of the program by 2 large and 11 medium-sized systems.¹⁴ Furthermore, the CEC's October 2000 preliminary evaluation estimates that installed costs for medium and large systems (i.e., those > 10 kW) declined by \$2.10/Watt during the first two years of the program. To date, almost 11 MW of medium and large systems (i.e., > 10 kW) have been funded in California, compared to about 10 MW of small systems (< 10 kW).

Most of Illinois' funding for PV has gone to large installations, many of them

¹³ California Energy Commission, June 2001, *Investing in Renewable Electricity Generation in California: Report to the Governor and Legislature*, P500-00-022.

¹⁴ The relatively small amount of funds (\$4.2 million) set aside for medium and large systems in proportion to the maximum buy-down per project (\$1 million) created a sense of urgency among larger projects wanting to cash in on the most lucrative \$3/Watt incentive level before funds were depleted. Op. Cit., 9.

installed at no cost (through additional funding from the City of Chicago and ComEd) on public museums and buildings in Chicago. New Jersey's first-year results show that systems larger than 10 kW have captured 90% of PV funding (accounting for 1.2 MW of the total 1.3 MW of PV funded to date). NYSERDA, through a targeted solicitation (not a buy-down program), has also funded 11 commercial installations ranging from 40 kW to 260 kW.

Several factors favor commercial over residential systems: (1) larger systems permit greater economies of scale; (2) commercial and industrial customers often pay time-of-use or real-time rates coupled with demand charges, all of which favor a peak-shaving generation source such as PV; (3) commercial customers are able to take advantage of the 10% federal investment tax credit and 5-year accelerated depreciation; and (4) government policies and programs often target installations on state buildings, which are able to house large systems.

- *Concerns about ongoing system performance have been raised.* Monitoring of selected PV systems installed under California's program revealed that AC output was as much as one-quarter to one-third below that expected on the basis of certified module and inverter efficiencies.¹⁵ A combination of factors contributed to the under-performance, including

¹⁵ Op. Cit., 12. Note that California rates system components under PVUSA test conditions (PTC), which already include the normal degradation that commonly occurs when PV systems are first installed. The cited underperformance is in addition to that experienced under PVUSA test conditions.

component mismatch, wiring sizes, shading, battery storage, panel orientation, and inverter loading. It was also discovered that many program participants have no means of monitoring their systems' instantaneous or cumulative performance, or else do not understand what quantity of output to expect.

Pennsylvania has taken steps to address these contingencies by using only a select group of installers, requiring rigorous technical and installation standards, and tying a portion of the incentive to the performance of the system over the first year. In addition, California and other states have begun to offer training programs for installers. The trend towards pre-engineered systems and smarter inverters may also reduce the chance or impact of installation problems.

II. ALTERNATIVES TO (OR VARIATIONS ON) BUY-DOWNS

Given the high incentive requirement of typical buy-down programs, along with modest initial (i.e., pre-electricity crisis) results, some state funds have explored whether other incentive policies may more cost-effectively support the development of a self-sustaining PV market.

While experience with these programs is too limited to evaluate their successes relative to buy-downs, nine specific policies have been used or considered:

1. *Project-Based Competitive Solicitations:* NYSERDA issued a \$2.1 million solicitation targeting PV systems of 40 kW or more on commercial buildings. This approach has the advantage of a high project completion rate and cost

minimization – receptive sites are identified up front, removing one large barrier to project completion. The RFP process also allows NYSERDA to consider factors other than cost, such as which projects provide the most visibility and demonstration value. To date, NYSERDA has selected 5 companies to install over 600 kW of PV on 11 buildings throughout the state. Projects, which range in size from 40 kW to 260 kW, receive about \$5/W.

Montana has also taken this approach by soliciting as many as 17 schools and 39 residences to receive 2 kW and various-sized systems, respectively, and Minnesota recently awarded \$100,000 for an 8 kW PV-integrated roof on the Science Museum of Minnesota's new Environmental Experiment Center.

2. *Developing Distribution Channels:* NYSERDA has targeted the residential PV market in a more indirect way by funding three PV manufacturers (Astropower, SunWize Technologies, and Four Seasons Solar Products) to develop distribution channels that are intended to enable them to more effectively market their products to residential customers.

By leaving the residential solicitation open-ended in terms of the types of responses it would consider, NYSERDA hoped to effectively tap into the expertise of the private sector, allowing respondents to propose funding approaches that would best suit their needs. Although Four Seasons recently dropped out of the program,¹⁶ the other two efforts are starting to bear fruit:

¹⁶ Four Seasons had been working with Siemens Solar to create PV panels that fit into existing (or

- Astropower has funded the *NY Shines* educational program developed by the Pace Energy Project, is selling its *SunUPS* and *SunLine* residential systems at *Home Depot* stores, and has successfully teamed up with installers to market its fully integrated *SunChoice* rooftop systems.
- SunWize Technologies has developed the Solar Connect New York buy-down program described earlier.

3. *Low-Cost Financing:* Easily accessible low-cost financing – the lack of which is often noted as a barrier to PV sales – may enhance the effectiveness of customer-sited programs.

