Appraising Into The Sun:

Six-State Solar Home Paired-Sale Analysis

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An Analysis for Appraisers
and other Valuation Professionals

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Abstract

Although residential solar photovoltaic (PV) installations have proliferated, PV systems on some U.S. homes still receive no value during an appraisal because comparable home sales are lacking. To value residential PV, some previous studies have employed paired-sales appraisal methods to analyze small PV home samples in depth, while others have used statistical methods to analyze large samples. Our first-of-its-kind study connects the two approaches. It uses appraisal methods to evaluate sales price premiums for *owned* PV systems on single-unit detached houses that were also evaluated in a large statistical study. Independent appraisers evaluated 43 recent home sales pairs in six states: California, Oregon, Florida, Maryland, North Carolina, and Pennsylvania. We compare these results with contributory-value estimates—based on income (using the PV Value® tool), gross cost, and net cost—as well as hedonic modeling results from the recent statistical study. The results provide strong, appraisal-based evidence of PV premiums in all states. More importantly, the results support the use of cost- and income-based PV premium estimates when paired-sales analysis is impossible. PV premiums from the paired-sales analysis are most similar to net PV cost estimates. PV Value® income results generally track the appraised premiums, although conservatively. The appraised premiums are in agreement with the hedonic modeling results as well, which bolsters the suitability of both approaches for estimating PV home premiums. Therefore, these results will benefit valuation professionals and mortgage lenders who increasingly are encountering homes equipped with PV and need to understand the factors that can both contribute to and detract from market value.

Key words: photovoltaic, PV, solar, homes, residential, property value, selling price, premium, paired sales, appraisers, hedonic, California, new homes, existing homes, host-owned

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1. Background

As of the end of 2014, almost 600,000 properties—most of which were residential—had a solar photovoltaic (PV) system installed, and almost 200,000 of these systems had been installed in 2014 alone (SEIA & GTM, 2015). Approximately 50% of them are in California, but Hawaii, Arizona, New Jersey, Colorado, and New York, among others, are seeing robust markets as well. This rapid growth is related to the dramatic reduction in installed PV costs over the last 10 years (Barbose et al., 2014) as well as federal, state, and utility PV incentives and the rise of innovative financing such as leased PV and other zero-money-down options (SEIA & GTM, 2015). The growth 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 (e.g., Randazzo and Reagor, 2015). 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.[1]

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 is imperfect owing to incomplete reporting of property conditions, varying seller and buyer motivations, and sales prices that may not reflect the definition of market value.

A limited number of PV home value studies have been published in the past 10 years. Only a few of these have been written by real estate appraisers using standard appraisal methods, including Watkins (2011), who analyzed sales in Oregon, and Desmarais (2013), who analyzed sales in the Denver metro area. Both found evidence of PV home price premiums. In addition, three large-scale statistical analyses using hedonic pricing models have been conducted. Hoen et al. (2015) investigated almost 4,000 sales across eight states, with most sales in California. Other studies analyzed a smaller dataset of homes in California (Hoen et al., 2011; 2013) and in San Diego and Sacramento (Farhar, 2008; Dastrup et al., 2012). Each of these studies showed premiums for homes with PV.

What Is a Hedonic Model?

A house can be thought of as a bundle of home, site, neighborhood, and market characteristics. When a price is agreed upon between a buyer and seller, there is an implicit understanding that those characteristics have value. When data from a large number of sales are available, the average marginal contribution to the sales price of each characteristic can be estimated with a hedonic regression model. For example the average effect on sales prices of adding an additional bathroom or 1,000 ft^2 of area to a home can be estimated, as can the effect of having a PV system.

Hedonic pricing models employ accepted statistical measures of confidence to provide statistically defensible estimates of the marginal price differences associated with various home

[1] That is, it is not a Fannie Mae, Freddie Mac, Federal Housing Administration (FHA), or Department of Veterans Affairs (VA) guideline for lending.

characteristics across a large sample of homes (see sidebar above). Although researchers prefer such models, many appraisers and their lending clients do not, because they are often unfamiliar with the statistical methodology and would be unable to easily access a large enough sample size (hundreds of sales or more) for the analysis, in any case. 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); as would be the case with most appraisers and hedonic modeling.[2] 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.

Our 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. (2015) 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 these paired-sales results, we compare them to the hedonic modeling results from Hoen et al. (2015) and draw conclusions. We also provide recommendations for improving PV system valuation techniques, and we include resources for appraisers in an appendix.

