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September 2002

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CASE STUDIES OF STATE SUPPORT FOR RENEWABLE ENERGY

The Use of Capital- and Performance-Based Buy-Down Programs for PV in California, Pennsylvania, and Massachusetts

Mark Bolinger and Ryan Wisler, Berkeley Lab

CASE SUMMARY

Case Description

As one of the first states to implement a system-benefits charge funded buy-down program for photovoltaics (PV) and other customer-sited renewable technologies, California has set the standard for other states to follow. Eleven states now offer capital-based buy-down programs in one form or another.

This case study focuses on only three of these programs: California, which has had the most success in stimulating the installation of large amounts of PV capacity, and Pennsylvania and Massachusetts, whose programs are just getting underway yet deserve mention because of their innovative incorporation of performance-based incentives into a standard buy-down program.

Innovative Features

- The California Energy Commission's (CEC) buy-down program, which provides a capital-based incentive of

\$4.50/W for up to 50% of installed system costs, has met with significant response in recent years. Concerns have been raised, however, that the CEC's program may not provide adequate incentives for system performance, that it has not driven significant PV cost reductions among small systems, that its buy-down payment levels are high, and that it might not lead to sustainable markets for PV once the subsidy is removed.

- Pennsylvania and Massachusetts have designed programs that seek to overcome one of these shortfalls by awarding a portion of the incentive based on system performance. Pennsylvania's program awards \$3/W at installation, and then pays both the system owner and installer a smaller performance-based incentive at the end of one year. Massachusetts awards 70% of a \$5/W incentive up front, and pays out the remaining 30%

based on system performance over three years.

- Massachusetts is also targeting geographically clustered installations in an attempt to minimize programmatic and system costs.

Results

- Over \$80 million in support of 21 MW of PV has been reserved under the CEC's program, with 9 MW already installed. 1.1 MW of small wind has also been reserved, with 500 kW installed so far. Furthermore, another 16.5 MW of PV capacity has been reserved under the CPUC's self-generation program

(\$4.50/W for PV systems between 30kW and 1 MW). This aggregate reserved volume of 37.5 MW of PV is impressive considering the relatively small size of the PV market domestically and abroad, and shows that buy-down programs can significantly increase demand for PV in both the residential and non-residential sectors.

- Modified buy-down programs in Pennsylvania and Massachusetts demonstrate how funds can support PV using performance-based incentives, though it is too early to judge the success of these programs.

CASE STUDY DETAILS

Buy-down programs, which provide capital grants to "buy down" the initial cost of photovoltaics (PV) and other customer-sited renewable technologies such as small wind, 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, provide a relatively stable incentive over time that encourages PV manufacturers and installers to market their systems and plan for expansion, and have the potential to provide quick and tangible results that may, over time, drive reductions in PV costs. At the same time, some have criticized capital-based buy-down programs as being expensive and doing little to encourage system performance or create sustainable markets once the subsidies decline or disappear.

As one of the first states to implement a system-benefits charge 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. At this time, California, Delaware, Illinois, Massachusetts, Minnesota, Montana, New Jersey, New York, Pennsylvania, Rhode Island, and Wisconsin either offer or are in the process of implementing buy-down programs. See

Bolinger and Wiser (2002) for information on all of these programs.

In this case study, however, we limit our coverage to just three states: California, which has had considerable success in stimulating the installation of large amounts of PV (and small wind) capacity, and Pennsylvania and Massachusetts, whose programs are just getting underway, yet deserve mention because of their innovative incorporation of performance-based incentives into a standard buy-down program. We begin by examining the successes (and potential shortcomings) of the California Energy Commission's (CEC's) program, and then describe how Pennsylvania and Massachusetts are attempting to innovate on the CEC's approach. We note that the "quality assurance" aspects of these and other PV programs (other than the use of performance-based incentives, which is discussed here) are described in a separate case on quality assurance for PV systems.

