An Analysis of Solar Home Paired Sales across Six States

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Abstract

Solar photovoltaic (PV) installations on some US homes still receive no value during an appraisal because comparable home sales are lacking. This first-of-its-kind study uses appraisal methods to evaluate sale price premiums for *owned* PV systems on single-unit detached houses across six states that were also evaluated in a large statistical study. The results provide strong, appraisal-based evidence of PV premiums in all the states studied, and the results support use of cost- and income-based PV premium estimates when paired sales analysis is impossible. The appraised premiums agree with statistical modeling results, which bolsters the suitability of both approaches for estimating PV home premiums.

Introduction

As of the second quarter of 2015, over 725,000 residential properties had a solar photovoltaic (PV) system installed, and almost 135,000 of these systems had been installed in the first two quarters of 2015 alone.[1] Approximately 50% of these properties are in California, but Hawaii, Arizona, New Jersey, Colorado, and New York, among others, are seeing robust markets for PV installation as well. This rapid growth is related to the dramatic reduction in installed PV costs over the last ten years[2] as well as federal, state, and utility PV incentives and the rise of innovative financing, such as leased PV and zero-money-down options.[3] The growth in installations has raised the question, How much value do PV systems add to homes?

Valuing residential PV systems is a complex appraisal assignment, and data are rarely adequate to provide accurate premium estimates.[4] In some market areas this is due to the lack of comparable PV home sales. If the lender's underwriter requires that the sales comparison approach use the sale of a similar property with a PV system, and such a comparable sale is not available, this can result in zero value assigned to the PV system. Such a requirement is an individual lender's underwriting guideline, not a secondary mortgage market guideline.[5]

Underwriters reviewing residential real estate transactions prefer to support the value of a feature using a *paired sales analysis* in which at least one sale includes the same feature as the home in question. It is difficult, however, to pair sales accurately in a market that has incomplete reporting of property conditions, varying seller and buyer motivations, and sale prices that may not reflect the definition of market value.

Literature Review

A limited number of PV home value studies have been published in the past ten years. Only a few of these have been by real estate appraisers

1. Solar Energy Industries Association (SEIA) and GTM Research, *U.S. Solar Market Insight: Q2 2015* (Washington, DC: Solar Energy Industries Association, 2015).
2. Galen Barbose and Naïm Darghouth, *Tracking the Sun VII: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2014* (Berkeley, CA: Lawrence Berkeley National Laboratory, August 2015).
3. SEIA and GTM Research, *U.S. Solar Market Insight*.
4. Ibid.
5. That is, it is not a Fannie Mae, Freddie Mac, Federal Housing Administration (FHA), or Department of Veterans Affairs (VA) guideline for lending.

using standard appraisal methods, including studies of Oregon[6] and the Denver metro area.[7] Both of these studies find evidence of PV home price premiums.

In addition, three large-scale statistical analyses using hedonic pricing models have been conducted. A study by Hoen, Cappers, Wiser, and Thayer[8] investigates almost 4,000 sales across eight states, with most sales in California. Other studies analyze a smaller data set of homes in California[9] and in San Diego and Sacramento.[10] Each of these studies shows premiums for homes with PV systems.

Hedonic pricing models employ accepted statistical measures of confidence to provide statistically defensible estimates of the marginal price differences associated with various home characteristics across a large sample of homes. Although researchers prefer such models, many appraisers and their lending clients do not, because they are often unfamiliar with the statistical methodology. In addition, they would be unable to easily access a large enough sample size (hundreds of sales or more) for the analysis. Moreover, paired sales methodology is well suited to examine the effects on a single home, which is often the assignment, rather than a broad group of homes as would be the case for the hedonic models. Finally, appraisers are forbidden to use the work of others if they do not understand the methodology and cannot attest to its credibility, per the Uniform Standards of Professional Appraisal Practice (USPAP); this would be the case with most appraisers and hedonic modeling.[11] Therefore, although both methods are similar—in that they both adjust for differences in selling price based on the underlying characteristics—appraisers and their lending clients typically employ studies that use paired sales.

The current study helps bridge this gap between the two methods by comparing them directly through the analysis of a sampling of data from Hoen et al.,[12] using paired sales techniques. This first-of-its-kind research effort draws on evaluations of individual market areas by local appraisers, who are intimately aware of the local market conditions and the relationship between prices and home features. After detailing the paired sales results, those results are compared to the hedonic modeling results from Hoen et al. and conclusions are drawn. Recommendations are also provided for improving PV system valuation techniques.

Methodology

This study uses appraisal methods to evaluate sale price premiums for owned PV systems on single-unit detached houses in areas covered by the recent Lawrence Berkeley National Laboratory (LBNL) study.[13] LBNL provided data for a large number of PV home sales that took place between 2011 and 2013, clustered in relatively populous areas across six states: California, Oregon, Florida, Maryland, North Carolina, and Pennsylvania. Seven appraisers were selected to analyze these data based on their knowledge of the local markets, access to multiple listing service (MLS) data, and experience with PV sales. These appraisers developed the 43 home sales pairs used for this study across the six states. All the pairs were reviewed and, in some cases, other local appraisers were consulted to enhance the accuracy of value estimates. Each of the seven appraisers were asked to perform the following tasks:

6. Taylor Watkins, *Market-Based Investigation of Residential Solar Installation Values in Oregon* (Portland, OR: Energy Trust of Oregon, September 2011).
7. Lisa K. Desmarais, *The Impact of Photovoltaic Systems on Market Value and Marketability: A Case Study of 30 Single-Family Homes in the North and Northwest Denver Metro Area* (Denver: Colorado Energy Office, 2013).
8. Ben Hoen et al., *Price Premium Analysis of a Multi-State Dataset of Solar Homes: Host-Owned Rooftop Solar Adds Significant Value to U.S. Homes across 8 States* (Berkeley, CA: Lawrence Berkeley National Laboratory, 2015).
9. Ben Hoen et al., *An Analysis of the Effects of Photovoltaic Energy Systems on Residential Selling Prices in California* (Berkeley, CA: Lawrence Berkeley National Laboratory, 2011); and Ben Hoen et al., "Residential Photovoltaic Energy Systems in California: The Effect on Home Sales Prices," *Contemporary Economic Policy* 31, no. 4 (October 2013): 708–718.
10. Barbara C. Farhar, "Advancing a Market for Zero-Energy Homes," *Solar Today* 22, no. 1 (January/February 2008): 24–29; and Samuel R. Dastrup et al., "Understanding the Solar Home Price Premium: Electricity Generation and 'Green' Social Status," *European Economic Review* 56, no. 5 (2012): 961–973.
11. Appraisal Standards Board, *Uniform Standards of Professional Appraisal Practice*, 2016–2017, Standards Rule 2-3, lines 858–862.
12. Hoen et al., *Price Premium Analysis of a Multi-State Dataset*.
13. Ibid.

- Research the PV sales to establish they met the definition of market value
- Identify sales that included PV systems that were not mentioned in the MLS listing
- Compare MLS data to public record data on the PV sale and any sale used in the analysis
- Develop a credible paired sales analysis using a sample table to estimate the difference in value between PV and non-PV properties
- Collect information about time on the market for all transactions
- Estimate gross costs of the PV system as of the date of the PV home sale
- Identify incentives as of the date of the sale and estimate the net cost of the system

In addition to the appraisers' paired sales and cost estimates, contributory value income estimates are developed using the Photovoltaic Energy Valuation Model, or PV Value® tool.[14] This section describes the paired sales, cost, and income methods as well as the method for calculating time on the market.

