# GOVERNMENT BUYDOWNS FOR THE RESIDENTIAL MARKET

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## I. INTRODUCTION

A buydown may be defined broadly as any incentive that effectively reduces the cost of acquisition, operation, or ownership of a technology. An even broader definition might encompass tax credits, tax deductions, accelerated depreciation, and the elimination or forgiveness of sales or property taxes. But in this paper, we define buydowns narrowly: a government-funded cash rebate or other cash subsidy that effectively reduces the cost of acquiring new technology.

Buydowns for new technologies can be configured in a great number of ways and can be characterized based on several parameters:

- *The duration or length of time the buydown will be available.* A buydown can be available for a period as short as 1 year to as long as several years. It can even become "permanent."
- *How the amount or size of the incentive is calculated*. The incentive can be calculated as a percentage of capital costs or instead specified in some other way (e.g., an amount per Watt of system output or per kilowatt-hours (kWhs) of electricity produced).
- *Whether the payment level is constant over the entire existence of the incentive, or will change over time, most typically by declining in some predictable manner*. Changes in buydown level can be tied to the calendar or fiscal year so that time is the determinant of how fast the incentive will be phased out. Alternatively, changes can be linked to specified amounts of funds expended, to the number of systems or kilowatts (kWs) of capacity sold, or to some number of cumulative kWhs produced. In the latter cases, the buydown level would change as a function of market response.
- *To whom the payments are made.* Payments can be provided to manufacturers to affect wholesale prices, or instead provided to retailers or customers to influence retail prices more directly.
- *The timing of payments*. Payments can be provided in one lump sum paid prior to, at the time of, or sometime after the sale of the PV system, or instead made in predetermined annual installments or periodic payments based on a specific measure (e.g., kWhs produced).
- *The manner in which payments are made*. One approach is for buydown payments to manufacturers or retailers to be provided in blocks of funds or in blocks of kWs of equipment,

with distribution based presumably on some competitive bidding process. Another approach is to award buydown payments to individual systems on a first-come, first-served basis.

- *The basis for determining incentive levels*. If the initial acquisition costs are the basis for determining the incentive amount, then which of the various component costs and costs of installation or sales taxes are included or excluded can vary. Likewise, only systems of certain sizes or used in certain applications might be eligible for the incentive or might attract more incentives.

Clearly there are a great number of ways to structure a buydown program. Many of these arrangements will likely not contain an effective combination of features. In the discussion that follows, we focus on only the few buydown arrangements that have actually been tried in California and elsewhere to date. The reader should keep in mind, however, that there are almost certainly variations on these programs that might be more desirable to a particular legislative or regulatory body—and which also could be effective if structured and implemented properly.

# II. CALIFORNIA'S BUYDOWN PROGRAM FOR EMERGING RENEWABLE TECHNOLOGIES

## A. Origins of California's Buydown Program

In September 1996, the California legislature passed Assembly Bill No. 1890 (AB 1890)—a groundbreaking law that comprehensively restructured the state's electricity industry.[1] One of the mandates of AB 1890 was that the state of California collect funds from electricity customers to support public purpose programs—including renewable generation. Specifically, AB 1890 required California's three largest investor-owned utilities to collect $540 million from their customers over 4 years to support electricity generation using existing, new, and emerging renewable technologies.

AB 1890 also required the California Energy Commission (CEC) to make recommendations to the California legislature with respect to allocating the $540 million using market-based mechanisms. The CEC issued its report in March 1997,[2] and its recommendations were adopted by the California legislature in Senate Bill No. 90 (SB 90)—essentially an implementing statute for the original restructuring legislation.[3]

SB 90 specified that the $540 million collected from electricity customers should be placed into a Renewable Resources Trust Fund and contained explicit guidance for distributing the funds through four separate accounts:

- an Existing Renewable Resources Account,

[1]California Assembly Bill 1890 (enacted September 23, 1996).

[2]California Energy Commission, *Policy Report on AB 1890 Renewables Funding,* CEC Pub. No. 500-97-002 (Sacramento, Calif.: March 1997).

[3]California Senate Bill 90 (enacted October 12, 1997).

- a New Renewable Resources Account,
- a Customer-Side Renewable Resource Purchases Account, and
- an Emerging Renewable Resources Account.

The Senate bill required that *10% of the $540 million Renewable Resources Trust Fund—$54 million—be allocated to the Emerging Renewable Resources Account* for a multiyear, consumer-based program to foster the development of emerging renewable technologies in distributed generation applications. SB 90 defined eligible emerging renewable technologies to include the following four technologies:

- solar-thermal electric systems,
- photovoltaics (PV),
- small wind turbines of not more than 10 kW rated capacity,
- fuel cells utilizing renewable fuels.

In addition, the California Senate bill specified the following requirements for the Emerging Renewable Resources Account:

1. Funding for emerging renewable technologies shall be provided through a competitive, market-based program.
2. The program for emerging renewable technologies shall be in place for a period of at least 4 years.
3. The program for emerging renewable technologies shall provide monetary rebates, buydowns, or equivalent incentives to purchasers, lessees, sellers, or lessors of eligible renewable generating systems.
4. Incentives under the program for emerging renewable technologies shall be based on the rated capacity of the generating system.
5. The incentive amount shall be limited to a maximum percentage of the generating system's cost.
6. The amount of the incentive shall decline over the term of the emerging renewable technologies program.
7. Portions of the incentive funds for emerging renewable technologies shall be allocated for smaller generating systems of specified sizes.

## B. Design and Implementation of California's Buydown Program

In discussing the California Emerging Renewables Buydown Program as a model for what might be accomplished on the federal level or by other states, it is important to emphasize the role of the California PV Alliance in developing the program.

The California PV Alliance is a loosely organized stakeholder group consisting of PV manufacturers, retailers, and installers, as well as representatives of interested utilities and environmental organizations. It is similar to the 14 state chapters of Photovoltaics for Utilities (PV4U) currently organized around the United States.

The California PV Alliance originated the concept of a PV buydown program by consensus among its members. Then, the fall of 1996, in response to the passage of California Assembly Bill 1890 (AB 1890), the California PV Alliance presented a proposal for a PV buydown program to the California Energy Commission. Members of the alliance were instrumental in having the buydown concept amended into California Senate Bill 90 (SB 90) as California's Emerging Renewables Buydown Program.

With SB 90 providing the basic features of the Emerging Renewables Buydown Program, the task of designing the details and implementing the buydown program was left to the California Energy Commission. The commission held a series of public forums, workshops, and hearings at which California PV Alliance members and others were able to provide valuable feedback and advice to commission staff. California Energy Commissioners heard testimony on implementation details and ultimately approved the proposal developed by the staff. This process—involving interactions between industry representatives and other stakeholders of the California PV Alliance with the legislative and administrative bodies of the state—culminated in the issuance of guidelines for California's Emerging Renewable Technologies Buydown program in January 1998.

The model for developing California's Emerging Renewables Buydown Program is a useful model for the development of buydown programs in other states. A buydown program should have "buy-in" from the affected industries, and the parameters should be adopted for a buydown program should help ensure the program's success.

Following the approval of the guidelines for California's Emerging Renewable Technologies Buydown program, the California Energy Commission prepared and published the *Guidebook for the Renewable Technology Program*, with each of four volumes corresponding to one of the Renewables Resource Trust Fund accounts. The third volume, covering California's Emerging Renewables Buydown Program, included 19 pages of text, a glossary, plus sample forms for reserving reservations and claiming buydown funds.[4] The guidebook was made available to the public by telephone, fax, e-mail, regular mail, and the Internet.

Several complex issues came up during the final design of California's buydown program. Some of these issues, which are discussed below, took months to resolve through negotiations among the stakeholders and deliberations among the California Energy Commissioners.

### *1. Parameters of California's Emerging Renewables Buydown Program*

Although the California legislature (in AB 1890 and SB 90) decided how much money would be allocated to the California's Emerging Renewables Buydown Program, it left decisions about the level

[4]California Energy Commission (CEC), *Renewable Technology Program Guidebook, Volume 3: Emerging Renewable Resources Account*, CEC Pub. No. P500-97-011V3 (Sacramento, Calif., January 1998).

of buydown payments, and how they change over time, up to the California Energy Commission. The commission decided on five tiers, or blocks, of buydown funding, with $10.5 million in each of the first four tiers and $12.0 million in the fifth (see Table 1). It set the maximum buydown per Watt of system output at $3/Watt in the first tier, declining $0.50 per tier to $1/Watt in the final tier.

Because California's Emerging Renewables Buydown Program includes multiple technologies with a range of initial capital costs, a buydown based solely on dollars per Watt of system output might provide excessive stimulation to lower capital cost technologies, such as wind or fuel cells. For this reason, the California Energy Commission also decided on a maximum buydown amount as a percentage of eligible system cost, set at 50% for the first tier and declining to 20% in the fifth tier.

One of the key decisions that the California Energy Commission made was that the tiers would *not* be tied to a calendar year or any other specific time frame. Instead, each block of funds would be made available until exhausted, independent of the 4-year time frame over which the funds are collected. This approach allows the marketplace—not the calendar or the fiscal year—to dictate the rate at which the buydown levels decline.

Finally, it should be noted that although the various values found in the table below meet the requirements of SB 90 delineated above, they can all be reviewed and adjusted in the future to ensure program success, since these values were selected by the California Energy Commission rather than specified in law.

**Table 1: Parameters of California's Emerging Renewables Buydown Program**

| Program parameter | Tier 1 | Tier 2 | Tier 3 | Tier 4 | Tier 5 | TOTAL |
|---|---|---|---|---|---|---|
| Total buydown funds (millions) | $10.5 | $10.5 | $10.5 | $10.5 | $12.0 | $54 |
| Maximum buydown per Watt of system output | $3.00 | $2.50 | $2.00 | $1.50 | $1.00 | na |
| Maximum buydown as a percentage of eligible system cost | 50% | 40% | 30% | 25% | 20% | na |
| Minimum system capacity bought down by the program (kilowatts) | 3,500 | 4,200 | 5,250 | 7,000 | 12,000 | 32,000 |

### *2. Imposition of Warranty Requirements*

The final program guidelines for California's Emerging Renewables Buydown Program required all retailers receiving a buydown payment to provide a "full 5-year warranty" to the purchaser against breakdown or degradation of output. Although PV module (i.e., solar panel) manufacturers have routinely provided warranties of 10 to 20 years, the "balance of system" (BOS, including inverters, etc.) components and the system installation have short or no warranty coverage. Thus, the requirement of a full 5-year warranty for the entire PV system was much stricter than anything the PV industry historically had been providing.

We regard the requirement for a 5-year warranty as a perfect example of a government leveraging the use of public funds to force an emerging technology toward maturity. Full warranties with longer terms are common for comparable consumer products, such as large appliances, but the PV industry has been hesitant about adopting stringent requirements. Yet, the California warranty requirement has already had the intended effect: Retailers, who are now required to provide these stricter warranties, are asking the manufacturers whose equipment they sell to match their warranties to the California standards. In effect, California's buydown is forcing manufacturers to strengthen and lengthen their product warranties.

