Tracking the Sun V: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2011

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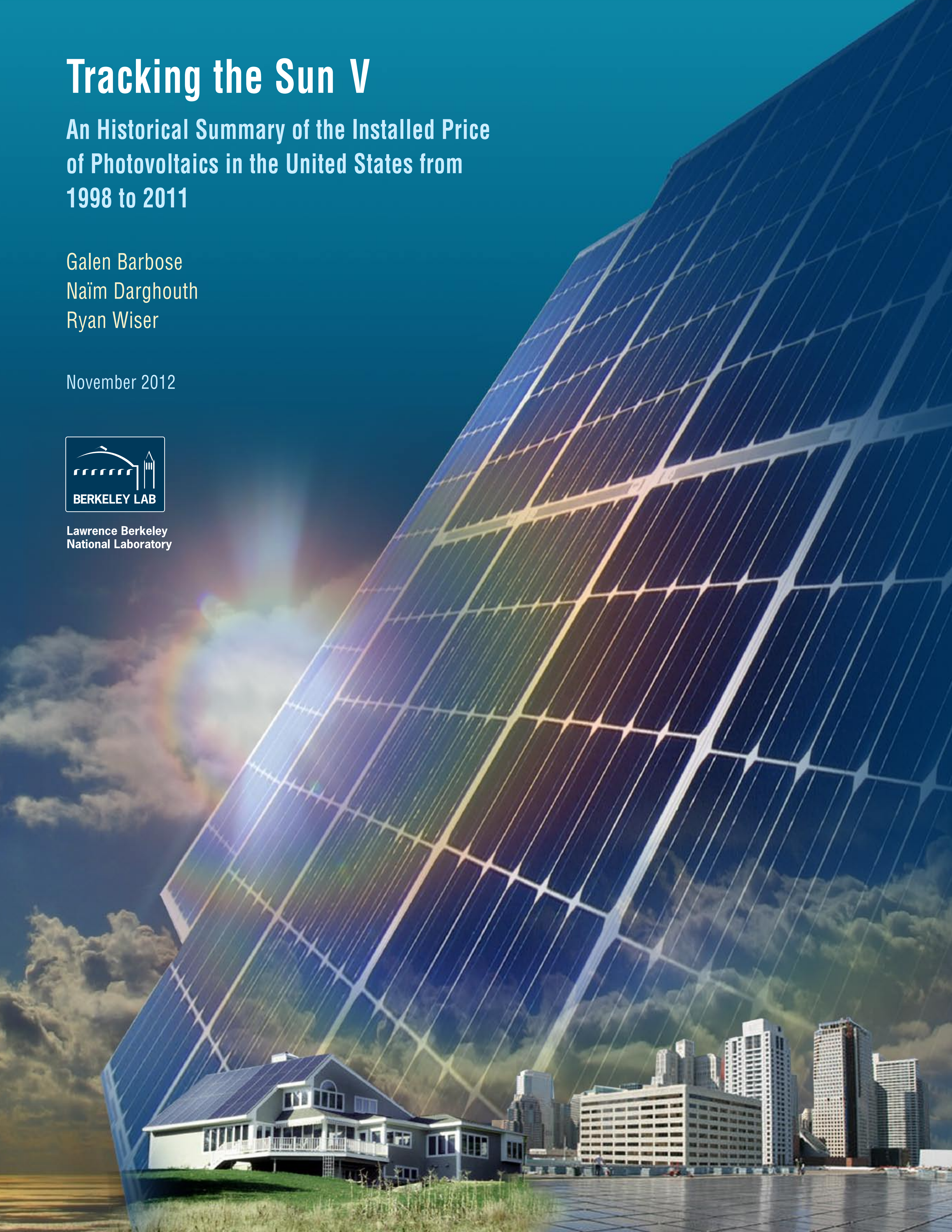

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Executive Summary

As the deployment of grid-connected solar photovoltaic (PV) systems has increased, so too has the desire to track the installed price of these systems over time and by location, customer type, and system characteristics. This report helps to fill this need by summarizing trends in the installed price of grid-connected PV systems in the United States from 1998 through 2011, with preliminary data for 2012. The analysis is based on project-level data for more than 150,000 individual residential, commercial, and utility-scale PV systems, totaling more than 3,000 megawatts (MW) and representing 76% of all grid-connected PV capacity installed in the United States through 2011.

It is essential to note at the outset the limitations inherent in the data presented within this report. First, the installed price data are historical, focusing primarily on projects installed through the end of 2011, and therefore do not reflect the price of projects installed more recently (with the exception of the limited set of results presented for systems installed in the first half of 2012); nor are the data presented here representative of prices currently being quoted for prospective projects to be installed at a later date. For this reason and others (see Text Box 1 within the main body), the results presented in this report likely differ from current PV price benchmarks. Second, this report focuses on the up-front price paid by the PV system owner; as such, it does not capture trends associated with PV performance or other factors that affect the levelized cost of electricity for PV. Third, the underlying data collected for this report include third party owned projects where either the system is leased to the site-host or the generation output is sold to the site-host under a power purchase agreement. In some cases, installed prices reported for third party owned systems may be based on an appraised value, rather than on a purchase price paid to an installer. To the extent possible, *projects for which reported prices were deemed likely to represent an appraised value were removed from the sample*, whereas other third-party-owned systems were retained in the data sample (see Section 2 and Appendix A for further details). Nevertheless, some residual number of appraised-value systems may remain in the data sample, though any bias introduced by these projects is unlikely to have skewed the installed price trends presented here.

The report describes installed price trends for residential and commercial PV systems, and another set of trends for utility-scale PV. In all cases, installed prices are identified in terms of real 2011 dollars per installed watt (DC-STC), prior to receipt of any direct financial incentives or tax credits.

Key findings for residential and commercial PV are as follows:

- Installed prices continued their precipitous decline in 2011. Among projects installed over the course of 2011, the median installed price was \$6.1/W for systems ≤10 kW in size, \$5.6/W for systems 10-100 kW, and \$4.9/W for systems >100 kW. This represent a year-over-year decline of \$0.7/W (11%) for systems ≤10 kW, \$0.9/W (14%) for systems 10-100 kW, and \$0.8/W (14%) for systems >100 kW.
- Partial data for the first six months of 2012 indicate that installed prices have continued to fall, with the median installed price of projects funded through the California Solar Initiative declining by an additional \$0.2/W to \$0.4/W during the first half of 2012, depending on the system size range, amounting to a 3-7% drop relative to systems installed in 2011.
- The recent decline in installed system prices is largely attributable to falling module prices, which fell by \$2.1/W from 2008 through 2011 (based on Navigant Consulting's Global Power Module Price Index), and have fallen further still in 2012, with spot prices falling by roughly \$0.3/W from January to September 2012. Movements in global module prices, however, do not necessarily translate into an immediate, commensurate change in the price paid by the system owner; in some cases, system prices may lag changes in module prices.

- Over the long-term, installed system prices have fallen also as a result of reductions in non-module costs (which may include such items as inverters, mounting hardware, labor, permitting and fees, customer acquisition, overhead, taxes, and installer profit). From 1998-2011, non-module costs declined by approximately $2.0/W (30%), constituting more than one-third of the reduction in total installed system prices over that period.
- Although this report focuses on describing trends in median installed prices, the distribution of installed prices across projects is quite wide. For example, among ≤10 kW systems installed in 2011, roughly 15% of systems had an installed price less than $5.0/W, while a similar percentage was priced above $8.0/W. The price distribution has narrowed somewhat over time, though no discernible narrowing has occurred in recent years.
- Third party owned systems were screened out of the data sample in cases where reported installed prices were deemed likely to represent appraised values; the median installed price reported for these systems was significantly higher than for host customer owned systems (e.g., $8.0/W vs. $6.2/W, among ≤10 kW systems completed in 2011). In contrast, installed prices reported for other third party owned systems that were retained in the sample were similar to those reported for host customer owned systems.
- Installed prices exhibit significant economies of scale, with a median installed price of $7.7/W for systems ≤2 kW completed in 2011, compared to $4.5/W for commercial systems >1,000 kW. The installed price of utility-scale systems is even lower, as discussed further below. To a limited extent, these economies of scale help to explain the long-term decline in median installed prices, as typical PV system sizes have grown over time.
- Installed prices vary widely across states. Among ≤10 kW systems completed in 2011, for example, median installed prices range from a low of $4.9/W in New Hampshire to a high of $7.6/W in Washington D.C., potentially reflecting a number of differences in state and local factors (e.g., market size, permitting requirements, the competitiveness of the installer market, labor rates, sales tax exemptions, and incentive levels).
- International experience suggests that greater near-term price reductions in the United States are possible, as the median installed price of small residential PV installations in 2011 (excluding sales/value-added tax) was just $3.2/W in Germany, $4.0/W in Australia, $4.5/W in Italy, and $5.4/W in France, compared to $6.0/W in the United States.
- Installed prices for systems installed at tax-exempt customer sites are moderately higher than for similarly sized systems at residential and for-profit commercial customer sites. Among 2011 systems, for example, the median price of tax-exempt systems was $0.2/W to $0.5/W higher than residential and commercial systems, depending on the system size range.
- Installed prices have generally been somewhat higher for building-integrated PV (BIPV) than for rack-mounted systems. Among systems ≤10 kW, the median installed price of BIPV systems exceeded that of rack-mounted systems by $0.3/W to $0.9/W in each year from 2007-2010 (though median prices were nearly identical for systems installed in 2011).
- The installed price of small residential PV has historically been lower in new construction than in retrofit applications. Over the 2007-2009 period, the median installed price of 2-3 kW systems installed in new construction was $0.3/W to $0.5/W less than comparably sized residential retrofit systems, depending on the year (or $0.8/W to $1.2/W less if comparing only rack-mounted systems). The same trends did not persist in 2010 and 2011, which may potentially be an artifact of the slowdown in the residential housing market.
- Installed prices have generally been higher for ground-mounted systems than for similarly sized rooftop systems, and higher for systems with tracking than for fixed-tilt systems. For

example, among ≤10 kW systems installed in 2011, the median installed price was $8.0/W for ground-mounted systems with tracking, $6.3/W for fixed-tilt ground-mounted systems, and $5.9/W for rooftop systems.

- Reductions in cash incentives and falling solar renewable energy certificate prices have offset recent installed price reductions to a large extent. Among systems installed in 2011, the median pre-tax value of cash incentives provided by state and utility PV incentive programs ranged from $0.9/W to $1.2/W, depending on systems size, representing a 21% to 43% drop from 2010 and a roughly 80% decline relative to the historical peak in 2002.

This report separately summarizes installed price data for utility-scale PV projects, defined for the purposes of this report to include all ground-mounted projects larger than 2 MW. Several additional limitations are worth noting with respect to the utility-scale PV project data. First, the sample size is small (80 projects in total, including 49 projects installed in 2011), and includes a number of relatively small projects (i.e., 2-10 MW) and projects with “atypical” characteristics that have installed prices that are likely higher than for many of the larger utility-scale PV projects currently under development. Second, the installed price of any individual utility-scale project may reflect component pricing one or even two years prior to project completion, and therefore the reported prices of the utility-scale projects within the data sample may not fully capture the steep decline in module prices that occurred over the study period.

With these important caveats in mind, **key findings for utility-scale PV are as follows**:

- The installed price of utility-scale systems varies significantly across projects. Among the 49 projects in the data sample completed in 2011, for example, installed prices ranged from $2.4/W to $6.3/W, reflecting the wide variation in project size (from 2 MW to 35 MW), differences in system configurations (e.g., fixed-tilt vs. tracking and thin-film vs. crystalline modules), and the unique characteristics of individual projects.
- Discerning a time trend for the installed price of utility-scale PV is challenging, given the small and diverse sample of projects. As a rough measure, the capacity-weighted average installed price declined from $6.2/W for projects installed during 2004-2008, to $3.9/W for projects installed during 2009-2010, and to $3.4/W for projects installed in 2011.
- Larger utility-scale systems have lower installed prices. In particular, among projects installed in 2011, the installed price of projects larger than 10 MW generally ranged from $2.8/W to $3.5/W, whereas projects smaller than 10 MW span a broader range, with most priced between $3.5/W and $5.0/W.
- Installed price trends according to system configuration are less evident. Among <10 MW utility-scale projects installed in 2011, systems using thin-film modules are relatively low-priced, compared to crystalline systems with and without tracking. Among projects >10 MW, however, no clear differences in installed prices are observable either between crystalline and thin-film systems or between systems with and without tracking.
- Within the class of systems 2-10 MW in size, utility-scale systems (ground-mounted, by definition) generally have slightly lower installed prices than similarly sized commercial rooftop systems. Although median installed prices are similar between these two groups, the distribution is skewed lower for utility-scale systems, with one-third priced from $2.9/W to $3.5/W, whereas the lowest-priced third of the large commercial roof-mounted systems range from $3.6/W to $3.8/W.

1. Introduction

Installations of solar photovoltaic (PV) systems have been growing at a rapid pace in recent years. In 2011, approximately 21,000 megawatts (MW) of grid-connected PV were installed globally, up from roughly 17,000 MW in 2010, and 8,000 MW in 2009.[1,2] With roughly 1,850 MW of grid-connected PV capacity added in 2011, the United States was the world's fourth largest PV market in that year, behind Germany, Italy, and China.[3] Despite the significant year-on-year growth, however, the share of global and U.S. electricity supply met with PV remains relatively small.

The market for PV in the United States is, to a significant extent, driven by national, state, and local government incentives, including up-front cash rebates, production-based incentives, renewables portfolio standards, and federal and state tax benefits. These programs are, in part, motivated by the popular appeal of solar energy, and by the positive attributes of PV – modest environmental impacts, avoidance of fuel price risks, coincidence with peak electrical demand, and the ability to deploy PV at the point of use. Given the relatively high historical cost of PV, a key goal of these policies is to encourage cost reductions over time. Complementing these incentive policies is the U.S. Department of Energy (DOE)'s SunShot Initiative, which aims to reduce the cost of PV-generated electricity by about 75% between 2010 and 2020. As these various incentive policies and other initiatives have become more prevalent, and as PV deployment has accelerated, so too has the desire to track the cost of PV systems.

To address this need, Lawrence Berkeley National Laboratory (LBNL) initiated an annual report series focused on describing historical trends in the *installed price* (that is, the up-front cost borne by the system owner) of grid-connected PV systems in the United States. The present report, the fifth in the series, describes installed price trends for projects installed from 1998 through 2011, with some limited and preliminary results presented for projects installed in the first half of 2012. The analysis is based on project-level data from more than 150,000 residential, commercial, and utility-scale PV systems in the United States. The combined capacity of all systems in the data sample totals more than 3,000 MW, equal to 76% of all grid-connected PV capacity installed in the United States through 2011 and representing one of the most comprehensive sources of installed PV price data.[4] Based on this dataset, the report describes historical installed price trends over time, and by location, market segment, and technology and application type. The report also briefly compares recent PV installed prices in the United States to those in other major international markets, and describes trends in customer incentives for PV installations. The analysis presented here focuses on descriptive trends in the underlying data, serving primarily to summarize the data in tabular and graphical form; later analysis will explore some of these trends with more-sophisticated statistical techniques. A subset of these trends are also presented in a companion summary report issued jointly by LBNL and the National Renewable Energy Laboratory (NREL), which describes historical installed price trends along with modeled installed price benchmarks and projections of near-term system pricing, drawing upon parallel research efforts underway at NREL.[5]

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[1] Throughout this report, all capacity numbers represent rated direct current (DC) module power output.
[2] Mints (2012) and Mints (2011).
[3] SEIA/GTM Research (2012a) and REN21 (2012).
[4] The data for this report is collected in concert with the National Renewable Energy Laboratory's *OpenPV* project, an online data-visualization tool (https://openpv.nrel.gov) that includes most of the data contained within the present report as well additional data contributed by individual PV system owners and installers, and by other entities.
[5] Feldman et al. (forthcoming).

It is essential to note at the outset the limitations inherent in the data presented within this report. First, the installed price data are historical, focusing primarily on projects installed through the end of 2011, and therefore do not reflect the price of projects installed more recently (with the exception of the limited set of results presented for residential and commercial systems installed in the first half of 2012); nor are the data presented here representative of prices that are currently being quoted for prospective projects to be installed at a later date. For this reason and others (see Text Box 1), the results presented in this report likely differ from current PV price benchmarks. Second, this report focuses on the up-front price paid by the PV system owner; as such, it does not capture trends associated with PV performance or other factors that affect the levelized cost of electricity for PV. Third, the utility-scale PV data presented in this report are based on a small sample size (reflecting the small number of utility-scale systems installed through 2011), and include a number of relatively small projects and "one-off" projects with atypical project characteristics. Fourth, the data sample includes many third party owned projects where either the system is leased to the site-host or the generation output is sold to the site-host under a power purchase agreement. In some cases, installed prices reported for third party owned systems may be based on an appraised value, rather than on a purchase price paid to an installer. To the extent possible, projects for which the reported price data were deemed likely to represent an appraised value were removed from the sample, whereas other third-party-owned systems were retained in the data sample (see Section 2 and the Appendix for further details).[6] Notwithstanding these efforts, some residual number of appraised value systems may remain in the data sample, though any bias introduced by these projects is unlikely to have skewed the installed price trends presented here.

The report begins in Section 2 with a summary of the data collection methodology and resultant dataset. Section 3 describes trends in the installed price of residential and commercial PV, prior to receipt of any financial incentives, including trends over time and by system size, state, system ownership model (host customer owned vs. third party owned), host customer segment (residential vs. commercial vs. tax-exempt), application (new construction vs. retrofit and ground-mounted vs. roof-mounted), and technology type (building-integrated vs. rack-mounted, crystalline silicon vs. thin-film, and tracking vs. fixed-tilt). Section 3 also compares installed prices between the United States and other major international markets and summarizes trends in PV incentive levels over time, focusing specifically on state and utility incentive programs. Section 4 then summarizes trends in the installed price of utility-scale PV systems. Brief conclusions are offered in the final section, and several appendices provide additional details on the analysis methodology and additional tabular summaries of the data.

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[6] The installed price data presented in this report derive primarily from state and utility PV incentive programs. For a *subset* of the third-party-owned (TPO) systems – namely, those systems installed by *integrated* third party providers that both perform the installation and finance the system for the site-host – the prices reported to incentive programs may represent an appraised value (in many cases, the assessed "fair market value" claimed when the third party finance provider applies for a Section 1603 Treasury Grant or federal investment tax credit), and those projects were removed from the data sample, to the extent possible. For *non-integrated* third party financing providers that purchase systems from installation contractors, however, the prices reported to incentive programs typically represent actual purchase prices paid to those installation contractors. These prices are assumed to be roughly comparable (though not necessarily identical) to the price that would be paid in a cash sale transaction, and these projects were therefore retained in the data sample.

Text Box 1. Reasons for Deviations between Market Price Data and Current Price Benchmarks

Various entities routinely publish benchmarks for the installed price of PV systems in the United States. The historical market price data presented in this report are likely to differ from price benchmarks issued near the time of report publication.[7] These differences may arise, in part, due to issues of timing. This report focuses on systems installed through the end of 2011, and installed prices for those systems generally reflect module and other component pricing at the time that installation contracts were signed (which could precede installation dates by one year or more for relatively large projects). In contrast, installed price benchmarks are generally based on contemporaneous module and other component pricing, which have fallen significantly in recent years. Preliminary data for systems installed through the California Solar Initiative in the first half of 2012, for example, show that installed prices have continued to fall relative to the values cited in this report for systems installed in 2011.

The historical market price data presented in this report may also differ from current installed price benchmarks for a number of other reasons, depending upon how the benchmarks are constructed:

- *System size*: The reported market prices reflect the system size distribution of projects within the data sample (as described in Section 2). Current price benchmarks may, instead, be based on prototypical system sizes that may differ significantly from those in the data sample.
- *Geographic location*: The reported market prices reflect the geographical distribution of projects within the data sample, which is weighted heavily towards California and New Jersey. Current price benchmarks may, instead, be based on national average costs and pricing.
- *PV component selection*: The reported market prices are based on the distribution of PV module and other component models employed within the projects in the data sample; the utility-scale systems in the sample, in particular, include many systems with high-efficiency (and relatively high-cost) modules. Current price benchmarks may, instead, be based on average component prices across the range of models available.
- *Utility-scale PV definition*: This report classifies all ground-mounted projects greater than 2 MW as "utility-scale PV," and therefore the data sample includes a number of PV systems that are considerably smaller than what might be considered prototypical "central-station" PV systems for the purpose of price benchmarking.
- *Atypical utility-scale PV project characteristics*: The data sample includes a number of "one-off" utility-scale projects with unique characteristics (e.g., brownfield developments, systems built to withstand hurricane winds, utility pole-mounted systems, etc.) that likely led to higher installed prices. Current price benchmarks are, instead, generally based on more prototypical project characteristics.
- *Inefficient pricing*: Current price benchmarks are sometimes based on stipulated developer/owner profit margins. The reported market price data, in contrast, are based on whatever profit margin the developers/owners were able to capture or willing to accept. In markets with barriers to entry, developers and/or third-party owners may be able to price their projects above the theoretically "efficient" level based on underlying project costs. Conversely, some developers may be willing to accept "below-market" profit in order to capture market share. In either case, the underlying profit margin embedded in the reported market price data may differ from the assumptions within current PV price benchmarks.

[7] NREL published a set of installed price benchmarks (Goodrich et al. 2012), based on bottom-up modeling of system pricing, informed by in-depth interviews with installers and industry experts. A joint summary report prepared by NREL and LBNL (Feldman et al., forthcoming) compares those benchmarks to the market price data reported here, and discusses specific reasons for differences.

2. Data Summary

The analysis presented in this report is derived from project-level data for residential, commercial, and utility-scale PV systems collected from a variety of sources (see note on terminology below for definitions of these market sectors). This section describes the data sources and the procedures used to standardize and clean the data, and then summarizes the basic characteristics of the data sample, including: the number of systems and installed capacity; the sample size relative to the total U.S. grid-connected PV market; and the distribution of PV systems in the sample by year, state, and project size.

Data Sources

Data for *residential and commercial systems* were sourced primarily from state and utility PV incentive program administrators. Ultimately, project-level installed price data were provided for systems funded through 42 PV incentive programs (see Table B-1 in the Appendix for a list of these programs and the associated sample sizes). Data for *utility-scale systems* were collected from a diverse set of sources, including the Section 1603 Grant Program, FERC Form 1 filings, SEC filings, company presentations, and trade press articles; data from the same set of sources were also used for a limited number of large commercial PV systems that were not already included within the data provided by state and utility PV incentive programs.

A Note on Terminology

Throughout this report, ***residential PV*** refers to systems installed at residential customer sites, regardless of size. ***Commercial PV***, unless otherwise indicated, includes rooftop systems of any size and ground-mounted systems up to 2 MW in size installed at non-residential customer sites, regardless of whether the host customer is a for-profit, non-profit, or public-sector entity. ***Utility-scale PV*** refers to ground-mounted systems larger than 2 MW. All three market segment definitions are independent of whether electricity is delivered to the customer-side or utility-side of the electrical meter.

Data Standardization and Cleaning

To the extent possible, this report presents the data as provided directly by the aforementioned sources; however, several steps were taken to clean and standardize the raw data, as briefly summarized here and described in greater detail in Appendix A. Two key conventions used throughout this report and applicable to all systems deserve specific mention:

1. All price and incentive data are presented in real 2011 dollars (2011$), which required inflation adjustments to the nominal-dollar data provided by PV programs.
2. All capacity and dollars-per-watt ($/W) data are presented in terms of rated module power output under Standard Test Conditions (DC-STC), which required that capacity data provided by several PV incentive programs that use a different capacity rating be translated to DC-STC.[8]

A number of additional steps were then undertaken to clean and standardize the data. First, projects with clearly erroneous installed price or incentive data or with missing price or system size

[8] Various permutations of rating conventions may be used to describe the size of PV systems. The most common rating used by PV incentive programs is the total nameplate capacity of the PV modules in direct current (DC) watts under standard test conditions (STC). This is the rating convention used throughout this report. Alternatively, PV system sizes may be denominated in terms of DC watts under PVUSA test conditions (PTC), or in terms of alternating current (AC) watts under either STC or PTC.

data were eliminated from the data sample. Second, all projects for which reported installed prices were deemed likely to represent an *appraised value*, rather than a purchase price paid to an installer, were eliminated from the data sample.[9] The remaining data were then cleaned by correcting text fields with obvious errors and by standardizing identifiers for module and inverter models. To the extent possible, each PV project was classified as either building-integrated PV or rack-mounted and as using either crystalline or thin-film modules, based on a combination of information sources. Finally, for utility-scale systems and large commercial systems for which installed price data were not available from other sources, we estimated the installed price based on the reported Section 1603 grant amount, by assuming that the grant is equal to 30% of the installed price.[10]

Sample Description

The final data sample, after all data cleaning was completed, consists of 152,311 residential and commercial PV systems totaling 2,224 MW, and 80 utility-scale systems totaling 798 MW (see Table 1).[11] The residential and commercial systems in the sample were installed over the 14-year period from 1998-2011, though the majority (64%) were installed within the last three years of the sample period. The utility-scale systems in the sample, as to be expected, are even more heavily concentrated within the latter years of the sample period, with 90% of these systems installed from 2009-2011. See Tables B-1 through B-3 in the Appendix for further detail on the residential and commercial sample disaggregated by system size range and state.