California

The \$54 million allocated to the CEC's Emerging Resources Account over the program's first 4 years (from March 1998-March 2002) was to be used to buy down the capital cost of customer-sited renewable facilities that offset some portion of the

customer's load. Qualifying "emerging" technologies include CEC-certified photovoltaic systems, solar thermal electric systems, fuel cells utilizing renewable fuels, and small (<10 kW) wind turbines, though in practice over 90% of all reservations have been for PV. Though eligible systems are not limited in size, at least 60% of the funds must be awarded to systems of 10 kW or smaller, and another 15% is reserved for systems rated at 100 kW or less.

Consistent with the idea that production costs should decline as demand and volume increase, the funds were initially distributed sequentially in five blocks of decreasing value (see table below). Once all the funds in a block were committed, the next block offering a lower subsidy would become available.

Block	1	2	3	4	5
Total Funds (million)	\$10.5	\$10.5	\$10.5	\$10.5	\$12.0
Max \$/W Rebate	\$3.0	\$2.5	\$2.0	\$1.5	\$1.0
Max Rebate as % of Cost	50%	40%	30%	25%	20%

Source: CEC Guidebook for Emerging Renewable Resources Account

In mid-2001, however, the CEC abandoned this declining block structure and implemented a flat \$4.50/W buy-down up to 50% of installed costs (i.e., an increase of \$1.50/W over the first and most lucrative block). This abrupt shift was in response to indications that anticipated cost reductions had not occurred (at least among small systems), and concerns over the potential effect that a lower incentive would have on system sales at a time when California needed all the extra generation it could get (i.e., due to the electricity crisis, which peaked in the winter of 2000/2001). At around the same time, funding for the program was increased from \$54 million to \$100 million, with the vast majority of new funding going to small systems (<10 kW).

The graph below shows the number of system reservations received by the CEC in each quarter of the program's history. Several caveats are in order:

- The data include all eligible technologies, including PV, small wind, and fuel cells using renewable fuels. More than 90% of

all reservations, however, are for PV systems.

- The graph combines reservations for small (<10 kW), medium (10 – 100 kW), and large (>100 kW) systems, and is therefore not a good representation of trends in *capacity* reserved under the program, since a few large projects could represent as much capacity as thousands of small projects.¹
- Funding for medium and large projects was depleted in the fourth quarter of 2001, and will not be restored until the 5-year implementation plan of the Renewable Energy Program is approved by the state legislature. It is likely, therefore, that reservation requests in 2002 include only small systems,² with medium and large systems pursuing incentives through the

CPUC's self-generation program instead (see next bullet).

- The data represent only the CEC's buy-down program, and not other state or municipal programs. For example, in mid-2001, the California Public Utilities Commission (CPUC) implemented a statewide "Self-Generation Program", which offers, among other incentives, a \$4.50/W incentive (up to 50% of system costs) for customer-sited PV installations of between 30 kW and 1 MW. Through June 2002, 112 PV projects totaling 16.5 MW of capacity

¹ For example, through the end of 2001, the program had 22 active reservations for large projects totaling more than 7 MW, compared to 3,454 active reservations for small projects totaling about 10 MW.