Moreover, because the manufacturers are unlikely to offer different warranties in different states, the stricter warranties required in California are likely to be available to customers in other states. We see this as a positive development, reflecting the maturing of the industry to more closely resemble other, more established consumer product manufacturers. The change has resulted in some tension between PV retailers and manufacturers, however, and there are some lingering uncertainties regarding the interpretation of California's warranty requirement.

### *3. Certification of Components or Systems*

The California Emerging Renewables Buydown Program has imposed quality-control requirements for PV components and may eventually impose standards on entire PV systems. Currently, for instance, all PV modules and inverters must be certified by a nationally recognized testing laboratory (such as Underwriters Laboratories) as meeting established wiring and fire safety standards. In the future, the California Emerging Renewables Buydown Program may "raise the bar" still higher by also requiring that PV modules—or perhaps the entire generating system—be certified as meeting nationally or internationally developed performance standards.

In addition, the California Emerging Renewables Buydown Program requires that only an appropriately licensed contractor or the purchaser install PV systems covered by the program. The contractor or purchaser must install the system in conformance with manufacturers' specifications and applicable electrical codes and standards. It is possible that the California Emerging Renewables Buydown Program will impose specific certification standards for PV installers if relying on state contractor licensing proves inadequate. Again, these conditions are likely to have the effect of forcing the PV industry toward maturity.

## C. Status of California's Buydown Program

California's Emerging Renewables Buydown Program appears to be off to a good start in increasing the level of private investment in grid-connected PV systems. The program began accepting applications on March 20, 1998. Within the first month, purchasers of PV applications had reserved more than $3.5 million in buydown funds.[5] This amount represents 1,268 kW of peak generating capacity and approximately $11.5 million in PV sales.

Most of the maximum of $4.2 million available in the first tier for projects larger than 10 kW was quickly consumed in the first month by two large (greater than 100 kW) and 11 medium-sized (10- to

[5] Another $2.4 million had been reserved by purchasers of fuel-cell systems, which also are eligible for the California Emerging Renewables Buydown Program. These funds will support the installation of three fuel-cell projects using methane from sewer plants, with a combined total generating capacity of 1,000 kW.

100-kW) PV projects. For the smaller (under 10 kW) PV systems, only $275,000 representing 31 systems was reserved in the first month. Under the rules, a minimum of 60% of program funds are reserved exclusively for small systems; this would represent over 1,000 2-kW systems in the first tier alone.

As of August 13, 1998, essentially all of the first tier ($3/Watt) funds for medium and large projects had been reserved with the addition of several more medium-sized projects; however, less than 7% of the tier-1 funds for small systems had been reserved. The breakdown of the reservations for PV systems under California's Emerging Renewables Buydown Program as of August 13, 1998, is shown below in Table 2.

**Table 2: Summary Statistics for PV Systems under California's Emerging Renewables Buydown Program as of August 13, 1998**

| | Program Reservations of Funds: Blocks 1 and 2 | | |
|---|---|---|---|
| **Size of system** | **Dollars** | **Kilowatts (Peak)** | **Number of systems** |
| Small system (< 10 kW) | 363,693 | 121 | 41 |
| Medium system (10 to 100 kW) | 1,306,263 | 438 | 11 |
| Large system (> 100 kW) | 2,000,000 | 738 | 2 |
| **TOTAL** | **3,669,956** | **1,297** | **54** |

The early results are encouraging for medium and large PV projects. The program has stimulated over 1,600 kW in just its first few months. On the other hand, the results also indicate that the program goal of stimulating large numbers of small system sales—and the industry infrastructure that will result from these sales—will take longer to achieve.

That stimulating sales of smaller systems will take longer to achieve is not surprising. The most fundamental changes in the way the PV industry designs, fabricates, markets and installs its products must be made precisely in the area of small system sales. There are early positive signs of this evolution—several PV manufacturers are moving towards offering standardized sizes of small PV systems and are beginning to mass-market such systems.

## D. Initial Results with California's Buydown Program

As of late 1998, the California Emerging Renewables Buydown Program had been in place for only a few months of its expected 4-6 year life. Conclusions regarding the eventual scope and effects of the program would be premature. Nonetheless, the initial results with the program support some interesting observations:

- *PV system costs reported on buydown reservation forms vary dramatically—in fact, across a much wider dollar range than the initial buydown amount of $3/Watt.* Among the first 54 PV system sign-ups, costs (before the buydown) ranged from below $6/Watt to approximately $19/Watt. The low end of this range typically reflects sales which have also benefited from other incentives, for example awards through the Technology Experience to Accelerate Markets in Utility Photovoltaics (TEAM-UP) program. The high end reflects sales of smaller systems sold the way off-grid systems have typically been sold, i.e., as custom designed, one-of-a-kind systems. It is hoped that as the pace of small system sales increases, especially as the result of the new design, integration and marketing approaches being developed by some firms, typical system prices will tend towards the $6/Watt range.

- *PV system costs reported on buydown reservation forms were generally lower for the largest system, higher for midsize systems, and even more expensive for small systems.* Of the five PV systems over 30 kW, one had the lowest cost at under $6/Watt; three had costs of $6-$8/Watt; and one had a cost of about $9/Watt. On the other hand, costs for midsize (10-kW to 30-kW) PV systems were generally higher, with none of these reported orders coming in below $8/Watt and six of seven coming at $10/Watt or higher. Smaller (between 2-kW and 10-kW) PV systems generally came in at $6-$10/Watt—and the systems under 2 kW were more expensive; only two of the smaller systems had costs below $10/Watt, and there was wide distribution of costs up to the most expensive systems at approximately $19/Watt (see Figure 1 and Table 3). Given the limited time California's Emerging Renewables Buydown Program has operated and the limited number of systems sold, it is too early to tell if the intent of the program—to reduce retail prices to as low as $3/Watt by the end of the program—will be realized.

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**Figure 1: California's Emerging Renewables Buydown Programs: System Cost vs. System Size**

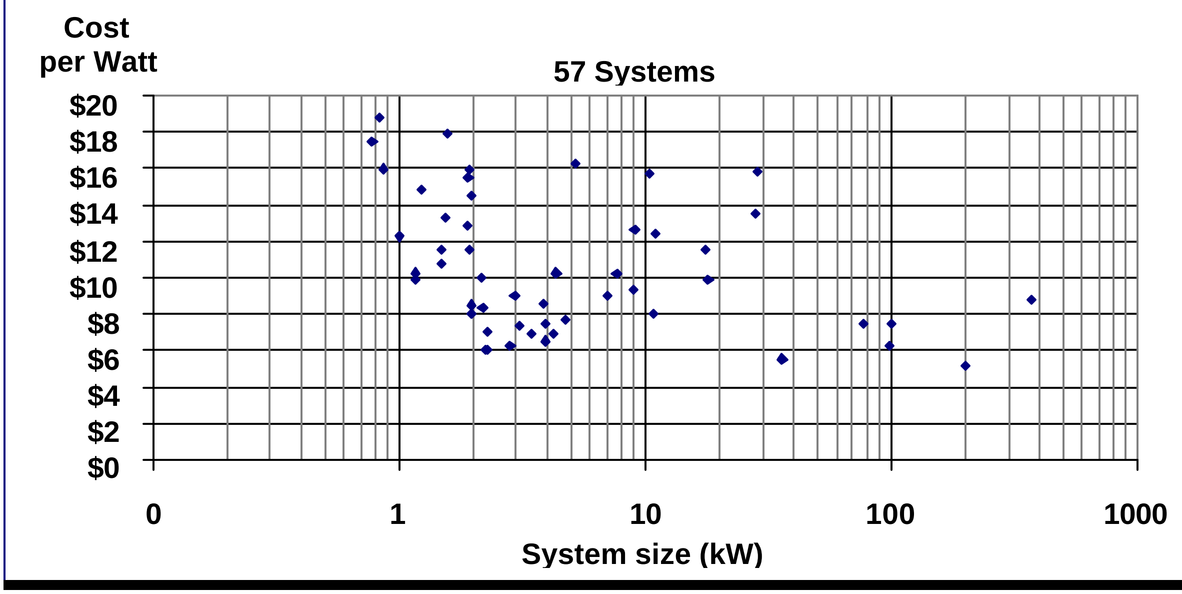



**Table 3: California's Emerging Renewables Buydown Program: Average System Cost vs. System Size**

| | Smallest systems (2 kW or less) | Small systems ( 2.1-10 kW) | Mid-sized systems (10.1- 50 kW) | Large systems (50.1-100 kW) | Largest systems (100 kW or more) |
|---|---|---|---|---|---|
| Number of systems | 18 | 19 | 8 | 3 | 1 |
| Average cost | $13.40 | $8.80 | $11.60 | $7.20 | $8.80 |

SOURCE: Derived from California Energy Commission, Figure 2: CEC Graph—System Cost Versus System Size.

## III. BUYDOWN MODELS IN OTHER COUNTRIES AND STATES

Although the California Emerging Renewables Buydown Program has attracted the most attention among PV incentive programs in the United States, other countries including Japan and Germany, as well as states other than California, have adopted or are considering adopting buydown programs of their own. Some of these are discussed below.

## A. Japan's Buydown Program for PV Systems

Starting in 1994, the Japanese government offered buydowns for rooftop PV investments. It combined these buydowns with low-interest consumer loans and a large consumer education and marketing program to increase awareness of PV technology and the buydown opportunity. The number of grid-connected rooftop PV systems in Japan has skyrocketed in recent years as a result of the country's national buydown program.

