BERKELEY LAB

ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY

REPORT LBNL-4476E

An Analysis of the Effects of Residential Photovoltaic Energy Systems on Home Sales Prices in California

Ben Hoen, Ryan Wiser ,
Peter Cappers, and Mark Thayer

Environmental Energy Technologies Division

April 2011

The report can be downloaded from:
http://eetd.lbl.gov/ea/emp/reports/lbnl-4476e.pdf

This work was supported by the Office of Energy Efficiency and Renewable Energy (Solar Energy Technologies Program) of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231, by the National Renewable Energy Laboratory under Contract No. DEK-8883050, and by the Clean Energy States Alliance.

Research Report Summary

An Analysis of the Effects of Residential Photovoltaic Energy Systems on Home Sales Prices in California

Background

The market for photovoltaic (PV) energy systems is expanding rapidly in the U.S. Almost 100,000 PV systems have been installed in California alone, more than 90% of which are residential. Some of those "PV homes" have sold, yet little research exists estimating if those homes sold for significantly more than similar non-PV homes. A clearer understanding of these effects might influence the decisions of homeowners considering installing PV on their home or selling their home with PV already installed, of home buyers considering purchasing a home with PV already installed, and of new home builders considering installing PV on their production homes.

To determine whether PV homes sell for significantly more than comparable non-PV homes, Berkeley Lab analyzed a dataset of approximately 72,000 California homes, almost 2,000 of which had PV systems installed at the time of sale. The study also investigated whether premiums for PV installed on new homes were different than those for PV installed as a retrofit on existing homes, and whether the age or the size of the PV system impacted premiums.

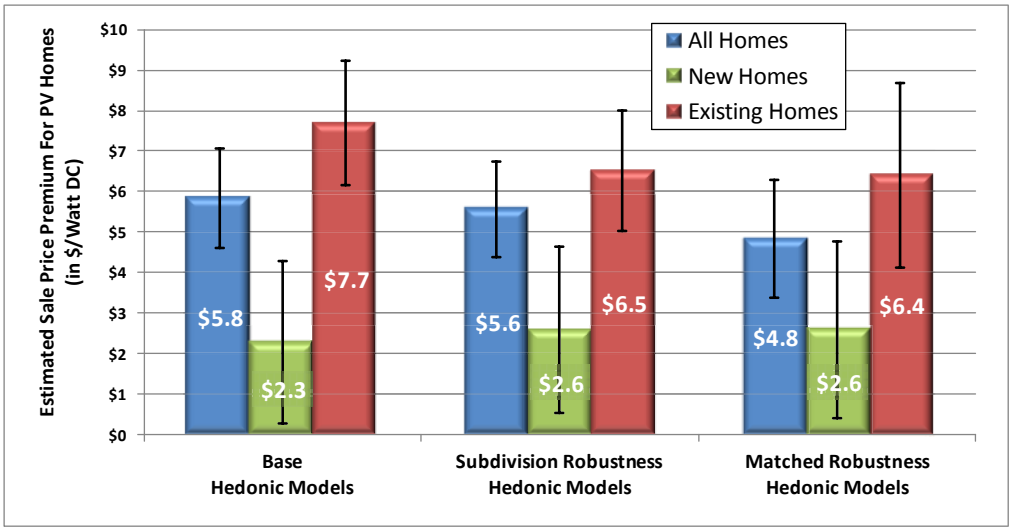
A large number of hedonic pricing and difference-in-difference models (see sidebar on next page) were used to ensure that the results were robust.

Results

The research finds strong evidence that homes with PV systems in California have sold for a premium over comparable homes without PV systems. More specifically, estimates for average PV premiums among a large number of different model specifications coalesced near $17,000 for a relatively new "average-sized" - based on the sample of homes studied - PV system of 3,100 watts (DC). This corresponds to an average home sales price premium of $5.5/watt (DC), with the range of results across various models being $3.9 to $6.4/watt.

These results are similar to the average increase for PV homes found by Dastrop et al. (2010), which used similar methods but focused on homes in the San Diego area. The average sales price premiums also appear to be comparable to the investment that homeowners have made to install PV systems in California (after applicable state and federal incentives), which from 2001-2009 averaged approximately $5/watt (DC) (Barbose et al., 2010), and homeowners with PV also benefit from electricity cost savings after PV system installation and prior to home sale.