Paired Sales Analysis

A paired sales analysis compares the sale price of a property with a feature of interest (here, a PV system) to the price of a similar property sold recently without the feature. After adjusting for home differences, the difference in the sale prices attributed to the study feature can be identified.[15] Increasing the number of pairs evaluated increases the certainty of the feature's influence on value, as does a tight range of price premium results. A study that is inconclusive owing to a wide range of premiums can occur for a variety of reasons, most often because the paired homes are too different to be compared accurately. Paired sales analysis is difficult and time-consuming for the following reasons:

- Few sales of almost-identical properties, in the same area and selling within a reasonable period, occur on a regular basis.
- Home condition, motivation of buyer and seller, and financing can affect prices paid; these factors must be accounted for to ensure both sales meet the definition of market value and do not skew the results.
- Just as with the study feature (PV system), adjustments for non-study features must be quantifiable and market based to provide credible results.

Cost Approach

The cost approach estimates the replacement cost of the PV system. A typical buyer would consider the replacement cost of a system as of the date of the house purchase, and not the original price paid for the system. Therefore, the appraiser must use cost estimates as of the sale date or appraisal date, not the date of installation. This is especially important because, over the past three years, installed PV system prices have declined dramatically as have the incentives paid by federal, state, and local governments to spur solar deployment.

A variety of resources can help appraisers establish the gross PV replacement cost as of the sale date. Such resources include the publicly available incentive databases, the Solar Energy Industries Association (SEIA), local installers, the National Renewable Energy Laboratory (NREL), and records of known purchases. The cost approach considers depreciation, which is the difference between the new cost and the amount the market is willing to pay on the specified date (also known as contributory value). Depreciation is difficult to calculate when a feature is new to the market and limited sales are available.

For this study, a gross cost and a net cost are established. The net cost is calculated as the gross cost less federal, state, and utility incentives available at the time of sale. It is assumed that homeowners consider the incentives at the time of sale; thus, the net cost is used to represent the depreciated value that best captures what the market is willing to pay. The gross and net costs are not depreciated in this study. Some data suggest the sale price premium for PV system is similar to the net cost; therefore, the incentives

14. One anonymous reviewer noted the *PV* in PV Value could be misconstrued as meaning *present value*. In this case it refers to photovoltaic, but coincidently, the tool does employ a present value calculation. For more information on the PV Value tool, see Geoffrey T. Klise, Jamie L. Johnson, and Sandra K. Adomatis, "Valuation of Solar Photovoltaic Systems Using a Discounted Cash Flow Approach," *The Appraisal Journal* (Fall 2013): 316–331, and Energy Sense Finance at http://www.energysensefinance.com/products.
15. The types of features requiring adjustment in the paired sales analysis include market conditions (such as date of sale), concessions paid by the seller, site size, view amenities, age, gross living area, bathrooms, bedrooms, pools, porches, garage size, quality, and condition. The adjustments are based on the local market's reaction to the feature, and they would vary with the market and housing price range.

and rebates are taking the place of depreciation normally applied in the appraisal process.[16] By examining premiums in relation to net and gross cost estimates, this study can provide valuable support for potential rates of PV system depreciation in the market.[17]

Income Capitalization Approach

The income capitalization approach[18] is useful for valuing items with a quantifiable income stream, such as a rental property or PV system. The value of income received over time is discounted and summed to a present value, because money received in the future is not worth the same as money received today, and a homeowner is expected to discount the income stream using a rate similar to an alternative investment with similar risks.

In the study, PV income values are estimated for each PV sale in the paired sales analysis using the PV Value tool, a free web-based valuation tool developed by Energy Sense Finance based on prior work.[19] PV Value estimates PV energy output, discounts the value of the energy produced to the present, and then sums the discounted savings over the PV system's expected lifetime—based on the remaining warranty period of the PV panels—to provide a present value estimate.[20] Most warranties are 25–30 years, and in the study a 25-year warranty is assumed when the actual warranty term is not available. Other inputs include the size and age of the system, home site address (to derive geographic characteristics such as weather, latitude, and longitude), the estimated tilt and azimuth of the system,[21] the electric retail rate at the time of sale, the estimated utility rate escalation similar to the historical escalation, and the discount rates as of the time of sale. The discount rate used is equivalent to 50–200 basis points over the 90-day Fannie Mae fixed-rate 30-year mortgage.[22] The copyrighted algorithm default parameters assume a module degradation factor of 0.5% per year and an expected inverter replacement at 15 years. Data from the NREL's PVWatts and Developer Network websites,[23] and from the US Energy Information Administration "Average Price by State Provider" website are used to estimate the energy produced by the system, average retail electric rates, and average electrical escalation rate.

The estimation procedure produces a set of low, average, and high estimates of the present value of expected energy output, based on a risk premium of 200, 125, and 50 basis points above the base interest rate or weighted average cost of capital, respectively. The average value was used throughout this study. For California homes, where a tiered volumetric rate structure is present, the PV Value "default" average electric rate is likely lower than rates paid by the typical PV homeowner in this market.[24] Therefore, for California homes, the high estimate might better compensate for this difference. Although not employed for this study, PV Value provides an option to input a custom electric rate to match the homeowner's actual utility rate.[25]

16. For example, see Hoen et al., *Price Premium Analysis of a Multi-State Dataset*, which shows that PV premiums are highly correlated with net cost estimates.
17. Depreciation, as used by appraisers, is the cost new without any reductions for incentives, less the value the market is willing to pay. Therefore, this study examines if the net cost is similar to the depreciated amount.
18. Also known as discounted cash flow analysis.
19. Jamie L. Johnson and Geoffrey T. Klise, *PV Value® User Manual v. 1.1* (Albuquerque: Sandia National Laboratories, September 1, 2012), http://energy.sandia.gov/wp-content/gallery/uploads/PV_Value_v1_1_user_manual.pdf; Jamie L. Johnson, *Factors to Consider for a PV Valuation Model* (Tampa: Solar Power Electric, 2010).
20. Klise, Johnson, and Adomatis, "Valuation of Solar Photovoltaic Systems."
21. When the tilt and azimuth were not available, they were estimated based on Google Satellite Maps and the Solmetric Roof Azimuth Tool, http://tools.solmetric.com/Tools/RoofAzimuthTool.
22. Fannie Mae, "Required Net Yields to 1985," https://www.fanniemae.com/singlefamily/required-net-yields-to-1985.
23. The PVWatts calculator is a basic solar modeling tool that calculates PV energy production based on minimal inputs; see http://pvwatts.nrel.gov and https://developer.nrel.gov.
24. Naïm R. Darghouth, Galen L. Barbose, and Ryan H. Wiser, "The Impact of Rate Design and Net Metering on the Bill Savings from Distributed PV for Residential Customers in California," *Energy Policy* 39, no. 9 (2011): 5243–5253. California Public Utilities Commission, *California Net Energy Metering Ratepayer Impacts Evaluation* (San Francisco: California Public Utilities Commission, 2013).
25. One reviewer suggested it would be best to use a blended rate that takes into account the weighting by tier, which would better reflect the average rate of the homeowner. Although this would be appropriate for future users of the tool, doing so is beyond the scope of the current analysis because we could not obtain individual home consumption and, therefore, the appropriate weighted rate.