The combined 3,022 MW of PV capacity in the data sample represents approximately 76% of all cumulative grid-connected PV capacity installed in the United States through 2011, and 69% of 2011 annual capacity additions (see Figure 1). The gap between the final cleaned data sample and the total U.S. grid-connected PV market consists of: PV systems that were dropped from our data sample due to data quality issues, residential and commercial PV systems not funded by any of the PV incentive programs that contributed data to the analysis, and utility-scale PV systems for which reliable installed price data could not be obtained.

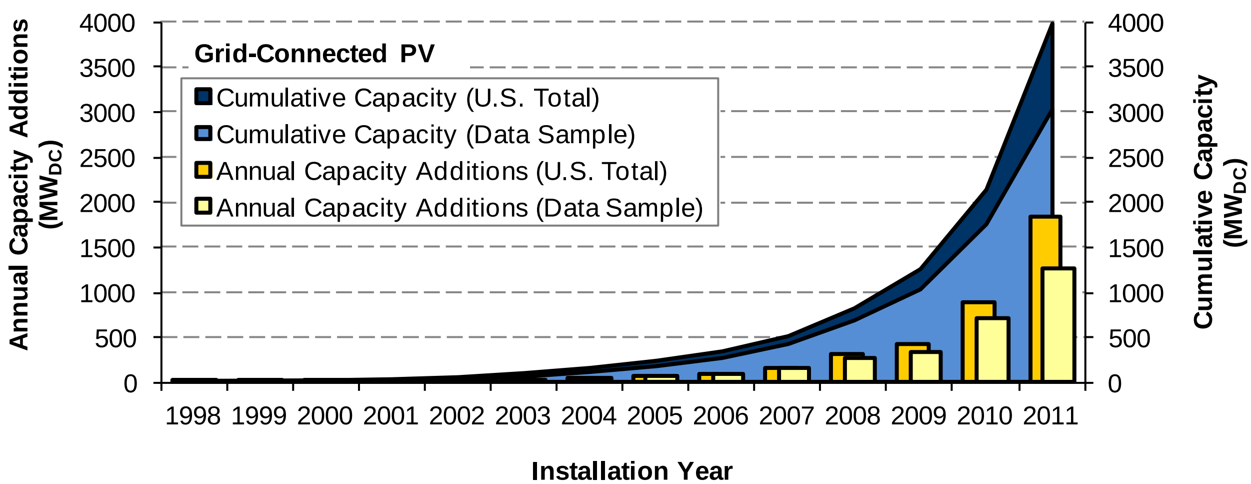
[9] The issue of appraised value reporting is specific to third party owned systems installed by *integrated* companies that provide both the installation service and the customer financing. In these cases, the price reported to incentive program administrators is typically based on the appraised value of a larger bundle of systems, and those appraised values have historically been considerably higher than the reported price for otherwise host customer-owned systems.

[10] We acknowledge that this is a highly simplified assumption and ignores that (a) some project costs may be deemed ineligible for the grant, in which case the grant amount would be *less* than 30% of total project costs, and that (b) the grant amount for some projects may be based on an appraised "fair market value" that is *greater* than the price paid to the installer. Section 1603 grant data was used to estimate installed prices for 300 MW (38%) of the utility-scale PV capacity in the data sample, and a negligible portion of the residential and commercial PV capacity in the data sample.

[11] The sample of residential and commercial systems is described in aggregate, rather than describing the samples of residential and commercial systems separately, as some PV incentive programs do not provide data on the market segment of each system.

Table 1. Data Sample by Installation Year and Market Segment

Installation Year	No. of Systems			Capacity (MW_{DC})		
	Residential & Commercial	Utility	*Total*	Residential & Commercial	Utility	*Total*
1998	39	0	*39*	0.2	0	*0.2*
1999	187	0	*187*	0.8	0	*0.8*
2000	220	0	*220*	0.9	0	*0.9*
2001	1,315	0	*1,315*	5.8	0	*5.8*
2002	2,436	0	*2,436*	18	0	*18*
2003	3,443	0	*3,443*	31	0	*31*
2004	5,589	2	*5,591*	45	8	*53*
2005	5,686	0	*5,686*	64	0	*64*
2006	8,755	0	*8,755*	91	0	*91*
2007	12,913	2	*12,915*	132	22	*155*
2008	14,241	4	*14,245*	241	20	*261*
2009	24,324	4	*24,328*	285	58	*343*
2010	35,178	19	*35,197*	481	241	*723*
2011	37,985	49	*38,034*	827	448	*1275*
Total	***152,311***	***80***	***152,391***	***2,224***	***798***	***3,022***



Data source for U.S. grid-connected PV capacity additions: Sherwood (2012)

Figure 1. Data Sample Compared to Total U.S. Grid-Connected PV Capacity

Geographical and Size Distribution: Residential and Commercial PV

The data sample includes residential and commercial systems spanning 27 states, again, representing the vast majority of all U.S. systems installed to-date.[12] As is the case for the entirety of the U.S. market, the residential and commercial PV capacity in the data sample is heavily weighted towards California and New Jersey, which represent 54% and 18% of the sample, respectively, in terms of total installed capacity (see the left-hand chart in Figure 2). Arizona, Pennsylvania, Massachusetts, North Carolina, and New York each represent 2-7% of the sample capacity, with the remaining 20 states comprising 9% in aggregate.[13] The U.S. PV market has diversified significantly in recent years, however, and this is reflected in the geographical distribution of the 2011 capacity additions in the data sample, as shown on the right-hand chart in Figure 2. Of particular note, California, though still the largest market, represents a smaller share (40%) of this sub-set of the data sample, with correspondingly greater representation among the other leading state markets.

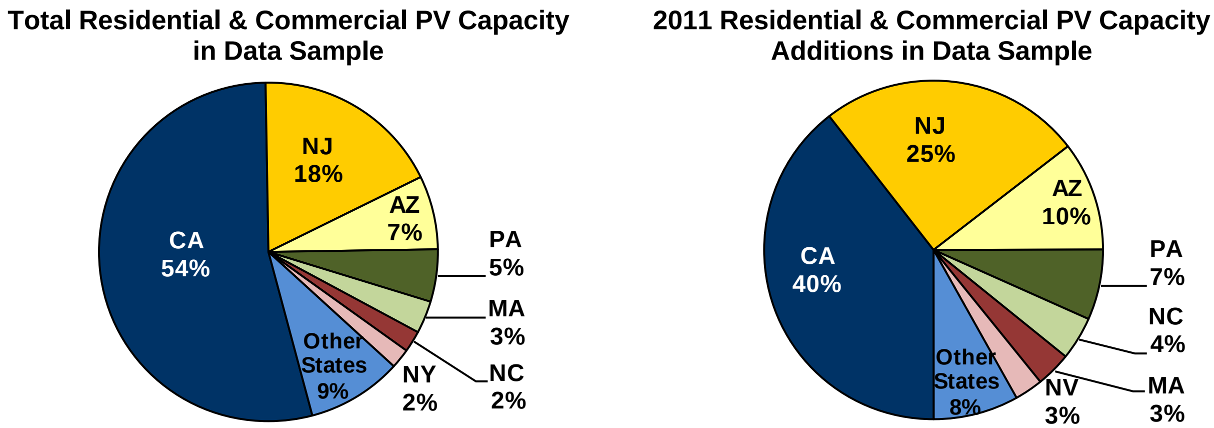


Figure 2. Residential & Commercial PV Sample Distribution among States

The residential and commercial PV systems in the data sample span a wide size range, from as small as 100 W to as large as 9 MW. In terms of the number of projects, the vast majority are relatively small systems, with more than 85% of the systems being ≤10 kW in size (see Figure 3). In terms of installed capacity, however, the sample is considerably more evenly distributed across system size ranges, with the sample capacity split roughly into thirds among systems ≤30 kW, 10-500 kW, and >500 kW.

[12] Data from state and utility PV incentive programs were provided for 23 states; data for a small number of additional large commercial projects were obtained from other secondary data sources, including systems located in an additional 4 states. Note that the sample is largely missing data from two key state solar markets: Colorado and Hawaii. Colorado is unrepresented because its primary PV incentive program administrator was unwilling to contribute data to this research effort, and Hawaii is unrepresented because its primary incentive program does not collect system-level installed-price data. All other major state PV markets are well represented in the final data sample.

[13] The distribution of the residential and commercial PV data sample comports reasonably well with the geographical distribution of the overall U.S. PV market, with the exception of Colorado and Hawaii, which are largely absent from the sample for the reasons explained above. Based on data from SEIA/GTM Research (2012a), cumulative U.S. residential and commercial PV capacity additions through 2011 were distributed among California (43%), New Jersey (19%), Arizona (7%), Pennsylvania (5%), Colorado (5%), Hawaii (3%), New York (3%), Massachusetts (2%), and all other states (14%).

Over time, an increasing portion of residential and commercial PV capacity has consisted of relatively large systems, as shown in Figure 4 (see also Table B-2 in the appendix). For example, systems in the >500 kW size range represented 44% of residential and commercial PV capacity installed in 2011, compared to 0% in 1998-2001. Conversely, systems <100 kW represented 100% of the capacity installed in 1998 but only 35% of the 2011 capacity additions.

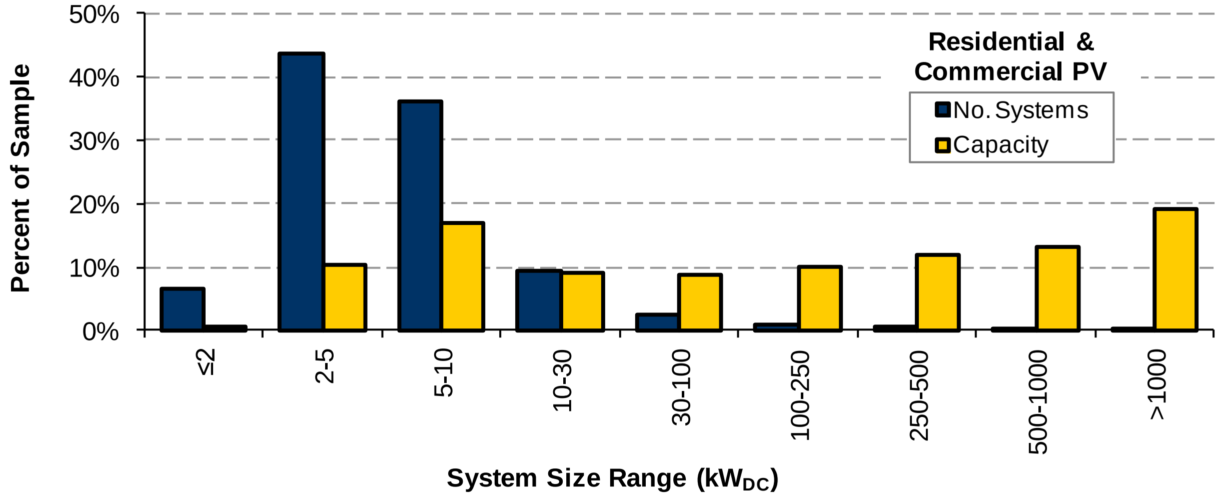


Figure 3. Residential & Commercial PV Sample Distribution by System Size

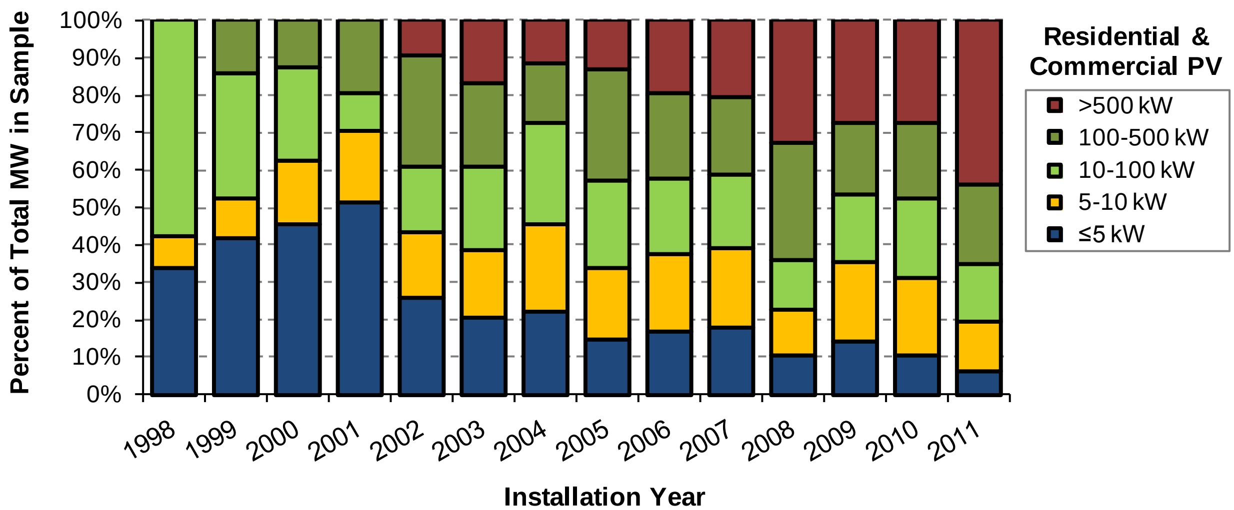


Figure 4. Residential & Commercial PV Sample Distribution by System Size over Time

Geographical and Size Distribution: Utility-Scale PV

The 80 utility-scale PV systems in the data sample are located in a total of 17 states, with almost 90% of the capacity distributed across eight states (California, New Jersey, New Mexico, Nevada, Colorado, Arizona, Florida, and Texas), as shown in Figure 5. As indicated previously, *utility scale PV*, for the purposes of this report, is defined to include any ground-mounted system with a nameplate capacity of 2 MW or larger. As such, the size of the utility-scale PV systems in the data sample ranges widely, from 2 MW up to 58 MW. As indicated in Figure 6, most of the systems in the utility-scale PV data sample (66%) are smaller than 10 MW, though most of the sample capacity (72%) consists of systems larger than 10 MW.

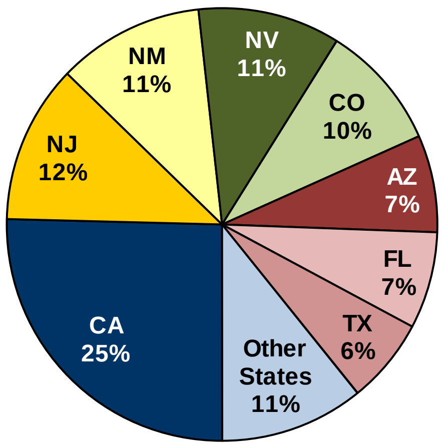


Figure 5. Utility-Scale PV Sample Capacity Distribution among States

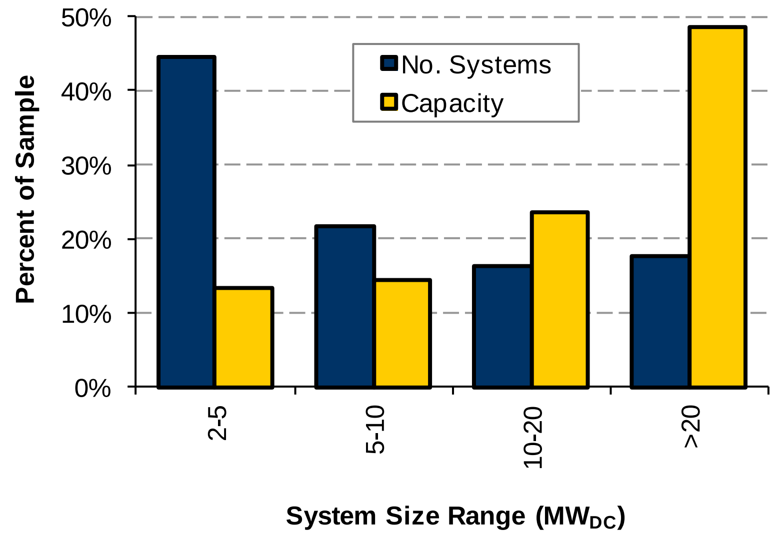


Figure 6. Utility-Scale PV Sample Distribution by System Size

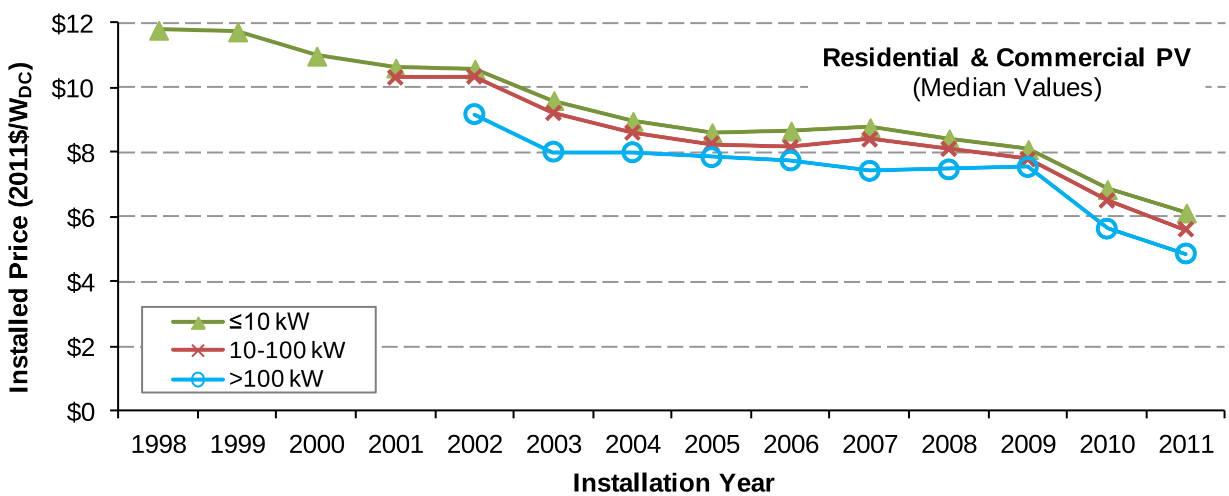
3. Installed Price Trends: Residential and Commercial PV

This section describes trends in the installed price of grid-connected, *residential and commercial* PV systems, based on the data sample and cleaning methods described in Section 2. The installed price data represent reported installed prices, prior to receipt of any financial incentives (e.g., rebates, tax credits, etc.). As indicated previously, the data sample excludes systems for which the reported price was deemed likely to represent an appraised value, rather than a purchase price paid to an installer (see Appendix A for further details).

The present section begins by describing trends in installed price over time, by system size, between the United States and other international markets, among individual states, between customer-owned and third party-owned systems, and across host customer sectors. It then compares installed prices across several types of applications and technologies: BIPV vs. rack-mounted systems, residential new construction vs. residential retrofit, systems with thin-film modules vs. those with crystalline modules, systems with varying module efficiencies, and rooftop systems vs. similarly sized ground-mounted systems with and without tracking. The section then summarizes incentive and solar renewable energy certificate price trends.

Installed Prices Continued Their Precipitous Decline in 2011

Figure 7 presents the median installed price of all residential and commercial projects within the sample, segmented into three system size groupings, from 1998 through 2011. Among the roughly 38,000 residential and commercial PV systems in the sample installed in 2011, the median installed price was \$6.1/W for systems ≤10 kW, \$5.6/W for systems 10-100 kW in size, and \$4.9/W for systems >100 kW. Importantly, though, these median values represent central tendencies, and considerable spread exists among the data that will be described in subsequent figures. Also of particular note is that the national price trends in Figure 7 are dominated by trends within California, which, as discussed previously, constitutes a large fraction of the total U.S. market, and, as will be shown later, has relatively high PV prices compared to other states.



Notes: See Table 1 and Table B-2 for residential and commercial PV sample sizes by installation year. Median installed prices are shown only if 15 or more observations are available for the individual size range.

Figure 7. Installed Price of Residential & Commercial PV over Time

As depicted in Figure 7, installed prices have declined by 5-7% per year, on average, depending on the system size. Price declines, however, have not occurred at a steady pace over the historical period. In particular, installed prices declined markedly until 2005, but then stagnated through roughly 2009 while the PV supply chain struggled to keep pace with surging worldwide demand. Since 2009, installed prices have fallen precipitously as upstream cost reductions – principally PV module cost reductions – worked their way through to end consumers, and as state and utility PV incentive programs continued to ramp down their incentives. From 2010 to 2011, installed prices fell by $0.7/W (11%) for systems ≤10 kW, $0.9/W (14%) for systems 10-100 kW, and $0.8/W (14%) for systems >100 kW. Preliminary data for the first half of 2012 (Text Box 2) show that installed prices have continued to fall, and declines in global module prices over the first half of 2012 suggest that installed system prices will continue to decline as projects in the development pipeline, whose costs reflect current module pricing, are constructed.

Text Box 2. Preliminary Price Trends for Systems Installed in 2012: A Focus on California

Early evidence suggests that the decline in prices for systems installed in 2012 is on pace to match the decline observed in 2011. As an indication of this trend, Figure 2 compares the installed price of projects funded through the California Solar Initiative (CSI) in 2011 and the first half (H1) of 2012.

The median installed price of CSI systems installed in H1 2012 fell by roughly $0.4/W (7%) for systems ≤10 kW and by roughly $0.4/W (6%) for systems 10-100 kW in size, relative to 2011. Prices for systems >100 kW, on the other hand, increased slightly from 2011 to H1 2012, but that is largely due to the fact that the underlying data sample of >100 kW CSI systems consisted of a larger share of relatively small systems in H1 2012 than in 2011 (and smaller systems tend to cost more per watt). Within the narrower size range of 100-500 kW, the median price of CSI systems declined by roughly $ 0.2/W (3%) from 2011 to H1 2012. If CSI prices through the remainder of 2012 continue on the trajectory established during the first half of the year, and if the same price reductions observed within the CSI program transpire more broadly, then the national price reductions in 2012 will be similar to those witnessed in 2011.[14]

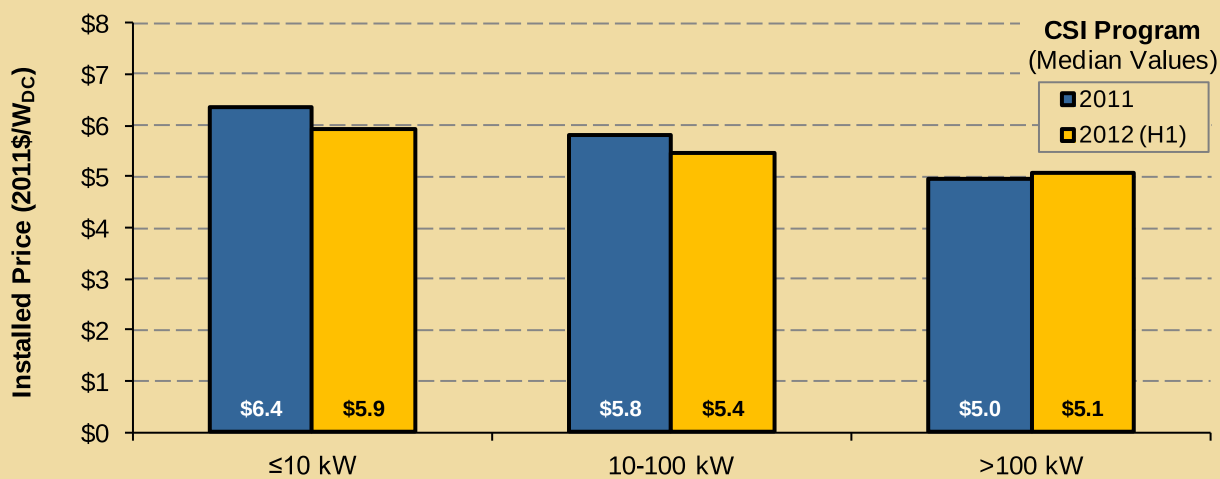
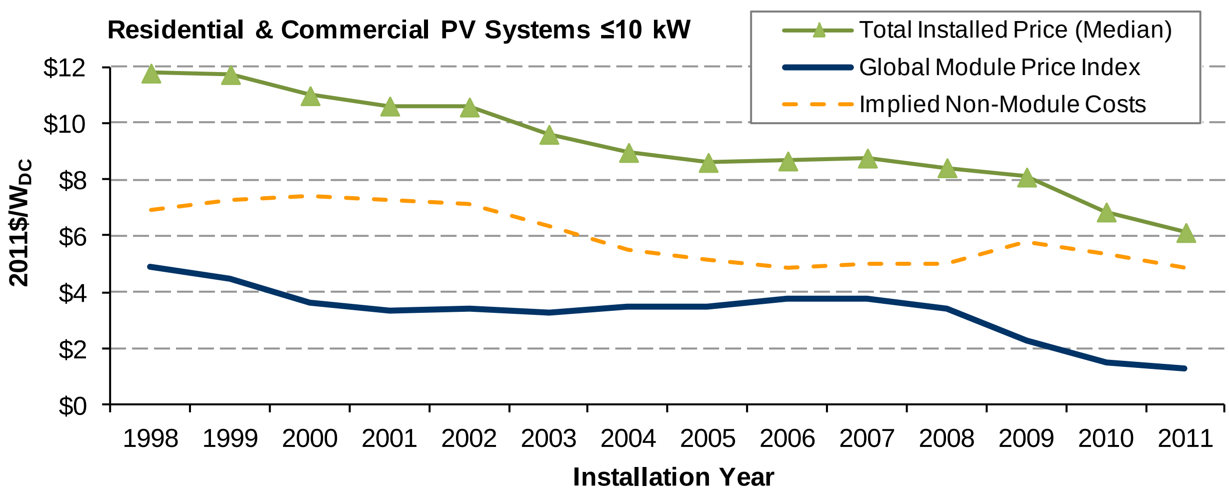


Figure 8. Installed Prices for the CSI Program in 2011 and the First Half of 2012

[14] SEIA/GTM Research (2012b) reported that, nationally, installed prices in the second quarter of 2012 fell by 14.1% year-over-year in the residential sector, and by 13.8% in the non-residential (behind-the-meter) sector, which is roughly on par with 2010-2011 reductions noted previously.