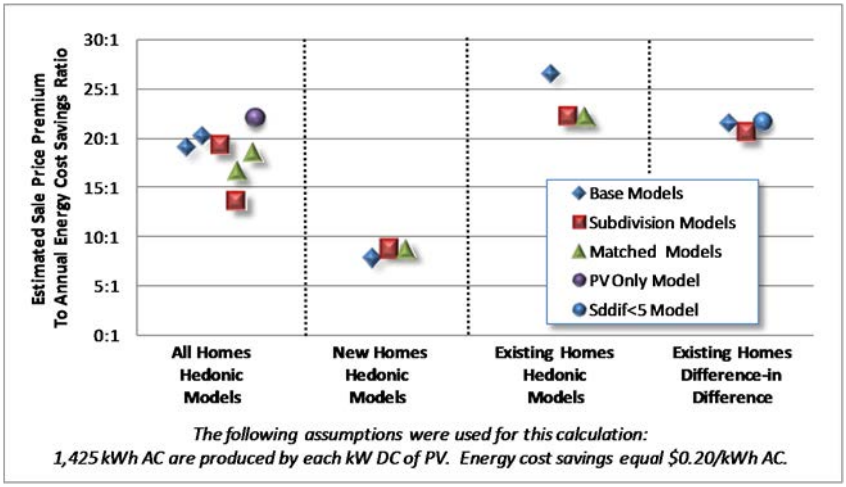
When the dataset is split between new and existing homes, PV system premiums are found to be markedly affected (see figure on back), with new homes with PV demonstrating average premiums of $2.3 to 2.6/watt, while the average premium for existing homes with PV being more than $6/watt. The report offers a number of possible explanations for why this disparity might exist, including differences in the underlying net installation costs for PV systems between new and existing homes. Additionally, new home builders may gain value from PV as a market differentiator, and have therefore often tended to sell



PV as a standard (as opposed to an optional) product on their homes and perhaps been willing to accept a lower premium in return for faster sales velocity and decreased carrying costs.

The research also finds that, as PV systems age, the premium enjoyed at the time of home sale decreases, indicating that buyers and sellers of PV homes may be accounting for the decreased efficiency and remaining expected life of older PV systems.

When the results are expressed as a ratio of the sales price premium to estimated annual electricity cost savings associated with PV (see figure below) they are consistent with those of the more-extensive existing literature on the impact of energy efficiency on home sales prices; the present research finds an averages range from 7:1 to 31:1, with models coalescing near 20:1.



Applicability

Although this research finds strong evidence that homes with PV systems in California have sold, on average, for a significant premium over comparable homes without PV systems, the authors recommend that extrapolation of these results to different locations or market conditions be done with care.

Further Research Warranted

The report outlines a number of additional questions that warrant further research, such as investigating more-recent home sales (the report's dataset spanned 1999 thru 2009) from a broader geographic area (the dataset included only California homes), and further investigating the difference in premium between new and existing PV homes.

References

Dastrop, S., Zivin, J. G., Costa, D. L. and Kahn, M. E. (2010) Understanding the Solar Home Price Premium: Electricity Generation and "Green" Social Status. UC Center for Energy & Env. Econ., Berkeley, CA. Dec 9, 10. WP-001.

Barbose, G., Darghouth, N. and Wiser, R. (2010) Tracking the Sun III: The Installed Cost of Photovoltaics in the U.S. 1998-2009. LBNL, Berkeley, CA. Dec, 10. LBNL-4121E.

What Is a Hedonic Pricing Model?

Hedonic pricing models are frequently used by real estate professionals and academics to assess the impacts of individual house and community characteristics on property values by investigating the sales prices of homes. A house can be thought of as a bundle of characteristics (e.g., number of square feet). When a price is agreed upon between a buyer and a seller there is an implicit understanding that those characteristics have value. When data from a large group of residential transactions are available, the average marginal contribution to the sales price of each characteristic can be estimated with a regression model. The contribution to the selling price of having a PV system can be thus be estimated, if other important housing market influences are adequately controlled for.

What Is a Difference-in-Difference Model?

A variant of the hedonic model, a difference-in-difference model compares inflation adjusted selling prices of homes that have sold twice, both before a condition exists (e.g., having a PV system installed) and after.

What Are Robustness Models?

Because models are built on assumptions, practitioners often test those assumptions by trying multiple model forms. In this research, "base" models, which used the full dataset and controlled for "neighborhood" effects at the census block group level, were compared with "robustness" models. Examples include models that controlled for "neighborhood" at the subdivision level (a potentially better proxy than the block group), models that "matched" PV and non-PV homes to be statistically identical in many respects (similar to what an appraiser might do when valuing a home), and models that only evaluated PV homes.

The general consistency in results across all of the models demonstrates the robustness of the study's findings.