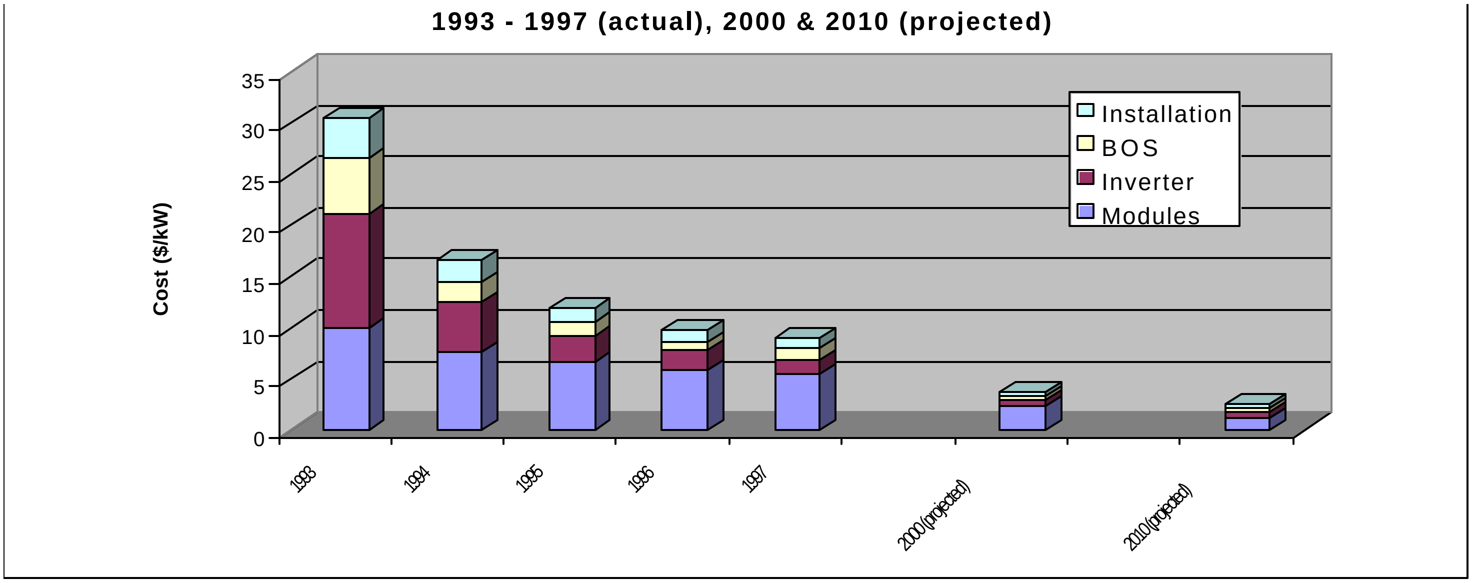
In contrast to California's program, Japan's program makes blocks of funds available to PV system retailers in a competitive bid program. The buydown amount is 50% of the system cost, and the amount of buydown has decreased rapidly from over $13/Watt in 1994 down to $3.75 in 1997. The result has been over 36 megawatts (MW) installed since 1994, including approximately 20 MW during 1997 alone. To put these figures in perspective, total worldwide PV production during this period averaged about 100 MW. The California program is expected to produce orders for about 30 MW over its entire lifetime.

An important question is whether Japan's buydown program has successfully driven down the price of PV technology. Recent evidence suggests that it has. The cost of PV systems installed under the Japanese Ministry of International Trade and Industry's (MITI) rooftop program has declined from 1993 to 1997 (see Figure 2).

In addition, Japan is making substantial commitments to PV beyond the rooftop program. Field tests for public and industrial applications, financial support for new industries investing in PV, marketing and promotional efforts, and local government support will add another 13.1 billion yen ($109 million).[6]

As a result of its efforts, Japan now leads the world in the development of grid-connected PV technology. Its success is the direct result of a conscious policy to promote PV technology, both for reasons of national energy security (Japan imports almost all of its fossil fuels) and for reasons of economic development (Japan seeks to dominate PV manufacturing in the same way it dominates consumer electronics manufacturing).

[6]Tom Jensen, Photon International, personal communication, Irvine, Calif., Aug. 4, 1998.




## B. Germany's Incentive Rate Program for PV Systems

Germany has also used government policies to trigger a tremendous expansion in the number of grid-connected rooftop PV systems; however, the mechanism Germany has used is very different from that used in the California and Japanese buydown programs.

In Germany, many municipally owned utilities throughout the country have separately approved a small utility tax—typically 1% of the customer's bill—and funds collected via this utility tax are placed into an account used to pay back residents of the municipality who buy rooftop PV systems. The funds are paid out not as a one-time, lump-sum buydown on the initial PV system cost, but rather as a per-kWh premium over many years.

The per-kWh premium is very substantial, ranging from 1 deutsche mark (DM) to 2DM ($0.70 to $1.40), depending on the municipality. At this rate, German customers recover their investments in rooftop PV systems in approximately 10 to 12 years. As in Japan, incentive rate programs in Germany have combined financial incentives with low-interest consumer loans and a consumer education and marketing campaign.

The adoption of incentive rate programs by increasing numbers of municipalities in Germany has led to an explosion of the grid-connected PV market there. According to Robert Johnson of Strategies Unlimited, annual market volume increased from 100 kW in mid-1995 to over 2 MW in mid-1996.[7] By 1997, cumulative capacity was up to 7 MW, with approximately 4 MW installed during 1997 and an additional 11 MW projected for 1998.[8]

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[7]Robert O. Johnson, "PV Industry Overview, Domestic & International," *Conference Proceedings, Utility PhotoVoltaic Group Annual Utility PV Experience Exhibition & Conference* (Mountain View, Calif., October 1996), p. 32.

[8]This information is from Howard Wenger, AstroPower Inc., "Distributed Generation & Regulatory Reform: Grid-Connected PV as a Case Study," presented at the National Association of Regulatory Utility Commissioners (NARUC) Summer Meetings, Seattle, Wash., July 1998; and Tom Jensen, Photon International, personal communication, Irvine, Calif., Aug. 4, 1998.

## C. Other U.S. Models: State and Federal Programs

In the United States, no states have enacted buydown programs similar to California's Emerging Renewables Buydown Program, so there is currently no basis for comparison between the California program and programs in other states.

- Massachusetts has established a system benefit charge (SBC) as part of its state utility restructuring legislation that will provide $150 million for renewable energy over the next 5 years and about $20 million in each subsequent year. There are indications that at least part of the money in Massachusetts might be used for a buydown program, but the details are just beginning to be worked out.[9] Other states may establish similar programs as they go through the restructuring process, but it is too early to predict.

- The Clinton Administration has released its draft electricity restructuring bill, entitled the Comprehensive Electricity Competition Act.[10] Section 301 of the draft bill would establish a public benefits fund to support, among other things:

  > . . . the development and demonstration of an electricity generating technology that the Secretary determines is emerging from research and development, provides environmental benefits, and [either] has significant national commercial potential, or provides energy security or generation resource diversity benefits.

  PV technology would likely meet all of these requirements. The specified target level for the proposed public benefits fund is $3 billion—an amount that would be raised by a per-kWh charge levied on electricity generated under the jurisdiction of participating states and tribal governments. The fund would be administered by a joint federal-state board. Participating governments would submit requests to the board for matching funds for up to 50% of the governments' expenditures on eligible public purposes programs. The public benefit fund would operate for 15 years. The proposed public benefits fund, if enacted, would provide substantial additional support for state buydown programs. A federal match for California's program, for example, could support twice the PV buydown volume, or approximately 64 MW over 5 years.

# IV. ANALYSIS OF GOVERNMENT BUYDOWN PROGRAMS

## A. Rationale for Government Buydown Programs

Supporters of government buydown programs for new technologies cite two major rationales for their use:

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[9]The Massachusetts State Legislature appointed the Massachusetts Technology Collaborative to administer the new Renewable Energy Initiative. The Technology Collaborative selected the firm Arthur D. Little to analyze markets and technologies for the fund and Bain & Company to develop a strategic plan for the use of the fund. See the *Photovoltaics for Utilities Program (PV4U) Monthly Memorandum*, June 1998.

[10]The text of the draft bill is available on the U.S. Department of Energy (DOE) website at http://www.doe.gov/ceca/ceca.pdf.

- One rationale—which is perhaps the most widely acknowledged one—is that short-term subsidies such as buydowns will lower the net cost of the technology to consumers, thus leading to increased market demand, which in turn will encourage manufacturers to increase production to levels that capture new economies of scale. Such subsidies are needed to address a "chicken and egg" dilemma of technology commercialization: Increased production volumes are needed to capture economies of scale in manufacturing the technology, but increased production volumes are precluded by the high initial cost of the technology.

- A second rationale for buydown programs—focusing less on the technology and more on the institutional setting in which new technologies are commercialized—is that early sales of a new technology help overcome institutional barriers, encourage the development of appropriate infrastructure, and generally pave the way for later adoption by a broader market. This rationale is particularly appropriate for technologies whose commercialization depends on integration within complex technical or regulatory systems. The electricity industry is complex both technically and from a regulatory standpoint.

### *1. Capturing Economies of Scale in Manufacturing*

A 1992 paper on structural issues in PV commercialization, written by Michael Lotker of Siemens Solar Industries, stated as one of its key assumptions that "the current and expected PV market will not be sufficient to lead to production volumes necessary to reduce PV prices to the point where grid-connected systems are cost effective."[11] Lotker went on to explain:

> In making this assumption, we reject the likelihood that a scientific breakthrough will lead to significant price reductions without large production volume increases in the next 5-10 years. We further conclude that the levels of early cost-effective applications are not sufficient to allow manufacturers to commit to significant increases in the level of PV production. While we do not know which PV technology will be the lowest cost technology in the long run, we do know that in order to achieve and sustain prices competitive in utility-grid-connected applications, large-scale production will be needed.[12]

Although the report in which Lotker made these statements is 6 years old—nearly an eternity in the evolution of the PV industry—the PV industry continues to face the "chicken and egg" dilemma that Lotker described: how to make the grid-connected PV market reach the production volumes necessary to capture substantial economies of scale in manufacturing. Simply put, PV equipment manufacturers need higher production volumes to reduce costs, but manufacturers cannot justify expanding production volumes because the early markets won't support higher volumes at current costs.

The way out of this dilemma, according to various industry followers, is to stimulate PV market demand at a high enough volume and for a long enough time that manufacturers can justify increasing production in response. Once these higher production volumes are reached, the theory goes, the corresponding costs will be low enough that the higher production volumes will be self-sustaining.

[11] Michael Lotker, "A Structure for Commercialization of Utility Scale Photovoltaic Systems," *PV for Utilities State Working Group Handbook* (Camarillo, Calif.: Photovoltaics for Utilities, 1992).

[12] Ibid.

The corresponding question, of course, is how to stimulate market demand to support higher production levels. And the most frequent answer suggested by industry followers is a large and sustained buydown program. Denis Hayes, former director of the Solar Energy Research Institute and long-time champion of PV commercialization efforts, has said that the model for this kind of market stimulus is the semiconductor industry. In the 1960's, Hayes notes, computer chips were far too expensive for general uses that could benefit the public, but massive government purchases—mostly by the U.S. Department of Defense and the National Aeronautics and Space Administration—led to design innovations and to efficiencies of mass production. As prices fell, large commercial markets for computer chips emerged.[13]

The most obvious application of this model in the PV industry is the Japanese PV commercialization program, described earlier in this section. Although English-language materials describing the rationale (as opposed to the results) of the Japanese program are scarce,[14] it seems clear that Japan's motivation for spending over $100 million a year on its subsidy program is at least in part to stimulate higher production volumes at correspondingly lower prices.[15]

California had a similar motivation for using AB 1890 funds to support emerging technologies. In its *Policy Report on AB 1890 Renewables Funding: Report to the Legislature*, the California Energy Commission said that one criteria used to justify supporting the emerging technologies program would be "that the funding of such technology will produce cost reductions in the technology or sufficient California market potential such that the technology will be competitive without further financial assistance at the end of the AB 1890 support period."[16]

Other PV industry followers have used this rationale to support sustained buydown programs. Robert H. Williams has proposed a "Grand Bargain" for commercializing renewable electric technologies in China that calls for a rapid buildup in renewable generating capacity to narrow the gap between prices for renewable energy technologies and prices for conventional energy technologies. Williams favors a buydown approach "because the product offered by RETs [renewable energy technologies] (electricity) is a commodity, for which profit margins are inherently thin, so that commercialization

[13]The Bullitt Foundation, *1997 President's Report: Climate Change & Solar Energy: Lessons from the Computer Revolution* (available on the Web at http://www.bullitt.org/presiden.htm). Denis Hayes is now the president of the Bullitt Foundation, based in Seattle, Wash.

