Sources of Price Dispersion in U.S. Residential Solar Installations: The Importance of Information

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Overview

A key goal for the solar industry, policymakers, and other decision makers—as exemplified by the U.S. Department of Energy's *SunShot Initiative*—is to foster continued, dramatic declines in solar costs. And yet, despite impressive recent cost reductions, there remains a considerable range of installed prices for small-scale solar photovoltaic (PV) systems in the United States. Past research by our team has explored some of the reasons for this pricing variability: broadly exploring factors affecting pricing differences (Gillingham et al. 2014); identifying the impact of local regulatory and permitting processes (Burkhardt et al. 2015; Wiser and Dong 2013) and solar rebates (Dong et al. 2014); pinpointing the characteristics of low-priced PV systems (Nemet et al. 2016a, Nemet et al. 2016b); and exploring the impact of installer size on PV price quotes (O'Shaughnessy and Margolis 2017).

The current study—led by the University of Wisconsin—analyzes price dispersion in U.S. residential PV installations, and seeks to inform questions such as: Why is there such a range of prices for a seemingly indistinguishable good? Why are consumers paying more than they need to? And would better-informed consumers increase the social benefits of solar PV? Most notably, we find that factors that increase consumer information—neighbors who have recently installed PV and having third-party quotes available—are also associated with less price dispersion. These results provide support for the importance of public efforts to enhance access to price information, e.g. by supporting price quote providers. The results also point to the particular need for information in nascent markets for PV in which access to the experience of neighbors is not available.

We draw on the sizable literature in industrial organization that focuses on the levels and sources of price dispersion in other sectors. Access to and the cost of consumer information about attributes of a good have consistently provided explanations of observed price dispersion, and we too focus on so-called "search costs." Search costs are particularly important in PV because buying decisions are complicated: the technology is new and dynamic; historically, almost no residential consumer is used to making capital investments to procure electricity; the value of PV to the consumer is associated with complicated rate designs and changing policies; and PV systems typically last 20 years or more, precluding repeat purchases. Furthermore, because the technology is new, still rare, and infrequently purchased, consumers likely have few acquaintances from which to obtain trustworthy experiential information. From a policy perspective, meanwhile, understanding the reasons why prices vary is important for improving the effectiveness and cost-efficiency of policies targeting the adoption of PV.

This fact sheet summarizes the full report: Nemet et al. 2017. *Sources of Price Dispersion in U.S. Residential Solar Installations.* Berkeley, CA: Lawrence Berkeley National Laboratory. The full report 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.

Data and Methods

This paper analyzes price dispersion in U.S. residential PV installations between 2008 and 2014. The study relies on Berkeley Lab's sizable *Tracking the Sun* data set of system-level PV prices, supplemented with other data sets. For most of our analysis, we restrict our sample to residential systems installed between 2008 and 2014, sized from 1 kW to 15 kW, and with prices between $1/W and $25/W. 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 234,666 PV systems across the United States.

We measure price dispersion in a given time and place using the coefficient of variation. In order to help gauge the possible drivers for price dispersion, we first examine certain descriptive characteristics of the trends and patterns of the data set, drawing on our review of the broader literature on the possible drivers for price dispersion. We then use multiple regression models and robustness checks to assess each variable's significance in driving the variation in PV pricing.

Results

The impressive recent declines in the cost of PV obscure the complication that not everyone receives low-priced solar. Instead, as shown in Figure 1, people pay dramatically different prices for what, on its face, appears to be a homogenous good.

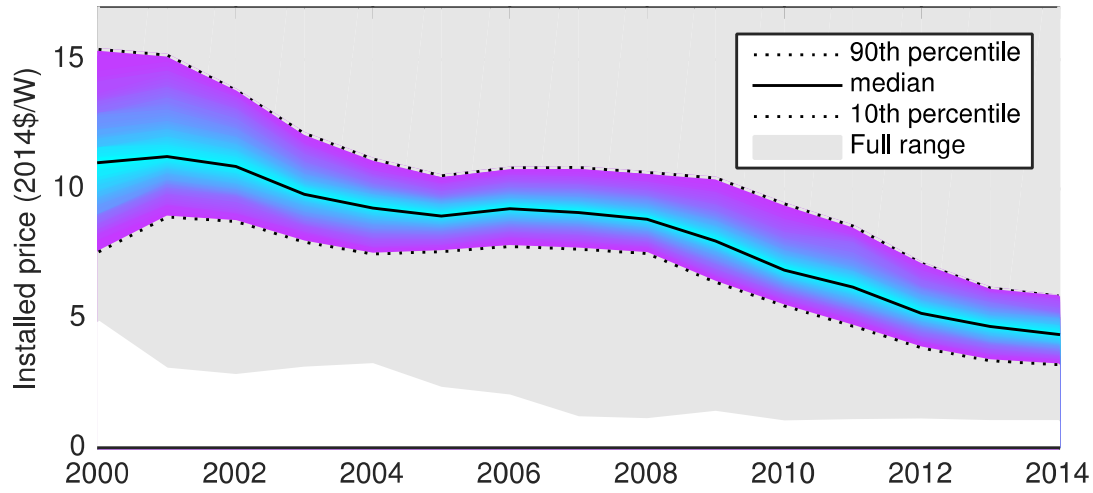

Figure 1. Distribution of installed residential PV prices

We find higher levels of price dispersion in our residential PV data than the average of 55 previous studies that cover a wide range of other products. We also find that residential PV price dispersion has been persistent, even increasing since 2008 despite industry maturation.