New York (both NYSERDA and LIPA), Pennsylvania, and Wisconsin have developed financing programs, focusing either on providing unsecured loans, or on “buying down” the interest rate to below-market levels. While experience suggests that financing programs alone are unlikely to significantly increase PV sales, they may offer a low-cost complement to other PV incentives, and all three states offering financing programs have marketed them in conjunction with their other PV incentives.

4. *Equity Investments:* Rather than funding PV projects, at least one fund has invested in PV companies. The Connecticut Clean Energy Fund has provided seed capital to Solar Dynamics, Inc., a start-up spin-off whose initial product is the Solar Power Companion, a portable PV generator originally developed by ASE Americas, Inc. The

goal of this investment is not necessarily to boost PV use in Connecticut, but to develop a Connecticut-based business that can tap into the national and international PV markets. Other state funds focusing on economic development (notably Massachusetts and Pennsylvania) may also find opportunities in such export markets, especially as the most cost-effective and promising markets for PV are arguably overseas.

5. *Bulk Purchases:* As an alternative or supplement to buy-down incentives, state funds may be able to leverage their impact by facilitating the aggregation of interested participants into a bulk purchase order, which may reduce per-unit system and installation costs.

The Sacramento Municipal Utility District’s PV Pioneer program has achieved considerable success in driving the installed cost of PV systems down through a “sustained orderly development and commercialization” approach involving scheduled bulk purchases and installations. Similarly, Spire Corporation has secured \$8 million in firm commitments (\$6 million from ComEd and \$2 million from the City of Chicago Department of Environment) to purchase a substantial number of PV systems from its new Spire Solar Chicago manufacturing plant located on a redeveloped brownfield on Chicago’s west side. These commitments were not only sufficient to lure Spire into Chicago, but should also result in lower per-unit system and installation costs to the City of Chicago (though cost savings have reportedly not yet materialized, due primarily to construction delays with the new factory).

new) sun room frames, but experienced problems integrating panels directly into the roof system.

Finally, as one facet of its proposed buy-down program, Massachusetts will fund geographically clustered PV systems, which should reduce installed system costs through geographic concentration of installations, volume purchases, system standardization, and coordinated permitting and interconnection. In addition, Massachusetts hopes this program will create additional value by focusing on areas with constrained distribution system infrastructure.

6. *Project Leasing:* Leasing programs remove perhaps the greatest barrier to PV adoption – high up-front costs – and may also reduce homeowner anxiety over system performance or maintenance, or having to move before the system pays for itself. Furthermore, a leasing company may be able to reduce PV costs by taking advantage of bulk equipment purchases, the federal five-year accelerated depreciation schedule, the federal 10% business energy tax credit, and long-term financing.

Despite these potential advantages, consumer research suggests that leasing may not hold much appeal when it comes to customer-sited PV systems: a survey of prospective hosts of residential PV systems in Colorado revealed that leasing a system is less desirable than owning it,¹⁷ while CEC market research

¹⁷ The question asked “If you were considering a grid-tied PV system, on a 1 [not at all important] to 10 [very important] scale, how important would each of the following features be to you?” With a sample size of greater than 2200, the mean response to “Leasing the PV system, or leasing with an option to buy” was 5.34 (± 2.84 standard deviation) versus 6.57 (± 2.89 standard deviation) for “Owning the PV system.” See Barbara C. Farhar and Timothy C. Coburn. September 2000. *A Market Assessment of Residential Grid-Tied PV Systems in Colorado*. NREL/TP-550-25283. Golden, Colorado: National Renewable Energy Laboratory.

focusing on the California commercial sector indicates that the ability to lease a system is among the least important system installation and ownership features.¹⁸ Furthermore, financial analysis suggests that if the system owner is able to finance the PV system through a mortgage, or even a long-term home equity loan, the purported financial advantages of leasing disappear, due to the relatively higher financing costs of leasing companies.¹⁹ However, with no PV leasing programs currently in place – Pennsylvania initially explored the possibility of implementing a leasing arrangement, but has not yet identified a leasing company willing to take on and administer the program – it is difficult to say whether actual experience will reflect the findings of market research.

7. *Niche Markets:* As an alternative to supporting the broad market for PV, several funds have targeted niche applications where the technology creates economic or other value and where sustainable markets are perhaps readily achievable without substantial ongoing incentives.

Green buildings, which gain public relations benefits from incorporating PV, represent one such market, and have been targeted by both Massachusetts and Pennsylvania. New construction represents another niche market: PV systems can potentially be installed more

¹⁸ Regional Economic Research, August 2000, *Market Research for Emerging Renewable Technologies*, California Energy Commission, P500-00-025.

¹⁹ See E. Jones and J. Eto, September 1997, *Financing End-Use Solar Technologies in a Restructured Electricity Industry: Comparing the Costs of Public Policies*, LBNL-40218, Berkeley, California: Lawrence Berkeley National Laboratory.

cost-effectively when incorporated into the design and construction of new buildings than when retrofitted to existing buildings. Targeting new construction may also enable volume discounts from bulk purchases. One facet of Massachusetts' proposed buy-down program would target new construction, while Astropower, one of the three manufacturers funded by NYSERDA to develop distribution channels for their products, has teamed up with residential developers in California to provide entire neighborhoods of solar homes.