Exhibit 1 Summary of Paired Sales Preparation Process

			Step 1	Step 2	Step 3	Step 4	
State	**Market**	**Original Sales**	**Non-Market Value**	**PV System Not Identified in MLS**	**Comparable Home Not Available**	**Additional Sales Discovered**	**Final Set of Paired PV Home Sales**
CA	San Diego Metro Area	76	-28	-2	-33		13
FL	Gulf Coast	13	-3		-5		4
MD	Baltimore Metro Area	13	-4		-6		3
NC	Raleigh Metro Area	23	-6	-2	-8		7
OR	Portland Metro Area	39	-9	-2	-19		9
OR	Bend Metro Area	22			-20		2
PA	Southeast Portion	22			-19	2	5
	Total	**208**	**-50**	**-7**	**-110**	**2**	**43**

Days on the Market

The appraisers hired for this study examined the number of days a property was listed before selling to determine if PV homes sell at a different rate than paired non-PV homes. They calculated the time between the contract date and the most recent MLS listing date. If a listed home price changed, or if the listing was removed and the home was relisted, only the most recent change was used. The same rules were applied to PV and non-PV homes.[26]

Data

This analysis uses a subset of the almost 4,000 PV home transactions analyzed by Hoen et al., consisting of sales from the following markets: San Diego metro area; Florida Gulf Coast area; Baltimore metro area; Raleigh metro area (North Carolina); Portland and Bend metro areas (Oregon); and the southeast portion of Pennsylvania.[27]

In each market area, the local appraiser was given data on PV home sales drawn from the larger data set, almost entirely from the most recent years (2011 through 2013). The sales for the hedonic analysis were drawn from public records (mostly from county assessor and deed recorders offices) and were not separately verified. Therefore, the appraiser in each area culled the transactions to produce a final set appropriate for the paired sales analysis. Although this resulted in a smaller data set, it enabled the appraisers to be more confident in the results.[28]

Exhibit 1 summarizes the data preparation process for each market area. In Step 1, the appraisers determined if sales would be considered market value[29] transactions. Sales not considered market value were eliminated, including short sales, sales between private parties, and, more commonly, sales not listed in the MLS that were thus unverifiable. In Step 2, the appraisers eliminated sales for which PV systems were not listed in the MLS to ensure that the system was marketed properly to all potential buyers. In addition, for two sales the sale date preceded the reported installation date; thus the sales could not be considered PV home sales, and these sales were eliminated. In Step 3, the appraisers eliminated all PV home sales for which a comparable non-PV home sale could not be identified. In addition, homes that were not single-family, detached structures—such as townhouses and manufactured homes—were eliminated, because those are not the focus of this study. Finally, in Step 4, the appraisers added homes to the data set in areas where additional appropriate PV homes were discovered.

Out of the 208 sales provided to appraisers in all market areas, 50 sales (24%) were eliminated

26. An anonymous reviewer noted that if prior listings are ignored it is much less likely to find a difference in days on the market.
27. Hoen et al., *Price Premium Analysis of a Multi-State Dataset*. The Portland and Bend metro areas were not included in that analysis because of limitations to the data for those areas, but those metro areas were appropriate for this analysis and therefore have been included.
28. This screening process was in addition to the one employed in Hoen et al. *Price Premium Analysis of a Multi-State Dataset* as described in Section 3 and footnote 17 of that report.
29. Rules and Regulations, 55 Fed. Reg. 65 (August 24, 1990).

because they were not considered market value transactions or information about the transaction was not readily available, 7 sales (3%) were eliminated because information about the PV system was not shown in the MLS listing or the sale preceded the PV installation date, and 110 sales (53%) were eliminated because no comparable non-PV home sales were found or they were not single-family detached structures. Two PV home pairs were added that were not part of the original data set. None of the homes had leased PV systems.

The percentage of non-usable sales, therefore, was higher than 75%. This underscores how difficult it is for appraisers to develop usable paired sales of PV homes.[30] Thus, it is essential to have other methods to value PV, such as the income or cost approaches; this is discussed later in this article in the context of recommended future work.

The final data set consists of 43 PV home transactions and a similar number of comparable non-PV home transactions. Of these, 13 PV home sales were in California, and 30 sales were outside of California.

A summary of the full data set is shown in Exhibits 2 and 3. The average PV home in the data set sold for $431,964 (median $405,000) in November 2012. The earliest sale occurred in May 2010 and the most recent in October 2014, with 90% occurring between July 2011 and December 2013. The minimum sale price for PV and non-PV homes was $139,900, and the maximum was $1,050,000, with 90% of the sales ranging from $180,000 to $680,000. The gross adjustments of the non-PV homes ranged from 0% to 16.87%, with 80% being below 9%.[31] The average PV system size was 3.8 kW (median 3.9 kW), and the average age was 2.7 years (median 2.2 years). The sizes of the systems ranged from 1 kW to almost 10 kW, but 90% fell between 2 kW and 6.25 kW. The ages of the systems ranged from new (0 years) to more than 11 years, with 90% between just less than 1 year and 7.25 years.

Results

Warning to Users of This Study

This study includes sales mostly occurring between 2011 and 2013, and it may not be appropriate to apply these premiums to sales outside this timeframe.

This study focuses on homes with host-owned PV systems, thus its results are not applicable to homes with leased/third-party-owned PV systems. Additionally, this study only includes PV systems that use crystalline-silicon panels. It does not address thin-film PV or PV systems built into asphalt shingles or tile roofing. Thin-film PV and PV systems built into asphalt shingles or tile roofing may vary in efficiency from the systems in this study, and adjustments to the derate factor and degradation rates used in the PV Value tool might need to be made.

Finally, this study does not address potential sale price implications related to the location of the PV systems. Future study is necessary to understand if locating PV panels on the front of a house versus the rear of the house or orienting them differently (e.g., east or west facing instead of south facing) impacts the sale price premium.

State-Level Results

Southern California—San Diego Metro Area. All paired sales in the San Diego metro area show a price premium for homes with PV systems. The average premium is $17,127, which is 3.37% of the sale price or $4.31 per watt (W) of the installed PV system. The per-watt premium is considerably lower than the average gross cost estimate of $5.96/W but similar to the average net cost ($4.00/W) and average income ($3.67/W) estimates.[32] This California market is the most mature of all the markets studied, with an oldest PV system of 11.4 years old, but the mean age is only 4.2 years. Therefore, although the data span a relatively large set of ages, most systems are relatively young. Further study is required to track market reaction to older systems, e.g., those more than 10 years old.

30. This issue will continue to persist until adoption rates of solar increase to levels found for other non-standard home amenities.

31. The *gross adjustment* to each comparable non-PV sale price is calculated by adding the absolute values of all positive and negative adjustments. Appraisal Institute, *The Dictionary of Real Estate Appraisal*, 6th ed. (Chicago: Appraisal Institute, 2015), s.v. *gross adjustment*.

32. For all income estimates noted in this section, the average PV Value estimate is used. However, the default PV Value average electric rate is likely lower than rates paid by the typical PV homeowner in this California market, where tiered volumetric rates are prevalent.