Recent Installed Price Declines Primarily Reflect Falling Module Prices

Figure 9, which focuses specifically on ≤10 kW systems, illustrates the close, but imperfect, historical linkages between installed system prices and PV module prices. As shown, module prices began a steep descent in 2008, falling by $2.1/W in real 2011 dollars, from an annual average price of $3.4/W in 2008 to $1.3/W in 2011 (and have continued to decline through 2012[15]). Over the same period, the total installed price of systems ≤10 kW fell by a similar amount ($2.3/W), though it clearly did not fall in perfect lock-step with module prices within each intervening year. For example, module prices dropped by $1.1/W from 2008-2009, while total installed prices fell by only $0.3/W over that year; installed prices began their dramatic descent a year later than module prices. Conversely, in the last year of the historical period, from 2010-2011, total installed prices fell by a larger amount ($0.7/W) than the decline in the module price index ($0.2/W), potentially indicative of a delayed response to the larger drop in module prices in the preceding year (and/or reductions in non-module costs from 2010-2011).[16] Notwithstanding the imperfect correlation, it is nevertheless clear that the recent installed price declines are primarily the result of rapidly falling module prices.



Notes: The Global Module Price Index is Navigant Consulting's module price index for large-quantity buyers (Mints, 2012). "Implied Non-Module Costs" are calculated as the Total Installed Price minus the Global Module Price Index.

Figure 9. Installed Price, Module Price Index, and Implied Non-Module Costs over Time for Residential & Commercial PV Systems ≤10 kW

Over the longer term, however, installed prices have fallen also as a result of reductions in non-module costs (which include such items as inverters, mounting hardware, labor, permitting and fees, overhead, taxes, and installer profit). The "implied non-module costs" presented in Figure 9 are a residual term, calculated as the difference between the total installed price for systems ≤10 kW and the module price index in each year, and provide a rough proxy for non-module costs over time for this system size range. Given the manner in which this residual term is calculated, it is not a

[15] Module spot-market prices fell by roughly $0.3/W from January to September 2012 (BNEF 2012).

[16] The fact that movements in the global module price index are not immediately reflected in total installed price may reflect any number of underlying dynamics, including: differences in time between when installation contracts are signed and when systems are actually installed, excess module inventory by system installers, supply and delivery constraints among installers or component manufacturers, a lack of competitive pressure in particular markets resulting in value-based rather than cost-reflective pricing, a divergence between global and domestic module prices, or differences between module prices paid by large-quantity buyers (the basis for this index) and installers more generally.

particularly reliable indicator of short-term movements in actual non-module costs, but it does provide a reasonable approximation for longer term trends.[17] Specifically, over the full 14-year period shown in Figure 9, implied non-module costs fell by approximately $2.0/W (30%), from $6.9/W in 1998 to $4.9/W in 2011.[18] This represents 36% of the decline in the total installed price for ≤10 kW systems over that period, clearly indicating the significant impact of non-module cost reductions over the long-term. In fact, it is evident in Figure 9 that, during the first half of the historical period shown, the overall decline in total installed prices was primarily attributable to a reduction in non-module costs. Within the past several years, however, module prices have declined at a much faster pace than non-module costs, and as a result, non-module costs have grown in terms of their relative share of total system costs. This shift in the cost structure of PV systems has heightened the emphasis within the industry and among policymakers on reducing non-module costs and, particularly, business process (or "soft") costs.[19]

Installed Prices Vary Widely Across Individual Projects

The preceding figures have focused on median installed prices among the PV systems in the data sample. Considerable spread exists among these data, however, as illustrated in Figure 10 through Figure 12, which present frequency distributions of installed prices for systems ≤10 kW, 10-100 kW, and >100 kW over time. Over time, the installed price distributions have both *shifted* to the left, reflecting the long term decline in installed prices, and have also *narrowed*. This convergence of prices, with high-priced outliers becoming increasingly infrequent, is consistent with a maturing market characterized by increased competition among installers and module manufacturers and by better-informed consumers. That said, the narrowing trend was most evident within the early years of the historical period, i.e., when comparing the distributions for 1998-2003 and 2004-2008. Since then, the spread in the installed price distribution has remained relatively stable, and a significant degree of variability in pricing across systems has persisted.

For example, among ≤10 kW systems installed in 2011 (which, as shown previously, had a median installed price of $6.1/W), roughly 15% of systems had an installed price less than $5.0/W, while a similar percentage was priced above $8.0/W. The remaining 70% of systems were spread within the relatively wide range of $5.0/W to $7.0/W. The installed price distribution for 10-100 kW and >100 kW systems also exhibit considerable spread, though somewhat less so than for the smaller systems. The fact that such variability exists across all system sizes underscores the need for caution and specificity when referring to the installed price of PV, as clearly there is no single "price" that characterizes the market as a whole. The underlying causes of this variability, some of which are explored throughout the remainder of this report, include project-specific details (e.g., related to system size, technology type, or configuration), as well as attributes of the individual installer and characteristics of the regional/local market (e.g., degree of installer competition and local retail rates or incentive levels).

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[17] In effect, the calculated implied non-module costs reflect both actual non-module costs as well as the effect of any divergence between the module price index in a given year and the module prices actually paid by installers for systems installed in that year. Thus, for example, the increase in implied non-module costs in 2009 may not signify a true increase in actual non-module costs in that year, but may instead largely be an artifact of the lag between the precipitous drop in module prices in 2009 and the associated impact on total installed system prices.

[18] Given the manner in which implied non-module costs are calculated, the decline in *actual* non-module costs over the 1998-2011 period could be greater than the amount estimated here, to the extent that total installed prices in 2011 did not completely absorb module price declines through 2011.

[19] The line between module costs and non-module costs can, admittedly, become somewhat blurred in cases such as modules with integrated racking and AC modules with micro-inverters, which also impact design and installation costs.

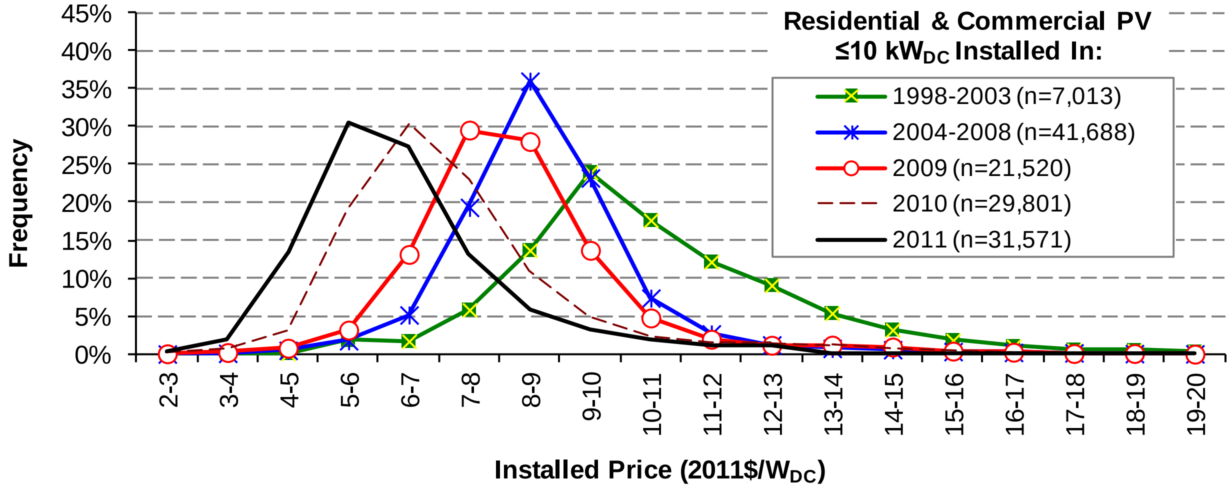


Figure 10. Installed Price Distribution for Residential & Commercial PV (≤10 kW Systems)

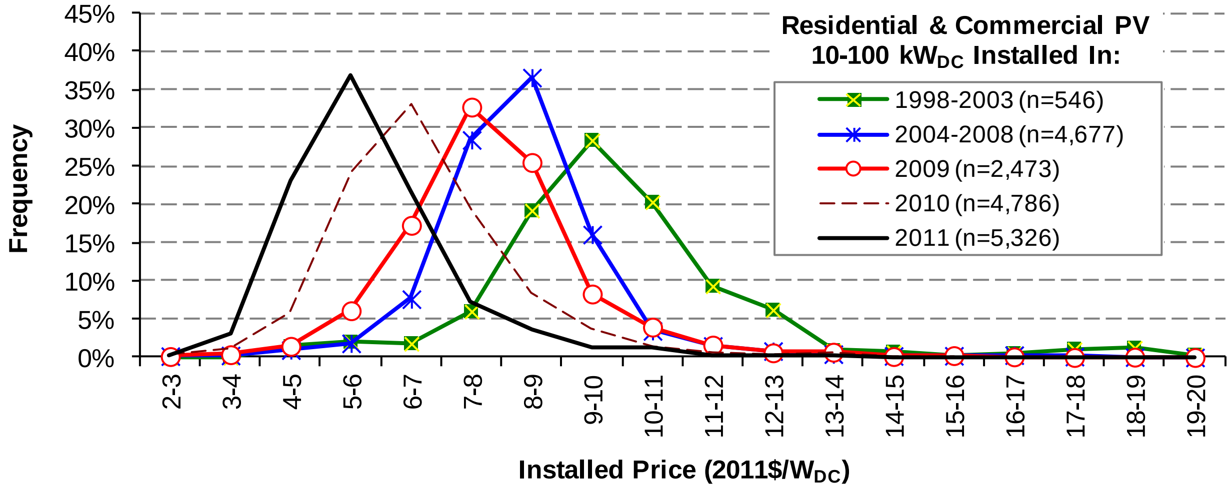


Figure 11. Installed Price Distribution for Residential & Commercial PV (10-100 kW Systems)

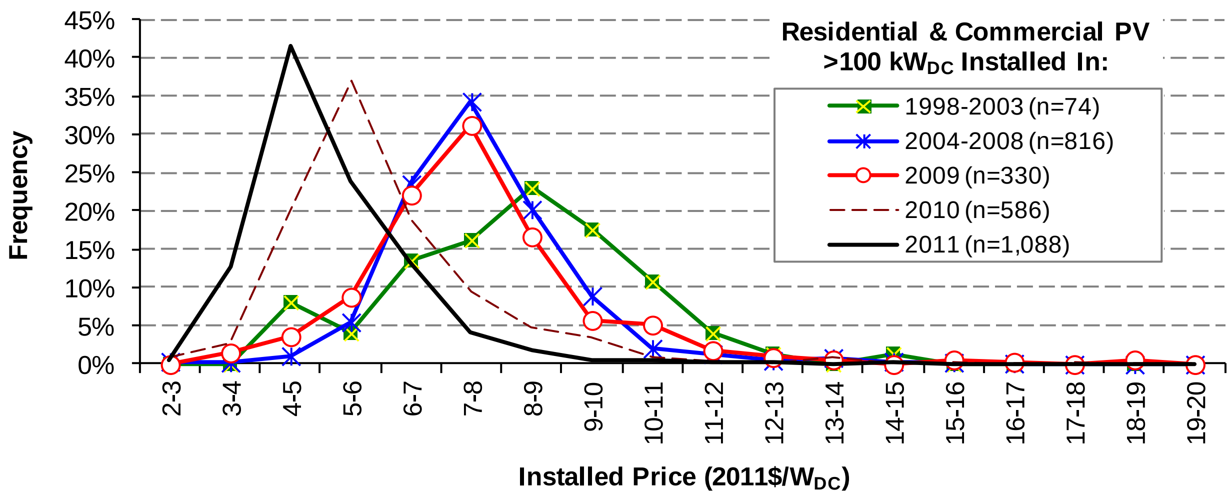


Figure 12. Installed Price Distribution for Residential & Commercial PV (>100 kW Systems)

Installed Price Reporting for Third Party Owned Systems Complicates Analysis of Price Trends

Third party ownership of customer-sited PV systems through power purchase agreements and leases has become increasingly common for PV systems of all sizes and in all market sectors. Under these arrangements, the transaction between the host customer and the system owner typically consists of a series of payments over time, rather than a single up-front payment for the purchase of the PV system. As such, the reporting of prices to state and utility PV incentive programs may differ from a standard cash sale transaction, depending on the type of third party finance provider.

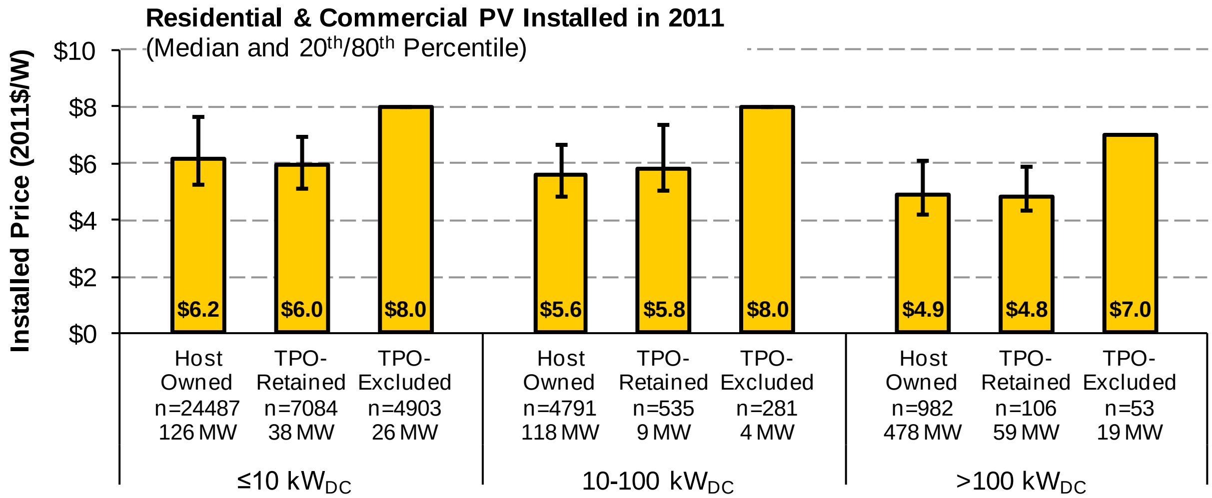
In particular, for systems financed by *non-integrated* third party providers (i.e., companies that provide customer financing but purchase the system from an engineering, procurement, and construction [EPC] contractor), the installed price data reported to PV incentive programs generally represent the actual price paid to the EPC contractor by the third party finance provider, and is roughly (though not perfectly) comparable to what the reported installed price would be under a cash sale transaction.[20] Accordingly, these systems were retained in the data sample. In contrast, in the case of systems financed by *integrated* third party providers (i.e., companies that provide both the installation service and customer financing), the installed price data reported to PV incentive program administrators generally represents an *appraised* value, as there is no intermediate transaction to report. To the extent that systems installed by integrated third party finance providers could be identified, they were removed from the data sample and are excluded from the summary statistics presented in this report (see Appendix A for a description of the screening criteria).

To provide some insight into the potential significance of irregular installed price reporting for third party owned (TPO) systems, Figure 13 and Table 2 compare the reported installed price of host customer owned systems to the reported price for both types of third party owned systems, based on the subset of the sample for which data on system ownership was provided or could be inferred. The figure focuses specifically on systems installed in 2011, while the table provides a time series comparison for the period 2008-2011. The figure and table distinguish between TPO systems that were retained within the data sample (TPO-Retained) and those that were otherwise excluded from the data sample and from all other figures in the report (TPO-Excluded). As shown, installed prices reported for TPO systems retained in the data sample, which are presumed to represent actual transaction prices between third party finance providers and EPC contractors, are nearly identical to the prices reported for host customer owned systems. This is consistent with the expectation that installed price reporting to PV incentive programs for systems financed by non-integrated TPO providers is similar to what would be reported under a cash sale transaction.

In contrast, installed prices reported for TPO systems excluded from the data sample, which are presumed to represent appraised values, are substantially higher than for the other two groups. For example, among systems ≤10 kW installed in 2011, the median price of the excluded TPO systems is \$8.0/W, compared to \$6.0/W for the retained TPO systems and \$6.2/W for the host customer owned systems. The reason for this marked difference is that, for the excluded TPO systems, the installed prices reported to state and utility PV incentive programs are often the same assessed “fair market value” reported by the system owner when applying for a Section 1603 Treasury Grant or federal investment tax credit, which is typically based on a discounted cash flow from the project

[20] In some cases, for example, the installed price reported for systems financed by non-integrated third party finance providers may not reflect certain soft costs that are, instead, borne by the finance provider (e.g., customer acquisition costs or costs associated with filing incentive paperwork).

that is substantially higher than the price that would be paid under a standard cash sale transaction.[21,22,23]



Notes: TPO-Excluded refers to third party owned systems for which reported installed prices were deemed likely to represent an appraised value; those systems are excluded from all other figures in this report. No percentile bands are shown for TPO-Excluded systems, as the percentile values and median values are identical within each size range.

Figure 13. Installed Prices Reported for Host Customer Owned vs. Third Party Owned PV Systems

Table 2. Installed Prices Reported for Host Customer Owned vs. Third Party Owned PV over Time

Installation Year	≤10 kW			10-100 kW			>100 kW		
	Host Owned	TPO-Retained	TPO-Excluded	Host Owned	TPO-Retained	TPO-Excluded	Host Owned	TPO-Retained	TPO-Excluded
2008	$8.4 (n=12169)	$8.2 (n=275)	$10.5 (n=318)	$8.1 (n=1329)	$8.2 (n=69)	$10.5 (n=15)	$7.5 (n=237)	$7.3 (n=162)	* (n=3)
2009	$8.1 (n=20652)	$7.7 (n=868)	$10.8 (n=891)	$7.8 (n=2323)	$7.6 (n=150)	$10.7 (n=56)	$7.5 (n=243)	$7.6 (n=88)	* (n=4)
2010	$6.9 (n=27039)	$6.6 (n=2764)	$9.0 (n=1508)	$6.5 (n=4489)	$6.5 (n=300)	$9.0 (n=94)	$5.6 (n=516)	$6.1 (n=70)	* (n=4)
2011	$6.2 (n=24487)	$6.0 (n=7084)	$8.0 (n=4903)	$5.6 (n=4791)	$5.8 (n=535)	$8.0 (n=281)	$4.9 (n=982)	$4.8 (n=106)	$7.0 (n=53)

Notes: Results are omitted (*) if fewer than 15 observations are available.

[21] Integrated and non-integrated TPO providers both follow similar reporting conventions when reporting fair market value to Treasury; the difference is simply in what is reported to state and utility PV incentive program administrators, where non-integrated providers are able to report an intermediate transaction price with the EPC contractor.

[22] Starting in 2012, one major integrated installer has changed its installed price reporting methodology for PV incentive programs, and is now reporting a standard appraised *cost*, rather than an appraised *fair market value*.

[23] The Treasury Department's guidelines for assessing the cost basis of solar properties identifies three allowable methods for assessing fair market value: the cost approach, based on the actual cost to install the project; the market approach, based on the sale price of comparable properties; or the income approach, based on the discounted value of future cash flows generated by and appropriately allocable to the eligible property. For additional information, see: http://www.treasury.gov/initiatives/recovery/Documents/N%20Evaluating_Cost_Basis_for_Solar_PV_Properties%20final.pdf. The fair market value assessed under the third approach (discounted value of future cash flows) may exceed typical cash sale transaction prices, in part, because of the lease or PPA payments cover additional costs (e.g., financing costs, extended warranties, and performance guarantees) that would not ordinarily be included in a cash sale price.

Installed Prices Exhibit Economies of Scale

Larger PV installations benefit from economies of scale by spreading fixed project and overhead costs over a larger number of installed watts and, depending on the installer, through price reductions on volume purchases of materials. This trend was evident in Figure 7 and can be observed with greater resolution in Figure 14, which shows median installed prices by system size for all residential and commercial PV systems in the data sample installed in 2011. Across the two extremes (excluding utility-scale systems, which are addressed in Section 4), the median installed price for systems >1,000 kW in size ($4.5/W) is 42% lower than for systems ≤2 kW ($7.7/W). Particularly strong economies of scale arise at the low end of the size spectrum, as shown in Figure 15, which provides greater granularity for systems up to 10 kW in size and illustrates the significant price declines that accompany increases in system size from 1-2 kW to 5-6 kW.[24] Economies of scale continue to manifest with further increases in system size, but occur more gradually. Also of note is that, even within each of the system size bins in Figure 14 and Figure 15, significant variability in pricing remains, as evident by the percentile bands within the figures.

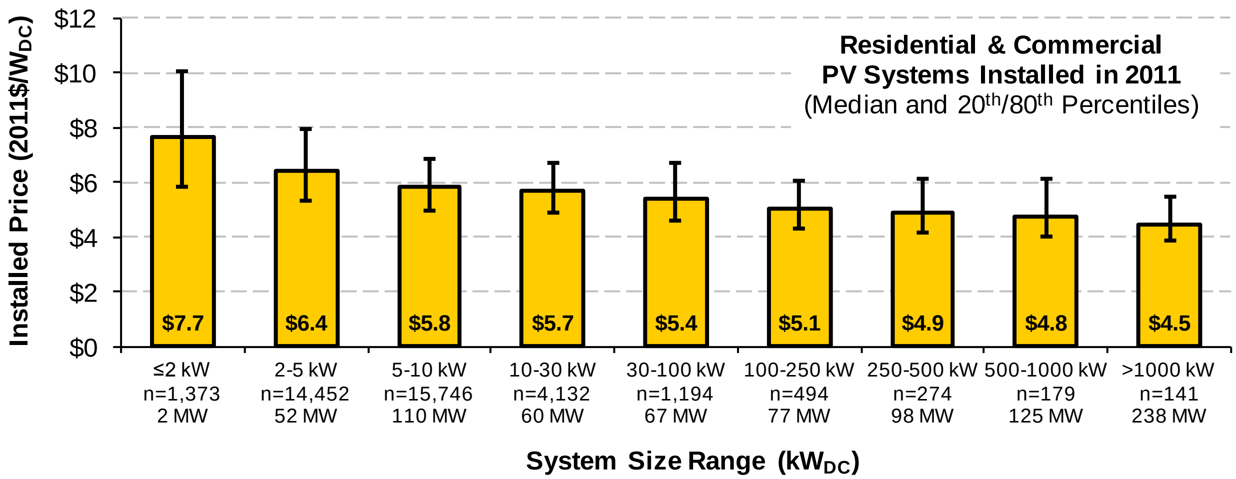


Figure 14. Installed Price of Residential & Commercial PV According to System Size (All Sizes)

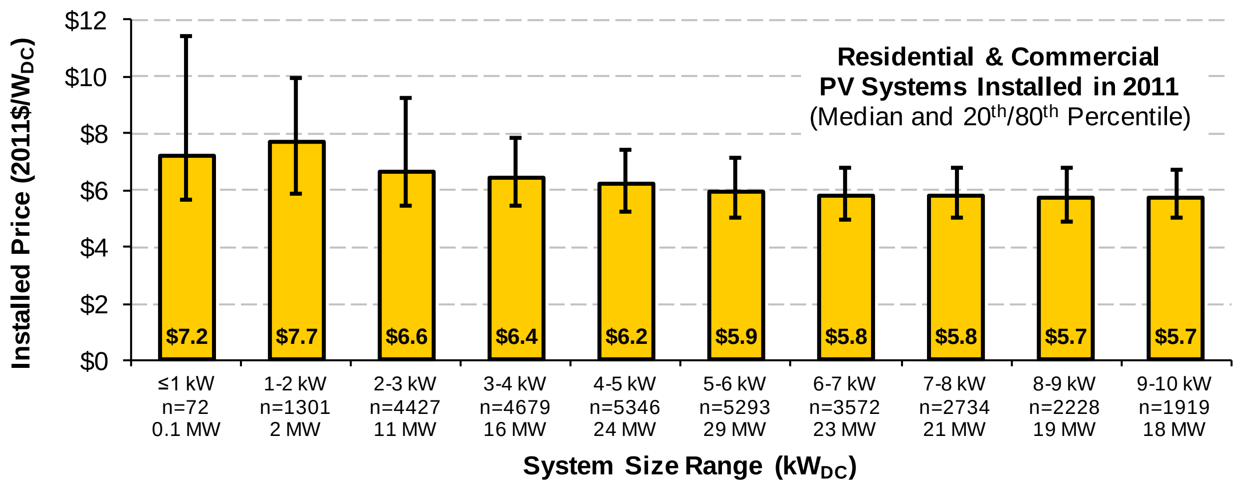


Figure 15. Installed Price of Residential & Commercial PV According to System Size (≤10 kW)

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[24] Given the small sample size of systems within the ≤1 kW size range in Figure 15, no particular significance should be ascribed to the fact that the median price of those systems was less than the median price of 1-2 kW systems.