[14]Robert Johnson, of Strategies Unlimited, has said that the Japanese program "addresses the multiple objectives of becoming pre-eminent in the production of photovoltaics, providing an energy alternative for a national largely without domestic sources, and reducing the impact of global warming." Robert O. Johnson, "PV Industry Overview, Domestic & International," *Conference Proceedings, Utility PhotoVoltaic Group Annual Utility PV Experience Exhibition & Conference* (Mountain View, Calif., October 1996) , p. 29.

[15]A 1994 paper by representatives from the Solar Energy Department at Japan's New Energy and Industrial Technology Development Organization stated: "Breaking through this [cost] barrier can be done when the Japanese government introduces a nationwide policy to stimulate the installation of photovoltaic power generation systems to bring about a extended [sic] use, which will lead to mass-production of the system, and thereby to reduced production cost and price." Koshi Nakagawa and Hiroshi Katsumata, "Arranging Social Circumstances for Spreading Photovoltaic Power Generation Systems," *Conference Proceedings,1994 IEEE First World Conference on Photovoltaic Energy Conversion* (Waikaloa, Hawaii, 1994), p. 2364.

[16]California Energy Commission, *Policy Report on AB 1890 Renewables Funding: Report to the Legislature* (Sacramento, Calif.: March 1997), p. 33.

incentives offered by the public sector are needed to launch the technologies in the market."[17] Williams suggests that governments buy down the price of PV systems to $3/Watt and that the buydown be combined with a renewable portfolio standard or U.K.-style non-fossil fuel obligation to encourage only the most competitive technologies.

Denis Hayes has similarly proposed a major government buydown as the favored mechanism for lowering the cost of PV technology.[18] Hayes has called for a $5-billion federal program to buy PV systems over 5 years, with the government offering $1 billion in subsidies each year at a price 20%-25% below the previous year. A smaller program will not work, Hayes argues, because it will lack the leverage to dictate swift price reductions. According to Hayes, PV module manufacturers are content to manufacture small volumes of PV modules at high profit margins, and large incentives will be required to encourage the module manufacturers to substantially increase production.

Hayes also argues that substantial annual reductions in the target price are necessary and appropriate because in the PV industry prices are being set by the highest-cost manufacturers (with lower-cost manufacturers content to reap excess profits rather than sharply increase production volumes). The price targets mean that only low-cost manufacturers will be able to compete, and that they will have the market to themselves. Any other approach, Hayes argues, is "just contributing to the profit margins of 10-year-old assembly lines." His analogy is that "[w]e need solar Intels, not solar Chryslers."[19] Finally, Hayes emphasizes that the goal of a large-scale purchase program is to capture economies of scale. As he puts it:

> When large-scale purchases lower the price of a product, the change is permanent. Unlike tax credits and other legislated loopholes, economies of mass production cannot be repealed. Part of the beauty of this computer chip strategy is that, after a few years, no additional government action would be needed. If no company steps forward to sell solar cells at those prices, the program will not cost taxpayers a cent. But if some companies are willing to meet the challenge, it will be the best bargain taxpayers have had since the GI bill.[20]

Although the proposals outlined here vary significantly in the details of implementation, they share a common idea: The best approach for overcoming the "chicken and egg" problem of increasing production volumes to decrease costs is to heavily subsidize the cost of PV purchases over a relatively short period; this approach will permit manufacturing economies that will lead to permanent price reductions in PV technology.

## *2. Encouraging Early Adoption and Overcoming Institutional Barriers*

Although the high cost of PV is almost certainly the primary obstacle to broader commercialization of the technology, there are other obstacles. The other obstacles include barriers that are typical of those

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[17] Robert H. Williams, "Proposed Grand Bargain for Commercializing Renewable Electric Technologies in China," unpublished paper, Princeton University, Princeton, N.J., February 1998.

[18] The Bullitt Foundation, *1997 President's Report: Climate Change & Solar Energy: Lessons from the Computer Revolution* (available on the Web at http://www.bullitt.org/presiden.htm).

[19] Denis Hayes, The Bullitt Foundation, Seattle, Wash., personal communication, July 26, 1998.

[20] Bullitt Foundation, *1997 President's Report.*

encountered by early adopters seeking to use new or emerging technologies that have to operate within a complex, networked system.

One PV equipment manufacturer reports that roughly four out of five potential customers who understand the economics of PV but are still willing and able to pay the price for a PV system end up abandoning their efforts out of frustration over unanticipated obstacles. Most of the problems stem from a lack of familiarity with PV technology among utilities, building code officials, insurers, lenders, and others whose cooperation and approval is needed to install and operate even the smallest-scale generating facilities. These individuals and institutions tend to be wary of new technologies, particularly technologies that seem to represent a radical change. Self-generation using PV technology clearly falls into this category.

Early adopters of new technologies play a key role in overcoming these institutional obstacles. Because they are motivated to invest in new technologies by non-economic factors—including a sense of adventure, curiosity, responsibility, or prestige—early adopters are more willing than the general public to bear the costs of being pioneers. These costs may include higher prices, poorer quality, and lower reliability than later generations of product. Early purchasers of consumer electronics—ranging from the first calculators in the early 1970s to the first digital wireless telephones in the mid 1990s—have been willing to pay the price for being "first on the block."

Consumer electronics are not the best analogy to PV, however, because they are typically stand-alone products whose purchase and integration does not require involvement in a complex regulatory regime. A better analogy to PV is the early adoption of competing telecommunications providers, or more recently electricity providers, as those markets were initially opened to competition. Individuals who chose MCI or Sprint as their long-distance provider in the early years after the AT&T divestiture were accepting the risks of technical failure but were also accepting the risks of regulatory and administrative failures.

These problems have been compounded for early purchasers of grid-connected PV systems. In the case of long-distance telephony, MCI and Sprint took on the responsibility for challenging AT&T's exclusionary practices and anticompetitive behavior; these challenges were tremendously expensive but were essentially transparent to the customer. In the case of grid-connected PV systems, by contrast, the purchasers of individual systems have themselves faced the challenge of wary—or openly hostile—utilities and local governments, whose engineers and inspectors are reluctant to embrace a new technology, particularly when it poses a potential threat to their traditional businesses.

In short, early adopters of PV pave the way for later adopters by breaking through the barriers raised by institutions that are either unaware of the technology or uninterested in encouraging its proliferation. The first customer to ask her utility for a copy of the requirements for interconnecting a rooftop PV system may find that the requirements do not exist—or more likely that the requirements are the same as those for interconnecting a 500-MW cogeneration facility, since the utility has little incentive to spend the time to develop simpler requirements, just as they have little incentive to encourage the development of PV technology to begin with. This customer is likely to face roadblock after roadblock, from the utility, from the local electrical inspector, from her insurance company, and from her mortgage finance company. The second customer is likely to find it easier, and the third easier still.[21] As the number of inquiries climbs, however, the approving entity sooner or later must acknowledge the need to streamline the process, in order to reduce their own transaction costs associated with processing the customer requests. This is the point the PV industry needs to reach—the point at which utilities see the need to develop standard form contracts, and local governments start training their building inspectors to recognize proper wiring of PV systems.

Buydown programs such as California's are certain to play an important role in overcoming institutional barriers that have held up the broader commercialization of grid-connected systems. Overcoming these barriers is, quite simply, a numbers game. Before this year, the number of grid-connected PV systems in California—excluding utility research, development, and demonstration (RD&D) projects— probably numbered around a dozen. In its first 5 months, the buydown has resulted in over 1,600 kW of planned additions. At least three companies—AstroPower, BP Solar, and Green Mountain Energy Resources—are implementing marketing plans that target residential customers in California.

It seems likely that even if the California Emerging Renewables Buydown Program is only modestly subscribed by residential customers, at least 500 residential- and commercial-scale systems will be connected to the California utility grid by the end of 1999. Those customers will be paving the way for the next generation of customers by working through a common set of issues with their local city or county building inspectors, their utilities, their contractors, their insurers, and their loan officers. Resolving these issues is largely a matter of experience, complicated by the existence of multiple parties and interests. Some of these parties have a strong interest in spurring PV commercialization, while others are indifferent, and still others are hostile but acting under legal compulsion. In any case, there is simply no substitute for the efforts of these early adopters, with their willingness to tackle barriers and obstacles that the general public would not tolerate.

## B. Concerns about Buydowns and Other Subsidies

Analysts skeptical of large-scale government subsidy programs such as government buydown programs raise three concerns. One is that subsidies such as buydowns can skew the market for a technology in inappropriate ways. A second is that governments have a poor record of picking technology winners and losers, and should not use buydowns to do this. And third is that the marketplace may perceive buydowns as transitory and resist the investment necessary to achieve the expected economies of scale.

### *1. Subsidies as Market Signals: Now You See Them . . .*

The principal argument against government subsidies for direct consumer purchases is that subsidies skew the market in a manner that provide short-term incentives but ultimately prove to be destabilizing. The renewable energy industries are particularly sensitive to this issue because of past "boom-and-bust" cycles caused largely by the sudden availability of financial and tax incentives,

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[21] This assumes that the utility (or other entity whose approval is needed) has interest in learning from its earlier experiences; if the goal is to continue making life as miserable as possible for the customer seeking to interconnect, the utility may conveniently fail to learn these lessons. One PV provider told us that his utility voluntarily waived its onerous technical requirements for PV interconnection, but only on a case-by-case basis and at its discretion. His conclusion was that the utility wanted to be able to fall back on the more onerous requirements if the PV market started to accelerate.

followed by their equally sudden repeal. For the wind industry, the boom came in the early 1980's, when generous federal and state tax credits and accelerated depreciation benefits, combined with other financial and regulatory incentives[22] succeeded in spurring billions of dollars of private investment in California "wind farms." The bust came in 1986, with the expiration of these federal and state tax credits. Frequent reports of abuse of these credits may have led to a loss of governmental support for renewing investment tax credits for wind energy. Annual capacity additions—which peaked at 485 MW in 1985—dropped to 240 MW in 1986 and 154 MW in 1987.[23] Although the wind industry has continued to grow worldwide, the California market for wind energy is a shadow of its former self.