Exhibit 2 Combined Set of Paired Sales Premiums and Contributory Value Estimates

Paired Sale	ST	Location	Total PV Premium ($)	Sale Price Premium ($/W)	Gross Cost ($/W)	Net Cost ($/W)	Low Income Estimate ($/W)	Average Income Estimate ($/W)	High Income Estimate ($/W)	Sale Price of PV Home ($)	Premium as % of Sale Price
1	CA	Chula Vista	20,700	5.05	6.11	4.14	3.61	3.89	4.20	400,000	5.18
2	CA	Chula Vista	11,000	3.67	6.37	4.32	3.62	3.91	4.23	836,000	1.32
3	CA	El Cajon	16,800	3.72	6.11	4.14	3.61	3.90	4.22	575,000	2.92
4	CA	LaJolla	15,000	3.21	5.63	3.80	2.17	2.30	2.43	1,050,000	1.43
5	CA	San Diego	5,850	4.09	6.37	4.32	2.06	2.18	2.31	675,000	0.87
6	CA	San Diego	30,850	6.02	6.37	4.32	2.95	3.14	3.36	499,000	6.18
7	CA	San Diego	52,500	7.53	6.37	4.32	4.07	4.40	4.78	500,000	10.50
8	CA	San Diego	16,580	6.09	6.11	3.77	3.72	4.02	4.34	535,000	3.10
9	CA	Chula Vista	5,000	2.46	5.59	3.77	3.95	4.28	4.65	455,000	1.10
10	CA	El Cajon	5,000	1.46	5.59	3.77	3.31	3.56	3.82	475,000	1.05
11	CA	El Cajon	11,970	5.70	5.59	3.77	4.02	4.37	4.75	500,000	2.39
12	CA	Alpine	14,500	2.80	5.63	3.80	4.08	4.42	4.80	436,500	3.32
13	CA	Lemon Grove	16,900	4.27	5.59	3.77	3.14	3.38	3.64	379,000	4.46
14	FL	Davenport	17,941	3.62	5.60	3.81	2.24	2.42	2.62	165,000	10.87
15	FL	North Port	10,100	4.83	5.60	3.92	1.68	1.82	1.98	150,000	6.73
16	FL	Palm Harbor	15,000	3.75	4.00	2.80	2.44	2.63	2.84	405,000	3.70
17	FL	Lakewood Ranch	8,000	1.60	5.30	3.57	1.58	1.69	1.82	188,000	4.26
18	PA	Ambler	15,224	3.55	4.58	3.21	2.49	2.70	2.92	645,124	2.36
19	PA	Ambler	15,124	3.53	4.58	3.21	2.49	2.70	2.92	645,124	2.34
20	PA	Flourtown	18,000	2.87	5.44	3.80	1.85	1.99	2.15	344,000	5.23
21	PA	Macungie	17,575	4.57	6.10	4.27	1.60	1.75	1.91	290,000	6.06
22	PA	Garnett Valley	15,960	1.66	5.44	3.80	1.58	1.70	1.84	600,000	2.66
23	NC	Cary	3,400	1.06	6.60	3.00	1.39	1.50	1.63	250,900	1.36
24	NC	Cary	15,499	3.23	5.30	2.41	1.60	1.75	1.92	309,999	5.00
25	NC	Durham	8,400	1.83	5.30	2.41	1.54	1.67	1.82	289,000	2.91
26	NC	Durham	6,775	3.07	5.70	2.59	1.80	1.97	2.15	352,117	1.92
27	NC	Durham	2,431	1.10	5.70	2.59	1.81	1.98	2.17	344,273	0.71
28	NC	Durham	4,000	0.96	7.30	3.32	1.46	1.58	1.71	243,000	1.65
29	NC	Holly Springs	38,100	7.53	5.30	2.41	1.51	1.64	1.77	325,000	11.72
30	MD	Laurel	3,900	3.90	4.80	3.80	2,34	2.55	2.79	411,000	0.95
31	MD	Timonium	23,800	4.05	4.80	3.24	2.32	2.51	2.71	575,000	4.14
32	MD	Gambrills	13,300	3.50	4.80	3.18	1.89	2.03	2.19	535,000	2.49
33	OR	Portland	7,900	3.32	5.46	3.32	0.93	1.01	1.11	401,000	1.97
34	OR	Portland	6,900	2.35	5.46	1.83	1.64	1.80	1.98	467,900	1.47
35	OR	Portland	0	0.00	4.97	1.48	1.78	1.96	2.15	274,000	0.00
36	OR	Portland	7,400	2.58	4.97	1.83	1.64	1.80	1.98	444,500	1.66
37	OR	Portland	8,000	3.33	4.97	1.48	1.70	1.85	2.03	475,000	1.68
38	OR	Beaverton	18,800	6.27	4.97	1.48	0.98	1.06	1.15	300,000	6.27
39	OR	Oregon City	14,400	3.48	5.46	2.14	1.84	2.03	2.25	240,000	6.00
40	OR	King City	16,100	6.56	4.97	1.48	1.44	1.56	1.70	290,000	5.55
41	OR	North Plains	15,900	7.36	4.97	1.48	1.54	1.67	1.82	345,000	4.61
42	OR	Bend	9,500	4.04	4.97	1.48	2.05	2.23	2.43	559,000	1.70
43	OR	Bend	36,050	6.96	4.97	2.00	2.42	2.64	2.89	395,000	9.13
Mean			**14,329**	**3.78**	**5.48**	**3.10**	**2.27**	**2.46**	**2.67**	**431,964**	**3.74**
Median			**14,500**	**3.55**	**5.46**	**3.32**	**1.87**	**2.03**	**2.25**	**405,000**	**2.91**

Exhibit 3 Combined Set of Days on Market, PV System Information, and Electric Rate Information

