Characteristics of Low-Priced Solar Photovoltaic Systems in the United States

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Overview

Despite impressive recent cost reductions, installed prices for small-scale (<15kW) solar photovoltaic (PV) systems in the United States continue to exhibit considerable heterogeneity. The price dispersion occurs across U.S. states, among different installers, and within those groups. These trends suggest a variety of questions for policies aimed at stimulating PV cost reductions, such as: What is different about systems at the low end of the PV price distribution? What factors increase the likelihood of a system being a low-priced system? And, ultimately, what can be done to reproduce or facilitate those conditions more broadly, to drive down U.S. PV system prices?

Researchers from University of Wisconsin—Madison, Yale University, University of Texas—Austin, the Lawrence Berkeley National Laboratory (LBNL), and the National Renewable Energy Laboratory empirically examined the characteristics of the lowest-priced small-scale PV systems in United States. Our analysis relies on the sizable dataset of system-level PV prices managed by LBNL, consisting of over 40,000 PV systems installed in 15 U.S. states during 2013. Focusing on systems under 15 kW and applying a variety of statistical methods, we identify those factors that are most likely to result in low-priced systems. In doing so, the research helps to identify practices and policies that might reduce future PV prices and further stimulate the market.

Specifically, the study finds that low-priced systems are associated with markets with fewer active installers; experienced installers; customer ownership; larger size; retrofits; and thin-film, low-efficiency, and Chinese modules. The analysis also finds that low-priced systems are much more likely to occur in some states than in others. Finally, PV subsidies appear to simultaneously shift and broaden the price distribution, such that low-priced systems are more likely to occur in the presence of higher incentives. Much of this broadening occurs in a particular location, northern California, which is worthy of further investigation with new data. The study's focus on the left tail of the price distribution differs from recent analyses of mean prices, which have found that PV subsidies increase mean prices, even if higher subsidies might also help to increase the number of low-priced systems.

Data and Methods

The study relies on LBNL's sizable *Tracking the Sun* data set of system-level PV prices, which includes characteristics of 71,861 systems installed in 2013, along with additional data from SEIA/GTM, DSIRE, IREC, and the U.S. Census Bureau. To develop a complete data set for analysis, we restrict our sample to systems: sized from 1 kW to 15 kW, with prices between $1/W and $25/W, with known PV installers, and with known locations. Appraised-value third-party owned (TPO) systems are excluded from the analysis, but other TPO systems for which prices reflect transactions between installers and finance providers are retained. The final sample contains 42,611 PV systems across 15 states.

This fact sheet summarizes the full report: Nemet et al. 2016. Characteristics of Low-Priced Solar Photovoltaic Systems in the United States. Berkeley, CA: Lawrence Berkeley National Laboratory. The full report, along with a summary slide deck, is available here or via emp.lbl.gov/reports. This work was funded by the Solar Energy Technologies Office, Office of Energy Efficiency and Renewable Energy of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

Our analytical approach has three parts. First, we examine descriptive characteristics of the trends and patterns in the entire data set. Second, we use t-tests of means to assess the significance of the differences between low-priced and non-low-priced systems for each variable, individually. Finally, we use regression models with various specifications to assess each variable's significance in predicting whether a specific PV installation is in the low-priced group. Our base case definition of a low-priced system is whether its price is below the 10th percentile of all systems in our data set.

Results and Conclusions

Taking the results altogether—including the means tests, the main regression results, and all robustness checks—we find that systems are more likely to be low-priced under the following conditions:

- **Competition**: in markets with fewer installers, and to some extent in more concentrated markets.
- **Firm**: installed by firms with more county-level installation experience but less county-level market share, or by smaller firms.
- **Markets**: for commercial installations and for customer-owned installations.
- **Policy**: systems with a high "consumer value of solar", considering utility bill savings and incentives, with caveats, and a higher portion of those incentives from solar renewable energy credits (SRECs).

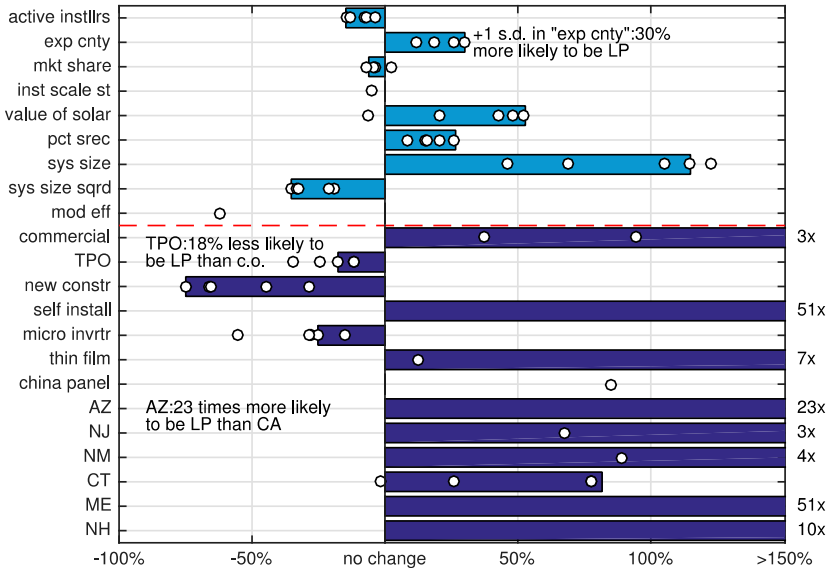

Figure 1. Size of effect of each significant variable on odds of a system being low priced. Bars refer to primary regression model. Circle markers refer to alternate formulations. Variables above dashed line are ratios; those below are binary. See full report for definitions and descriptions of variables.

- **System**: for larger systems; systems excluding tracking, BiPV, micro-inverters, and batteries; systems installed on existing homes and self-installed; and systems using thin films, less efficient modules, and modules from China.
- **States**: after controlling for all of the above, AZ, CT, NJ, NM, ME, and NH are large markets that are more likely to have low-priced systems; the base state, CA, has about half as many low-priced as would occur if such systems were proportionally distributed based on market size.

Figure 1 shows that the largest predictors of low-priced systems are system size, customer value of solar, county-level installer experience, and percent of value from SRECs. Among binary variables, the largest predictors are commercial systems, self-installations, thin films, existing homes, and installations in Arizona, Maine, and New Hampshire. Several of our results—in particular the effects of new construction and the customer value of solar—run counter to the findings from other previous studies in this series and in *Tracking the Sun*. Our primary interpretation of these differences is that they arise from a focus on central tendencies in those other studies and a focus on the left tail of the price distribution in ours. In

other words, certain factors may lead to both higher average prices but also a greater incidence of relatively low-priced systems.

The low-priced system results can inform solar policy aimed at stimulating cost reductions by demonstrating achievable cost targets, and may presage what average systems may look like in the future, as prices continue to drop. At the same time, the results raise questions about which predictors of low-priced systems are controllable and which are likely to be exogenous or driven mainly by consumer preferences. If a goal of policy is to generate—and learn from—new system configurations, financing models, and adoption dynamics, then policy makers should examine these results and consider which low-priced system predictors are appropriate for intervention via public incentives. Of particular note, our results suggest that solar subsidies might positively influence the incidence of low-priced systems in some areas, but not in others. Further work using new data will help to refine these findings.