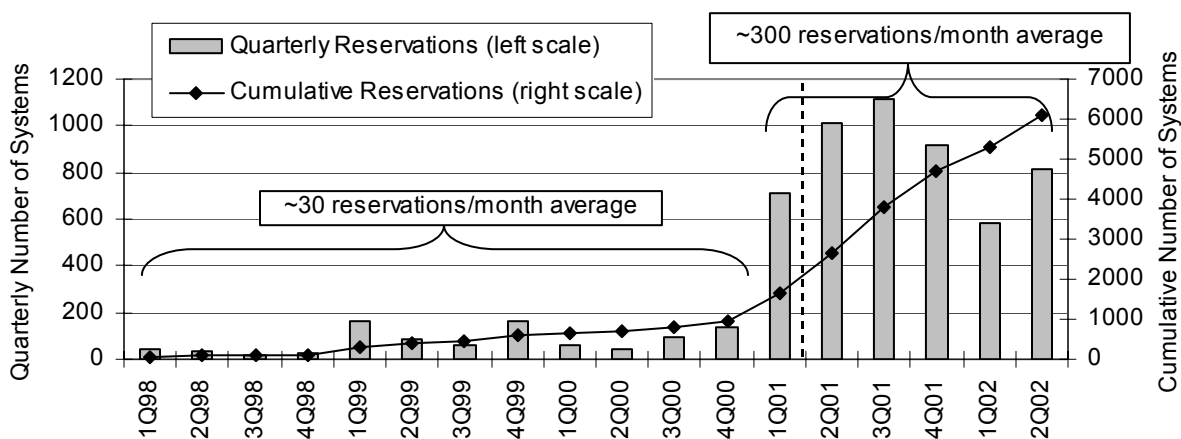
² As there have been only several hundred reservations for medium and large systems since the program's inception (though, again, for a large amount of capacity), the depletion of funding for such systems likely does not drastically alter the appearance of the graph, which is based on the number of projects rather than the amount of capacity.

were actively reserved under the CPUC's program; these projects are not represented by the graph.

According to the CEC, grid-tied 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). While this represents a 30-fold increase, the pace of reservations during these first 3 years was nevertheless below expectations for the program: small systems (<10 kW) never made it out of Block 1, while large systems languished in Block 2 after having quickly exhausted Block 1 funding.

- the increased marketing efforts of solar suppliers.

While the first bullet (above) likely played a large role in motivating the residential sector,³ it is possible that the commercial sector was motivated more by the second two bullets: the increase in the buy-down level from \$2.50/W (remember that commercial systems had migrated to Block 2 prior to the elimination of funding blocks) to \$4.50/W, and the complementary expansion of net metering and elimination of standby charges. Increased marketing by solar suppliers also played a role. Though new system reservations showed signs of tapering off during the winter of 2001/2002 (concurrent with the electricity crisis fading



Source: CEC Quarterly Reports to Legislature

Since the beginning of 2001, however, system reservations have jumped to almost 300 systems per month on average, presumably the result of:

- the severity of the state's electricity crisis, along with extensive media coverage and state consumer awareness campaigns targeting distributed generation solutions;
- the increase in the buy-down level from \$3 to \$4.5/Watt;
- the implementation or expansion of several other policies, including a new state solar tax credit, a temporary expansion of net metering per-project size limits from 10 kW to 1 MW, and the elimination of utility standby charges; and

from the public's memory),⁴ the rebound in the second quarter of 2002 is encouraging, and implies that the crisis may have brought about a fundamental shift in consumer awareness of and attitudes towards PV.

³ The jump in reservations during the first quarter of 2001 was not influenced by the increase in the buy-down level, which, as depicted by the dashed line in the graph, did not occur until April (and was then made retroactive to February).

⁴ Again, note that some of the decline in reservation activity at this time may have been due to the depletion of funding for medium and large systems, and the likely migration of any new reservations for such systems over to the CPUC's self-generation program. However, as explained in footnote 13, this impact should be small.

To date, over \$80 million in support of 21 MW of PV has been reserved (with 9 MW already installed) under the CEC's buy-down program, while another 16.5 MW remain active in the CPUC's Self-Generation Program.⁵ Large systems (>10 kW) account for roughly three quarters of the combined 37.5 MW of PV capacity reserved through these two programs, proving that buy-down programs can be an effective medium for supporting large-scale customer-sited systems.⁶ These are impressive numbers given the relatively small size of the domestic and global PV markets: roughly 20 MW of PV were installed in the US in 2000 (~300 MW globally), bringing cumulative installed capacity to roughly 140 MW (>1,000 MW globally). The sheer volume of planned installations in California has attracted a number of infrastructure investments to the state; for example, three major PV manufacturers – Sharp, Schott Applied Power, and Shell – have located manufacturing facilities in California to better serve the strong in-state market, and one manufacturer/installer of large systems (PowerLight) reports having tripled the size of its workforce within the past year or so. Thus, in terms of stimulating both the supply and demand sides of the market, California's buy-down program has clearly been a success.