Paired Sale	Total PV Premium ($)	Size System (kW)	Age System (yrs)	Sale Date	PV Home Days on Market	Non-PV Home Days on Market	Electric Cost ($/kWh)	Est. Yrly Electric Escalation Rate (%)	Sale Price of Comp. House ($)	Adjustment of Comp. (%)
1	20,700	4.1	3.60	8/31/2012	10	113	0.164	2.89	339,000	13.4
2	11,000	3.0	2.20	4/3/2012	30	7	0.164	2.89	825,000	0.0
3	16,800	4.5	2.50	7/21/2012	9	10	0.164	2.89	550,000	10.6
4	15,000	4.7	11.41	11/16/2012	50	56	0.167	4.24	1,050,000	1.4
5	5,850	1.4	10.58	4/17/2012	35	8	0.164	2.93	665,000	8.1
6	30,850	5.1	7.12	5/24/2012	77	2	0.164	2.93	440,000	12.1
7	52,500	6.3	1.20	6/26/2012	18	21	0.164	2.93	440,000	16.9
8	16,580	2.7	2.50	6/15/2012	24	35	0.164	2.93	529,000	2.0
9	5,000	2.0	1.67	5/13/2013	4	5	0.167	2.85	450,000	0.0
10	5,000	3.4	4.75	4/20/2013	10	7	0.167	2.82	470,000	0.0
11	11,970	2.1	0.50	5/11/2013	21	9	0.167	2.85	520,000	6.1
12	14,500	5.2	1.25	2/11/2013	14	9	0.167	2.85	432,000	2.3
13	16,900	4.0	5.33	5/20/2013	22	4	0.170	2.80	355,000	2.0
14	17,941	5.0	2.40	4/30/2012	11	1	0.132	3.42	146,000	6.2
15	10,100	2.1	3.84	4/1/2013	40	16	0.106	1.58	139,900	0.0
16	15,000	4.0	4.00	7/5/2013	9	12	0.134	3.75	390,000	0.0
17	8,000	5.0	2.70	8/31/2012	18	10	0.104	1.58	180,000	0.0
18	15,224	4.3	1.20	10/23/2014	7	39	0.158	2.00	629,900	3.2
19	15,124	4.3	1.20	10/23/2014	7	7	0.158	2.00	680,000	7.0
20	18,000	6.3	1.50	7/11/2011	299	33	0.138	1.63	330,000	1.2
21	17,575	3.9	2.50	9/23/2012	200	44	0.116	2.21	284,500	4.2
22	15,960	9.6	1.30	7/12/2011	6	12	0.104	1.95	593,000	1.5
23	3,400	3.2	1.50	3/7/2011	167	210	0.101	1.90	247,500	2.0
24	15,499	4.8	0.70	5/13/2013	10	9	0.105	1.90	297,500	3.5
25	8,400	4.6	2.40	11/21/2013	20	154	0.105	1.90	277,500	7.7
26	6,775	2.2	0.03	7/27/2012	4	111	0.104	1.95	322,642	11.6
27	2,431	2.2	0.06	6/22/2012	2	111	0.104	2.11	322,642	12.6
28	4,000	4.2	1.27	5/24/2010	162	25	0.104	2.11	239,000	0.0
29	38,100	5.1	1.60	6/24/2013	35	9	0.105	1.90	294,500	3.6
30	3,900	1.0	1.15	2/28/2013	12	26	0.136	3.04	425,000	5.2
31	23,800	5.9	2.10	12/6/2013	1	37	0.136	2.92	560,000	7.5
32	13,300	3.8	4.95	10/23/2013	12	8	0.136	2.92	560,000	7.7
33	7,900	2.4	6.50	7/26/2012	30	3	0.107	4.25	382,500	4.3
34	6,900	2.9	1.50	7/2/2012	5	2	0.107	3.95	452,000	4.7
35	0	3.0	1.00	11/28/2012	46	3	0.107	3.95	270,000	4.1
36	7,400	2.9	1.50	7/20/2012	24	5	0.107	3.95	429,000	10.0
37	8,000	2.4	2.50	3/29/2013	23	14	0.116	3.92	485,000	11.2
38	18,800	3.0	3.00	2/11/2013	200	72	0.111	3.98	264,000	9.5
39	14,400	4.1	2.00	6/27/2012	79	9	0.107	3.95	215,000	6.8
40	16,100	2.5	4.00	9/20/2013	50	54	0.111	4.07	260,000	5.3
41	15,900	2.2	2.50	8/12/2013	4	79	0.111	3.92	325,000	6.4
42	9,500	2.4	2.50	6/14/2013	43	100	0.104	4.25	550,000	2.3
43	36,050	5.2	0.00	10/21/2011	221	203	0.104	3.95	372,950	5.1
Mean	**14,329**	**3.8**	**2.74**	**11/17/2012**	**48**	**40**	**0.131**	**2.92**	**418,373**	**5.3**
Median	**14,500**	**3.9**	**2.20**	**11/16/2012**	**21**	**12**	**0.116**	**2.89**	**390,000**	**4.7**

Florida—Gulf Coast Area. All paired sales in the Florida Gulf Coast area show a price premium for homes with PV systems. The average premium is $12,760, which is 6.39% of the sale price or $3.45/W of the installed PV system. The per-watt premium is considerably lower than the average gross cost estimate of $5.13/W, similar to the average net cost estimate ($3.53/W), and considerably higher than the average income estimate ($2.14/W). This is a young PV market—the average PV system is around 3 years old, and none is more than 4 years old. Future efforts should be made to understand the market's reaction to these PV systems over the next five years, when data should be more prevalent, especially for older systems.

Maryland—Baltimore Metro Area. All paired sales in the Baltimore metro area show a price premium for homes with PV systems. The average premium is $13,667, which is 2.52% of the sale price or $3.82/W of the installed PV system. The per-watt premium is considerably lower than the average gross cost estimate of $4.80/W, similar to the average net cost estimate ($3.41/W), and higher than the average income estimate ($2.36/W).

North Carolina—Raleigh Metro Area. All paired sales in the Raleigh metro area show a price premium for homes with PV systems. The average premium is $11,229, which is 3.61% of the sale price or $2.68/W of the installed PV system. The per-watt premium is considerably lower than the average gross cost estimate of $5.89/W, identical to the average net cost estimate ($2.68/W), and considerably higher than the average income estimate ($1.73/W). PV systems in this region are less than 3 years old, suggesting the area is new to residential PV systems. Some of the PV sales were in new subdivisions where all homes included PV systems. These sales could not be paired owing to a lack of similar non-PV home sales. As this market grows with new construction including PV systems, sale price premiums should become easier to identify.

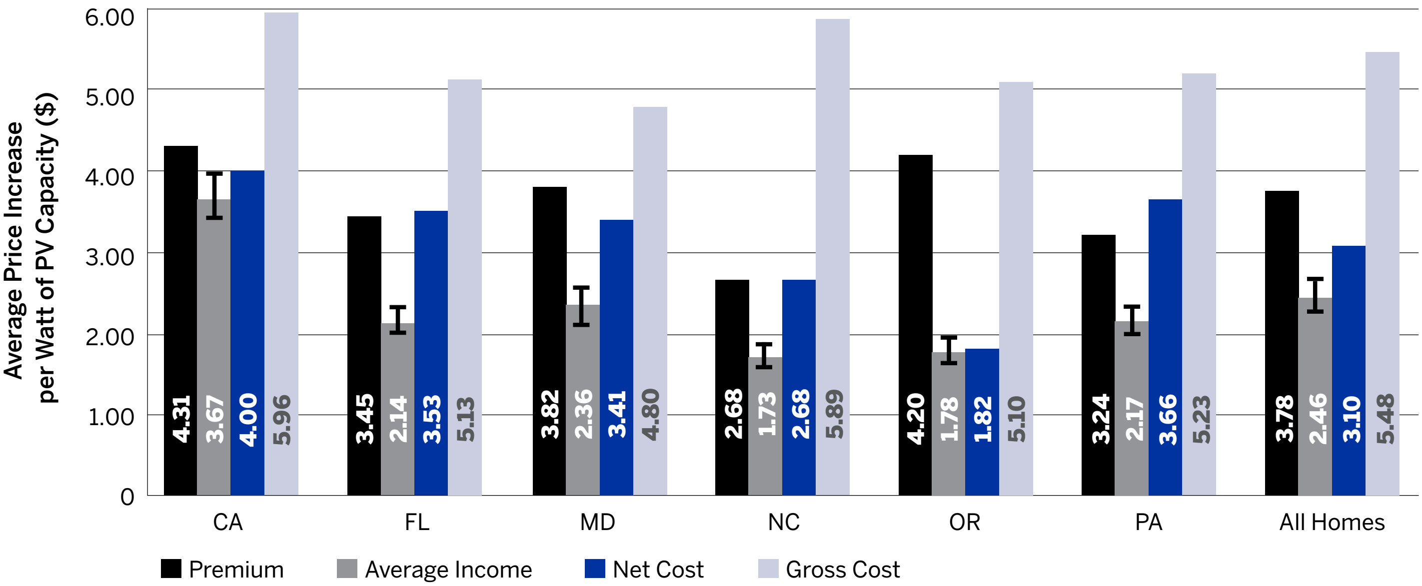
Oregon—Portland Metro Area. Eight of the nine paired sales in the Portland, Oregon, metro area show a price premium for homes with PV systems. The average premium is $10,600, which is 3.25% of the sale price or $3.92/W of the installed PV system. The per-watt premium is considerably lower than the average gross cost estimate of $5.13/W but considerably higher than the average net cost ($1.84/W) and income ($1.64/W) estimates. The net costs are much lower than net costs in other areas; however, the net cost in this area includes an incentive that is paid back over a four-year period, although the full amount was included in the net cost estimate. The typical buyer may only be considering the first-year incentive amount.[33] The local appraiser in the study suggested the market also might be inflating prices based on green cachet, which would occur when additional value is placed on green energy items that are scarce in the market.[34]

Oregon—Bend Metro Area. Both paired sales in the Bend, Oregon, metro area show a price premium for homes with PV systems. The average premium is $22,775, which is 5.41% of the sale price or $5.50/W of the installed PV system. This premium is similar to the gross cost contributory value estimate of $4.97/W, yet considerably higher than both the net cost ($1.74/W) and the average income ($2.44/W) estimate.