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Figure 2 summarizes, conceptually, some of the key findings from our investigation. Generally, analysis of the factors affecting PV price dispersion supports theories from the economic literature focusing on access to information and the costs and benefits of consumer search.

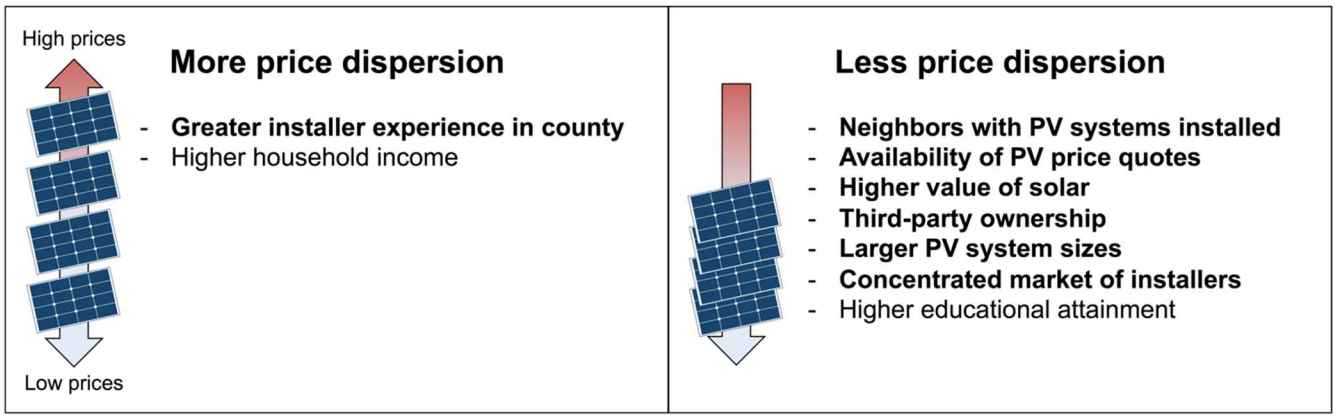

Figure 2. Core drivers for price dispersion in residential PV (bolded items found to be more significant)

Factors that reduce the costs of search—neighbors who have recently installed solar and having third-party quotes available—are associated with less price dispersion.

- Neighbors with PV systems installed: Price dispersion decreases in areas with clusters of PV systems. Having neighbors with recent purchase experience provides a channel for low cost information dissemination. It allows a one-time purchaser to obtain some of the benefits of learning-by-shopping emphasized in the economic literature. Further, the local aspect of the information makes it likely to be both relevant and trusted, potentially providing the new customer with information about pricing strategies, negotiation experience, reliability, and installer quality.
- Availability of PV price quotes: Third party provision of price quotes to consumers reduces the cost of accessing price information, also reducing price dispersion. Only a small number of parameters are needed for the consumer to begin to obtain such quotes; contrast this with negotiating pricing with individual installers, in which obtaining pricing is costlier and more time consuming.

Factors that increase the consumer payoffs of investing time in searching for information are also associated with lower levels of price dispersion. For example, given the higher cost of a larger PV system, areas with larger PV systems tend to have lower levels of price dispersion. Similarly, as the average consumer value of solar increases, price dispersion declines. In both cases—larger PV systems and higher value of solar—consumers have heightened incentives to search for the best deal.

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Areas with large proportions of third party owned systems are also associated with lower levels of price dispersion. In this case, the price refers to the transaction price between the third party owner and the PV installer. The broader literature emphasizes the costs of consumer search, learning from repeated purchases, and payoffs from scale. For customer owned systems, there are no repeat purchases and scale is limited by roof area or electricity demand. In contrast, third-party owners are involved in purchasing hundreds of systems and can spread the costs of search over megawatts rather than kilowatts: it therefore comes as no surprise that price dispersion declines with third party ownership.

Other findings—related to installer experience, installer concentration, household income, and educational attainment—are discussed in the full report.

Conclusions

This study assesses the existence of and factors affecting price dispersion in U.S. residential PV installations from 2008 to 2014. While price dispersion is empirically common, our results indicate that PV markets violate the "law of one price" even more than many other products.

The existence of price dispersion matters in part because some consumers are paying higher—and in some cases much higher—prices than others. Perhaps more important is the effect on consumers that we do not see in our data: those that do not adopt solar because they perceive that prices are higher than what is actually available or because they are unwilling to invest the time to search for better deals.

Finding ways to reduce price dispersion could have substantial public benefits; unless there is a strong and persistent barrier to entry, reducing price dispersion will lower consumer prices. Moreover, the evidence of information problems in the residential PV market fits well with the economics literature on consumer search. Where and when the consumer benefits of searching for lower-priced systems are high (large system size, and high value of solar), price dispersion is smaller. Similarly, factors that reduce the time or cost of searching for reliable information (having neighbors with PV, or having many quotes in the market) also reduce price dispersion.

These results are encouraging for programs that increase access to information, such as by making installer price quotes more broadly available. They also make clear that pricing is more competitive in clusters of PV installations where potential consumers can make use of a trusted and relatively accessible information source—their neighbors. This might suggest that targeting adoption in existing clusters has higher potential to result in low-priced solar. It also points to the particular need for pricing, system, and installer information in nascent markets in which access to the experience of neighbors is not available.