[2] Uniform Standards of Professional Appraisal Practice, 2014–2015, Standard Rule 2-3, lines 854–858.

2. Methodology

This study uses appraisal methods to evaluate sales price premiums for owned PV systems on single-unit detached houses in areas covered by the recent Lawrence Berkeley National Laboratory (LBNL) study (Hoen et al., 2015). 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. We selected seven appraisers 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. We reviewed all the pairs and, in some cases, consulted other local appraisers to enhance the accuracy of value estimates. We asked each of the seven appraisers to do the following:

- 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 (see Appendix Section 10.3) 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, and
- 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, we developed contributory-value income estimates using the PV Value® tool.

This section describes the paired-sales, cost, and income methods as well as the method for calculating time on the market.

2.1 Paired-Sales Analysis

A paired-sales analysis compares the sale price of a property with a feature of interest (in our case PV) to the price of a similar property sold recently without the feature. After adjusting for home differences, the difference in the sales prices attributed to the study feature can be identified.[3] 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.

[3] 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.

- 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), adjustments for non-study features must be quantifiable and market based to provide credible results.

2.2 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, not the original price paid for the system. Therefore, the appraiser must use cost estimates as of the sale date or appraisal date and not the date of installation. This is especially important because, over the past 3 years, installed PV system prices have declined dramatically as have the incentives paid by federal, state, and local governments to spur solar deployment.

Resources—including the publically available incentive databases, the Solar Energy Industries Association (SEIA), local installers, the National Renewable Energy Laboratory (NREL), and records of known purchases—can help appraisers establish the gross PV replacement cost as of the sale date. The cost approach includes depreciation, 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, we establish a gross cost and a net cost. The net cost is calculated as the gross cost less federal, state, and utility incentives available at the time of sale. We assume that homeowners would have considered the incentives at the time of sale, and thus using the net cost to represent the depreciated value might best capture what the market is willing to pay. The gross and net costs are not depreciated in this study. Some data suggest the sales price premium of PV is similar to the net cost; therefore, the incentives and rebates are taking the place of depreciation normally applied in the appraisal process (Hoen et al., 2015). Thus this study, by examining premiums in relation to net and gross cost estimates, can provide valuable support for potential rates of PV system depreciation in the market.[4]

2.3 Income Approach

The income approach[5] 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.

We estimated PV income values for each PV sale in the paired-sales analysis using PV Value®, a free web-based tool developed by Energy Sense Finance and based on prior work by Johnson

[4] We also based this decision on the results in Hoen et al. (2015), which showed that PV premiums were highly correlated with net-cost estimates. In addition, depreciation, as used by appraisers, is the cost new without any reductions for incentives, less the value the market is willing to pay. Therefore, in this study, we examine if the net cost is similar to the depreciated amount.

[5] Also known as the income capitalization approach or discounted cash flow analysis.

and Klise (2012) and Johnson (2010). 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 (Klise et al., 2013). Most warranties are 25–30 years, and we assumed 25 years when the actual warranty term was 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,[6] an electric retail rate at the time of sale, an estimated utility rate escalation similar to the historical escalation, and discount rates as of the time of sale. We used a discount rate equivalent to 50–200 basis points over the 90-day Fannie Mae fixed rate 30-year mortgage to estimate the spread of likely values in the market.[7] The copyrighted algorithm default parameters assume a module degradation factor of 0.5% per year and an expected inverter replacement at 15 years. It uses data from PVWatts®, NREL's Developer Network, and the U.S. Energy Information Administration's "Average Price by State Provider" websites 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 home owner in this market (Darghouth et al., 2011; CPUC, 2013). 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.[8]

2.4 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.

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[6] When the tilt and azimuth were not available, we estimated them based on Google Satellite Maps and the Solmetric Roof Azimuth Tool (http://tools.solmetric.com/Tools/RoofAzimuthTool).

[7] Fannie Mae Required Net Yields to 1985: https://www.fanniemae.com/singlefamily/required-net-yields-to-1985. Also see Appendix 10.5 for PV Value sample.

[8] 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, because we could not obtain individual home consumption and therefore the appropriate weighted rate, doing so is beyond the scope of this analysis.

3. Data

This analysis uses a subset of the almost 4,000 PV home transactions analyzed in Hoen et al. (2015), consisting of sales from the following market areas: San Diego metro area; Gulf Coast of Florida; Baltimore metro area; Raleigh metro area (North Carolina); Portland and Bend metro areas (Oregon)[9]; and the southeast portion of Pennsylvania.