Southeastern Pennsylvania Area. All paired sales in the Southeastern Pennsylvania area show a price premium for homes with PV systems. The average premium is $16,377, which is 3.73% of the sale price or $3.24/W of the installed PV system. The per-watt premium is considerably lower than the average gross cost estimate of $5.23/W, similar to the average net cost estimate ($3.66/W), and considerably higher than the average income estimate ($2.17/W). All the PV systems are 2.5 years old or younger. This is a new market to residential PV. The appraiser reported a frequent motivation for installing PV in this area was to provide power during blackouts, which are common in the area. The average PV system size is larger than in the other states studied.

33. Oregon's state solar tax credit is the lower of $1.90/W or $6,000, which would be applied for any system larger than 3,157 W. The incentive is taken over 4 years. If the market heavily or entirely discounts the payments received in years 2 through 4, then it would be appropriate to adjust the net cost up. Assuming a 100% discounting of these payments, the net cost would be 1.43/W higher or $3.27/W. This is more in line with the paired sale premium.
34. Dastrup et al., "Understanding the Solar Home Price Premium."

Exhibit 4 Average PV Home Premium and Contributory Value Estimates ($/W)



Note: The error bars (I) around the average income estimate represent the low and high PV Value estimates.

Six-State Combined Results

Exhibit 2 shows results for all the paired sales in the study. The average premium for all study areas is $14,329, which is 3.74% of the average sale price and equates to $3.78/W for the average-sized PV system. This premium is considerably lower than the average gross cost estimate of $5.48/W, somewhat higher than the average net cost estimate ($3.10/W), and considerably higher than the average income estimate generated with the PV Value tool ($2.46/W). The premium as a percentage of the home sale price is an inconsistent metric that varies widely by the size of PV systems and the price range of homes.

Exhibit 4 summarizes the results by state. Average income estimates are shown with the error bar representing the low and high estimates. The sale price premiums closely follow the net cost in five of the six states, with Oregon being the exception. None of the premiums follows (i.e., is statistically identical to) the gross cost or income estimates, regardless of whether low, average, or high values are used.[35] That notwithstanding, some interesting correlations exist. For example, the income estimates and the premiums across all states, not including Oregon, are correlated, implying that they move in a similar direction.[36] This is not true when Oregon is included. The premiums and gross cost estimates are not correlated with or without Oregon included.

As noted earlier, finding credible pairs of sales was very difficult in all locations, so using alternative valuation methods might sometimes be the only way appraisers and valuation professionals can value the PV system credibly. Some underwriters and some representing the secondary mortgage market believe that the paired sales method is the only viable method,

35. *T*-tests indicate a non-statistically significant difference between the premium and the net cost in all states but Oregon. It follows that the *t*-test for the premium and net cost for all states combined (excluding Oregon) is not statistically significant (*p*-value 0.7542) indicating they *are not* statistically different from each other. For the five non-Oregon states, *t*-test differences are statistically significant between the premium and the gross cost (-$1.98/W, *p*-value 0.000) and between the premium and the PV Value average income estimate ($0.93/W, *p*-value 0.026), indicating they *are* statistically different.

36. Although not statistically identical (as tested via a *t*-test and noted above), the premiums and average income estimates are highly correlated in all states when Oregon is not included ($r = 0.38$, *p*-value 0.03) but are not highly correlated when Oregon is included ($r = 0.20$, *p*-value 0.18). The premiums are not correlated with gross cost estimates when Oregon is included ($r = -0.07$, *p*-value 0.63) or when Oregon is not included ($r = 0.01$, *p*-value 0.95).

but these results show the cost approach and the income capitalization approach are both worthy replacements.

Turning back to the full set of results, Exhibit 3 shows days on market information for all the paired sales and information about electric rates. In aggregate, the PV and non-PV homes sold at a similar pace: the mean for all the sales is 48 days for PV homes (median 21 days) and 40 for non-PV homes (median 12 days). Exhibit 5 summarizes the days on market by state. In four of the six states, which make up 80% of all the sales, non-PV homes sell more quickly on average, but the opposite is true in Maryland and North Carolina. Overall, 18 of the 43 PV homes studied sold more quickly than their corresponding non-PV homes (Exhibit 3). In summary, there appears to be no clear days-on-market difference in this sample between PV and non-PV homes.[37]

Exhibit 6 combines per-state average retail electric rates (right axis, $/kWh) and annual retail escalation rates (right axis, %/year) with the average premiums and income estimates (left axis, $/W). Although there are clearly higher retail electric and escalation rates in some states (e.g., California) than in others (e.g., North Carolina) and they appear to move in the same direction as the premiums (i.e., higher rates appear to be aligned with higher premiums), there is not a strong statistical relationship between them.[38] This is not surprising, because the retail rates and

Exhibit 5 Average Days on Market for PV and Non-PV Homes by State

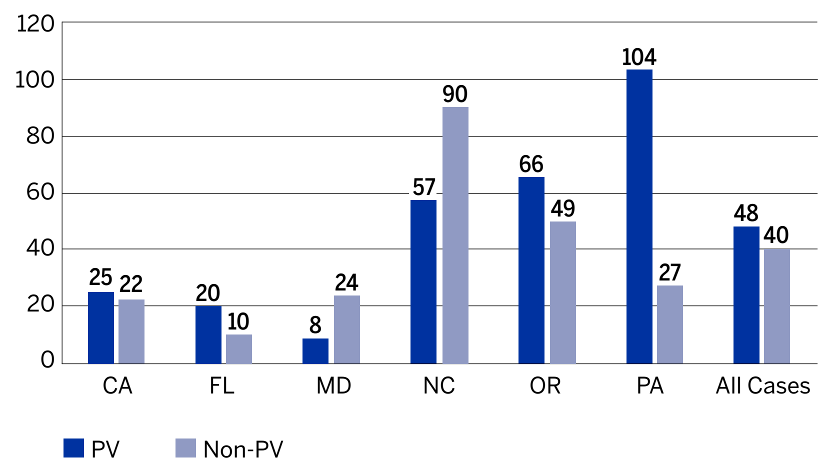
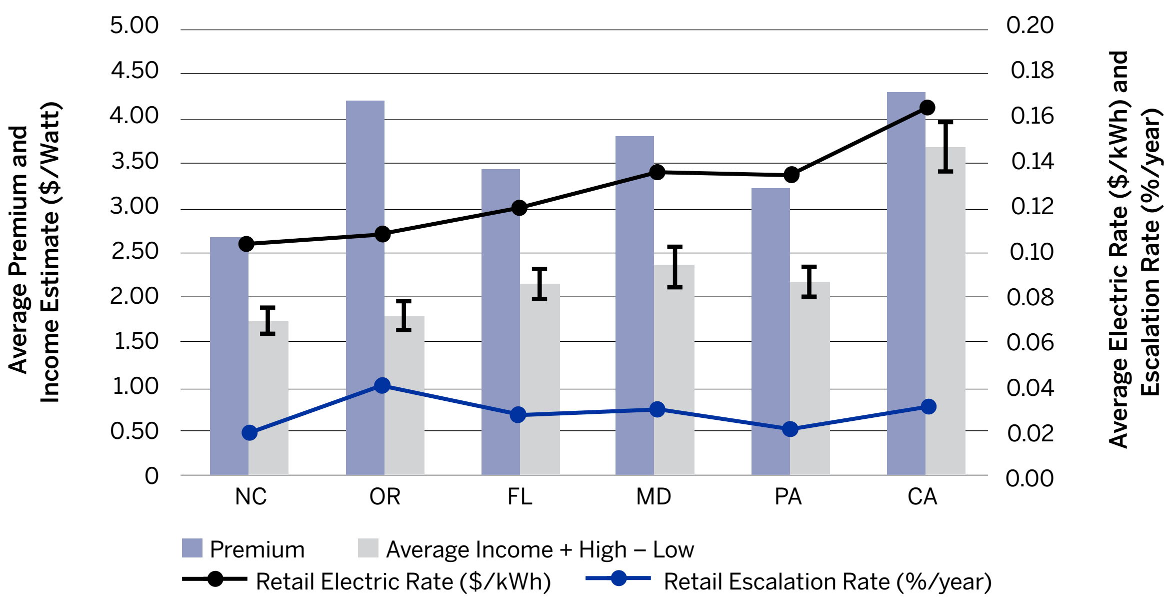