Certain other aspects of California's program, however, leave room for improvement:

- **Small System Underperformance:** Monitoring of selected small (<10 kW) PV systems installed under the CEC's program revealed that – unbeknownst to the system owners – AC output was on average one-quarter to one-third below that expected on the basis of module ratings (based on PVUSA Test Conditions) and inverter efficiencies (RER 2000). This “quality

⁵ Meanwhile, 1.1 MW of small wind systems have been reserved under the CEC's program, with 500 kW on line.

⁶ Along with California, New Jersey's experience also demonstrates that very large systems do participate in buy-down programs, contrary to the concerns of some policymakers who fear that buy-down funding devoted to large systems will remain idle.

assurance” problem is discussed in more detail in a separate case study.

- **Minimal Cost Reductions for Small Systems:** The CEC's October 2000 preliminary evaluation of the first two years of California's buy-down program estimates that installed costs for medium and large systems (i.e., those > 10 kW) declined by \$2.10/Watt, but *small systems showed virtually no reduction in costs* (RER 2000). Since then, anecdotal evidence suggests that total system costs, at least for small systems, may have actually *increased* as the surge in buy-down activity in 2001 taxed the existing manufacturing and installation infrastructure to its maximum capacity, leading to supply bottlenecks and higher costs.
- **High Incentive Level:** California's buy-down remains high, having been increased by 50% (more for larger systems) in response to both the electricity crisis and evidence that small system costs had not materially declined. An increase of this magnitude, combined with limited PV cost reductions among small systems, calls into question the ability of this program to create a sustainable market for PV in the absence of incentives.

Pennsylvania and Massachusetts have recently announced buy-down programs that attempt to improve upon one aspect of California's program by tying a portion of the incentive payment to system performance. While both of these programs are too young to have any meaningful results, we briefly describe them as potentially useful innovations on California's program.

Pennsylvania

The Sustainable Development Fund's \$4 million PV program in PECO's service territory, which debuted in December 2001, provides a \$3/W buy-down payment (up to \$6,000) to system owners upon inspection and approval of installed systems of between 1 and 5 kW. After the first 12 months of operation, the system owner receives a *second* payment of \$1/kWh (up to \$2,000), and the *installer* receives a payment

of \$0.10/kWh (up to \$250).⁷ These delayed, performance-based payments create an incentive for both the owner and installer to ensure that the system is operating at peak performance.

Of course, performance-based incentives (as well as system monitoring) also 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). Though likely minimal, this requirement does add some extra cost to the system. Furthermore, the need to verify system output in order to award performance-based incentives adds to the overall administrative cost of the program.

In addition to offering "carrots" to both the owner and installer, 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 at that site (optimal production is determined using NREL's PVWATTS program in combination with Solar Pathfinder). With only a few staff, the SDF has opted to outsource the administration of this program at a cost of \$80,000.

Though innovative, this program has gotten off to a slow start. As of May 2002, only 3 applications had been approved, with another 4 in the works. SDF is having better luck, however, outside of its buy-down program: a total of 168 kW of PV is currently in the pipeline at 2 commercial sites and 2 low-income residential developments. Strong commercial interest is perhaps not surprising given California's experience, which demonstrates that non-residential customers may be very motivated to take advantage of PV incentives.

⁷ For a 2 kW system, the \$1/kWh one-year production incentive roughly equates to an extra \$1/W up-front incentive, bringing the aggregate incentive to roughly \$4/W. This incentive level places Pennsylvania squarely in the middle of the range among funds offering buy-down incentives, which vary from roughly \$2/W to \$6/W.