The solar-thermal electric industry suffered a similar boom and bust. Luz International's solar parabolic trough systems were a symbol of the success of the Public Utility Regulatory Policies Act of 1978 (PURPA) through the 1980's, with over 350 MW of generating capacity installed in California's Mojave Desert. Because the technology was so land-intensive, however, the economic viability of the Luz systems depended on the continued availability of a California property tax exemption. The tax exemption was being renewed on a year-to-year basis in a highly politicized environment, creating havoc for the company's efforts to secure investment funding for the following year's capacity additions. Finally, in 1992, the company was forced into bankruptcy when the California Governor's failure to sign promptly a tax exemption passed the by Legislature prevented the company from securing investment funding in time to meet its financial obligations.

The solar water heater industry suffered through similar problems, which the industry attributed to financial incentives creating a market stimulus that the industry's infrastructure—still in its infancy—was unable to absorb. The chief result was quality control problems both in manufacturing and installation, which took their toll on the market in ensuing years when system failures rates were high enough to discourage customers from investing in the technology. The expiration of tax credits in 1985 also created a "cliff" in sales from which the industry is still recovering.

In our view, there are three lessons to be learned from these prior renewable energy incentive programs:

- ***Once governments make a commitment to support the commercialization of a renewable technology—whether through tax policy or other means—maintaining continuity is essential to the success of the program***. The problem with many of the renewable energy incentives offered during the 1980s is that they were vulnerable to political forces, frequently on an annual appropriations cycle. There obviously were devastating effects when the incentives were eliminated, but there also were adverse effects even when the incentives were ultimately continued, because the uncertainty meant that the industries and their investors tended to discount the incentives by an amount corresponding to the perceived probability that the incentives would be eliminated. This uncertainty was particularly hard on manufacturers, who were understandably wary of investing in new factories and facilities

[22] Also influential were California's own tax credits, the California Public Utility Commission's favorable interpretation of Public Utility Regulatory Policies Act's (PURPA) avoided-cost requirements, and the requirement that utilities offer "standard contracts" for the purchase of power.

[23] Thomas A. Starrs, "Legislative Incentives and Energy Technologies: Government's Role in the Development of the California Wind Energy Industry," *Ecology Law Quarterly*, Vol. 18, No. 1 (1988), p. 109.

when there was some likelihood that the demand would drop out from under them. But it was also hard on system vendors, whose retail customers tended to be very responsive to the incentive programs, rushing to make investments when there was a threat of non-renewal, and holding off on purchases when there was a possibility of new incentives being offered.

- ***There is a need for varying or adjusting the amount of the incentive in a renewable energy incentive program over time***. Even incentives that are in place for a period sufficient to permit the marketplace and industry to respond appropriately can still cause unintended negative consequences on the very industries they were intended to help. This is often the case when an incentive is set at one fixed level of benefit and then terminates abruptly, such as the tax credits of the early 1980's. Maintaining a constant level of benefit will probably mean that this level is the right level only for a limited period. If the program succeeds it means that prices should fall, so the level of incentive that was needed to induce customers to buy one year may be overly generous the next. Similarly, when the incentive finally expires, businesses see a rush of orders to take advantage of the incentive followed by a dearth of orders immediately after expiration. This cliff in new sales can be devastating on small businesses. For example, many solar retailers in California went out of business the year after the state and federal tax credits expired in 1985. The solution to such volatility is to include a phased decline of the incentive over the life of the program. This will give potential customers incentives to buy sooner rather than later if the incentive is greater at the beginning. It also weans the industry and the marketplace off of the incentive and reduces the extent of any sales discontinuity when the incentive ceases.

  In short, any buydown program should, if at all possible, adopt a long-term, sustained approach with appropriate phasing out over time. This approach should give manufacturers the confidence they need to justify new infrastructure investments, and let purchasers know that with the continuity in the program there is no need to either rush in or hold off. The implementation of the California Emerging Renewables Buydown Program reinforces these points by providing both positive and negative examples. On the positive side, the generous allocation of buydown money for the small-scale (under 10 kW) systems, coupled with no time limits on the availability of these funds, meant that there was essentially no threat that the first tier of funds (at $3/Watt) would be quickly exhausted. The result was that companies have had a chance to take their time in developing marketing campaigns and refining product offerings without the threat of losing out on the most generous tier of funds. The end result is likely to be stronger product offerings. On the other hand, the relatively small allocation of buydown funds for large systems (greater than 100 kW), in proportion to the size of buydown a single project could receive (up to $1 million), posed a threat that the first tier of funds for these large systems would quickly disappear. The result was a rush to sign up for those funds, which were reserved by five large projects within the first few days the funds were made available.[24]

- ***Making generous financial incentives available without addressing structural and institutional concerns is likely to detract from the effectiveness of renewable energy incentive programs.*** The chief structural concern is whether the industry has the ability to respond effectively to a sharp increase in demand. For emerging technologies with historically

[24]The five projects included three fuel-cell systems totaling 1,000 kW and two PV projects totaling 738 kW.

small markets, financial incentives that strongly stimulate demand can cause tremendous stress at all levels of the market, from manufacturers to distributors and retail vendors.

The institutional concerns are essentially the “early adopter” issues raised earlier in this paper. PV systems must be integrated into the electrical network, with implications for safety, power quality, and reliability that transcend the individual PV system and affect others on the network. Each institutional entity that has authority over the design, installation, or operation of the PV system must be brought along as a participant in the process of scaling up the integration of the technology. This means utilities must have standardized interconnection agreements in place; energy service providers must have ‘net metering’ or other purchase and sale contracts ready to sign; cities or counties must have electrical inspectors who are trained to inspect the wiring and components of a PV system; and bankers. Realtors, and insurers all have to recognize the value of a PV system on a residential rooftop in order for the market to respond appropriately.

One might think that the best solution to institutional immaturity would be to publicly announce an incentive program, but delay the startup of the program for an appropriate period of time to allow the industry to anticipate the increase in demand and be prepared for it. This might be fine for cases where there are no pre-existing markets.

However, if there is already some fledgling market for the PV applications supported by the incentives, this approach could have the unintended consequence of making potential customers wait until the incentive starts, thus robbing the industry of the sales needed to survive in the interim. In cases were there is already some established market for a technology intended to be stimulated by the incentive, it is best to minimize the time between the enactment of incentive programs and their actual beginning. In the case of the California buydown program, the enabling legislation (Senate Bill 90) was enacted on October 12, 1997, and the buydown program had all its details worked out, guidelines adopted, and its door open for business on March 20, 1998—less than 6 months later. To speed implementation of a buydown program, proponents should be mindful of securing any needed authority to enact all necessary regulations or guidelines in an expeditious manner.

To avoid “overstimulation” of the industry due to the initiation of a new incentive, it may be desirable to ramp-up the amount of incentive in the early years of a program. Again, by way of an example, the California Buydown Program divided its funds into five roughly equal blocks so that each block or tier could provide a level of incentive that would decline over the course of the program. This also means mathematically that each block or tier will also stimulate a larger amount of sales (see Table 1). Thus, the program can slowly increase the number of megawatts of sales it will stimulate. This approach can provide time for the industry to ramp-up its production, installation and marketing capabilities. It can also permit more time for any structural or institutional problems or roadblocks to be removed, such as having the utilities establish their net metering and interconnection standards. The program should minimize the number of potential sales and customers who might be frustrated or delayed by institutional shortcomings.

## 2. Picking Winners: Governments as Fortune Tellers

A second argument advanced against buydowns or other government subsidies for particular technologies is that governments have a poor history of choosing technologies that ultimately prove to be winners in the marketplace.

The most obvious—and controversial—example is the commercial nuclear energy industry, which has been heavily supported and subsidized since the 1950's, when the federal government decided to avoid the demonization of nuclear technology by seeking peaceful uses for the tremendous forces associated with the conversion of mass to energy. But a half-century later, in spite of the federal government's efforts, the nuclear energy industry faces serious problems. Utilities in the United States have canceled or indefinitely deferred plans for more than 100 nuclear power plants since the early 1970's, and since 1978 have ordered no new commercial reactors.[25] Although concerns about global climate change and atmospheric pollution from fossil-fueled power plants may revitalize the nuclear power industry, it seems equally plausible that the industry may die on the vine.

A more ambiguous case of the government favoring (or disfavoring) particular technology options occurred with the development of wind turbine technology following the Carter Administration's National Energy Act in 1978. The National Energy Act called for federal research, development, and demonstration (RD&D) support for wind turbine technology, which was implemented through U.S. Department of Energy (DOE) grants to prominent aerospace firms, including Boeing, General Electric, Grumman, and Westinghouse. This effort focused on the development of large, multi-MW wind turbines, culminating in Boeing's 3.2-MW MOD-5B machine, with its 320-foot rotor and near-supersonic blade tip speeds. None of these prototype turbines performed well; and within a decade, all of the prototype turbines had been decommissioned and dismantled. More to the point, none of these turbines attracted the interest of wind energy developers, who felt that the large turbines were too complex and too expense for commercial operation at that time.

Meanwhile, other components of the National Energy Act—specifically the Public Utility Regulatory Policies Act of 1978 (PURPA)—and the Energy Tax Act paved the way for private investment in wind energy projects that would be entitled to interconnect and sell their power to utilities at pre-determined (and often favorable) rates. This effort almost failed as well, as entrepreneurial wind developers struggled to find wind turbines manufacturers who were able to produce efficient and reliable designs. One prominent wind development company installed half a dozen different turbines, none of which performed well, and was struggling financially when it discovered a Danish wind turbine that was well suited to the wind regime at the company's Tehachapi, Calif., properties. The success of this turbine, coming on the heels of previous failures, helped turn the company around and contributed significantly to its becoming the second largest wind energy development company in the United States. What is important is that all early windfarms were built with the wind turbines available at the time, which were in the 25- to 200-kW scale, not the multi-MW scale wind turbines favored by government RD&D programs.

Of course, many factors contribute to the success and failure of different wind turbine technologies. For our purposes, however, the interesting point is that the federal government and the private

[25] Dan W. Reicher, "Nuclear Energy and Weapons," *Sustainable Environmental Law* (St. Paul, Minn.: West Publishing Co., 1993), p. 966.

entrepreneurs took very different approaches to choosing among wind turbine technologies, and that private firms successfully developed the market for wind energy in spite of—and perhaps because of—their rejection of the large-scale technology the federal government had chosen to support so early in the development of this technology.

The cases just cited have interesting implications for expanding PV markets. There are, in our view, three basic issues:

- Should government incentives favor or single out a specific renewable technology, such as PV, or should incentive programs encompass all or a number of renewable technologies?
- Should buydown programs favor a particular subtechnology within PV, such as amorphous silicon or cadmium telluride?
- Should buydown programs should favor a particular scale of PV systems or particular types of PV applications?