To a limited extent, the economies of scale exhibited in Figure 14 and Figure 15 help to explain the long-term decline in median installed prices shown previously in Figure 7. As Table 3 shows, median system sizes have risen over time within each of the three size ranges shown, though by varying degrees. Among ≤10 kW systems, in particular, the long-term trend towards increasing median system sizes, from 2.3 kW in 1998 to 5.0 kW in 2011, likely contributed to the installed price decline over that period of time, given the significant scale economies that materialize within that range of system sizes. For the other two system size groups, however, the growth in median system sizes was relatively modest and uneven, and is unlikely to have had any material influence on the observed price declines, either over the long-term or within the more recent past, especially given the declining returns to scale at larger system sizes.

Table 3. Median System Sizes over Time

System Size	Installation Year													
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
≤10 kW	2.3	2.1	2.2	2.8	3.0	3.0	3.1	3.7	3.9	4.2	4.0	4.5	4.9	5.0
10-100 kW	-	-	-	12	12	12	14	16	14	14	15	14	14	15
>100 kW	-	-	-	-	220	230	212	179	231	250	268	251	239	281

Notes: Median system sizes are shown here only if 15 or more observations are available for the corresponding size range. See Table B-2 for sample sizes by installation year for each system size range.

Installed Prices Differ Significantly Among States

The potential importance of state or local conditions is indicated in Figure 16 through Figure 18, which compare median installed prices across states, for systems installed in 2011 within each of the three size groupings: ≤10 kW, 10-100 kW, and >100 kW (see Table B-3 in the Appendix for the full time series of median installed prices by state). Note that the figures include only those states with at least 15 systems installed in 2011 within the respective size grouping; nevertheless, some caution is warranted in interpreting the results for those states with relatively small sample sizes (identified within the figures), as the installed price differences relative to other states may simply reflect idiosyncrasies of the particular systems or installers in the sample for that state, rather than any fundamental underlying state or local conditions.

Across all three system size ranges, substantial differences in median installed prices can be observed. Specifically, among systems ≤10 kW in size, median installed prices range from a low of $4.9/W in Texas to a high of $7.6/W in Washington, D.C. Within the 10-100 kW size range, median installed prices range from $5.0/W in Florida and Nevada to $7.2/W in Texas.[25] Finally, for systems >100 kW, median installed prices range from $4.5/W in Pennsylvania to $6.2/W in Arizona. Within the first two size categories, California is a relatively high-cost state (as asserted previously), thereby pulling installed price statistics for the entire country upward owing to its large fractional share of the sample, especially for systems ≤10 kW.

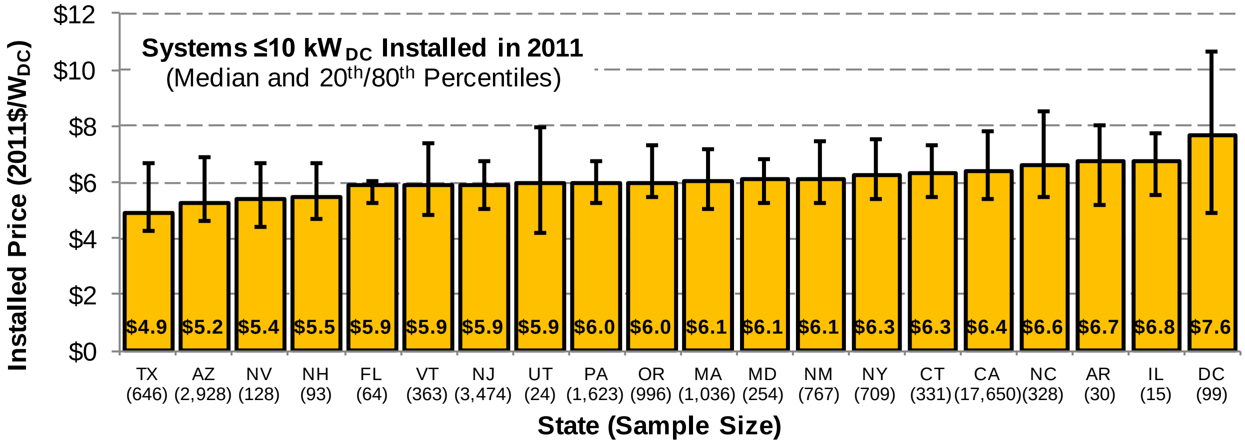
Differences in installed prices across states reflect an array of underlying drivers. Larger or more mature state and regional PV markets can facilitate lower prices through greater competition and efficiency, more extensive bulk purchasing, and better access to low-cost products. That said, a strong correlation is not always evident between state market size and installed system prices, demonstrating that other factors also clearly play an important role in determining state-level

[25] The high median price and wide percentile bands for 10-100 kW systems in Texas are driven, in large part, by a single installer with a large number of relatively small (just over 10 kW) high-priced, customer-owned systems.

pricing. For example, states with less competition among installers, higher incentives, and/or higher electricity rates may have higher prices, if installers are able to “value-price” their systems (i.e., price their systems based on the value they provide to the customer, rather than based on the cost borne by the installer). Variability in prices across states also likely derives from differences in administrative and regulatory compliance costs (e.g., incentive applications, permitting, and interconnection) as well as differences in labor wages. State-level price variation can also arise from differences in the characteristics of the systems installed in each state, such as typical system size, roof-pitch and mounting structures, and the prevalence of tracking equipment. For example, within the class of systems ≤10 kW, systems installed in California in 2011 are relatively small (a median size of 4.3 kW) compared to some of the lower-priced states with sizable markets (e.g., 5.5 kW in Texas, 5.1 kW in Arizona, and 6.9 kW in New Jersey).[26] Finally, differing sales tax rates, which range from zero in Oregon and New Hampshire to a greater-than 9% average sales tax rate in California, and the fact that 11 of the 20 states represented in the figures exempt PV systems from state sales tax, translate to installed price differences of as much as $0.4/W across states.[27]

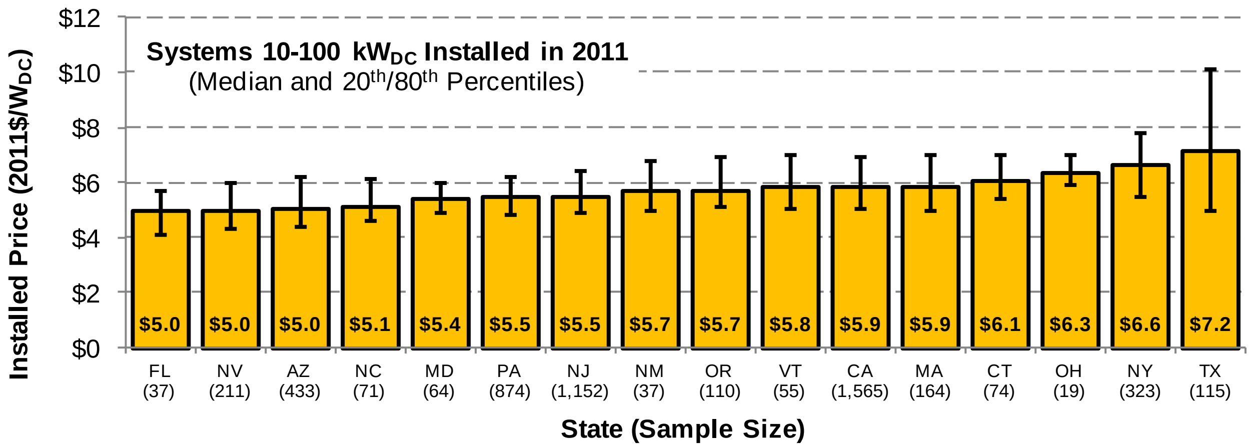
[26] See Table B-3 in the Appendix for median system sizes by state.

[27] Among the states represented within Figure 16 through Figure 18, PV systems are exempt from state sales tax in Arizona, Connecticut, Florida, Massachusetts, Maryland, New Jersey, New Mexico, New York, Ohio, Utah, and Vermont. Nationally, PV systems are currently exempt from state sales tax in 21 states (DSIRE, 2012).



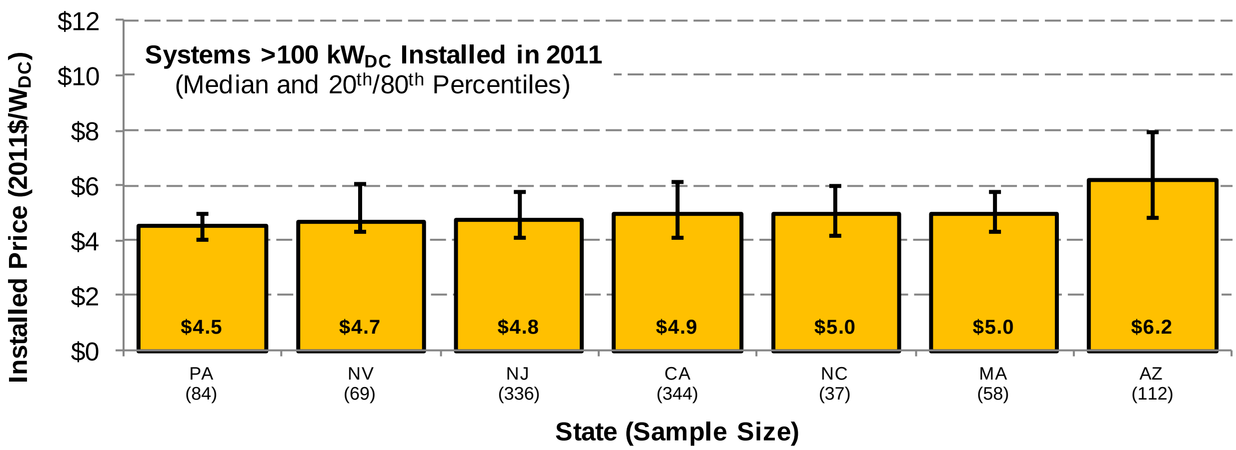
Notes: Median installed prices are shown only if 15 or more observations were available for a given state.

Figure 16. Installed Price of Residential & Commercial PV Systems by State (≤10 kW Systems)



Notes: Median installed prices are shown only if 15 or more observations were available for a given state.

Figure 17. Installed Price of Residential & Commercial PV Systems by State (10-100 kW Systems)



Notes: Median installed prices are shown only if 15 or more observations were available for a given state.

Figure 18. Installed Price of Residential & Commercial PV Systems by State (>100 kW Systems)

Installed Prices in the United States Are Higher than in Many Other Major International PV Markets

Notwithstanding the significant installed price reductions that have already occurred in the United States, international experience suggests that greater near-term reductions may be possible. Figure 19 compares the installed price of *small residential systems* installed in 2011, *excluding sales or value-added tax (VAT)*, across most of the major national PV markets (Germany, Italy, France, Japan, Australia, and the United States).[28] The figure focuses on small residential systems, as that is the size class for which data are available over the widest set of countries. The data, however, are not perfectly comparable, as the specific system size ranges differ slightly from one country to another, as does the quality and transparency of the underlying source.[29] Nevertheless, the figure suggests that the installed price of small residential PV in the United States remains relatively high compared to many other major markets. In particular, of the five other countries shown in Figure 19, all but one (Japan) had lower prices than the United States. The pricing disparity is greatest in comparison to Germany, where the installed price for small residential PV in 2011 was $3.4/W, roughly 43% below the median U.S. price.

Drawing upon a different and more extensive data source for Germany[30], Figure 20 compares median installed prices between the United States and Germany across a broader range of residential and commercial system sizes, again excluding sales tax/VAT and focusing on systems installed in 2011. Although the two sets of data are also not perfectly comparable (because the German data are based on price quotes for prospective systems, while the U.S. data are based on installed systems), the figure indicates that the sizable U.S.-German PV price gap for small residential systems shown in Figure 19 also extends to larger residential and commercial systems.

Given that modules and other hardware items are effectively commodities, with only marginal price differences across countries, much of the pricing variation across countries can be attributed to differences in "soft costs".[31] These differences in soft costs may, in turn, be partly attributable to differences in the cumulative size of each market, as shown in Figure 19, where Germany and Italy had amassed roughly 25 GW and 13 GW of grid-connected PV capacity through 2011, far more than any other individual country, potentially allowing for learning-based cost reductions. That said, larger market size, alone, does not account for the entirety of the differences in average installed costs among countries, as indicated by the pricing shown for Australia in Figure 15.[32]

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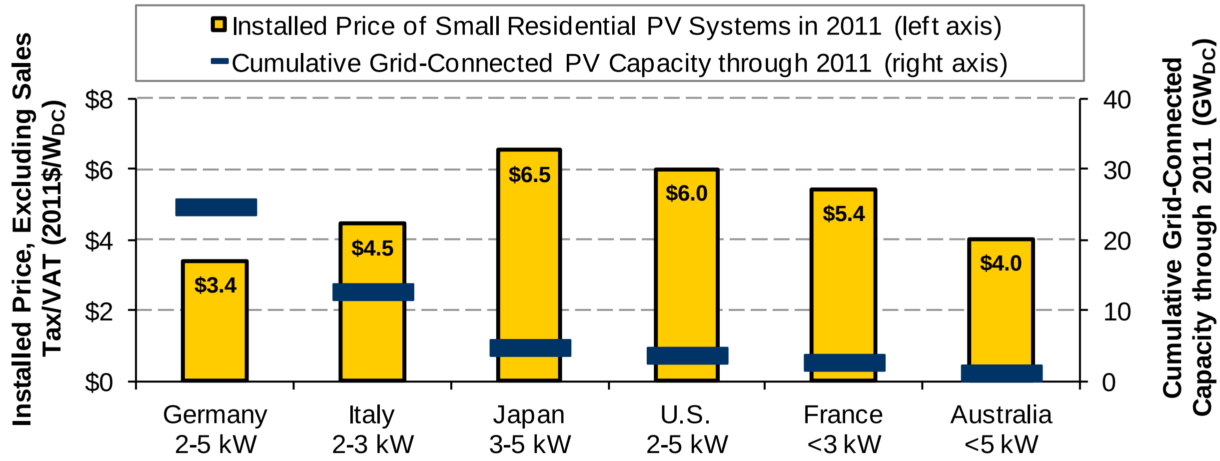
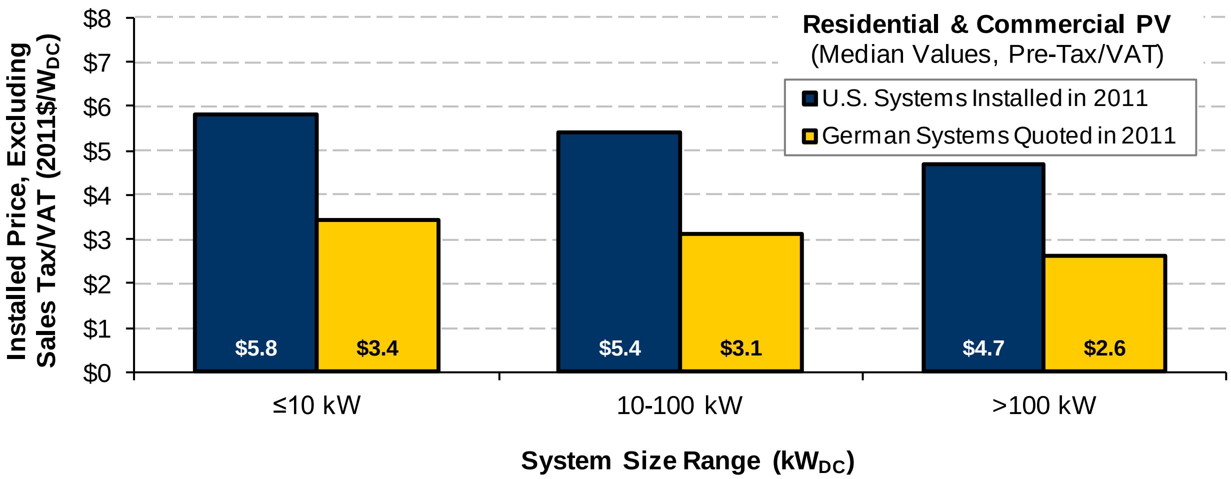
[28] Comparable data for China, the third-largest PV market in 2011, were not available at the time of report publication.
[29] The installed price data for each country derive from its respective IEA Programme on Photovoltaic Systems (PVPS) Country Report, and represent the reported "turnkey price of typical PV applications" of the particular size range identified. In general, little information is provided within the PVPS country reports about the underlying sources for the reported price data.
[30] This figure relies upon price quotes for 5,729 individual German PV systems, obtained by EuPD through its quarterly survey of German installers and provided to LBNL (EuPD 2012).
[31] See Seel et al. (2012)
[32] For example, installed prices may also differ among countries as a result of (among other things) differences in incentive levels; component country-of-origin; interconnection standards; labor costs; incentive, permitting, and interconnection processes; foreign exchange rates; and average system size.



Notes: The U.S. data point represents the median price of 2-5 kW residential systems installed in 2011, and unlike other figures presented in this report, excludes sales tax. All other installed price data represent the "turnkey price of typical PV applications" reported in each country's IEA PVPS Country Report, for the particular size range shown (Castello et al. 2012, Durand 2012, Watt et al. 2012, Wissing 2012, Yamada and Ikki 2012). For Germany, the reported price in each year's country report represents the year-end price, and the value plotted in the figure is the average of the year-end 2010 and year-end 2011 values, in order to provide greater comparability to the other values, which represent annual averages for 2011. Cumulative installed capacity data for each country derive from REN21 (2012).

Figure 19. Comparison of the Installed Price for Small Residential PV Systems in 2011 across Major National Markets (Pre-Sales Tax/VAT)



Notes: This figure relies upon price quotes for 5,729 individual German PV systems, obtained by EuPD through its quarterly survey of German installers and provided to LBNL (EuPD 2012).

Figure 20. Installed Price of Residential & Commercial U.S. PV Systems Installed in 2011 and German Systems Quoted in 2011 (Pre-Sales Tax/VAT)

Installed Prices Are Moderately Higher for Tax-Exempt Systems than for Other Similarly Sized Systems

Figure 21 and Table 4 compare median installed prices across three host-customer sectors: residential, commercial (for-profit), and tax-exempt (i.e., government, schools, and non-profit). The figure focuses specifically on systems installed in 2011, while the table provides a time series comparison for the period 2007-2011. Note that, for the purpose of this section only, a distinction is made between commercial/for-profit host customers and tax-exempt host customers; elsewhere both are included within the "commercial" designation.

In general, differences across host customer segments within each size range are relatively small. The most consistent trend, both across system sizes and over time, is that tax-exempt systems generally have higher installed prices than similarly sized residential and commercial systems. Among 2011 systems, specifically, the median price of tax-exempt systems was $0.2/W to $0.5/W higher than residential and commercial systems within each size range. This price gap may be attributable, in part, to relatively high transaction costs for systems installed at tax-exempt customer sites (e.g., associated with more complex government procurement processes). As shown in Table 4, however, the size of the price gap has shrunk considerably over time, as PV developers have gained considerable experience servicing public sector customers.

Comparing residential and commercial systems to one another, median installed prices within the 5-10 kW size range were identical, and they differed only marginally within the 10-100 kW range. In prior years, however, residential systems consistently exhibited modestly lower prices than similarly sized commercial systems, as Table 4 indicates. Previously, residential systems may have benefited from some greater degree of standardization and lower transaction costs, compared to similarly-sized commercial systems, but the significance of these differences has evidently diminished.

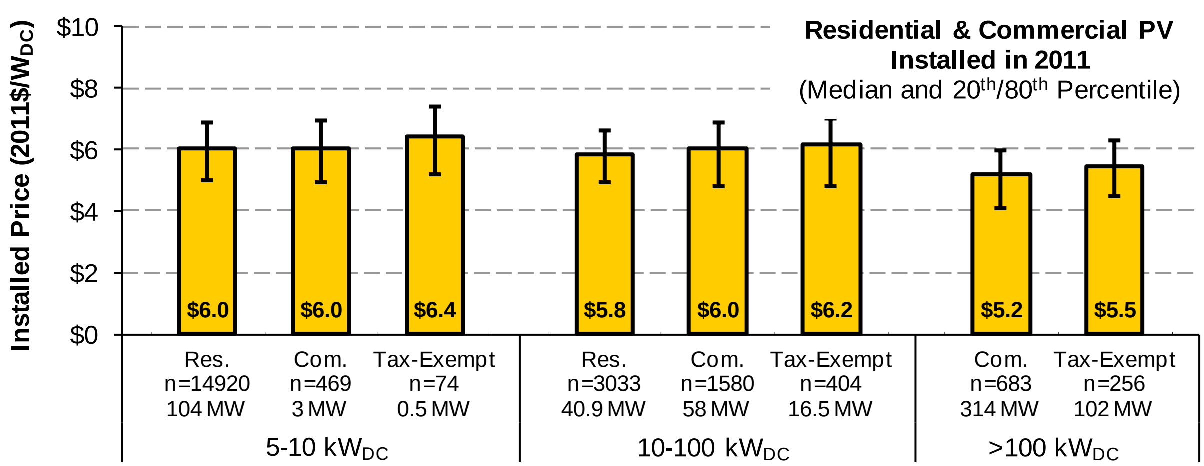


Figure 21. Installed Price Variation across Host Customer Sectors

Table 4. Median Installed Price by Host Customer Sector over Time

Installation Year	5-10 kW			10-100 kW			>100 kW	
	Residential	Commercial	Tax-Exempt	Residential	Commercial	Tax-Exempt	Commercial	Tax-Exempt
2007	$8.7 (n=2138)	$9.0 (n=92)	$9.7 (n=25)	$8.6 (n=313)	$9.1 (n=147)	$9.5 (n=35)	$7.4 (n=51)	* (n=13)
2008	$8.3 (n=3774)	$8.8 (n=178)	$8.8 (n=46)	$8.2 (n=712)	$8.3 (n=397)	$8.8 (n=123)	$7.3 (n=254)	$9.4 (n=66)
2009	$7.8 (n=8266)	$8.4 (n=319)	$9.1 (n=56)	$7.6 (n=1553)	$8.3 (n=675)	$8.7 (n=158)	$7.6 (n=199)	$8.3 (n=103)
2010	$6.7 (n=13599)	$7.0 (n=413)	$7.1 (n=64)	$6.6 (n=2889)	$7.0 (n=1311)	$7.5 (n=326)	$6.0 (n=419)	$6.4 (n=120)
2011	$6.0 (n=14920)	$6.0 (n=469)	$6.4 (n=74)	$5.8 (n=3033)	$6.0 (n=1580)	$6.2 (n=404)	$5.2 (n=683)	$5.5 (n=256)

Notes: The table is based on those systems for which the data provided by PV incentive program administrators identified host customer type. Results are omitted (*) if fewer than 15 observations are available.

Installed Prices Have Generally Been Somewhat Higher for Building-Integrated PV than for Rack-Mounted PV

Building-integrated PV (BIPV) technologies offer the potential for more aesthetically pleasing designs, but have attained relatively modest market shares to-date. Compared to traditional rack-mounted systems, BIPV also holds the prospect of lower costs associated with reduced mounting hardware and labor costs, as well as the ability to potentially offset roofing materials (James et al. 2011). At the same time, however, BIPV products may be sold at a premium relative to rack-mounted modules due to their additional structural features and functional requirements, and BIPV panel efficiencies are generally lower than typical crystalline module efficiencies in rack-mounted applications, leading to increased area-related balance of systems costs.[33]

To provide a measure of the net impact of these countervailing factors, Figure 22 compares the installed price of BIPV and rack-mounted systems installed in 2011, for each of the three system size ranges shown, while Figure 22 presents these comparisons over time (in both cases excluding ground-mounted and tracking systems). Importantly, by focusing on just the installed price of the PV system, these data do not account for avoided roofing material costs, and thus do not provide a comprehensive comparison of the relative cost of BIPV vs. rack-mounted systems.

Figure 22 exhibits no consistent relationship between the installed price of BIPV and rack-mounted systems, as the sample of BIPV systems has an identical median price to the rack-mounted systems within the ≤10 kW size range, a somewhat higher price within the 10-100 kW size range, and a somewhat lower price within the >100 kW range. This absence of any consistent direction trend among 2011 installations may be symptomatic of the small sample sizes for BIPV systems. The longer-term historical trend in Table 5, however, does indicate that the installed price of BIPV systems has generally been higher than for similarly sized rack-mounted systems. Among systems ≤10 kW, for example, the median installed price of BIPV systems exceeded that of rack-mounted systems by $0.3-$0.9/W in each year from 2007-2010. Within the 10-100 kW and >100 kW size ranges as well, BIPV systems have historically had a higher installed price than rack-mounted systems, though those time trends are considerably more volatile, given the much smaller sample sizes available.

[33] BIPV systems may also experience lower performance than rack-mounted systems as a result of higher operating temperatures and faster thermal degradation rates, which most directly affects the levelized cost of energy but may also put downward pressure on installed prices.