Other examples of niche markets include PV-powered outdoor lighting systems (funded by Rhode Island), PV-powered traffic control signs (funded by Pennsylvania), building-integrated PV (funded by NYSERDA), and off-grid or other "high-value" PV applications (also funded by NYSERDA). Niche market applications for PV are being explored jointly through the Clean Energy Funds Network: a report from the Stella Group was released in March 2002.

8. *Feasibility Studies:* Sometimes the first major hurdle facing larger commercial PV systems is finding the resources to investigate whether or not a project is feasible. Through a solicitation for green power predevelopment financing, Massachusetts has awarded a \$128,415 grant to the City of Brockton to assess the technical and financial feasibility of developing 5 to 10 MW of grid-connected PV on two brownfield sites within the city.
9. *Green Tags:* The proliferation of both regulated and competitive green power markets creates new opportunities to support PV. One such opportunity

involves green power marketers purchasing "green tags" that represent the generation from customer-sited grid-connected PV systems. Marketers can then lay claim to the PV generation and re-sell it as part of a green power product. As discussed earlier, the Energy Cooperative Association of Pennsylvania is in the process of implementing such a program in conjunction with the SDF's buy-down program.

III. CONCLUDING REMARKS

With roughly 24 MW of PV supported through buy-down programs and potentially half as much supported through alternative methods (depending on how feasibility studies, equity investments, and infrastructure-building activities are counted), state clean energy funds have devoted substantial funding in support of PV.

While the electricity crisis of 2000/2001 has revitalized some buy-down programs that had previously under-performed (namely California), the effect has not been universal: programs in the Northeast, for example, have not seen much of an increase in activity.²⁰ Furthermore, it remains to be seen whether or not the recent demand surge in California is sustainable: Figure 1 shows

²⁰ For example, Rhode Island reportedly has not seen much of a pickup, despite doubling its incentive level to \$3/Watt at the beginning of 2001. Similarly, although LIPA's program fared better in 2001 than in 2000 (when only 1 non-lottery system was installed), LIPA still felt compelled to double its buy-down incentive from \$3/W to \$6/W (for a limited time – 8 months only) in December 2001, and give away another 30 systems as a way to publicize the program and boost participation.

a noticeable dip in reservations over the last two quarters.²¹

With many consumers only recently becoming aware of PV as a viable residential option, however, it is still too early to draw conclusions about the relative successes of buy-down programs versus other forms of support, particularly given the limited sample of alternative approaches and the extended time frame in which they frequently operate. Only over the next few years, as clean energy fund programs come up to speed and begin to move PV from the fringe into the mainstream, will it be possible to make a more informed judgment of the merits of one approach versus another.

In the mean time, continued informed experimentation, with an eye towards lessons learned from the successes and failures of the past, is warranted. To that end, the following table offers a number of opportunities for cooperation and coordination among the funds, aimed at enhancing the learning process, and ultimately the success of future funding support for PV.

Opportunities for CEFN Coordination

This report suggests that there are at least four broad areas where state clean energy funds interested in supporting PV could benefit from joint work – education and infrastructure building, project coordination, joint research, and information sharing.

Education and Infrastructure Building: Since the message embedded in education and awareness raising activities is likely to be the same no matter where a fund is located, funds can avoid duplicative efforts and leverage their dollars by collaborating on effective educational campaigns. Likewise, training and certification programs for PV installers could perhaps be most cost-effectively developed and implemented through a regional or national effort (note: such efforts are currently underway). Finally, for those funds involved in regulatory affairs, advocating for regional or national interconnection standards and net metering provisions could have a large impact.

Project Coordination: Coordinated and standardized regional buy-downs could enable a broader market for PV and avoid situations where all marketing activity gravitates towards the state with the highest incentive level. Multi-fund project coordination could also present opportunities for “sustained orderly development and commercialization” through bulk purchase commitments. State funds may wish to investigate alternative vehicles to exploit these opportunities, such as aggregations of state funds or the creation of new facilities to pool customer demand through buying aggregations.

Research Questions: What types of funding (e.g., buy-downs, project-based solicitations) are least/most valuable to PV vendors and installers? What approaches are working/not working in other states and countries? What niche markets for PV might make attractive targets for state clean energy funds? What are the appropriate metrics to judge program success or failure? These questions deserve continued investigation and joint discussion.

Information Sharing: Greater transparency in the number and size of funded systems would allow more thorough analysis of program performance; web sites are a convenient medium to share such information. For those funds monitoring system performance, sharing any resulting concerns over equipment performance or installation procedures could prevent other funds from experiencing similar problems.

²¹ Perhaps indicative of a larger trend, at least one high-profile provider of solar home systems – Green Mountain Energy – has suspended its marketing of PV systems in California.