While the answers to these three questions depend on complex issues and the particular goals and intentions of the program developers, we feel that the answer to the first question is a qualified "YES," to the second question a qualified "NO," and to the third question a qualified "YES."

### a. Picking a Particular Technology for Favorable Treatment

The first question is whether buydowns, or other incentive programs, should be limited or focused on a single renewable technology—solar, wind, biomass, etc.—or somehow opened to all renewables to compete against each other. This question generally is not an issue for programs with unlimited resources, such as tax credits, or sales and property tax exemptions. In these circumstances, there is little reason to preclude any desirable technologies. However, where the incentive is a cash buydown or rebate, or even a portfolio standard, and the amount of incentive funds are limited, great caution must be taken before combining multiple technologies in a competitive situation within a single program.

Within a single technology, there are typically multiple subtechnologies, all vying to see which will ultimately produce the cheapest power and win out in the marketplace. This competition among subtechnologies is desirable and constructive, because regardless of which subtechnology eventually prevails, society will have the benefit of at least one commercial method of using a particular renewable resource to produce electricity sustainably.

It is important to note, however, that expecting immature technologies, which include all renewables today, to compete directly on the basis of *today's costs*—not their ultimate or future costs—is a dangerous and difficult proposition. Although programs that provide an equal level of incentive to all technologies may appear to be "fair" and market based, this equality towards all clearly favors the current low cost technologies, not the technologies that might someday be the lowest cost. Such competitions also ignore the fact that a sustainable energy future will require a mix of technologies in the appropriate combinations, not just today's lowest cost renewables.

To provide a sustainable energy future, we will probably need to harness widespread energy resources, such as solar or wind energy, in combination with "on-demand" energy resources, such as hydroelectric, geothermal, or biomass. Pitting these renewable technologies against each other today for incentive dollars is premature and shortsighted. We may ultimately need them all, not just some subset that are today's low-cost leaders.

An analogy might be the transportation industry early in this century. Today with hindsight we may recognize the need for a blend of cars (for individual transport); buses, light rail and subways (for mass transportation); rail and trucking (for transport of goods); and airplanes (for long-distance transportation). Although the federal government did not take the step of enacting a single incentive program to encourage all of these forms of transportation in their infancy, as some would advocate today for renewables, it can be argued that various past government programs have collectively provided unbalanced incentives that heavily favored only certain forms of transportation (i.e., cars, trucks, and airplanes at the expense of mass transit or rail) to the present detriment of our country.

There are two options for such multi-technology competitions: 1) provide tiers, bands, or set-asides for particular technologies; or 2) set different levels of incentives for different renewable technologies.

In the first approach, bands or tiers essentially convert one program into multiple programs targeted at individual technologies, or at least at smaller, more compatible, subsets of renewable technologies. This creates de facto separate programs for different technologies.

The second approach can produce more serious problems. If different incentive levels are set within a "one pot" program, great care must be taken to achieve the right ratios of incentives between the technologies. If the ratios stray even slightly from the ideal, some technologies in a competitive situation will possess a price advantage and consequently dominate the consumption of funds, while others will be largely shut out. Further complicating matters is that the "correct" level of incentive for each technology relative to the others is constantly changing, as the individual subtechnologies and companies within a technology reduce costs and proceed down the cost curve, typically at differing rates.

The California Emerging Renewable Buydown Program, for example, encompasses four "emerging" renewable technologies: solar-thermal electric, PV, small wind, and fuel cells. Since small wind and fuel cells currently have substantially lower capital costs, if the program were to pay buydowns based solely on *dollars per Watt*, these low-capital-cost technologies would be unfairly advantaged at the programs initial $3/Watt buydown level. In fact, $3/Watt would pay up to 100% of their system costs, while only covering 25 to 50% of PV's current costs. Consequently, a second criterion, *maximum percentage of cost*, also had to be applied. Applying this second criterion helps rebalance the competition, but it still presumes that small wind and fuel cells are equally priced today and will remain so during the course of the program, and that the values selected for *maximum percentage of cost* are the correct ones.

On balance, it is best if incentive programs can be segmented and targeted to individual renewable technologies. If several renewable technologies are to be encouraged, then different programs should be developed and tailored to the particular costs and characteristics of each technology.

**b. Picking a Subtechnology for Favorable Treatment**

Whether a buydown program should support a particular PV subtechnology is, in our view, a question that should be resolved by competitive markets rather than by administrative fiat. There are good arguments, for example, that the successful expansion of PV to mass markets will depend on the thin-film subtechnologies, because of their presumed ultimately lower production costs.

In particular, Terry Peterson of the Electric Power Research Institute (EPRI), has made a strong case that at the historical progress ratio for today's more widely used crystalline subtechnology, the economies of scale required to reach installed system prices of $3/Watt will not occur until the worldwide market reaches 40,000-45,000 MW.[26] According to the Utility Photovoltaic Group (UPVG), demand at $3/Watt will be approximately 8,000 MW. If these figures prove to be correct, the crystalline subtechnology cannot be the key to mass commercialization, because the projected amount of sales possible at $3/Watt is not great enough to provide the levels of production projected as needed to reduce prices to a sustainable $3/Watt level.

Although this may or may not prove to be the case for the crystalline subtechnology, we see no reason for a buydown program to discriminate on the basis of subtechnology. Instead, a buydown program should discriminate only on the basis of price—this will ensure that only the lowest-cost PV subtechnologies will ultimately prevail. This is the reason Denis Hayes argues that a buydown has to be structured with an aggressive set of price targets, in order to spur the most efficient and productive manufacturers rather than padding the profit margins of all manufacturers alike.[27] For instance, if indeed the prices of crystalline PV cannot decline as fast as thin film PV prices, for instance, a properly structured incentive program will let the marketplace decide the winners.

It is at this subtechnology, or individual company, level that government wisdom fairs poorest. To use the transportation example of the previous section, it might be appropriate for the government to have encouraged the development of air travel on the basis that faster, long distance travel was previously missing from our transportation mix. However, it would have been inappropriate for the government to have singled out particular airplane subtechnologies to be the only recipients of its support. For example, our air travel industry might look much different if the government had favored biplanes over single winged aircraft, piston engines over jet engines, or supersonic over subsonic. The government's only legitimate interest was in the development of some form of viable air transportation at economically practical costs and performance.

**c. Picking Particular Sizes or Applications of a Technology for Favorable Treatment**

Whether buydown programs should favor a particular scale of PV systems or a particular application is more complicated, but on balance our view is that they may. Favoring some subset of possible PV systems based on criteria such as system output or types of applications depends on the larger public policy objectives the incentive program is expected to address.

[26] Terry M. Peterson, "Making Photovoltaics Economical for Electric Utilities," *EPRI Strategic R&D Report* (Palo Alto, Calif.: Electric Power Research Institute, Fall 1997), p. 2.

[27] Bullitt Foundation, *1997 President's Report.*

Using our transportation analogy, it would have been appropriate for government to encourage the development of airplanes with sufficient range and carrying capacity to cross the oceans, if the public policy objective was to provide an alternative to transoceanic shipping, especially during times of war. More specifically, the California Buydown Program allows only grid-connected PV systems to participate. This is because many off-grid applications are already cost-effective compared to power line extension costs, but also because grid-connected PV has potential future advantages for grid support and reliability, issues important to California after recent power black-outs.

Another example of a public policy objective is the issue of whether the public will ultimately be better served encouraging large, centralized PV power plants occupying desert lands versus smaller, distributed systems located on customers' premises. Because another section of this report is dedicated to a discussion of distributed generation, we will not revisit the issue here except to say there are direct, quantifiable technical and economic benefits to distributed PV development. At the same time, there are economies to be captured in any large-scale project—even with a technology as modular as PV—so that a 10-MW PV plant is almost certain to be less costly than 10,000 1-kW rooftop systems.

Given these circumstances, one might conclude that there are two reasons for ensuring that at least some portion of a buydown program funds are reserved for small-scale distributed PV systems. First, we argued earlier that one of the benefits of a buydown program is encouraging investment by early adopters who will help overcome institutional barriers. These barriers are disproportionately burdensome for small-scale applications, because the costs of (for instance) negotiating technical requirements for interconnection or the terms of a purchase and sale agreement—burdensome as they may be for the developer of a megawatt-scale PV plant—are absolutely prohibitive for the owner of a kilowatt-scale plant. Having to pay $20,000 for an attorney and a consulting engineer may be cause to grumble for the company building a 5-MW solar PV plant in the desert near Albuquerque, but in the context of a $40 million project it is hardly a deal breaker.

On the other hand, the prospect of incurring a similar expense for a 2-kW rooftop system that costs $20,000 is sheer lunacy: Only the most die-hard solar advocate can be expected to tolerate even a fraction of that additional expense. We have suggested elsewhere that these transaction costs of installing rooftop PV systems need to be reduced to the point where getting the system installed and operating is no more cumbersome than signing up for new electricity service: The electrical inspector checks that the wiring and hardware meet Underwriters Laboratories (UL) standards, the utility engineer ensures that the inverter meets the appropriate Institute of Electrical and Electronics Engineers (IEEE) standard for utility safety and power quality, and the customer gets to flip the switch. This kind of streamlining will come only with increased market penetration, and a buydown program targeted at these small-scale systems can strongly encourage that level of market penetration.

A second reason for ensuring that at least a portion of buydown program funds goes to small-scale, distributed PV systems is the challenge for the PV industry to develop a healthy vertical market structure, including not only manufacturers but also distributors and retail vendors. The bidders on large projects at the megawatt scale tend to be manufacturers or specialized system integrators. Supporting these large projects certainly satisfies the fundamental goal of increasing PV production volumes to capture manufacturing economies, but it does little for the downstream segments of the PV industry's market structure. If public policy favors distributed systems, then a buydown program should allocate at least some funding to distributed markets so that distributors and vendors are supported along with manufacturers. If a chain is only as strong as its weakest link, then the PV industry is only as strong as its weakest market segment.

The above analysis would justify a program showing at least some preference towards small PV systems. There are a great number of similar policy objectives where similar analysis would justify skewing a buydown program towards some particular subset of PV customers and PV systems.

### *3. Choosing the Buydown and the Phase-Out: Science or Hand-Waving?*

An important issue that has not been sufficiently researched to date is what the appropriate scale and scope of a buydown program should be. There are, in our view, three core questions:

- *How large should the buydown program be?* What is the total dollar amount needed to stimulate increased production volumes necessary to drive costs down to self-sustaining levels?
- *How long should the buydown program last?* What is the appropriate duration of a buydown program, given that manufacturers need time to respond to the buydown stimulus by ramping up production, and that manufacturers, distributors, installers, and peripheral market participants all need time to ramp up their infrastructure to accommodate the increased demand?
- *How much of a subsidy should the buydown program provide?* What is the dollar amount needed per kilowatt of capacity, or per system, to convince purchasers to buy PV? At what rate can the industry be expected to reduce prices and, therefore, at what rate can this level of incentives be phased out?