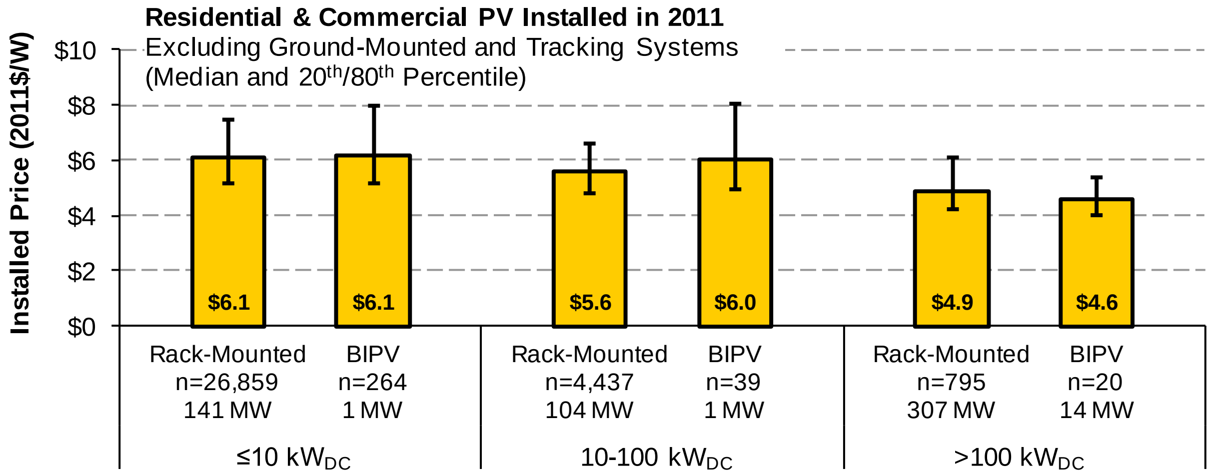


Figure 22. Installed Price of BIPV vs. Rack-Mounted PV Systems

Table 5. Median Installed Price of BIPV vs. Rack-Mounted PV over Time

Installation Year	**≤10 kW**		**10-100 kW**		**>100 kW**	
	Rack-Mounted	BIPV	Rack-Mounted	BIPV	Rack-Mounted	BIPV
2007	$8.7 (n=9652)	$9.0 (n=734)	$8.4 (n=1101)	$9.0 (n=15)	$7.4 (n=122)	$8.4 (n=15)
2008	$8.3 (n=9485)	$8.6 (n=1064)	$8.0 (n=1130)	$7.9 (n=32)	$7.5 (n=293)	$8.0 (n=16)
2009	$8.0 (n=16883)	$8.4 (n=1046)	$7.7 (n=1959)	$8.2 (n=49)	$7.7 (n=187)	* (n=7)
2010	$6.8 (n=24160)	$7.7 (n=613)	$6.4 (n=3793)	$6.2 (n=54)	$5.6 (n=396)	* (n=5)
2011	$6.1 (n=26859)	$6.1 (n=264)	$5.6 (n=4437)	$6.0 (n=39)	$4.9 (n=795)	$4.6 (n=20)

Notes: The table is based on those systems for which the module type could be determined from data provided by PV incentive program administrators. All known ground-mounted and tracking systems are excluded from the comparison. Results are omitted (*) if fewer than 15 observations are available.

The New Construction Market Has Historically Exhibited Price Advantages for Small Residential PV, but Recent Trends Are Unclear

PV systems installed in residential new construction may enjoy certain cost advantages relative to systems installed as retrofits to existing homes, as a result of economies of scale (in the case of new housing developments with multiple PV homes) and economies of scope (where certain transaction and labor costs can be shared between the PV installation and other elements of home construction). To examine the extent to which these potential cost advantages have materialized, Figure 23 and Table 6 compare the installed price of PV systems in residential new construction and residential retrofit applications, based on systems funded through two California programs, the California Solar Initiative (CSI) and the New Solar Homes Partnership (NSHP) program (Figure 23 presents data for 2011 installations, while Table 6 provides a time series for the 2007-2011 period). The figure and table both focus solely on 2-3 kW systems, the most typical size range for PV systems installed in residential new construction, and distinguish between rack-mounted and BIPV systems in residential new construction (given the much greater prevalence of BIPV within new construction).

The sample sizes for PV systems installed in new construction, and thus the quality of the comparisons in Figure 23 and Table 6, have been degraded by the slowdown in the residential new construction housing market in recent years. Within the first several years of the historical period shown in Table 6 when the sample sizes were more robust, the installed price of PV systems in residential new construction was moderately lower than in residential retrofits (i.e., a difference of $0.3 - $0.5/W, depending on the year) when including both rack-mounted and BIPV systems. As shown, though, within residential new construction the installed price of BIPV systems has consistently been significantly higher (by $0.6 - $1.1/W) than rack-mounted systems. Thus, if comparing only rack-mounted systems between residential retrofit and new construction, the cost advantages of new construction have been much more substantial, with a difference in median prices ranging from $0.8 - $1.2/W during the 2007-2009 period. The fact that these trends did not persist into 2010 and 2011 may, again, simply be an idiosyncratic consequence of the diminished sample size for new construction systems in 2011. However, the absence of any significant decline over recent years in the installed price of PV in new construction may also partly be the consequence of structural lags specific to PV in the residential new construction market (e.g., if PV modules are being held in inventory by housing developers as they slowly complete new developments and/or if PV system prices are being reported only after home sales occur, which may occur many months after the installation is completed).[34]

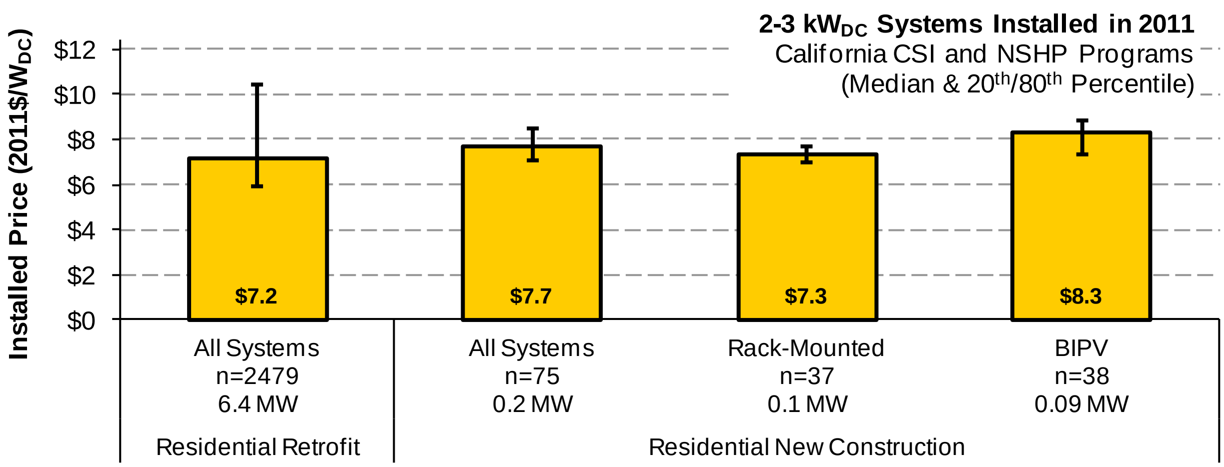


Figure 23. Installed Price of Residential Retrofit vs. New Construction

Table 6. Median Installed Price of Residential Retrofit vs. New Construction over Time

Installation Year	Residential Retrofit (2-3 kW)	Residential New Construction (2-3 kW)		
		All Systems	Rack-Mounted	BIPV
2007	$9.1 (n=499)	$8.6 (n=280)	$8.1 (n=64)	$8.7 (n=216)
2008	$8.7 (n=1094)	$8.4 (n=925)	$7.9 (n=256)	$8.5 (n=669)
2009	$8.6 (n=1549)	$8.3 (n=834)	$7.4 (n=226)	$8.5 (n=608)
2010	$7.9 (n=1737)	$8.0 (n=241)	$7.4 (n=57)	$8.2 (n=184)
2011	$7.2 (n=2479)	$7.7 (n=75)	$7.3 (n=37)	$8.3 (n=38)

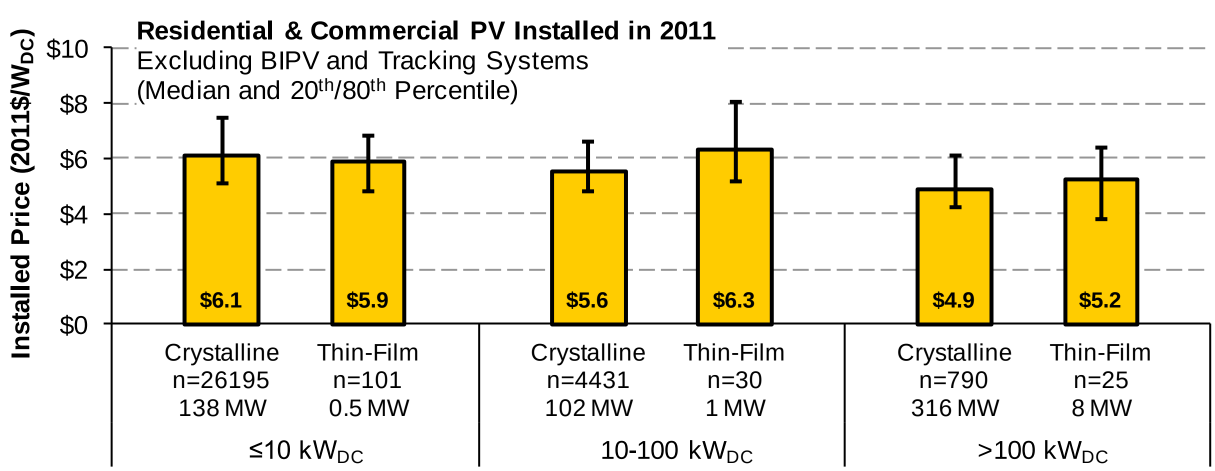
Notes: These are derived solely from systems funded through the CSI and NSHP programs that could be identified as either rack-mounted or BIPV. Results are omitted (*) if fewer than 15 observations are available.

[34] In addition, there may be some uncertainty in how installed prices are reported for PV systems in residential new construction (e.g., in cases where the homebuilder does not purchase the PV system on a stand-alone basis, but rather, the PV system is installed by an electrician or roofer and is invoiced as part of a larger job).

The Choice between Thin-Film and Crystalline Modules Has No Discernible Impact on the Total Installed Price of Residential and Commercial PV

Although thin-film modules (i.e., amorphous silicon and non-silicon technologies) may find their most competitive applications within the utility-scale market, the technology has attained modest use within the residential and commercial rooftop markets. The difference in installed price between systems employing thin-film modules and those with crystalline modules is driven by a number of countervailing factors. Thin-film modules are typically lower-priced than crystalline modules on a per-Watt basis, but are less efficient, which tends to increase balance of system costs. Some differentiation in system pricing may also occur as a result of anticipated differences in performance. In particular, greater uncertainty in the long-term performance of thin-film modules on the part of consumers and potentially faster degradation rates may tend to drive down the price of thin-film systems relative to crystalline systems. At the same time, however, some thin-film technologies have higher energy yields (annual kWh per installed kW) than crystalline modules, due to better performance at high temperatures or under diffuse irradiance, which would tend to increase the price that customers are willing to pay for PV systems with thin-film modules.

To understand the net effect of these cost drivers within the residential and commercial market, Figure 24 compares the average installed price of crystalline and thin-film systems installed in 2011, while Table 7 provides the corresponding time series (see Section 4 for a comparison of installed prices for crystalline vs. thin-film utility-scale systems). To eliminate any biases associated with a higher incidence of BIPV among thin-film systems and a higher incidence of tracking equipment among crystalline systems, the data sample used for this comparison excludes all identifiable BIPV and tracking systems. In 2011 as well as in prior years, neither those systems with crystalline modules nor those with thin-film modules exhibit any consistent price advantage across system sizes. Among 2011 systems, for example, thin-film systems in the 10-100 kW and >100 kW size ranges had higher median installed prices than comparably-sized crystalline systems ($0.7/W higher among 10-100 kW systems and $0.3/W higher among >100 kW systems), whereas thin-film systems in the ≤10 kW size range had a median installed price $0.2/W lower than crystalline systems. In general, however, the sample size of thin-film systems is quite small, particularly within the two larger residential and commercial size ranges show, and definitive generalizations from these comparisons should not be drawn.



Notes: The figure is derived from those systems for which module technology type could be readily determined from module manufacturer and model data provided by PV incentive program administrators.

Figure 24. Installed Price of Crystalline vs. Thin-Film Residential & Commercial Systems

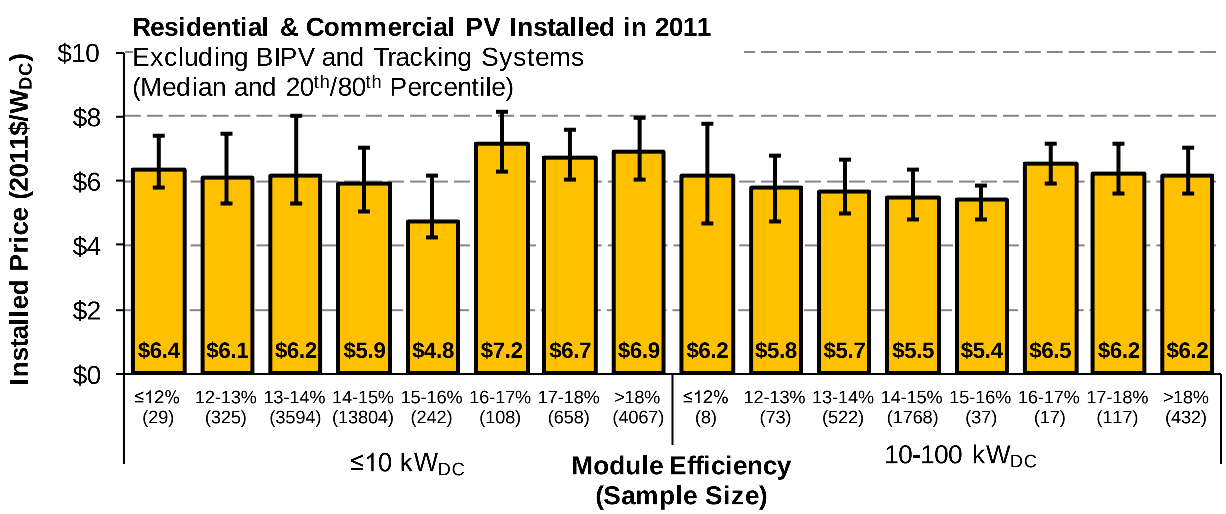
Table 7. Median Installed Price of Crystalline vs. Thin-Film Systems over Time

Installation Year	≤10 kW		10-100 kW		>100 kW	
	Crystalline	Thin-Film	Crystalline	Thin-Film	Crystalline	Thin-Film
2007	$8.7 (n=8469)	$5.9 (n=30)	$8.3 (n=972)	* (n=5)	$7.5 (n=94)	* (n=5)
2008	$8.3 (n=8202)	* (n=9)	$8.0 (n=973)	* (n=12)	$7.5 (n=224)	* (n=11)
2009	$8.0 (n=14005)	$7.8 (n=224)	$7.7 (n=1674)	$7.5 (n=33)	$7.6 (n=164)	* (n=8)
2010	$6.7 (n=22479)	$7.3 (n=73)	$6.4 (n=3623)	$7.1 (n=20)	$5.6 (n=382)	$5.6 (n=19)
2011	$6.1 (n=26195)	$5.9 (n=101)	$5.6 (n=4431)	$6.3 (n=30)	$4.9 (n=790)	$5.2 (n=25)

Notes: The table is derived from those systems for which module technology type could be readily determined from module data provided by PV incentive program administrators. Results are omitted (*) if fewer than 15 observations are available.

Installed Prices Were Lowest for Systems Using Modules with Mid-Range Efficiencies

To examine the relationship between total installed price and module efficiency more directly, Figure 25 compares median installed prices according to module efficiency for systems installed in 2011, within two system size ranges (≤10 kW and 10-100 kW). In order to avoid any bias associated with higher incidence of BIPV or tracking equipment among certain module efficiency levels, the figure again excludes BIPV and tracking systems. Within both system size ranges shown, median installed prices were lowest for systems with modules of mid-range efficiencies. The trend is particularly acute for systems ≤10 kW with module efficiencies of 15-16%, which have a median installed price of $4.8/W, more than $1.0/W lower than for systems within any other module efficiency range. The fact that installed prices within that module efficiency range were so much lower is due in large measure to a sizable contingent of particularly low-priced systems using one particular module model and installed by a single installer. The general trend, however, persists more broadly, though less dramatically, as systems with module efficiencies of 14-16% within both size ranges register the lowest median prices.



Notes: The figure is derived from those systems for which rated module efficiency could be readily determined from module manufacturer and model data provided by PV incentive program administrators.

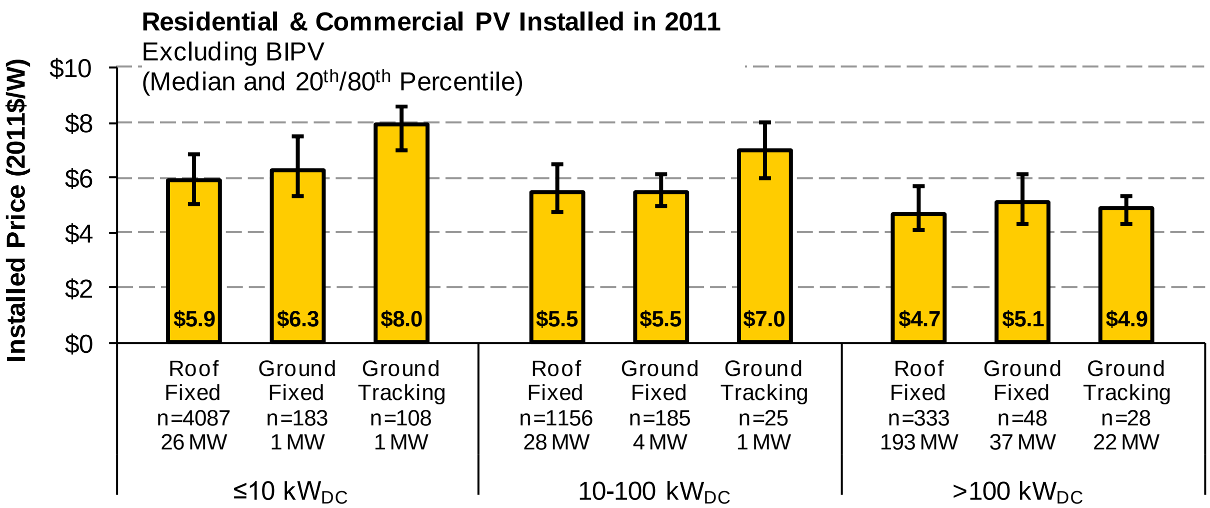
Figure 25. Installed Price Variation with Module Efficiency

Installed Prices Are Typically Higher for Ground-Mounted Systems and for Systems with Tracking Equipment

While residential and commercial PV systems are primarily roof-mounted, the data sample includes a modest number of ground-mounted residential and commercial systems, with either fixed-tilt or tracking. Figure 26 and Table 8 compare installed prices across these three system configurations – roof-mounted, ground-mounted with fixed-tilt, and ground-mounted with tracking – focusing here on residential and commercial systems only (similar comparisons for utility-scale systems are presented in Section 4). Note, though, that the sample sizes for ground-mounted systems are relatively small, suggesting a need for caution in generalizing from these results.

Comparing rooftop systems to fixed-tilt ground-mounted systems, the full time series presented in Table 8 shows that installed prices have generally been greater for ground-mounted systems. Among systems installed in 2011, in particular, the median installed price of fixed-tilt ground mounted systems was \$0.4/W greater than rooftop systems within both the ≤10 kW size range and the >100 kW size range. Median installed prices were identical between the two system configurations within the 10-100 kW size range for 2011 systems, though the time series presented in Table 8 indicates that, across all size ranges, fixed-tilt ground-mounted systems have generally had a higher median installed price than similarly sized rooftop systems.

Comparing ground-mounted systems with fixed-tilt to those with tracking, the time series presented in Table 8 indicates that systems with tracking have generally had higher installed prices than ground-mounted systems without tracking. Among systems installed in 2011, in particular, the median installed price of ground-mounted systems with tracking was \$1.7/W greater than fixed-tilt ground-mounted systems within the ≤10 kW size range and was \$1.5/W greater within the 10-100 kW size range. Curiously, within the >100 kW size range, systems with tracking had a slightly lower median installed price than ground-mounted systems without tracking (\$4.9/W vs. \$5.1/W), though this finding may simply be an idiosyncrasy of the small sample sizes, as for all system sizes and in all other years, systems with tracking had consistently higher installed prices than fixed-tilt ground-mounted systems.



Notes: The figure is derived from those systems for which data were available indicating whether or not the system is roof- or ground-mounted and whether tracking equipment is used.

Figure 26. Installed Price According to Mounting Location and Use of Tracking Equipment

Table 8. Median Installed Price According to Mounting Location and Use of Tracking Equipment

Installation Year	≤10 kW			10-100 kW			>100 kW		
	Roof, Fixed	Ground, Fixed	Ground, Tracking	Roof, Fixed	Ground, Fixed	Ground, Tracking	Roof, Fixed	Ground, Fixed	Ground, Tracking
2007	$8.9 (n=643)	$9.4 (n=44)	$10.6 (n=34)	$8.7 (n=78)	* (n=8)	* (n=4)	$7.4 (n=24)	* (n=0)	* (n=1)
2008	$8.6 (n=720)	$9.3 (n=71)	$10.6 (n=60)	$8.3 (n=122)	$8.8 (n=23)	* (n=14)	$8.5 (n=18)	* (n=2)	$7.4 (n=21)
2009	$8.3 (n=1204)	$8.7 (n=95)	$10.1 (n=102)	$8.0 (n=251)	$8.3 (n=44)	* (n=9)	$7.4 (n=62)	* (n=7)	$7.5 (n=34)
2010	$7.0 (n=2648)	$7.7 (n=144)	$9.1 (n=81)	$6.3 (n=708)	$7.1 (n=98)	$8.7 (n=24)	$5.2 (n=157)	$5.4 (n=24)	$6.1 (n=22)
2011	$5.9 (n=4087)	$6.3 (n=183)	$8.0 (n=108)	$5.5 (n=1156)	$5.5 (n=185)	$7.0 (n=25)	$4.7 (n=333)	$5.1 (n=48)	$4.9 (n=28)

Notes: The table is derived from those systems for which data were available indicating whether or not the system is roof- or ground-mounted and whether tracking equipment is used, and excludes all BIPV systems. Results are omitted (*) if fewer than 15 data points are available.

State/Utility Cash Incentives Continued Their Steady Decline in 2011

Financial incentives provided through utility, state, and federal programs have been a major driving force for the PV market in the United States. For residential and commercial PV systems, those incentives have potentially included some combination of cash incentives provided through state and/or utility PV programs, the federal investment tax credit (ITC) or U.S. Treasury grant in lieu of the ITC[35], state ITCs, revenues from the sale of renewable energy certificates (RECs) or solar renewable energy certificates (SRECs), and accelerated depreciation of capital investments in solar energy systems.

Focusing solely on cash incentives provided through state/utility programs, Figure 27 shows the median cash incentive over time provided by the PV incentive programs within the data sample.[36] These data are presented on a *pre-tax* basis – that is, prior to assessment of state or federal taxes that may be levied if the incentive is treated as taxable income. Note also that the figure presents data based on the year in which systems are installed; as such, it does not necessarily provide an accurate depiction of the size of cash incentives *offered* in each year, as there is typically some lag between the time that a project reserves its incentive and the time that it is installed.

As shown in Figure 27, cash incentives have declined steadily and significantly since 2001/2002. Among systems installed in 2011, median cash incentives ranged from $0.9/W to $1.2/W across the three system size categories shown, having fallen by roughly 80% from their historical peak. Within the last year of the analysis period, cash incentives fell by 21% to 43% ($0.3/W to $0.7/W) across the size ranges shown, an accelerated pace of decline relative to the preceding years.

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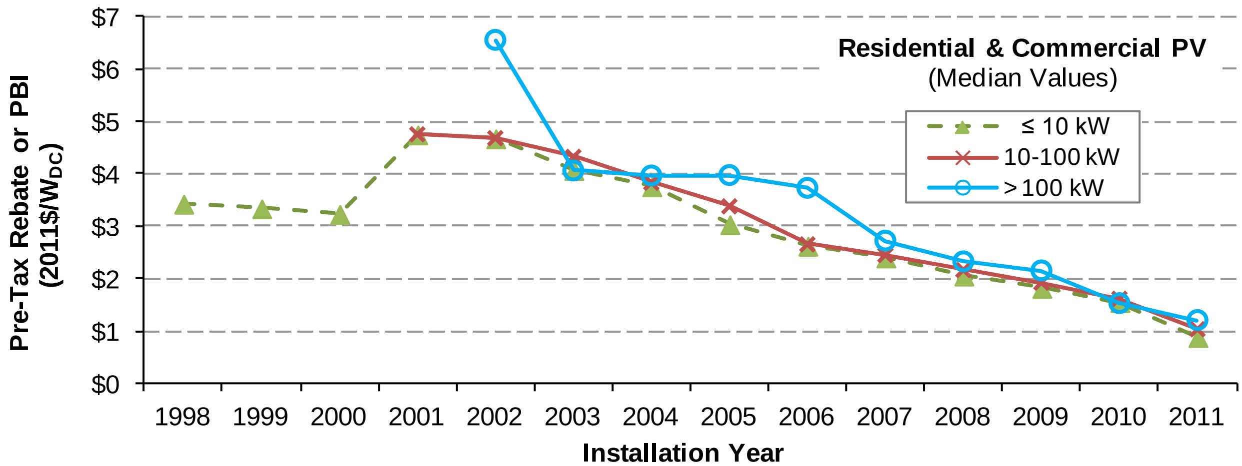
[35] Starting in 2009 and for a limited period, the federal ITC could be converted to a cash grant of equal nominal value from the U.S. Treasury.