Exhibit 6 Average Premiums, Income Estimates, and Electricity and Escalation Rates by State



Note: The error bars (I) around the average income estimate represent the low and high PV Value estimates.

37. The *t*-test for the days-on-market difference between all PV and non-PV homes is not statistically significant (*p*-value 0.43).

38. Pairwise correlations between premiums and electric rates are not significant ($r = 0.21$, *p*-value 0.18), nor are correlations between premiums and utility escalation rates ($r = 0.01$, *p*-value 0.93).

Exhibit 7 Premium, Income, and Cost Estimates from Paired Sales Analysis and Hedonic Study

	Sample	PV Premium ($)	PV Value – Income ($)	Net Cost ($)	Gross Cost ($)
Paired Sales	All Homes	3.63	2.70	3.54	5.61
Hedonic Model	All Homes	4.18	2.93	4.14	6.90
Paired Sales	California	4.31	3.67	4.00	5.96
Hedonic Model	California	4.21	2.95	4.16	6.94
Paired Sales	Rest of the US	3.17	2.03	3.23	5.38
Hedonic Model	Rest of the US	3.11	2.15	3.09	5.64

Notes: The hedonic model results are from Hoen et al., *Price Premium Analysis of a Multi-State Dataset*, and the paired sales results are from the present study. The paired sales estimates do not include Oregon, because it was not included in the Hoen et al. analysis. All values are shown in dollars per watt.

the escalations of those rates are only a portion of the factors that would likely influence premiums.

Comparing Paired Sales Results to Hedonic Pricing Model Results

This study enables comparison of the premiums and contributory value estimates from the hedonic pricing model in Hoen et al. with those made by appraisers.[39] Hoen et al. analyze almost 4,000 PV home sales, while the present study investigates 43 sales. Exhibit 7 summarizes both sets of results. Because Oregon was not included in the hedonic modeling study, it is not included here; therefore, the paired sales averages do not include Oregon. Exhibit 8 shows estimates from both analyses using the "All Homes" samples.

The exhibits show that both methods yield comparable results for premiums. The net cost and income estimates are also similar between the two sets of results. The gross costs from Hoen et al. are higher, in part reflecting the earlier period of the sample from that study, when installed prices were higher.

Each approach has strengths and weaknesses. For example, hedonic modeling produces a statistically defensible set of results, while paired sales are easier for most practitioners to understand. In any case, they reach similar results, which bolsters the suitability of both approaches for estimating PV home premiums. More importantly, regardless of the method used, a clear PV premium is identified for this subset of the market—a premium that is very close to the net cost at the time of sale.

Conclusions

This paired sales analysis of 43 PV homes provides strong, appraisal-based evidence of PV premiums in each of seven market areas in six states. More importantly, the study also supports the use of cost- and income-based PV premium estimates when paired sales analysis is not possible. Therefore, these results should benefit valuation professionals and mortgage lenders who increasingly are encountering homes equipped with host-owned PV systems and need multiple methodologies to value them appropriately.

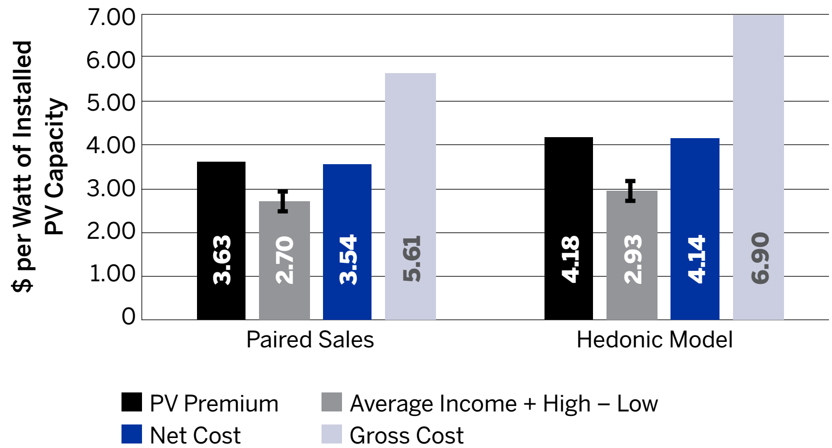
The following are specific conclusions from the study:

- After accounting for the ability to pair PV home sales with similar non-PV home sales, proper listing of PV homes in the MLS, and the existence of non-market-value transactions, appraisers were left with only 20% of the study's original pool of 208 PV home sales. This highlights the difficulty of conducting comparable-sales analysis on PV homes. Thus, lending appraisal guidelines and expectations should align with this reality and allow other forms of premium estimates (such as income and cost) when comparable sales are not available.
- On average, PV systems (all of which were less than 12 years old) garnered premiums in each of the six states, with an average of $3.78/W.
- PV location, age, size, and efficiency must be considered along with trends in the local market such as retail electricity rates and prevailing incentives to arrive at a credible value opinion for a specific PV system and home.
- Price per watt is the appropriate metric for valuing PV systems, not the premium as a percentage of the home sale price, which is an inconsistent metric that varies widely by the size of PV systems and the price range of homes.