As far as we have been able to determine, none of these questions have been adequately analyzed. In the case of California's Emerging Renewables Buydown Program, decisions relating to these three core questions were made through a combination of legislative mandate and California Energy Commission determination, with little serious analytical support or justification.

The California Energy Commission set $54 million in funding for the California Emerging Renewables Buydown in a highly politicized process that pitted advocates for the "emerging" renewables account against advocates for the "existing," "new," and "customer-side" renewables accounts. The $54 million will be collected over a 4-year time frame that corresponds to the length of time the competitive transition charge (CTC) will be imposed on customers of the California investor-owned utilities. Fortunately, the California Energy Commission determined that it had no obligation to spend the $54 million over any particular time frame. As a result, the California Emerging Renewables Buydown Program was able to utilize the tiered structure described earlier, in which each block of funds is available until exhausted, independent of the 4-year time frame over which the funds are collected. Finally, the California Energy Commission decided on the buydown amount ($3/Watt) and the phase-out, but once again there was little analytical support for these decisions.

Although the $54 million allocated to the California Emerging Renewables Buydown Program and the 4-year minimum term are the results of a political process, rather than an analytical process, historical industry price declines and production volumes would argue that these amounts may be within the range for having an impact on the industry. Any isolated program with funds much less than this amount, however, would not be expected to produce enough new sales to have any significant impact on price. Likewise, a term of less than 4 years would likely be ineffective. However, the proper coordination of multiple state and/or federal incentive programs, even small ones, could have a desirable cumulative impact on the industry. They will make a significant price impact only if they appear as one program, with similar duration, price levels, and schedules. In the case of uncoordinated programs, if one program were to offer substantially higher incentives one year and then another state program offered high incentives the following year, the industry might find itself trying to chase from state to state. This would make development of sales, installation and maintenance infrastructure difficult to achieve. Likewise, if the cumulative number of megawatts stimulated by multiple state or federal programs became too large too early, the industry might not be able to meet this high level of demand so quickly and set itself up for a perceived failure to meet the expectations of program proponents.

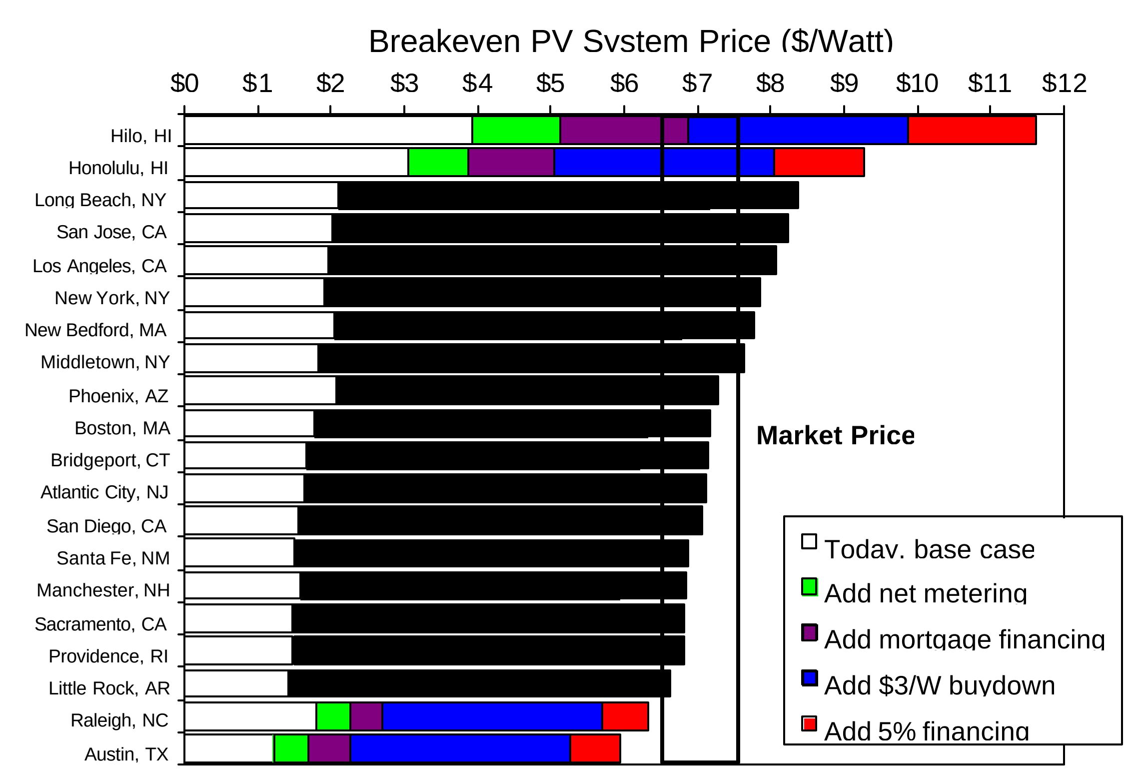
## C. Buydowns in Context: Single Solution or Part of the Policy Mix

Are buydowns alone enough to spur significant expansion of grid-connected PV markets? Almost certainly not. With respect to PV economics, recently published work by Howard Wenger[28] suggests that a $3/Watt buydown must be combined with net metering, mortgage financing, and a low-interest (5%) loan in order for customers to break even on a PV investment in most U.S. cities (see Figure 3).

This combination is achievable—in fact, each of these incentives except the low-interest loan is available to Californians today—but requires an affirmative commitment by one or more branches of government to encourage the use of the technology.

[28] Howard J. Wenger, "Net Metering Economics and Rate Impacts," *American Solar Energy Society: Proceedings of the 1998 Annual Conference,* Albuquerque N.M., June 1998.

**Figure 3: Combining Buydowns with Other Incentives to Achieve Cost-Effectiveness**




## D. Expanding the Use of Buydowns

### *1. Buydown Potential at the Federal Level*

Only customers of California's three investor-owned utilities are eligible to participate in the Buydown Program, because only these customers are paying the system benefits charge that funds the program. These three utilities—Pacific Gas & Electric, San Diego Gas & Electric, and Southern California Edison—serve about 27 million people.[29] Funding for the Buydown Program is $54 million over 4 years, or 50¢ per person, per year. Put in terms of its impact on the price of electricity, the California Emerging Renewables Buydown Program costs electricity consumers 0.01¢ per kilowatt hour or about 0.1% of their cost of electricity. With a U.S. population of approximately 260 million, a national program of a scale comparable to California's would require approximately $130 million per year, or $540 million over a 4-year period. Assuming an average buydown level of $2/Watt[30] and a fully subscribed program, this national program would result in 260 MW of PV capacity being installed over

[29]This is approximately 84% of California's population.

[30]California's Emerging Renewables Buydown Program starts at $3/Watt and declines 50¢ for each tier of funding to $1/Watt in the final tier.

its life.  To put this in perspective, worldwide PV module production in 1997 was approximately 126 MW per year.

Whether this is enough to capture substantial economies of scale in PV manufacturing is unclear. The Electric Power Research Institute (EPRI) has concluded that increased volumes of PV production have driven down prices at an 82% "progress ratio," or the percent of cost remaining after each cumulative doubling in production volume.[31] The PV market has been growing at an average annual rate of 20%. If this rate is maintained, the market will double three times over the next decade to around 800 MW/year. Using DOE/EPRI's figure for the progress ratio and for the current cost of PV systems ($6.46/Watt for individual home systems), installed costs at the end of the decade would be 55% of current costs, or roughly $3.50/Watt for grid-connected systems.

The threshold at which PV will be cost-effective for large-scale commercialization is generally considered to be on the order of $3/Watt for complete systems, which corresponds to approximately $1.50/Watt for PV modules. Assuming EPRI's progress ratio holds, a national buydown program would help reach this goal more quickly. On this basis, the 50% increase in demand from a national buydown program would result in a further 9% drop in the cost of PV technology.

### *2. Buydown Potential in the States*

As California has demonstrated with its Emerging Renewables Buydown Program, individual states have the ability to develop buydown programs without federal participation. Although few individual states come close to matching California's population and solar resource potential, the cumulative impact of buydown programs in a number of other states could well exceed the impact of California's program.

According to Howard Wenger, the states in which a buydown program would be most likely to spur significant commercialization (aside from California) are Arizona, Hawaii, New Jersey, New York, and most of the New England states (Connecticut, Massachusetts, New Hampshire, and Rhode Island).[32] These eight states combined had an estimated 1997 population of about 43 million.[33] If just these eight states offered a buydown program matching California's per capita contribution, the combined funding would be an additional $35 million per year—which at $2/Watt would support an additional 18 MW of PV capacity per year. As mentioned above, this 18 MW per year is at a funding level of 0.1 mil per kilowatt hour. Yet recently enacted and proposed levels of state system benefits charges (SBCs) for renewables are often on the order of 1 to 3 mils per kilowatt hour—or 10 to 30 times the level of funding for the California program. Thus, it is not unreasonable to imagine a combination of federal and state buydown programs which could stimulate many hundreds of megawatts of new purchases across the country.

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[31] See Williams, "Proposed Grand Bargain"; Peterson, "Making Photovoltaics Economical.

[32] Wenger, "Net Metering Economics."

[33] U.S. Census Bureau, State Population Estimates (available on the Web at http://www.census.gov/statab/www).

# V. CONCLUSIONS AND RECOMMENDATIONS

## A. The Case for Government Buydowns of PV Costs

We argue that government buydowns of PV costs should be the preferred cornerstone of any state or federal effort to expand markets for PV and to accelerate commercialization of PV. As discussed further below, we believe buydowns are preferable from both the perspective of the marketplace and from the perspective of government.

From the perspective of the marketplace, the buydown approach best stimulates the same kinds of PV purchasers that a healthy, unaided marketplace can someday be expected to produce. Buydowns motivate ordinary people and businesses to buy PV now rather than to wait several years. In alternative approaches—for example, a renewables portfolio standard (RPS), a large government direct purchase, or a set-aside program—the customer is not a typical customer but an entity that is being compelled or required to make purchases. Buydowns create large numbers of customers, each purchasing relatively small quantities of PV. This approach is desirable from a market development standpoint as it allows many firms to compete for and obtain some share of the market.

While portfolios or mass purchases of PV by the government may stimulate more orders of PV cells in the short run, these approaches do not require the development of an industry infrastructure and, in fact, may undermine such an infrastructure, leaving the PV industry in poor shape to continue to grow when the mandated purchases cease. Large concentrations of orders put PV manufacturers in a position of making direct sales to these large customers in order to offer the most competitive pricing. There would be little need in such a case for the development of financing mechanisms or a large network of PV retailers, installers and servicers. A few large mandated purchases potentially favor a much smaller group of successful bidders. Having large numbers of smaller customers— customers of a character closer to the customer base that is expected in a fully commercialized PV industry—is highly desirable in that it will stimulate the early development of the infrastructure of PV dealers, distributors, installers, servicers and financiers that a mature industry will require.