[36] The PV incentive programs within the data sample provide cash incentives of varying forms. Most provide up-front cash incentives (i.e., "rebates"), based either on system capacity, a percentage of installed cost, or a projection of annual energy production. Several programs instead provide performance-based incentives (PBIs), which are paid out over time based on a pre-scheduled PBI payment rate and actual energy production; for the purpose of constructing Figure 27, PBI payments are translated into an up-front incentive of equivalent net present value (see Appendix A for further details). Several of the programs within the data sample are not "incentive programs," per se, but are effectively registries for PV systems participating in state SREC markets. SREC payments are not included in Figure 27, as their net present value cannot be predicted with any reasonable level of certainty, but the potential value of SREC payments is discussed within Text Box 3.

Although the incentive levels depicted in Figure 27 are, to some extent, dominated by trends within California's programs, which comprise a large portion of the data sample, incentives within nearly all of the PV incentive programs in the sample have declined over time (see Table B-4 in the Appendix for incentive trends over time for each individual program). This continued ratcheting down of cash incentives over time reflects a combination of factors. States and utilities have reduced incentives both in response to, and to encourage further, installed price declines. State/utility cash incentives have also fallen over time as other sources of financial support for PV projects have become available or more lucrative – most notably, increases in the federal ITC and the emergence of SREC markets in a number of states (see Text Box 3).



Notes: The figure depicts the pre-tax value of rebates and PBI payments provided through state/utility PV incentive programs, excluding programs that provide incentives solely in the form of ongoing SREC payments over time. The high median incentive for >100 systems in 2002 reflects the large percentage of systems that received an incentive through LADWP's PV incentive program, which provided especially lucrative incentives in that year. Results are excluded if fewer than 15 observations are available.

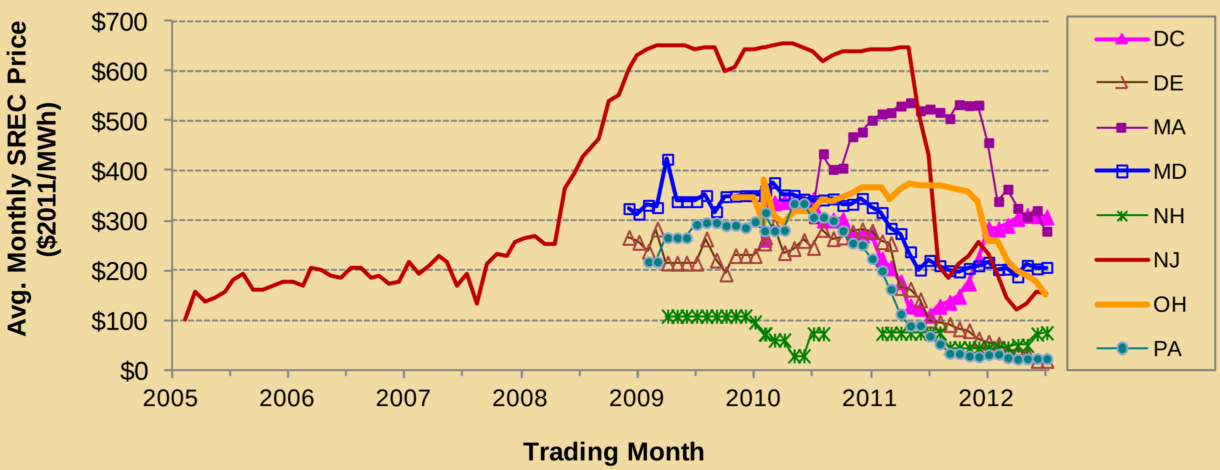
Figure 27. State/Utility Cash Incentives for Residential & Commercial PV

Text Box 3. SREC Prices and Revenues

Sixteen states plus the District of Columbia have enacted renewables portfolio standards with either a solar or distributed generation set-aside (also known as a "carve-out"), and in a number of these states, solar renewable energy certificate (SREC) markets have been established to facilitate compliance. PV system owners in these states (and in some cases, in neighboring states) may sell SRECs generated by their systems, either in addition to or in lieu of direct cash incentives received from state/utility PV incentive programs. Many solar set-aside states have transitioned away from standard-offer based incentives and towards SREC-based financing models, particularly for medium and large commercial systems, although traditional rebate programs (and/or SREC payments provided on an up-front basis) may still be offered to small residential and commercial systems.

SREC prices have varied significantly across states and over time, as illustrated in Figure 28, which shows monthly short-term SREC prices among solar set-aside states with active SREC trading. Within the span of 2011, monthly SREC prices ranged from a low of roughly $25/MWh in Pennsylvania to a high of roughly $650/MWh in New Jersey. SREC spot-market prices across most markets, however, declined significantly during the course of 2011 and into 2012, as states faced a surplus of available SRECs relative to their solar set-aside compliance obligations. Long-term SREC contract prices have also seen substantial reductions, although the availability of long-term contracts (and the visibility into their pricing) is limited. In New Jersey, for example, long-term SREC contract prices awarded through a series of solicitations issued by the state's regulated distribution utilities in September 2011 averaged roughly $215-$230/MWh, depending on system size, compared to $450-$480/MWh in the prior year. In Pennsylvania, long-term SREC contracts procured by the state's utilities fell from roughly $250/MWh for solicitations issued in 2010 to $90-$150/MWh for contracts signed in mid-2011. Long-term contracts procured through Delaware's Pilot SREC Procurement Program in early 2012 yielded contracts in the range of $130-$150/MWh, while the first solicitation issued by one of Connecticut's utilities in May 2012 under the state's zero-emission renewable energy certificate (ZREC) program yielded average prices of roughly $160/MWh.

Given the volatility in historical SREC prices and the general lack of availability of long-term SREC contracts, predicting the value of revenues from SRECs is clearly a highly speculative exercise. As a purely hypothetical illustration, an SREC price of $150/MWh extrapolated over 20 years is equivalent to an up-front, pre-tax incentive of roughly $1.13/W on a present value basis (assuming a 15% nominal discount rate, 1,200 kWh_{AC}/kW_{DC} in Year 1, and 0.5% degradation per year), which is roughly on par with the median state/utility cash incentive provided in 2011.



Sources: Spectron, SRECTrade, and Flett Exchange (data averaged across available sources). Plotted values represent SREC prices for the current or nearest future compliance year traded in each month.

Figure 28. Monthly SREC Prices for Current or Nearest Future Compliance Year

4. Installed Price Trends: Utility-Scale PV

This section describes trends in the installed price of utility-scale PV systems, based on the data sample described in Section 2. As indicated previously, utility-scale PV is defined for the purpose of this analysis to consist of ground-mounted systems >2 MW, and includes a number of customer-sited systems interconnected on the customer-side of the meter. The section begins by describing the range in the installed price of the utility-scale systems in the data sample and trends over time, before describing differences in installed prices according to project size and system configuration (crystalline fixed-tilt vs. crystalline tracking vs. thin-film fixed-tilt), and then comparing the installed price between utility-scale systems and similarly sized large commercial rooftop systems.

Before proceeding, it is important to note that the utility-scale installed price data presented in this section must be interpreted with a certain degree of caution, for several reasons.

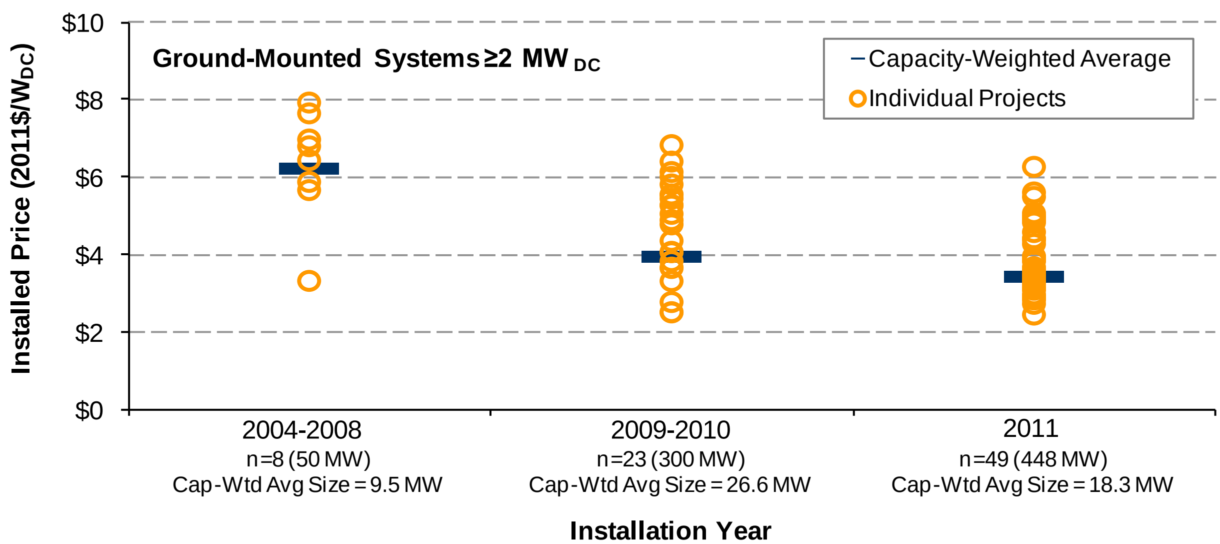
- *Small sample size with atypical utility PV projects*. The utility-scale PV project sample reflects the broader population of utility-scale PV projects that had been constructed in the United States through year-end 2011. As such, the sample is relatively small and it includes a large number of systems in the 2–10 MW size range as well as a number of "one-off" projects with atypical characteristics (e.g., brownfield developments, utility pole-mounted systems, projects built to withstand hurricane winds, etc.). All else being equal, the installed price of these small or otherwise atypical utility-scale projects is likely to be higher than that of the large utility-scale PV projects currently under development.
- *Lag in component pricing and market conditions*. The installed price for utility-scale PV projects may in some cases reflect component pricing, as well as the market conditions under which power sales agreements were signed, one or more years prior to project completion. The data therefore may not fully capture recent declines in module or other component prices or other changes in market conditions.
- *Reliability of data sources*. The installed price data for utility-scale PV projects are derived from varied sources and, in some instances, are arguably less reliable than the data presented for residential and commercial systems.
- *Focus on installed price rather than levelized cost.* It is worth repeating again that focusing on upfront installed price trends ignores performance-related differences and other factors influencing the levelized cost of electricity (LCOE), which is ultimately the more meaningful metric for comparing the cost of utility-scale PV systems.

For the above reasons and others (see Text Box 1), the data presented here may not correspond to recent price benchmarks for utility PV.

The Installed Price of Utility-Scale PV Varies Considerably Across Projects But Has Declined Overall

As is the case for residential and commercial PV, the installed price of utility-scale PV systems also varies widely, as shown in Figure 29. Among the 49 projects in the data sample completed in 2011, for example, installed prices ranged from $2.4/W to $6.3/W, and an even wider spread is evident for the other two time periods shown. This wide distribution of installed price for utility-scale PV data sample invariably reflects a combination of factors, including differences in project size (which range from 2 MW to over 35 MW for systems installed in 2011) and differences in module type (thin-film vs. crystalline) and system configuration (e.g., fixed-tilt vs. tracking systems), all of which are examined further below. The wide price distribution is also attributable to the presence of systems with unique characteristics that may increase costs.

Discerning a time trend is challenging, given the small and diverse sample of projects. As a rough measure of this trend, the capacity-weighted average installed price declined from $6.2/W for projects installed during 2004-2008, to $3.9/W for projects installed during 2009-2010, and to $3.4/W for projects installed in 2011.[37] Of some note, the decline in capacity-weighted average price in 2011 occurred in spite of the fact that utility-scale system sizes were somewhat smaller in 2011 than in 2009-2010 (as indicated by the capacity-weighted average system sizes[38] for each time period, shown along the x-axis).



Notes: The figure includes a number of relatively small (2-10 MW) utility-scale projects as well as several "one-off" projects. In addition, the reported installed price of projects completed in any given year may reflect module and other component pricing at the time of project contracting, which may have occurred one or two years prior to installation. For these reasons and others (see Text Box 1), the data shown here may not accurately depict the installed price of typical utility-scale PV projects completed more recently or currently under development and may not correspond well to recent installed price benchmarks for utility PV.

Figure 29. Installed Price of Utility-Scale PV over Time

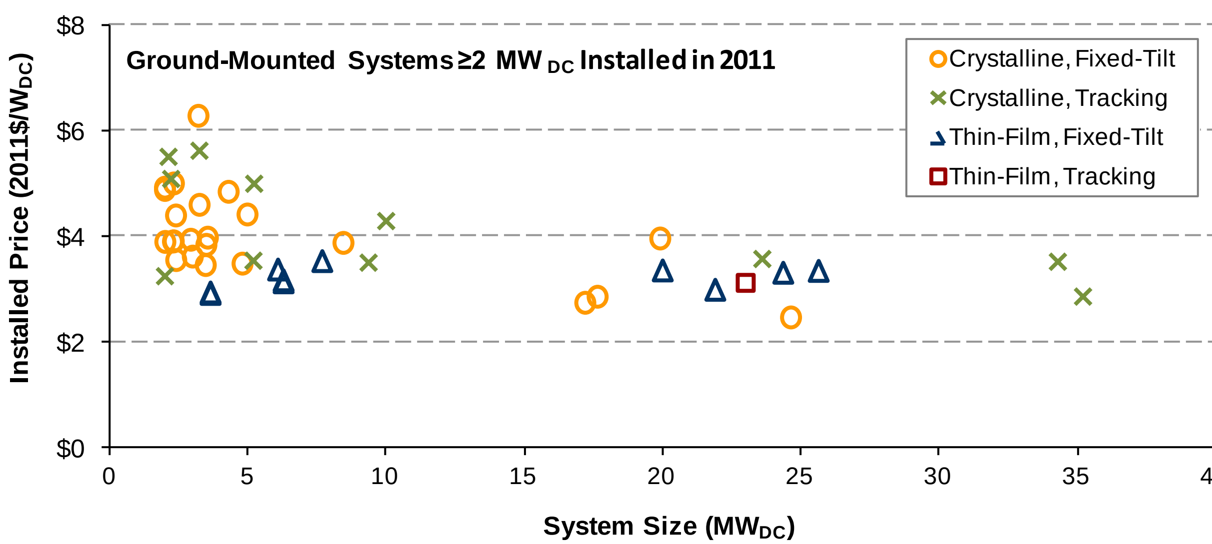
[37] A capacity-weighted average is used for this comparison, rather than a median value (as was used for residential and commercial systems), owing to the large number of relatively small systems (2–5 MW) within the utility-scale PV project data sample but the arguably greater relevance of the larger utility-scale projects.

[38] The capacity-weighted average system sizes shown are calculated as the sum of the squares of each system's size divided by the total capacity within each time period, and are intended to represent the system size associated with the corresponding capacity-weighted average installed price.

The Installed Price of Utility-Scale Projects Depends on Project Size and System Configuration

The wide range of prices is partially attributable to differences in project size and configuration, as shown in Figure 30, which focuses specifically on projects completed in 2011 and distinguishes between four system configurations according to module type (crystalline silicon versus thin-film) and mounting structure (fixed-tilt versus tracking). Clearly, the larger systems tend to have lower prices, with most projects larger than 10 MW ranging from roughly $2.8/W to $3.5/W. The projects smaller than 10 MW span a broader range, with most priced between $3.5/W and $5.0/W. These project size-based trends undoubtedly reflect underlying economies of scale. Other factors may also be at play, such as differences between the site characteristics typical of larger versus smaller projects and differences in the characteristics of the project developers (e.g., larger projects may be more likely to be developed by more experienced and/or vertically integrated companies).

The relationships between system configuration and installed price are somewhat less discernible (again, noting that a comparison of installed price ignores any performance-related differences associated with module efficiency and the use of tracking equipment). Among the class of utility-scale projects smaller than 10 MW, the thin-film projects (which include a group of five similarly configured and priced projects installed by a single southwestern utility) are all at the low end of the spectrum. Among the projects larger than 10 MW, however, no clear differences in installed prices are observable either between the crystalline and thin-film systems or between the systems with and without tracking. The absence of a visible trend of course does not mean that differences in system configuration have no impact on price; rather, within this small sample, the impact is lost within the noise of the myriad other factors that influence installed prices (e.g., regulatory compliance costs for projects built on public vs. private land, whether private land is leased or owned, design requirements associated with specific climatic conditions, etc.).



Notes: The figure includes eight thin-film, fixed-tilt systems <10 MW; however, a number of those systems have almost identical size and installed price and therefore cannot be visually distinguished in the figure. The reported installed price of projects completed in 2011 may reflect module and other component pricing at the time of project contracting, which may have occurred one or two years prior to installation. For this reason and others (see Text Box 1), the data shown here may not accurately depict the installed price of typical utility-scale PV projects completed more recently or currently under development, and may not correspond well to recent installed price benchmarks for utility PV.

Figure 30. Installed Price of Utility-Scale PV According to System Size and Configuration

Small Utility-Scale Projects Have Modestly Lower Prices than Large Commercial Rooftop Systems

A large contingent of utility scale systems in the U.S. (given the definitions used in this report) consist of ground-mounted systems less than 10 MW in size. While this market for relatively small utility-scale systems has grown considerably in recent years, so too has the market for similarly sized (i.e., multi-MW) commercial rooftop systems. Figure 31 compares the installed price of small utility-scale (ground-mounted, by definition) systems and large commercial rooftop systems installed in 2011; the figure focuses specifically on systems 2-10 MW in size and includes only fixed-tilt systems. Both groups include a number of systems with thin-film modules, but consist primarily of crystalline module systems.

Although the sample sizes are small, the results show a similar median installed price for ground-mounted and roof-mounted systems in this size range ($3.9/W and $4.0/W, respectively). Both samples exhibit significant spread around their respective median values, however, and the distribution for ground-mounted systems is shifted notably downward relative to the price distribution for rooftop systems. Among the lowest-priced third of utility-scale systems within this size range, installed prices range from $2.9/W to $3.5/W, whereas the bottom third of the roof-mounted systems range in price from $3.6/W to $3.8/W. Thus, notwithstanding the similar median values for these two specific groups of projects, the results appear to suggest that, at least under some circumstances, ground-mounted systems within this size class enjoy a slight price advantage relative to similarly sized commercial rooftop systems.

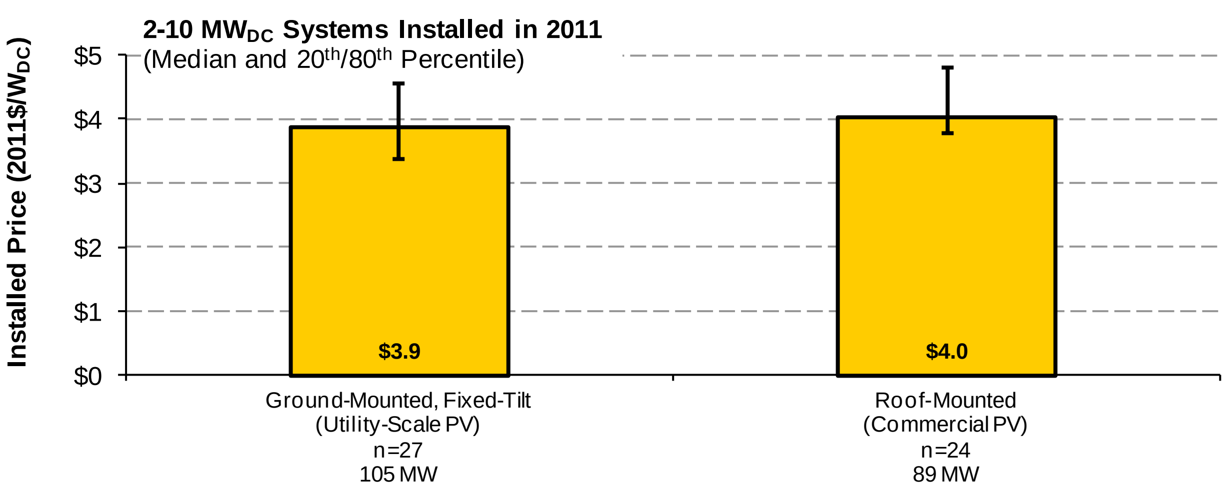


Figure 31. Installed Price of Small Utility-Scale PV vs. Large Commercial Rooftop PV

5. Conclusions and Policy Implications

The number of PV systems installed in the United States has grown at a rapid pace in recent years, driven in large measure by government incentives. Given the relatively high historical cost of PV, a key goal of these policies has been to encourage cost reductions over time. Efforts to drive cost reductions have also been led by the U.S. DOE's SunShot Initiative, which aims to reduce the cost of PV-generated electricity by about 75% between 2010 and 2020.

Available evidence confirms that the installed price of PV systems (i.e., the up-front cost borne by the PV system owner) has declined substantially since 1998, though both the pace and source of those cost reductions have varied over time. Prior to 2005, installed price reductions were associated primarily with a decline in *non-module* costs. Starting in 2005, however, installed price reductions began to stall, as the supply-chain and delivery infrastructure struggled to keep pace with rapidly expanding global demand. Starting in 2008, global module prices began a steep downward trajectory, driving installed price reductions of 25-35% among residential and commercial installations by 2011.

Non-module costs, in contrast, have remained relatively stagnant since 2005. Trends in non-module costs may be particularly relevant in gauging the impact of state and utility PV deployment programs. Unlike module prices, which are primarily established through global markets, non-module costs consist of a variety of cost components that may be more readily affected by local programs – including deployment programs aimed at increasing demand (and thereby increasing competition and efficiency among installers) as well as more-targeted efforts, such as training and education programs. Historical non-module costs reductions from 1998-2005 suggest that PV deployment policies have, in the past, succeeded in spurring cost reductions; however, the fact that non-module costs have remained largely unchanged since 2005 highlights the potential need to identify new and innovative mechanisms to foster greater efficiency and competition within the delivery infrastructure.

Preliminary data for California systems installed in the first half of 2012 indicate that installed prices have continued to decline. Notwithstanding this success, further price reductions will be necessary if the U.S. PV industry is to continue its expansion, given the expectation that PV incentive programs will also continue to ratchet down financial support. Lower installed prices in Germany and other major international markets suggest that deeper near-term cost reductions in United States are, in fact, possible and may accompany increased market scale. It is also evident, however, that market size alone is insufficient to fully capture potential near-term cost reductions, as suggested by the fact that many of the U.S. states with the lowest installed prices have relatively small PV markets. Targeted policies aimed at specific cost barriers (for example, permitting and interconnection costs), in concert with basic and applied research and development, may therefore be required in order to sustain the pace of installed price reductions on a long-term basis.

Finally, installed prices vary substantially across system sizes, market segments, technology types, and applications. Policymakers may wish to evaluate whether differential levels of financial support are therefore warranted (e.g., to avoid over-subsidizing more cost-competitive installations while providing sufficient support for promising but less mature technologies and applications).

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Appendix A: Data Cleaning, Coding, and Standardization

To the extent possible, this report presents data as provided directly by PV incentive program administrators and other data sources; however, several steps were taken to clean and standardize the data, as described below.

Projects Removed from the Data Sample: The data received from all PV incentive program administrators initially consisted of 165,929 PV systems installed through 2011. Projects were removed from the data sample first through an initial set of screens to eliminate systems with missing installed price or system size data, systems with unreasonably low or high installed price, battery back-up and self-installed systems, and duplicate systems. After these initial data screens, additional projects were removed from the data sample if the reported installed priced was deemed likely to represent an appraised value, rather than a purchase price paid to an installer.

Initial Data Screens: Systems missing installed price data (1,573 systems) or system size data (577 systems) were removed from the dataset. To eliminate presumably erroneous numerical data entries, systems were also removed from the dataset if the reported installed price was less than $2/W (91 systems) or greater than $30/W (126 systems). All battery back-up (307 systems) and self-installed (813 systems) were also removed from the dataset. Finally, an effort was made to identify systems that received incentives from multiple PV incentive programs in the data sample, in order to eliminate double-counting of individual systems. Where these systems could be identified (either using data fields that explicitly indicated participation in other programs or by matching addresses or other system characteristics across programs), duplicate entries were eliminated, and the cash incentive amounts associated with those systems represent the combined cash incentive from the combination of programs. Based on this process, 26 duplicate systems were removed from the Gainesville programs and 35 from the Orlando Pilot Solar Program that were already contained in the data for the Florida Energy & Climate Commission's Solar Rebate Program, 1,437 duplicate systems were removed from the Massachusetts SREC program that were already contained in the data for the MassCEC's programs, and 60 systems were removed from the California Self Generation Incentive Program that were already contained in the data from either SMUD's or LADWP's programs. In total, 4,204 systems from the initial sample were removed from the dataset as a result of all of the aforementioned filters (note that multiple filters apply to some systems, and thus the total number of systems removed is not equal to the sum the number of systems removed through each individual filter).