Massachusetts

Massachusetts recently unveiled its Solar-to-Market Initiative, part of which includes a buy-down program that is partially performance-based. Specifically, 70% of a \$5/Watt incentive will be paid up-front, with the remaining 30% paid down quarterly over three years at a rate of \$0.38/kWh. The rate of \$0.38/kWh is based on an assumed 15% capacity factor over 3 years. If the actual capacity factor exceeds 15%, the system will earn the full performance-based incentive (capped at 30% of \$5/W) in less than 3 years, whereas if the actual capacity factor is less than 15%, the system will not earn the full performance-based portion of the incentive.

Another innovative feature of this program is that it will target geographically clustered installations in an attempt to reduce program and system costs through concentrated marketing activities, system standardization, volume purchases, clustered installations, and coordinated interconnection and permitting. This program – which is more a targeted solicitation rather than a standard "open-to-all" buy-down program – could even help shore up weak areas of the grid.

Other elements of the Solar-to-Market Initiative include:

- An "open installations program" (solicitation not yet released), which will resemble the "clustered installations program" described above, except that it will not require clustering and will provide lower incentive levels for new buildings than for existing (based on the assumption that PV retrofits are more expensive than incorporating systems into new buildings).
- A production and tracking contractor, funded to track and provide documentation of performance for production payments. A total of \$300,000 has been budgeted for this effort.
- Installer training and certification, perhaps collaborating with national efforts underway.
- A loan fund to be used by PV companies for technology development and business expansion.

In addition, administrative aspects of the Solar-to-Market Initiative are covered in a separate case study. As this initiative is still in the

solicitation phase, there are no results to report at this time.

ORGANIZATION AND CONTACT INFORMATION

Tim Tutt
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814-5512
<http://www.energy.ca.gov/>
Ttutt@energy.state.ca.us
(916) 654-4590

Roger Clark
The Sustainable Development Fund
Cast Iron Building, Suite 300 North
718 Arch Street
Philadelphia, PA 19106-1591
<http://www.trfund.com/sdf>
clarkr@trfund.com
(215) 925-1130

Sam Nutter
Massachusetts Technology
Collaborative
75 North Drive
Westborough, MA 05181
<http://www.masstech.org/>
nutter@masstech.org
(508) 870-0312

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Personal communication with: Nils Bolgen (MTPC) and Roger Clark (SDF)

Comments provided by: Kari Smith (PowerLight)

ABOUT THIS CASE STUDY SERIES

A number of U.S. states have recently 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 Group, under the auspices of the Clean Energy Funds Network. 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 brief 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.

Twenty-one total case studies have now been completed. Additional case studies will be distributed in the future. For copies of all of the case studies, see:

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The Clean Energy Funds Network (CEFN) is a foundation-funded, non-profit initiative to support the state clean energy funds. CEFN collects and disseminates information and analysis, conducts original research, and helps to coordinate activities of the state funds. The main purpose of CEFN 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 CEFN, while Berkeley Lab provides CEFN analytic support.

CONTACT THE MANAGERS OF THE CASE STUDY SERIES

Ryan Wisner

Berkeley Lab
1 Cyclotron Rd., MS90-4000
Berkeley, CA 94720
510-486-5474
rhwisner@lbl.gov

Mark Bolinger

Berkeley Lab
1 Cyclotron Rd., MS90-4000
Berkeley, CA 94720
510-495-2881
mabolinger@lbl.gov

Lewis Milford

Clean Energy Group
50 State Street
Montpelier, VT 05602
802-223-2554
lmilford@cleanegroup.org

FUNDING ACKNOWLEDGEMENTS

Berkeley Lab's contributions to this case study series are funded by the Assistant Secretary of Energy Efficiency and Renewable Energy of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098. The Clean Energy Group's contributions are funded by the Energy Foundation, the Surdna Foundation, the Rockefeller Brothers Fund, and the Turner Foundation. An earlier version of this case study was prepared for the Energy Trust of Oregon, and we appreciate the vision of the Energy Trust – and Peter West in particular – for initiating this work. We also thank Larry Mansueti and Jack Cadogan of the U.S. Department of Energy for their ongoing support.

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