39. Hoen et al. *Price Premium Analysis of a Multi-State Dataset*.

- PV premiums from the paired sales analysis were most similar to net PV cost estimates (net of federal, state, local, and utility incentives).
- In no area did the premium approach the level of the gross PV cost estimate, indicating this is not an appropriate proxy for market values. If federal, state, local, or utility incentives are reduced or expire, the market may still reveal sale price premiums that are lower than the gross cost. This would be considered obsolescence as defined previously in this article.
- PV premiums were higher than PV Value average (and high) income estimates in all areas, though the two metrics were statistically correlated, meaning they moved in the same direction.
- Some underwriters and some representing the secondary mortgage market believe the income capitalization approach overvalues homes with PV systems.[40] This study suggests instead that the income capitalization approach values PV homes conservatively, at least if the default parameters are used. This implies the income capitalization approach in the PV Value tool is useful for two reasons: it is not likely to overvalue PV systems, and it is relatively easy to collect the data needed to use the tool.
- Paired sales analysis results from this study are in accord with the hedonic modeling results,[41] which bolsters the suitability of both approaches for estimating PV home premiums.
- No consistent difference in days on the market was found between PV homes and non-PV homes.
- Although the secondary mortgage market (Fannie Mae, Freddie Mac, FHA, and VA) does not require it, some underwriters require appraisers to use a PV sale in the sales comparison approach in order to accept PV premiums—otherwise they assign the presence of a PV system no value.[42] In contrast, USPAP requires appraisers to support adjustments using applicable appraisal methodology, and it requires the same amount of support for a zero adjustment as for a positive or negative adjustment. This study strongly indicates that, in the areas studied, homes with PV systems less than 12 years old sell for a premium.

Exhibit 8 PV Home Premiums from Paired Sales and Hedonic Pricing Model Studies



Notes: The hedonic model results are from Hoen et al. *Price Premium Analysis of a Multi-State Dataset*, and the paired sales results are from the present study. The paired sales estimates do not include Oregon, because it was not included in the Hoen et al. analysis. All values are shown in dollars per watt.

Although beyond the scope of this relatively small-sample study, an examination of intermarket differences would be a fruitful effort when more data are available. It could statistically identify drivers discussed here: the size and age of the system, the installed costs at the time of sale, the underlying retail electricity rate, etc. As well, it could identify more nuanced differences, including, potentially, regional back-up power needs, a hedge against uncertain state-level incentive policy, and expected utility retail electricity price increases.

Recommendations: Next Steps to Improve PV System Valuation

The appraisers involved in this study reported a number of hindrances and identified steps for improving the valuation process. The challenges

40. Based on personal conversations between Adomatis and appraisers and members of the lending/underwriting industry.
41. Hoen et al. *Price Premium Analysis of a Multi-State Dataset*.
42. A premium is also known as an adjustment in the sales comparison grid of an appraisal.

and possible solutions are summarized below.

1. **Challenge:** Verifiable documentation of houses with PV systems and their characteristics must be made available for the real estate market.
   Possible solutions:
   - Include the PV system, its size, year of installation, and if the system is owned or leased in the public record, even where PV systems are not assessed for taxation purposes.
   - Label the electrical box with the same inputs found on the AI Residential Green and Energy Efficient Addendum,[43] making a permanent record onsite.
   - Develop a public database—regularly updated by system installers, utilities, and permitting authorities—that allows practitioners to verify PV system details.
   - Encourage a data-friendly ecosystem where disclosure of site-specific PV system data is part of normal business practices, rather than using non-disclosure language.

2. **Challenge:** Gross and net costs of PV systems are often not readily accessible to the real estate market. Because this study reveals a correlation between the sale price premium and the net cost, appraisers should have access to net system costs.
   Possible solutions:
   - It would be ideal to develop a cost component to the PV Value tool linked to current US gross and net costs.[44]
   - Gross costs are also available by zip code through the Open PV[45] website.
   - In all cases the values used should be verified for a specific market and sale date.

3. **Challenge:** MLSs lack fields with details of the PV system sufficient to allow an adequate search for comparable properties. MLSs need searchable PV fields that include system size in kilowatts, system age, warranty term, and system location (ground mount, roof mount, community lot). Simply stating the house has solar panels in the narrative section of the MLS is not sufficient to understand the features and does not allow appraisers or buyers to search for sales strictly with PV systems.
   Possible solutions:
   - Green the MLS[46] has a template for green fields available for MLSs to use, but only 185 of 850 MLSs in the United States have implemented the green fields. MLSs with green fields only work if the agents populate the fields accurately. More agent education and a campaign to green all MLSs are needed.
   - Ideally, PV system characteristics would auto-populate into the MLSs as others have recommended.[47]
   - The Appraisal Institute offers a two-day course, *Residential and Commercial Valuation of Solar*,[48] to assist appraisers in attaining competency.
   - PV sales agents and installers need a better understanding of how they can assist real estate sales agents and appraisers in obtaining accurate PV system data. As the PV industry begins to understand and provide data needed to market a PV home, the real estate sales, appraisal, and mortgage lending transactions will be much smoother.

4. **Challenge:** PV Value users not only need system characteristics, as mentioned above for real estate practitioners in general, but also residential utility rate(s), appropriate discount rates, and system output information, the latter of which is not available at the time of installation.
   Possible solutions:
   - An appraiser would ideally review the owner's utility bill for the past year to understand the site-specific utility rate and system output. However, appraisers report difficulty in

43. Available for download at http://www.appraisalinstitute.org/assets/1/7/Interactive820.04-ResidentialGreenandEnergyEffecientAddendum.pdf.
44. This component is currently available for some markets through the licensed version of PV Value and will be available for more markets over time.
45. National Renewable Energy Laboratory, https://openpv.nrel.gov/.
46. Available at http://www.greenthemls.org/.
47. CNT Energy and National Home Performance Council, *Unlocking the Value of an Energy Efficient Home: A Blueprint to Make Energy Efficiency Improvements Visible in the Real Estate Market* (Washington, DC: CNT Energy & National Home Performance Council, 2013). National Association of Realtors, *Green MLS Implementation Guide*, v1.0 (Chicago: National Association of Realtors, 2014).
48. Available at http://www.myappraisalinstitute.org/education/course_descrb/Default.aspx?prgrm_nbr=844&key_type=C.

obtaining this kind of information from the homeowner, and utilities consider bills private and inaccessible to appraisers. Thus, appraisers must establish a credible method to estimate utility costs and system output.

- Determining an appropriate discount rate has an impact on the PV Value income approach output. To assist with this, Energy Sense Finance and Sandia National Laboratories are working on a discount rate model for residential PV and energy efficiency that can be used with PV Value to help valuation professionals develop an appropriate weighted average cost of capital and discount rate. (This is expected to be available in 2016.) Because little research has been vetted on residential discount rates in the last few years, the cocreators of the tool have relied on appraiser-reported homeowner responses to their expectations of expected yields on a similar investment. Most respond that the mortgage rate, second mortgage rate, or a rate similar to a safe investment in the bond or stock market best fits this expectation.

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Additional Resources

Suggested by the Y. T. and Louise Lee Lum Library

Appraisal Institute

- Green Building Resources
  http://www.appraisalinstitute.org/education/education-resources/green-building-resources/
- Lum Library External Information Sources [Login required]
  Information Files—Energy Efficiency

California Public Utilities Commission

- California Solar Initiative
  http://www.cpuc.ca.gov/General.aspx?id=6043

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Additional Resources

CONTINUED

Energy Star

- Buildings and Plants
  http://www.energystar.gov/buildings?s=mega
- New Homes
  http://www.energystar.gov/index.cfm?c=new_homes.hm_index&s=mega

National Association of Home Builders

- Green Development
  http://www.nahb.org/reference_list.aspx?sectionID=1801

National Association of Realtors

- Green Resource Council—Green Industry Articles
  http://www.greenresourcecouncil.org/green-resources/green-industry-articles
- The Green MLS Tool Kit
  http://www.greenthemls.org/

Residential Energy Services Network

- Understanding the HERS Index
  http://www.hersindex.com/understanding

Solar Energy Industries Association

- Research and Resources
  http://www.seia.org/research-resources

US Energy Information Administration

- Consumption and Efficiency
  http://www.eia.gov/consumption