Identification and Removal of Appraised-Value Systems: In addition to the set of filters described above, systems were removed from the data sample if the reported installed price contained within the raw data was deemed likely to represent an *appraised value*. As discussed further within the main body of the report (see section entitled "Installed Price Reporting for Third Party Owned Systems Complicates Analysis of Price Trends"), appraised-value reporting occurs for a particular type of third-party owned (TPO) systems – namely, for TPO systems financed by *integrated* third party providers that provide both the installation service and customer financing. In order to eliminate any bias that such data could introduce into the summary statistics presented in this report, an effort was made to identify and remove appraised-value systems from the data sample.

Appraised-value systems were identified, in part, using two specific data fields: *installer name* and *system ownership type* (i.e., host customer owned vs. TPO). Those two data fields were provided by only a subset of the PV incentive programs in the data sample: 20 programs provided data on installer name (76% of systems in the raw data sample); 18 programs provided data on system ownership type (57% of systems); and 8 programs, including those in California, Arizona, Texas, and Connecticut, provided both pieces of information (45% of systems). Where both data fields were available, all TPO systems installed by either SolarCity or Sungevity – the two known integrated third-party installers – were deemed likely to be appraised-value systems and were removed from the data sample (7,341 systems).

Of those systems explicitly identified in the raw data as TPO and installed by either SolarCity or Sungevity, roughly 60% were clustered into twelve groups with an identical reported installed price (which may reflect, for example, the average per-kW assessed fair market value of a bundle of systems sold to tax equity investors).[39] An additional 1,698 systems for which data on installer name and/or system ownership were not available were also grouped within these twelve price clusters; those systems were deemed likely to be appraised-value and were removed from the data sample if either of the following two additional conditions were met:

- Installer name is SolarCity or Sungevity and system ownership status is unknown (246 systems)
- System ownership status is TPO and installer name is unknown, but the system is located in a state where SolarCity or Sungevity are active (735 systems).

The 717 remaining systems in those twelve price clusters were retained in the dataset, either because they were explicitly identified as being installed by a different company than SolarCity or Sungevity, because they were explicitly identified as being host customer owned, because they were located in a state where neither SolarCity or Sungevity are active, or because no data were available for either installer name or system ownership type.

Thus, a total of 8,322 systems removed from the data sample on the basis that the reported installed price was likely an appraised value (consisting of 7,341 systems that were explicitly identified in the data sample as TPO systems installed by SolarCity or Sungevity, plus 981 systems within an appraised value price cluster). This represents roughly 5% of all systems in the raw data sample and 11% of 2011 systems.

In addition to those systems contained within the twelve SolarCity or Sungevity TPO "price clusters", a sizeable number of additional systems were clustered in other identically priced groups but were not removed from the data sample. Many of these price clusters consist of a large number of systems associated with one of several other major installers (Trinity Heating and Air, Salt River Solar and Wind, Verengo, and several others). Most of these other major installers provide installation services for *non-integrated* TPO finance providers. Based on discussions with PV incentive program managers and installers, we believe that these price clusters consist of "batches" of systems sold as a group to non-integrated TPO finance providers, and that the identical reported installed price for systems in those clusters reflects the actual average per-kW price of the transaction between an installer and a non-integrated TPO finance provider. As such, these reported prices do not represent an appraised value, and the systems were therefore retained in the data sample. Other price clusters within the data sample were, instead, associated with "round" numbers (e.g., there were roughly 800 systems with a nominal installed price of exactly $6.50/W and almost 650 systems with an installed price of exactly $6.00). Systems in these price clusters typically were dispersed across a large number of different installers and included many known host customer owned systems; they were therefore deemed unlikely to represent appraised values and were retained in the data sample.

Manual Data Cleaning: Module manufacturer/model and inverter manufacturer/model data were reviewed in order to correct obvious misspellings and misidentifications, and to create standardized identifiers for individual module and inverter models.

Completion Date: The data provided by several PV incentive programs did not identify installation dates. In lieu of this information, the best available proxy was used (e.g., the date of the incentive payment or the post-installation site inspection).

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[39] In order to identify identically priced systems, we relied on reported installed price data in *nominal* dollar values, rounded to three decimal places.

Identification of Residential New Construction and Residential Retrofit Systems: Section 3 compares the price of systems installed in residential new construction to those installed in residential retrofit applications, focusing specifically on systems installed through two California programs in 2011: the California Energy Commission (CEC)'s New Solar Home Partnership (NSHP) program and the California Solar Initiative (CSI). All systems installed through NSHP are assumed to be residential new construction, while all residential systems installed through CSI are assumed to be retrofit.

Identification of Building-Integrated and Rack-Mounted Residential Systems: The comparison between residential new construction and residential retrofit systems funded through NSHP and CSI is further differentiated between building-integrated PV (BIPV) and rack-mounted systems. The raw data provided by PV incentive program administrators generally did not include explicit identifiers for these categories; thus, systems were identified as either BIPV or rack-mounted by cross-referencing data provided on the module manufacturer and model for each system with the California Solar Initiative (CSI)'s List of Eligible Modules, which identifies whether modules are BIPV or rack-mounted.[40]

Identification of Crystalline and Thin-Film Systems: Section 3 compares the installed price of systems with thin-film modules to those with crystalline modules. The raw data provided by PV program administrators generally do not include explicit identifiers for these categories. Thus, systems were categorized as crystalline, thin-film, or hybrid by cross-referencing data provided on module manufacturer and model with the CSI's List of Eligible Modules, which identifies whether modules are crystalline, thin-film, or hybrid.

Conversion to 2011 Real Dollars: Installed price and incentive data are expressed throughout this report in real 2011 dollars (2011$). Data provided by PV program administrators in nominal dollars were converted to 2011$ using the "Monthly Consumer Price Index for All Urban Consumers," published by the U.S. Bureau of Labor Statistics.[41]

Conversion of Capacity Data to Direct Current (DC) Watts at Standard Test Conditions (DC-STC): Throughout this report, all capacity and dollars-per-watt ($/W) data are expressed using DC-STC capacity ratings. Most programs directly provided data in units of DC-STC; however, four programs (the CEC's Emerging Renewables Program and New Solar Home Partnership program, the CPUC's Self-Generation Incentive Program, and SMUD's Residential Retrofit and Commercial PV Programs) provided capacity data only in terms of the California Energy Commission Alternating Current (CEC-AC) rating convention, which represents peak AC power output at PVUSA Test Conditions (PTC). In addition, three programs (NM's Solar Market Development Tax Credit, NVEnergy's Renewable Generations Rebate Program, and VT's RERC Small Scale Renewable Energy Incentive Program) only specified module model and number of models per system. DC-STC capacity ratings for systems funded through these seven programs were calculated according to the procedures described below.

CEC Emerging Renewables Program (ERP), CEC New Solar Home Partnership (NSHP) Program, and SMUD Residential Retrofit and Commercial PV Programs: The data provided for these programs included data fields identifying the module manufacturer, model, and number of modules for most PV systems. DC-STC ratings were identified for most modules by cross-referencing the information provided about the module type with the CSI's List of Eligible Photovoltaic Modules, which identifies DC-STC ratings for most of the modules employed in the systems funded through these programs. For modules not in this list, the DC-STC rating was found in the modules' specification sheets from the manufacturer. The DC-STC rating for each module was then multiplied by the number of modules to determine the total DC-STC rating for the system, as a whole. This approach was used to determine the DC-STC capacity rating for all of the systems in the NSHP and SMUD datasets, and for 86% of the systems in the ERP dataset. For the remaining systems

[40] http://www.gosolarcalifornia.org/equipment/pvmodule.php
[41] ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt

in the ERP dataset, either the module data fields were incomplete, or the module could not be cross-referenced with the CSI list, or the estimated DC-STC rating for the system was grossly inconsistent with the reported CEC-AC rating. In these cases, an average conversion factor of 1.200 W_{DC-STC}/W_{CEC-AC} was used, which was derived based on the averages for other systems in the ERP dataset.

CPUC Self-Generation Incentive Program (SGIP): The data provided for SGIP included data fields identifying module manufacturer and model (but not number of modules), and inverter manufacturer and model. DC-STC module ratings and DC-PTC module ratings (i.e., DC watts at PVUSA Test Conditions) were identified by cross-referencing the reported module type with the CSI's List of Eligible Photovoltaic Modules. Similarly, the rated inverter efficiency for each project was identified by cross referencing the reported inverter type with the CSI's List of Eligible Inverters, which identifies inverter efficiency ratings for most of the inverters used within the systems funded through SGIP.[42] These pieces of information (module DC-STC rating, module DC-PTC rating, and inverter efficiency rating), along with the reported CEC-AC rating for the system, were used to estimate the system DC-STC rating according to the following:

$$System_{DC-STC} = (System_{CEC-AC} / \text{Inverter Eff.}) * (Module_{DC-STC} / Module_{DC-PTC})$$

In cases where data on module manufacturer and model either was not provided or could not be matched with the CSI module list, then the DC-STC rating was calculated using the median ratio of module DC-STC to DC-PTC ratings for systems installed in the same year (0.88-0.90 W_{DC-STC}/W_{DC-PTC}). In cases where data on inverter manufacturer and model either was not provided or could not be matched with the CSI's inverter list, the inverter efficiency was stipulated based on the average inverter efficiency of systems in the SGIP dataset installed in the same year and for which inverter efficiency ratings could be identified. If neither the module nor inverter data were provided, then the DC-STC rating was calculated directly from the reported CEC-AC rating, using the median annual ratio of module DC-STC rating to system CEC-AC rating (1.19-1.22 W_{DC-STC}/W_{CEC-AC}).

NM Solar Market Development Tax Credit, NVEnergy Renewable Generations Rebate Program, and VT RERC Small Scale Renewable Energy Incentive Program: The data provided for these programs did not specify the total PV system capacity, but did specify module model and number of modules for each system. We determined the nameplate DC-STC rating for each module model, based on the CSI's List of Eligible Photovoltaic Modules and/or from module manufacturer specification sheets, and then calculated the *system* DC-STC rating as the product of the module DC-STC rating and the number of modules.

Conversion of Reported PBI Payments to 2011$/W: Six PV incentive programs in the data sample provided performance-based incentives (PBIs), paid out over time based on actual energy generation and a pre-specified payment rate, to some or all systems. In order to facilitate comparison with up-front rebates provided to the other systems in data sample, PBI payments were translated into an equivalent up-front payment by calculating the net present value (NPV) of the expected PBI payment amount. The approach taken to calculate the NPV of the PBI payment differed somewhat across programs, depending on the data provided and the nature of the PBI payment.

AR Energy Office Renewable Technology Rebate Fund: In this program, all systems receive a single PBI payment based on total energy production during the first year of operation. The program administrator provided data on the estimated or actual PBI payment for each system. These data were used as-is, with no discounting.

APS Renewable Energy Incentive Program, CPUC California Solar Initiative, and SRP EarthWise Solar Energy Program: These three programs provided PBI payments to a subset of the participating projects

[42] http://www.gosolarcalifornia.org/equipment/inverter.php

(typically the larger non-residential projects). The PBI payments in these programs are paid out on a monthly or quarterly basis over multi-year periods (for APS: 10, 15, or 20 years; for CSI: 5 years; and for SRP: 20 years). In the case of APS, the PBI contract period for each system was not specified, and we therefore assumed 15 years. The program administrators provided the estimated total PBI payment for each system receiving a PBI, over the duration of the PBI contract term. Lacking any specific information otherwise, we assumed that these program administrators estimated lifetime PBI payments by multiplying the estimated first-year energy production for each system by the PBI payment rate and the PBI contract term, without any discounting and without accounting for system degradation over time. As such, we calculated the NPV of the PBI payments by first dividing the estimated total PBI amount for each system by the PBI contract term, in order to estimate the first-year PBI payment. Nominal PBI payments in subsequent years were estimated by applying a 0.5% annual degradation factor to the first-year PBI payment. The NPV of annual PBI payments over the contract term was then calculated assuming a 7% nominal discount rate.

Orlando Utilities Commission Pilot Solar Program. Under this program, all participating systems receive a monthly PBI paid out over the life of the system. The data provided by the program administrator included the total annual PBI payment in 2010 and 2011 for each system. For systems installed prior to 2010, we used the average of these values to calculate the NPV of all payments over the life of the system, assuming a 20 year lifetime, a degradation factor of 0.5%/yr, and an annual discount rate of 7%. For systems installed in 2010, we used the 2011 PBI amount to calculate the NPV, with the same assumptions. For systems installed in 2011, we could not use the provided PBI data, as these are for an incomplete year. Instead, we used the average annual PBI payment per kW ($/kW/yr) of all systems installed prior to 2011 to estimate the annual PBI payment per kW that each 2011 system would receive over the course of its first complete year of operation. We then followed the same procedure and assumptions as for the pre-2011 systems in order to estimate the NPV of the lifetime PBI payments (i.e., 20-year lifetime, 0.5% annual degradation, and 7% nominal discount rate).

Austin Energy Power Saver Program: This program provides PBI payments to a small sub-set of all participating projects, issued over a 10-year period. The program administrator, however, did not provide estimates for either estimated PBI payment or estimated annual system production. Therefore, we did not calculate the NPV of PBI payments for these systems, and treated these systems as having missing incentive data.

Appendix B: Residential and Commercial PV Data Sample Summaries

Table B-1. Residential and Commercial PV System Sample by PV Incentive Program

State	PV Incentive Program Administrator and Program Name	No. of Systems	Total MW_{DC}	% of Total MW_{DC}	Size Range (kW_{DC})	Year Range
AR	Arkansas Energy Office Renewable Technology Rebate Fund	97	0.7	0.0%	0.5 - 25	2010 - 2011
AZ	APS Renewable Energy Incentive Program	7,737	124.9	5.6%	0.3 - 2,677	2002 - 2011
	SRP EarthWise Solar Energy Program	3,100	26.0	1.2%	0.4 - 502	2005 - 2011
CA	CEC Emerging Renewables Program	27,620	145.3	6.5%	0.1 - 670	1998 - 2008
	CEC New Solar Homes Partnership	3,812	13.9	0.6%	1.2 - 154	2007 - 2011
	CPUC California Solar Initiative	56,269	738.3	33.2%	1.2 - 1,796	2007 - 2011
	CPUC Self Generation Incentive Program	854	159.8	7.2%	34 - 1,266	2002 - 2009
	LADWP Solar Incentive Program	4,794	58.2	2.6%	0.3 - 1,176	1999 - 2011
	Pacific Power California Solar Incentive Program	20	0.1	0.0%	1.4 - 14	2011 - 2011
	SMUD Residential Retrofit and Commercial PV Programs	1,299	17.5	0.8%	1.1 - 1,158	2007 - 2011
CT	CCEF Onsite Renewable DG Program	173	18.6	0.8%	1.6 - 570	2004 - 2011
	CCEF Solar PV Program	1,906	12.6	0.6%	0.7 - 19	2005 - 2011
DC	Dept. of Environment Renewable Energy Incentive Program	383	1.6	0.1%	1.1 - 27	2009 - 2011
FL	Gainesville Solar Feed-In Tariff[a]	171	9.2	0.4%	2.3 - 1,007	2009 - 2011
	Gainesville Solar-Electric System Rebate Program[a]	93	0.9	0.0%	2.4 - 74	2007 - 2011
	Orlando Pilot Solar Program[a]	38	1.4	0.1%	2.0 - 1,040	2008 - 2011
	Energy & Climate Commision Solar Rebate Program[a]	1,169	9.7	0.4%	2.0 - 1,016	2006 - 2010
IL	DCEO Solar and Wind Energy Rebate Program	521	3.8	0.2%	0.8 - 700	1999 - 2011
MA	DOER SREC Registration[b]	342	27.4	1.2%	0.4 - 1,801	2008 - 2011
	MassCEC PV incentive programs (multiple programs)[b][c]	3,645	41.6	1.9%	0.2 - 501	2002 - 2011
MD	MEA Solar Energy Grant Program	2,113	12.6	0.6%	0.5 - 200	2005 - 2011
MN	MSEO Solar Electric Rebate Program	400	2.1	0.1%	0.5 - 40	2003 - 2011
NC	NC Sustainable Energy Association (project data compiled from NCUC dockets)[d]	1,044	40.3	1.8%	0.7 - 1,999	2004 - 2011
NH	NHPUC Renewable Energy Rebate Program	556	1.8	0.1%	0.3 - 6.7	2008 - 2011
NJ	NJCEP Customer Onsite Renewable Energy Program	4,114	84.8	3.8%	0.3 - 2,372	2001 - 2011
	NJCEP Renewable Energy Incentive Program	3,454	34.6	1.6%	0.7 - 51	2009 - 2011
	NJCEP SREC Registration Program	4,998	259.4	11.7%	0.4 - 2,981	2007 - 2011
NM	Solar Market Development Tax Credit	1,757	7.9	0.4%	0.4 - 249	2009 - 2011

State	PV Incentive Program Administrator and Program Name	No. of Systems	Total MW_{DC}	% of Total MW_{DC}	Size Range (kW_{DC})	Year Range
NV	NVEnergy Renewable Generations Rebate Program	1,235	31.4	1.4%	0.4 - 1,145	2004 - 2011
NY	NYSERDA PV Incentive Programs	4,038	40.0	1.8%	0.7 - 254	2003 - 2011
OH	ODOD multiple programs[e]	212	8.8	0.4%	1.0 - 1,121	2005 - 2011
OR	Energy Trust of Oregon Solar Electric Buy-Down Program	3,517	32.1	1.4%	0.4 - 1,660	2002 - 2011
	Eugene Water and Electric Board Solar Electric Program	62	0.6	0.0%	1.0 - 100	2011 - 2011
	Pacific Power Solar Volumetric Incentive and Payments Program	157	2.2	0.1%	1.7 - 498	2010 - 2011
PA	DCEO grant programs	41	28.3	1.3%	8.0 - 2,998	2010 - 2011
	Dept. of Environmental Protection Sunshine Solar PV Program	5,646	79.1	3.6%	1.1 - 922	2009 - 2011
	Sustainable Development Fund Solar PV Grant Program	201	0.7	0.0%	1.1 - 12	2002 - 2008
TX	Austin Energy Power Saver Program	1,612	7.8	0.3%	0.2 - 93	2004 - 2011
	IOU Solar Incentive Programs (AEP, Entergy, Oncor, SWEPCO, TNMP)	871	10.3	0.5%	0.4 - 300	2001 - 2011
UT	RMP Solar Incentive Program	152	0.6	0.0%	0.7 - 27	2007 - 2011
VT	RERC Small Scale Renewable Energy Incentive Program	948	5.3	0.2%	0.2 - 148	2003 - 2011
WI	Focus on Energy Renewable Energy Cash-Back Rewards Program[f]	1,097	6.7	0.3%	0.2 - 273	2002 - 2010
Non PV Incentive Program Data (other sources)		43	115.6	5.2%	770 - 9,002	2008 - 2011
	Total	***152,311***	***2,224***	***100%***	***0.1 - 9,002***	***1998 - 2011***

[a] Some systems received incentives from both the Florida Energy & Climate Commission (FECC)'s Solar Rebate Program as well as from one of the Florida utility programs. In order to avoid double-counting, those systems were retained in the data sample for FECC's program and removed from the data sample for the utility program.

[b] Some systems received incentives from both the MassCEC PV programs and the MA DOER SREC Registration Program. In order to avoid double-counting, those systems were retained in the data sample for the MassCEC program and removed from data sample for the MA DOER program.

[c] The MassCEC PV programs include systems that were funded through predecessor programs offered by the Massachusetts Technology Collaborative, prior to creation of MassCEC.

[d] The data provided by the North Carolina Sustainable Energy Association (NCSEA) is not associated with a PV incentive program, but instead, was compiled by NCSEA from regulatory filings submitted to the North Carolina Utilities Commission for a Report of Proposed Construction or for a Certificate of Public Convenience and Necessity.

[e] The data provided by the Ohio Department of Development includes PV systems funded through a number of programs, including State Energy Plan, Advanced Energy Fund, ARRA Block Grants, and the Energy Loan Fund.

[f] Data from Wisconsin's Focus on Energy Renewable Energy Cash-Back Rewards Program was provided for systems installed through 2011; however, data quality issues for systems installed in 2011 precluded those systems from being included in the data sample.

Table B-2. Residential and Commercial PV System Sample by Installation Year and System Size Range

System Size Range	Installation Year														Total
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
No. Systems															
0-5 kW	31	162	184	1,106	1,761	2,251	3,482	3,246	5,045	7,413	8,222	12,621	15,265	15,825	**76,614**
5-10 kW	3	14	23	165	480	838	1,546	1,699	2,701	4,115	4,222	8,899	14,538	15,746	**54,989**
10-100 kW	5	10	12	37	166	317	519	636	894	1,230	1,398	2,473	4,789	5,326	**17,812**
100-500 kW	0	1	1	7	26	31	35	94	93	121	308	246	446	768	**2,177**
>500 kW	0	0	0	0	3	6	7	11	22	34	91	85	140	320	**719**
Total	*39*	*187*	*220*	*1,315*	*2,436*	*3,443*	*5,589*	*5,686*	*8,755*	*12,913*	*14,241*	*24,324*	*35,178*	*37,985*	***152,311***
Capacity (MW)															
0-5 kW	0.1	0.4	0.4	3.0	4.7	6.4	10.0	9.6	15.6	23.6	25.6	40.5	50.0	53.8	**244**
5-10 kW	0.0	0.1	0.2	1.1	3.2	5.6	10.5	11.9	18.7	28.5	28.9	60.5	100.1	109.8	**379**
10-100 kW	0.1	0.3	0.2	0.6	3.3	7.0	12.1	15.0	18.5	25.6	33.0	51.7	102.4	126.8	**396**
100-500 kW	0.0	0.1	0.1	1.1	5.4	6.9	7.1	18.9	20.7	27.7	74.9	54.7	95.9	174.7	**488**
>500 kW	0.0	0.0	0.0	0.0	1.7	5.3	5.1	8.4	17.7	27.1	79.0	77.5	132.7	362.4	**717**
Total	*0.2*	*0.8*	*0.9*	*5.8*	*18.3*	*31.3*	*44.7*	*63.8*	*91.2*	*132.4*	*241.5*	*284.9*	*481.1*	*827.5*	***2,224***

Table B-3. Residential and Commercial PV System Sample and Median Installed Price ($\$/W_{dc}$) by State and System Size

State	Size Range		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AR	≤10 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	45	30
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	3.5	4.3
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	6.3	6.7
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	8	14
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	12.9	15.8
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	6.4	6.3
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AZ	≤10 kW	No. Systems	-	-	-	-	5	16	40	91	323	336	426	2006	3352	2928
		Median Size	-	-	-	-	2.2	2.4	2.8	3.0	3.6	4.4	5.0	5.2	5.1	5.1
		Median Price	-	-	-	-	10.4	7.5	7.9	7.8	8.1	7.5	7.2	7.2	6.1	5.2
	10-100 kW	No. Systems	-	-	-	-	-	1	2	4	13	16	57	229	392	433
		Median Size	-	-	-	-	-	*	*	*	10.6	10.5	14.8	13.2	13.3	13.8
		Median Price	-	-	-	-	-	*	*	*	7.9	7.8	7.0	7.0	6.2	5.0
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	3	8	6	41	112
		Median Size	-	-	-	-	-	-	-	-	-	*	242.6	155.6	299.3	423.6
		Median Price	-	-	-	-	-	-	-	-	-	*	7.1	7.2	6.0	6.2
CA	≤10 kW	No. Systems	34	173	201	1259	2180	2755	4213	3587	5610	9021	9062	13261	15628	17650
		Median Size	2.3	2.1	2.2	2.8	3.0	3.0	3.1	3.6	3.9	4.2	4.0	4.2	4.6	4.6
		Median Price	11.8	11.7	11.0	10.6	10.6	9.6	8.9	8.4	8.6	8.7	8.4	8.1	7.0	6.4
	10-100 kW	No. Systems	5	10	12	35	156	286	468	457	704	1015	930	1286	1719	1565
		Median Size	13.2	14.2	11.9	11.6	11.9	12.0	14.4	17.3	14.0	13.7	14.5	13.8	13.2	13.8
		Median Price	11.4	10.5	8.8	10.3	10.3	9.1	8.5	8.0	8.0	8.3	8.0	7.7	6.5	5.9
	>100 kW	No. Systems	-	1	1	7	28	35	40	89	75	121	314	181	173	344
		Median Size	-	*	*	148.4	205.5	230.0	239.6	178.7	230.6	245.5	274.7	304.5	392.8	402.3
		Median Price	-	*	*	7.0	9.2	8.1	8.0	7.8	7.8	7.4	7.3	7.6	6.0	4.9

State	Size Range		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
CO	≤10 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	1	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	*	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	*	-
CT	≤10 kW	No. Systems	-	-	-	-	-	-	1	33	89	165	254	403	395	331
		Median Size	-	-	-	-	-	-	*	4.3	4.8	5.2	5.5	6.3	6.3	6.7
		Median Price	-	-	-	-	-	-	*	9.2	9.4	9.6	8.9	8.5	7.5	6.3
	10-100 kW	No. Systems	-	-	-	-	-	-	1	1	6	14	52	98	101	74
		Median Size	-	-	-	-	-	-	*	*	14.0	16.5	11.1	10.9	10.8	10.8
		Median Price	-	-	-	-	-	-	*	*	9.1	9.0	8.6	8.2	7.1	6.1
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	1	4	21	22	7	6
		Median Size	-	-	-	-	-	-	-	-	*	*	264.2	225.1	180.6	189.8
		Median Price	-	-	-	-	-	-	-	-	*	*	7.9	7.7	7.5	5.9
DC	≤10 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	85	189	99
		Median Size	-	-	-	-	-	-	-	-	-	-	-	3.4	3.5	4.3
		Median Price	-	-	-	-	-	-	-	-	-	-	-	8.5	7.5	7.6
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	3	7	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	*	11.3	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	*	3.4	-
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-