From the perspective of government, the buydown approach has the advantage of being a “carrot” rather than a “stick.” Buydowns are positive incentives for customers to buy—and thus tend to be popular and have little political opposition once enacted. Portfolio standards, set-asides, or large mandated direct purchases by government all involve enforcing a requirement to purchase PVs or PV-generated electricity by utility or government entities that would not have otherwise considered or wanted to do so. Consequently, even once enacted, such programs are subject to ongoing criticism and opposition by those mandated to purchase. At any sign of program failure or difficulty, opponents may attempt to have such mandated purchase requirements undone.

Buydowns, on the other hand, can be modified or adjusted with little uproar or threat to program continuance, because buydown programs have few entrenched opponents and large constituencies interested in their ultimate success. Additionally, from government’s standpoint, the cost of a buydown program is known and fixed. In addition, it can more easily adjust buydowns to accommodate market dynamics and to ensure ultimate program success. Policymakers cannot modify the level or duration of mandated purchases without creating substantial equity issues between those who complied with the old rules and those who had not. Also, the cost of compliance is unknown at the outset, so if costs are higher than anticipated there are few good options and a high potential for increased opposition to program continuance.

## B. General Recommendations for Buydown Programs

Based on the limited experience to date with a handful of buydown programs around the world, we believe that several conclusions and suggestions can be made regarding how effective buydown programs should be structured and operated while targeting residential markets to accelerate the commercialization of PV.

- ***Enabling legislation or regulations for a PV buydown program should avoid specifying program details and instead should allow the implementing agency to determine them. For a buydown program to succeed, its managers require the flexibility to adapt the program in light of market responses and actual experience.*** Thus, enabling legislation or regulations to establish a buydown program should only specify the broad parameters of the program and avoid specifics such as the level of buydown payment, the term of the program, the specific hardware components or applications to be covered by the program. The development of buydown program details should be entrusted to an implementing and administering agency along with adequate funding to administer the program. The legislation should require and empower the administering agency to periodically assess the program's success and empower that agency to change any program parameter to help ensure program success.

- ***Certain program features are critical to a buydown program's success: a multiyear term, certainty of funding during the program term, avoidance of arbitrary time limits for expenditure of program funds, and the ramping up of demand and ramping down of the level of incentive over the program's term.*** The details of a buydown program must be carefully worked out for the program to be effective in stimulating sales of PV. Establishing a poorly structured buydown program is worse than no program at all, because a buydown program with unworkable or ineffective parameters will be doomed to fail and may discredit other buydown programs.

- ***On the basis of policy goals and physical resources, program designers may appropriately determine which broad technologies (e.g., PV, wind) to include in their buydowns. However, government should avoid favoritism at the subtechnology or company level.*** Although governments may not always be successful at picking specific companies, markets, or subtechnologies as eventual winners on which to focus their support, governments can, with proper expertise and advice, successfully target their incentive programs on a more general level. Governments may elect to exclude some well established or cost-effective markets from eligibility, or provide differing levels of incentives for different sizes and types of PV applications. To do otherwise might provide excessive incentives for some market segments and provide inadequate incentives to others. Programs to stimulate PV should be kept separate from other renewables programs whenever possible. Combining other renewable technologies (e.g., wind or biomass) with solar technologies in a single program requires very careful structuring so that they do not pose a disadvantage to high current cost technologies such as solar technologies.

- ***Buydowns can be a central element of a PV commercialization strategy but will not succeed unless other issues—i.e., structural or institutional barriers, consumer protection concerns, and marketing and public education—are addressed simultaneously:***
    - ♦ Unaddressed structural or institutional barriers can prevent the best buydown program from succeeding:
        - ◊ Utility interconnection requirements and agreements need to be worked out in advance.
        - ◊ Local building inspectors and fire departments may need to be trained about PV.
    - ♦ Consumer protection concerns must be addressed as part of a buydown program to prevent negative publicity. Standards exist for both hardware and installation and certification is beginning to become available. A buydown program can accelerate this process.
    - ♦ Educating the public and marketing the technology are crucial for potential customers to learn about the incentives and become comfortable with the technology.

- ***Several financial incentives can complement and enhance buydowns, among them net metering, property and sales tax exemptions, income tax credits or accelerated deductions, low-interest rate, long-term financing for purchasers.***
    - ♦ Net metering substantially increases the value of self-generated electricity. The absence of net metering to augment a buydown program would mean that much higher levels of buydown would be required.
    - ♦ Exempting a PV system from property taxes to add value will not reduce the initial cost of acquisition but will substantially reduce the lifecycle costs of the electricity produced. In many states, property taxes on a high-capital-cost item, such as a PV system, can offset much of the value of the electricity generated.
    - ♦ A sales tax exemption, where applicable, can be an important incentive. In jurisdictions where the sales tax would have been imposed on the gross price before buydown, this exemption is even more valuable.
    - ♦ Income tax credits or accelerated deductions are available in several states. While the federal tax credits and deprecation are only available to business, such incentives can be significant, where available, in reducing the net system cost.
    - ♦ Low-interest, long-term loans can have a major impact on the lifecycle cost of a system. They can make it possible for cash-poor customers, who otherwise could not purchase a PV system outright, to buy PV.

- ***States and the federal government must coordinate their activities to maximize the number, size, and effectiveness of buydown programs for PV and other renewables***. Though largely missing today, interaction between the different programs from their earliest stages will ensure that such buydown programs make the maximum possible impact on the PV industry. Equally important, it will avoid poorly structured programs or conflicting requirements and incentives between programs, which would cause these programs to fail to achieve the intended market stimulation. Such coordination could quickly allow individual programs to add up to a nationwide effort that could collectively stimulate hundreds of megawatts of PV. This could be done at funding levels of 1 mil per kilowatt hour or less. Immediate actions should be taken to do the following:

- ♦ provide funding for such national coordination and consultation;
- ♦ begin dialogue among states that have already enacted PV incentives;
- ♦ identify and encourage states with the potential to enact a system benefits charge or similar funding mechanism for a buydown program; and
- ♦ develop model legislation/regulations and guidelines and make available to interested solar proponents.

## VI. ACTION RECOMMENDATIONS: BUYDOWNS FOR THE RESIDENTIAL MARKET

We believe that buydowns should be the premiere mechanism used by the U.S. government and states to expand domestic markets for PV. We believe that buydowns are the preferable approach to expanding domestic markets for PV from the perspective of both the marketplace and government. Thus, we recommend the following actions:

⇒ ***PV advocates—including renewables trade organizations, renewables policy organizations, interested environmental groups—and the U.S. Department of Energy and states that are contemplating buydown programs should urge the U.S. Congress to impose a national system benefits charge (SBC) on all electricity sold in the United States to develop a federal trust fund that would provide federal matching funds to states for buydown programs for PV and other renewables.*** Congress should enact legislation that imposes a nationwide SBC of 1 mil (0.1¢) per kilowatt hour (kWh) on all electricity sold domestically. Such a charge would generate approximately $1 billion per year and should remain in effect for 10 years.

Þ The funds collected from the SBC should be placed in a trust administered by the U.S. Department of Energy (DOE), where they should be held and invested until spent. The funds should not be subject to any short-term time restrictions for their expenditure.

Þ The trust fund administered by DOE should be used solely to provide matching grants to states that maintain their own programs to provide incentives for purchases of PV or other renewables. No matching funds should be granted for R&D expenditures nor could matching funds be allocated to programs that only mandate purchases of renewables, such as portfolio standards or set-asides. DOE should determine the level of matching, which would depend on the number of participating states and the level of their commitment. Presumably, the federal commitment should be substantial and on the same order as the amount of funds directly committed by the states (i.e., a 1:1 match).

Þ The availability of federal matching funds should provide a significant stimulus to states to set up and administer their own programs in order to be eligible to receive federal matching funds. The states should be permitted to determine the exact details of their buydown programs. The states could best arrive at appropriate levels of buydown payments and eligibility requirements given the states' renewables resources and other current incentives. Thus, states with large wind or biomass resources, but with relatively little solar potential might favor their indigenous resources. Or states that currently offer tax credits, net metering or other tax exemptions could take the economic effect of these incentives into account when determining their level of buydown payment. The federal government's trust funds could be used to extend the time frame of a program or to increase its scope, but the level of buydown payment would be established solely by the state. While the amount and types of new renewable generating facilities stimulated by this additional federal money will depend on the nature of the state programs to be supplemented, such an SBC can be expected to stimulate over 1,000 MW of new PV purchases over its lifetime, as well as thousands of megawatts of other renewables. Thus, its impact of the commercialization of renewables would be significant.

⇒ ***With or without a national SBC for renewables, PV advocates should make every effort to maximize the number, size, and effectiveness of state programs for PV and other renewables, especially in states that enact utility restructuring.*** To accomplish this goal, we recommend the formation of a small group of experienced, knowledgeable individuals who can devote their full efforts with support from a larger group of experts within government and nongovernmental organizations who can be called on as necessary. Knowledgeable individuals are scattered throughout the country; what is critical and currently missing, however, is a core group of individuals able to devote sufficient time and resources to provide effective national coordination to such an effort. Funding must be obtained from some combination of DOE, private foundations, state energy programs, or other sources. Expected annual expenditures to support such nationwide activities would be on the order of $500,000 to $1 million per year for a period of approximately 5 years.

Þ The funding for coordinating this effort is needed immediately, as there are already at least six states with programs in varying degrees of implementation and operation. Funding would be provided to a suitable nongovernmental organization (NGO), such as the Interstate Renewable Energy Council (IREC), to administer the program and to support a dedicated core staff and the necessary consulting, travel and other costs.

The effort to maximize the number, size and effectiveness of state programs for PV would involve three broad components:

1. *Identifying and working with states that may be receptive to establishing new PV and renewables programs*. PV advocates should work with state legislatures, regulators and local nongovernmental organizations, as appropriate, to assist in the creation of state level incentive programs. They should provide information, model legislation, communication with counterparts in other states, and expert witnesses as needed.

2. *Establishing and coordinating regular communications so that states that have enacted programs for renewables can assist in the successful design, implementation, and operation of other states' programs.* PV advocates should provide information, analysis, and expertise to the program designers and implementers in each state to ensure that state programs will be structured in ways to maximize the chances for success, and will provide a coherent and ordered program of market incentives.

3. *Conducting research and providing information to states on the effects and impacts of state programs for renewables on the market prices of PV and renewables and the development of the necessary long-term infrastructure.* PV advocates should provide pertinent information to the states in a timely fashion so that individual state programs can be modified as to their buydown level, program size, or duration, as necessary, to ensure continuous, effective reduction of the costs of renewables.