State	Size Range		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
FL	≤10 kW	No. Systems	-	-	-	-	-	-	-	-	16	41	28	580	496	64
		Median Size	-	-	-	-	-	-	-	-	3.5	4.8	5.0	5.0	5.1	6.8
		Median Price	-	-	-	-	-	-	-	-	10.5	10.2	9.0	7.7	7.4	5.9
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	6	11	65	106	37
		Median Size	-	-	-	-	-	-	-	-	-	25.1	25.2	25.0	25.1	27.7
		Median Price	-	-	-	-	-	-	-	-	-	7.8	8.8	7.1	7.0	5.0
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	2	7	12
		Median Size	-	-	-	-	-	-	-	-	-	-	-	*	258.7	205.3
		Median Price	-	-	-	-	-	-	-	-	-	-	-	*	6.1	4.9
HI	≤10 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	*
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	*
IL	≤10 kW	No. Systems	-	3	6	8	3	14	2	5	44	74	96	76	116	15
		Median Size	-	*	3.2	2.7	*	4.8	*	1.1	1.9	2.0	2.5	3.0	3.3	4.4
		Median Price	-	*	21.3	14.9	*	13.9	*	11.6	10.3	9.9	9.4	8.9	7.7	6.8
	10-100 kW	No. Systems	-	-	-	1	2	14	9	2	-	3	-	1	26	-
		Median Size	-	-	-	*	*	35.2	50.0	*	-	*	-	*	13.6	-
		Median Price	-	-	-	*	*	13.9	13.7	*	-	*	-	*	8.0	-
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	1	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	*	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	*	-

State	Size Range		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
MA	≤10 kW	No. Systems	-	-	-	-	-	65	119	74	244	200	335	702	552	1036
		Median Size	-	-	-	-	-	2.2	2.6	2.7	2.8	3.0	3.6	4.2	5.0	5.1
		Median Price	-	-	-	-	-	10.5	9.1	9.3	9.6	9.3	8.8	8.5	7.1	6.1
	10-100 kW	No. Systems	-	-	-	-	1	5	10	18	14	12	40	87	160	164
		Median Size	-	-	-	-	*	26.4	27.2	27.1	22.4	34.6	17.9	30.2	30.1	34.6
		Median Price	-	-	-	-	*	12.2	10.7	9.8	10.3	10.1	8.9	8.4	6.5	5.9
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	3	2	8	18	60	58
		Median Size	-	-	-	-	-	-	-	-	*	*	123.9	152.1	129.7	183.4
		Median Price	-	-	-	-	-	-	-	-	*	*	7.8	7.5	5.7	5.0
MD	≤10 kW	No. Systems	-	-	-	-	-	-	-	19	42	46	284	613	663	254
		Median Size	-	-	-	-	-	-	-	2.3	2.1	2.4	3.5	4.1	4.9	5.3
		Median Price	-	-	-	-	-	-	-	12.2	11.0	10.6	9.4	8.6	6.7	6.1
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	1	1	8	26	89	64
		Median Size	-	-	-	-	-	-	-	-	*	*	15.9	10.8	12.0	13.7
		Median Price	-	-	-	-	-	-	-	-	*	*	8.4	7.5	5.8	5.4
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	3
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	*
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	*
MN	≤10 kW	No. Systems	-	-	-	-	-	8	12	10	18	33	35	68	165	10
		Median Size	-	-	-	-	-	3.2	2.5	2.5	2.7	2.6	2.8	3.7	4.2	4.9
		Median Price	-	-	-	-	-	10.4	8.8	10.4	9.1	9.7	10.1	9.7	7.9	7.4
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	2	3	3	28	5
		Median Size	-	-	-	-	-	-	-	-	-	*	*	*	10.5	10.1
		Median Price	-	-	-	-	-	-	-	-	-	*	*	*	8.3	6.2
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-

State	Size Range		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
NC	≤10 kW	No. Systems	-	-	-	-	-	-	4	5	20	46	87	161	214	328
		Median Size	-	-	-	-	-	-	*	2.2	3.0	2.5	3.1	4.0	4.1	4.3
		Median Price	-	-	-	-	-	-	*	11.6	10.1	10.7	9.4	8.7	6.9	6.6
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	5	4	14	31	71
		Median Size	-	-	-	-	-	-	-	-	-	15.2	*	23.8	25.9	22.1
		Median Price	-	-	-	-	-	-	-	-	-	8.4	*	7.8	6.2	5.1
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	1	2	5	10	37
		Median Size	-	-	-	-	-	-	-	-	-	*	*	224.6	250.0	666.4
		Median Price	-	-	-	-	-	-	-	-	-	*	*	6.2	5.2	5.0
NH	≤10 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	34	172	257	93
		Median Size	-	-	-	-	-	-	-	-	-	-	2.2	2.7	3.0	3.8
		Median Price	-	-	-	-	-	-	-	-	-	-	9.3	8.0	6.2	5.5
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NJ	≤10 kW	No. Systems	-	-	-	3	30	84	255	578	693	568	609	932	2113	3474
		Median Size	-	-	-	*	2.7	4.6	5.5	6.8	6.8	7.4	7.2	7.4	7.2	6.9
		Median Price	-	-	-	*	11.0	9.8	9.4	9.1	9.0	8.8	8.5	8.3	7.2	5.9
	10-100 kW	No. Systems	-	-	-	-	6	5	17	116	111	80	149	249	663	1152
		Median Size	-	-	-	-	46.1	50.4	12.6	11.8	12.3	18.0	16.0	15.2	18.2	15.2
		Median Price	-	-	-	-	9.4	10.2	9.6	9.0	8.9	8.7	8.3	8.2	6.7	5.5
	>100 kW	No. Systems	-	-	-	-	1	1	1	16	36	24	38	79	153	336
		Median Size	-	-	-	-	*	*	*	215.2	244.7	290.5	270.6	221.0	239.2	277.2
		Median Price	-	-	-	-	*	*	*	7.9	7.6	7.4	7.8	7.4	5.2	4.8

State	Size Range		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
NM	≤10 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	223	695	767
		Median Size	-	-	-	-	-	-	-	-	-	-	-	3.3	3.6	3.7
		Median Price	-	-	-	-	-	-	-	-	-	-	-	8.4	7.1	6.1
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	8	26	37
		Median Size	-	-	-	-	-	-	-	-	-	-	-	11.3	11.0	11.4
		Median Price	-	-	-	-	-	-	-	-	-	-	-	8.5	6.4	5.7
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	1	1	1
		Median Size	-	-	-	-	-	-	-	-	-	-	-	*	*	*
		Median Price	-	-	-	-	-	-	-	-	-	-	-	*	*	*
NV	≤10 kW	No. Systems	-	-	-	-	-	-	3	55	68	91	77	166	212	128
		Median Size	-	-	-	-	-	-	*	4.5	5.8	5.9	5.6	5.7	5.6	6.0
		Median Price	-	-	-	-	-	-	*	8.0	8.3	8.2	8.2	7.8	6.5	5.4
	10-100 kW	No. Systems	-	-	-	-	-	-	-	7	4	5	7	16	109	211
		Median Size	-	-	-	-	-	-	-	15.1	*	20.4	13.7	34.6	34.1	36.7
		Median Price	-	-	-	-	-	-	-	16.2	*	8.0	7.2	5.6	5.4	5.0
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	1	6	69
		Median Size	-	-	-	-	-	-	-	-	-	-	-	*	116.9	119.1
		Median Price	-	-	-	-	-	-	-	-	-	-	-	*	5.7	4.7
NY	≤10 kW	No. Systems	-	-	-	-	-	38	113	100	179	326	373	649	713	709
		Median Size	-	-	-	-	-	3.0	2.8	3.2	4.2	4.8	4.8	5.2	5.0	5.2
		Median Price	-	-	-	-	-	10.2	10.1	9.7	9.5	9.4	8.9	8.9	7.4	6.3
	10-100 kW	No. Systems	-	-	-	-	-	6	9	16	24	30	47	126	255	323
		Median Size	-	-	-	-	-	14.8	14.9	14.9	13.4	12.2	20.0	20.5	25.4	25.4
		Median Price	-	-	-	-	-	10.2	9.4	8.5	8.9	9.2	8.9	8.7	7.5	6.6
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	1	2
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	*	*
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	*	*

State	Size Range		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OH	≤10 kW	No. Systems	-	-	-	-	-	-	-	19	12	30	25	3	6	3
		Median Size	-	-	-	-	-	-	-	3.0	2.3	3.5	3.0	*	6.1	*
		Median Price	-	-	-	-	-	-	-	10.8	11.4	10.0	8.9	*	7.8	*
	10-100 kW	No. Systems	-	-	-	-	-	-	-	1	1	2	7	22	45	19
		Median Size	-	-	-	-	-	-	-	*	*	*	10.9	17.5	44.7	49.5
		Median Price	-	-	-	-	-	-	-	*	*	*	8.8	8.2	7.0	6.3
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	1	11	5
		Median Size	-	-	-	-	-	-	-	-	-	-	-	*	250.0	220.0
		Median Price	-	-	-	-	-	-	-	-	-	-	-	*	6.2	5.4
OR	≤10 kW	No. Systems	-	-	-	-	-	55	136	86	124	199	205	400	1153	996
		Median Size	-	-	-	-	-	3.0	3.0	3.0	3.0	2.9	3.0	2.9	2.6	3.2
		Median Price	-	-	-	-	-	8.1	7.8	8.1	8.9	9.2	8.8	8.1	6.4	6.0
	10-100 kW	No. Systems	-	-	-	-	1	-	1	3	8	15	39	75	81	110
		Median Size	-	-	-	-	*	-	*	*	19.2	24.7	23.4	26.9	21.6	20.6
		Median Price	-	-	-	-	*	-	*	*	8.5	9.3	8.4	7.9	6.8	5.7
	>100 kW	No. Systems	-	-	-	-	-	1	1	-	-	-	8	13	18	8
		Median Size	-	-	-	-	-	*	*	-	-	-	102.6	143.6	182.4	394.7
		Median Price	-	-	-	-	-	*	*	-	-	-	8.0	7.7	6.1	5.6
PA	≤10 kW	No. Systems	-	-	-	-	8	33	26	96	12	10	13	304	1934	1623
		Median Size	-	-	-	-	2.7	4.1	4.7	2.7	3.5	4.8	4.8	5.3	5.8	6.1
		Median Price	-	-	-	-	10.4	10.3	10.8	9.6	10.9	10.0	9.5	7.9	7.0	6.0
	10-100 kW	No. Systems	-	-	-	-	-	-	-	1	1	1	-	66	718	874
		Median Size	-	-	-	-	-	-	-	*	*	*	-	10.8	10.6	11.5
		Median Price	-	-	-	-	-	-	-	*	*	*	-	7.8	6.4	5.5
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	1	85	84
		Median Size	-	-	-	-	-	-	-	-	-	-	-	*	198.3	199.6
		Median Price	-	-	-	-	-	-	-	-	-	-	-	*	5.6	4.5

State	Size Range		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
SC	≤10 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	*
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	*
TN	≤10 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	2	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	*	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	*	-
TX	≤10 kW	No. Systems	-	-	-	1	-	-	49	135	141	162	242	306	466	646
		Median Size	-	-	-	*	-	-	3.0	3.0	3.1	3.2	3.2	3.6	4.7	5.5
		Median Price	-	-	-	*	-	-	7.7	7.3	7.4	7.4	7.6	7.0	6.0	4.9
	10-100 kW	No. Systems	-	-	-	1	-	-	1	10	4	9	17	49	112	115
		Median Size	-	-	-	*	-	-	*	21.1	*	15.8	23.1	13.7	10.8	10.3
		Median Price	-	-	-	*	-	-	*	6.8	*	7.8	7.6	6.2	5.7	7.2
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	1	8	8
		Median Size	-	-	-	-	-	-	-	-	-	-	-	*	102.7	147.3
		Median Price	-	-	-	-	-	-	-	-	-	-	-	*	5.7	5.0

State	Size Range		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
UT	≤10 kW	No. Systems	-	-	-	-	-	-	-	-	-	28	30	31	28	24
		Median Size	-	-	-	-	-	-	-	-	-	2.0	2.6	2.5	2.8	3.0
		Median Price	-	-	-	-	-	-	-	-	-	10.2	10.5	9.6	8.9	5.9
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	3	2	3	3
		Median Size	-	-	-	-	-	-	-	-	-	-	*	*	*	*
		Median Price	-	-	-	-	-	-	-	-	-	-	*	*	*	*
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VT	≤10 kW	No. Systems	-	-	-	-	-	1	16	11	32	59	88	146	152	363
		Median Size	-	-	-	-	-	*	2.9	2.6	2.6	2.4	2.9	3.6	4.0	4.4
		Median Price	-	-	-	-	-	*	9.5	10.8	9.9	9.9	9.2	8.2	6.6	5.9
	10-100 kW	No. Systems	-	-	-	-	-	-	-	-	-	3	3	5	13	55
		Median Size	-	-	-	-	-	-	-	-	-	*	*	16.3	21.6	15.5
		Median Price	-	-	-	-	-	-	-	-	-	*	*	7.3	5.3	5.8
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	1
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	-	*
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	-	*
WI	≤10 kW	No. Systems	-	-	-	-	15	20	39	41	79	93	141	233	259	-
		Median Size	-	-	-	-	1.8	1.3	1.7	2.0	2.7	2.8	3.1	4.0	3.6	-
		Median Price	-	-	-	-	11.8	11.3	10.3	9.7	8.9	9.7	9.2	9.2	8.2	-
	10-100 kW	No. Systems	-	-	-	-	-	-	1	-	3	11	21	43	97	-
		Median Size	-	-	-	-	-	-	*	-	*	11.6	15.4	14.4	16.0	-
		Median Price	-	-	-	-	-	-	*	-	*	8.8	9.2	8.2	7.4	-
	>100 kW	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	1	-
		Median Size	-	-	-	-	-	-	-	-	-	-	-	-	*	-
		Median Price	-	-	-	-	-	-	-	-	-	-	-	-	*	-

* Median system size and median price are omitted if fewer than five data points available.

Table B-4. Residential and Commercial PV System Sample and Median Up-Front Cash Incentive by PV Incentive Program

State	Program Administrator and Program Name		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AR	Arkansas Energy Office Renewable Technology Rebate Fund	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	53	44
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	-	-	2.1	2.0
AZ	APS Renewable Energy Incentive Program	No. Systems	-	-	-	-	5	17	42	68	209	241	364	1542	2530	2719
		Median Incentive ($/W)	-	-	-	-	3.8	3.8	4.0	3.9	3.8	3.2	3.1	3.1	2.9	1.7
	SRP EarthWise Solar Energy Program	No. Systems	-	-	-	-	-	-	-	27	127	114	127	699	1254	752
		Median Incentive ($/W)	-	-	-	-	-	-	-	3.5	3.3	3.2	3.1	3.1	2.7	1.3
CA	CEC Emerging Renewables Program	No. Systems	39	178	214	1169	2038	2943	4540	3861	6104	5846	688	-	-	-
		Median Incentive ($/W)	3.4	3.3	3.2	4.7	4.7	4.1	3.8	2.9	2.6	2.5	2.3	-	-	-
	CEC New Solar Homes Partnership	No. Systems	-	-	-	-	-	-	-	-	-	307	1137	1528	622	218
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	2.5	2.4	2.5	2.3	2.2
	CPUC California Solar Initiative	No. Systems	-	-	-	-	-	-	-	-	-	3496	7873	12133	15225	17542
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	2.2	1.9	1.5	0.9	0.5
	CPUC Self Generation Incentive Program	No. Systems	-	-	-	-	16	76	149	193	148	145	112	15	-	-
		Median Incentive ($/W)	-	-	-	-	4.6	4.2	4.3	4.0	3.3	2.7	2.4	2.2	-	-
	LADWP Solar Incentive Program	No. Systems	-	6	-	132	310	57	32	79	137	311	426	802	1294	1208
		Median Incentive ($/W)	-	3.6	-	6.8	6.7	6.6	3.9	3.3	3.8	4.0	3.8	3.6	3.1	2.6
	Pacific Power California Solar Incentive Program	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	20
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6
	SMUD Residential Retrofit and Commercial PV Programs	No. Systems	-	-	-	-	-	-	-	-	-	52	68	249	375	555
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	2.2	2.1	1.9	1.6	1.3
CT	CCEF Onsite Renewable DG Program	No. Systems	-	-	-	-	-	-	2	2	7	15	54	45	30	18
		Median Incentive ($/W)	-	-	-	-	-	-	*	*	5.0	4.6	4.5	4.2	4.0	2.5
	CCEF Solar PV Program	No. Systems	-	-	-	-	-	-	-	32	89	168	273	478	473	393
		Median Incentive ($/W)	-	-	-	-	-	-	-	5.2	5.0	4.7	4.5	4.3	3.9	2.2
DC	Dept. of Environment Renewable Energy Incentive Program	No. Systems	-	-	-	-	-	-	-	-	-	-	-	88	196	99
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	-	3.0	2.9	2.7

State	Program Administrator and Program Name		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
FL	Gainesville Solar Feed-In Tariff[a]	No. Systems	-	-	-	-	-	-	-	-	-	-	-	24	43	104
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	-	**	**	**
	Gainesville Solar-Electric System Rebate Program[a]	No. Systems	-	-	-	-	-	-	-	-	-	20	28	35	4	6
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	1.6	1.6	1.3	*	1.1
	Orlando Pilot Solar Program[a]	No. Systems	-	-	-	-	-	-	-	-	-	-	11	13	11	3
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	0.8	0.7	0.8	*
	Energy & Climate Commision Solar Rebate Program[a]	No. Systems	-	-	-	-	-	-	-	-	16	27	-	575	551	-
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	4.4	4.3	-	3.9	4.1	-
IL	DCEO Solar and Wind Energy Rebate Program	No. Systems	-	3	6	9	5	28	11	7	44	77	96	77	143	15
		Median Incentive ($/W)	-	*	8.5	7.6	7.7	7.3	7.1	5.1	3.4	3.0	2.7	2.5	2.4	2.0
MA	DOER SREC Registration[b]	No. Systems	-	-	-	-	-	-	-	-	-	-	5	19	68	250
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	**	**	**	**
	MassCEC PV incentive programs[b][c]	No. Systems	-	-	-	-	1	70	129	92	261	214	378	788	704	1008
		Median Incentive ($/W)	-	-	-	-	**	5.2	5.3	4.5	3.9	3.2	3.6	3.5	2.2	0.9
MD	MEA Solar Energy Grant Program	No. Systems	-	-	-	-	-	-	-	19	43	47	292	639	752	321
		Median Incentive ($/W)	-	-	-	-	-	-	-	1.5	1.6	1.4	2.4	1.3	0.9	0.5
MN	MSEO Solar Electric Rebate Program	No. Systems	-	-	-	-	-	8	12	10	18	35	38	71	193	15
		Median Incentive ($/W)	-	-	-	-	-	2.4	2.4	2.3	2.2	2.2	2.0	2.1	1.9	1.7
NC	NC Sustainable Energy Assoc. (data compiled from NCUC dockets)	No. Systems	-	-	-	-	-	-	4	5	20	52	93	180	255	435
		Median Incentive ($/W)	-	-	-	-	-	-	**	**	**	**	**	**	**	**
NH	NHPUC Renewable Energy Rebate Program	No. Systems	-	-	-	-	-	-	-	-	-	-	34	172	257	93
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	2.7	2.3	1.9	1.1
NJ	NJCEP Customer Onsite Renewable Energy Program	No. Systems	-	-	-	3	37	90	273	710	840	670	740	565	162	24
		Median Incentive ($/W)	-	-	-	*	6.2	6.7	6.5	6.2	5.7	4.8	4.5	4.0	3.6	2.8
	NJCEP Renewable Energy Incentive Program	No. Systems	-	-	-	-	-	-	-	-	-	-	-	618	1969	867
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	-	1.8	1.6	0.7
	NJCEP SREC Registration Program	No. Systems	-	-	-	-	-	-	-	-	-	2	56	77	796	4067
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	**	**	**	**	**
NM	Solar Market Development Tax Credit	No. Systems	-	-	-	-	-	-	-	-	-	-	-	232	721	804
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	-	**	**	**
NV	NVEnergy Renewable Generations Rebate Program	No. Systems	-	-	-	-	-	-	3	62	72	96	84	183	327	408
		Median Incentive ($/W)	-	-	-	-	-	-	*	4.7	3.5	2.7	2.5	2.2	2.1	4.1
NY	NYSERDA PV Incentive Programs	No. Systems	-	-	-	-	-	44	122	116	203	356	420	775	969	1033
		Median Incentive ($/W)	-	-	-	-	-	4.9	4.8	4.6	4.5	4.3	4.2	4.1	2.7	1.7

State	Program Administrator and Program Name		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
OH	ODOD multiple programs[d]	No. Systems	-	-	-	-	-	-	-	20	13	32	32	26	62	27
		Median Incentive ($/W)	-	-	-	-	-	-	-	5.9	3.9	3.7	3.5	3.6	3.0	2.9
OR	Energy Trust of Oregon Solar Electric Buy-Down Program	No. Systems	-	-	-	-	1	56	138	89	132	214	252	488	1204	943
		Median Incentive ($/W)	-	-	-	-	*	5.2	4.6	3.4	2.2	2.2	2.1	2.1	1.8	1.7
	Eugene Water and Electric Board Solar Electric Program	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	62
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6
	Pacific Power Solar Volumetric Incentive Payments Program	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	48	109
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	-	-	**	**
PA	DCEO grant programs	No. Systems	-	-	-	-	-	-	-	-	-	-	-	-	20	21
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	-	-	1.2	1.3
	DEP Sunshine Solar PV Program	No. Systems	-	-	-	-	-	-	-	-	-	-	-	371	2715	2560
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	-	-	2.3	1.8	0.7
	Sustainable Development Fund Solar PV Grant Program	No. Systems	-	-	-	-	8	33	26	97	13	11	13	-	-	-
		Median Incentive ($/W)	-	-	-	-	6.2	6.2	5.8	5.5	5.3	5.3	4.2	-	-	-
TX	Austin Energy Power Saver Program	No. Systems	-	-	-	-	-	-	50	145	145	171	259	306	156	380
		Median Incentive ($/W)	-	-	-	-	-	-	5.5	5.4	4.7	4.6	4.4	4.4	2.5	2.8
	IOU Solar Incentive Programs	No. Systems	-	-	-	2	-	-	-	-	-	-	-	50	430	389
		Median Incentive ($/W)	-	-	-	*	-	-	-	-	-	-	-	2.6	2.5	2.0
UT	RMP Solar Incentive Program	No. Systems	-	-	-	-	-	-	-	-	-	28	33	33	31	27
		Median Incentive ($/W)	-	-	-	-	-	-	-	-	-	2.2	2.0	2.1	2.1	1.5
VT	RERC Small Scale Renewable Energy Incentive Program	No. Systems	-	-	-	-	-	1	16	11	32	62	91	151	165	419
		Median Incentive ($/W)	-	-	-	-	-	**	3.0	2.3	2.2	1.9	1.8	1.8	1.5	0.7
WI	Focus on Energy Renewable Energy Cash-Back Rewards Program	No. Systems	-	-	-	-	15	20	40	41	82	104	162	276	357	-
		Median Incentive ($/W)	-	-	-	-	3.3	2.9	2.3	2.7	2.6	2.0	2.0	2.0	1.8	-

* Median cash incentive data are omitted if fewer than five data points are available.

**Median cash incentive data are omitted for programs providing only SREC payments or feed-in tariff payments over time (the Gainesville Feed-in-Tariff program, the Orlando Pilot Solar Program, the MA DOER SREC Registration Program, the NJCEP SREC Registration Program, and the Pacific Power Solar Volumetric Incentive Payments Program). Incentive data are also omitted for the NM Solar Market Development Tax Credit Program, which provides incentives in the form of a tax credit. Finally, incentive data were not available for systems provided by the NC Sustainable Energy Association (who is not an incentive program administrator, but rather, provided LBNL with project data compiled from regulatory filings).

[a] Systems that received an incentive from one of the Florida utility programs in the data sample as well as from the Florida Energy & Climate Commission (FECC)'s Solar Rebate Program were retained in the data sample for FECC's program and removed from the data sample for the utility program.

[b] Systems that received an incentive through both the MA DOER SREC Registration Program and the MassCEC PV programs were retained in the data sample for the MassCEC program and removed from data sample for the MA DOER program.

[c] The MassCEC PV programs include systems that were funded through predecessor programs offered by the Massachusetts Technology Collaborative, prior to creation of MassCEC.

[d] The data provided by the Ohio Department of Development includes PV systems funded through a number of programs, including State Energy Plan, Advanced Energy Fund, ARRA Block Grants, and the Energy Loan Fund.

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