In each market area, we provided the local appraiser data on PV home sales drawn from the larger dataset 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 dataset, it enabled the appraisers to be more confident in the results.

Table 1 summarizes the data-preparation process for each market area. In Step 1, the appraisers determined if sales would be considered "market value"[10] transactions (see sidebar). 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 dataset in areas where additional appropriate PV homes were discovered.

What is "Market Value"?

"Market Value is defined as the most probable price which a property should bring in a competitive and open market under all conditions requisite to a fair sale, the buyer and seller each acting prudently and knowledgeably, and assuming the price is not affected by undue stimulus. Implicit in this definition are the consummation of a sale as of a specified date and the passing of title from seller to buyer under conditions whereby:

- Buyer and seller are typically motivated;
- Both parties are well informed or well advised, and acting in what they consider their own best interests;
- A reasonable time is allowed for exposure in the open market;
- Payment is made in terms of cash in U.S. dollars or in terms of financial arrangements comparable thereto; and,
- The price represents the normal consideration for the property sold unaffected by special or creative financing or sales concessions granted by anyone associated with the sale."

Out of the 208 sales provided to appraisers in all market areas, 50 (24%) were eliminated because they were not considered market value transactions or information about the transaction was not readily available, 7 (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 (53%) were eliminated because no comparable non-PV home sales were found or they were not single-family

[9] The Portland and Bend Metro Areas were not included in Hoen et al. (2015) because of limitations to the data for those areas, but they were appropriate for this analysis and therefore were included.
[10] Federal Register/Volume 55, Number 165/Friday, August 24th, 1990/Rules and Regulations.

detached structures. Two PV home pairs were added that were not part of the original dataset. None of the homes had leased PV systems.

The percentage of non-useable sales, therefore, was higher than 75%. This underscores how difficult it is for appraisers to develop usable paired sales of PV homes.[11] Thus having other methods to value PV, such as the income or cost approaches, is essential. Section 7 discusses this in the context of recommended future work.

Table 1: Summary of Paired-Sales Preparation Process

			Step 1	Step 2	Step 3	Step 4	
State	Market	Original Sales	Non-Market Value	Solar System Not Identified in MLS	Comparable Home Not Available	Additional Sales Discovered	Final Set of Paired Solar Home Sales
CA	San Diego Metro Area	76	-28	-2	-33		13
FL	Gulf Coast	13	-3	-1	-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**

Our final dataset 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 were outside of California.

A summary of the full dataset is shown later in Table 16. The average PV home in the dataset 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 a PV home was $150,000, and the maximum was $1,050,000, with 90% of the sales ranging from $188,000 to $675,000. The average PV system size was 3.78 kW (median 3.85 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 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 old.

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

4. Results

This section presents results from each of the seven market areas followed by results from the full set of paired sales across all the market areas.

4.1 Warning to Users of this Study

The sales price premiums identified in this study are based on a specific sale date and location. Applying the sales price premiums from this study to other areas or periods should be done only if the geographical areas have similar demographics, utility rates, and market conditions. Real estate values fluctuate, as do the values of PV systems, especially given the recent trend of declining PV system prices. 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 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. More importantly, 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.

Finally, this study does not address potential sales 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 sales price premium.

4.2 Southern California—San Diego Metro Area

A local appraiser in Southern California, Lynn Dordahl, narrowed 76 PV home sales occurring in the San Diego metro area in 2012 and 2013 to 13 paired sales (described in Table 2 and Table 3)—the largest dataset in this study.

All paired sales show a price premium for homes with PV. The average premium is $17,127, which is 3.37% of the sale price or $4.31/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.[12] The gross costs reflect the costs of a new PV system on the sale date and thus represent a ceiling for the potential price premium, although in two cases the premium was higher than the gross cost—in these cases a feature in the paired sales may not have been identified, or the buyers may not have known the true cost of PV. The results for the PV premium as a percentage of the sales price are the least consistent, indicating that this metric might not be useful.

This California market is the most mature of all the markets we 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 are relatively young. Further study is required to track market reaction to older systems, e.g., those more than 10 years old.

[12] 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.

As shown in Table 3, PV homes took slightly more time to sell than non-PV homes on average (and also based on the median), but the differences are small, and therefore no clear pattern emerges in California.

Table 2: San Diego Metro Area Paired-Sales Premiums and Contributory-Value Estimates

Paired Sale	ST	Location	Total PV Premium	Sales Price Premium ($/Watt)	Gross Cost ($/Watt)	Net Cost ($/Watt)	Low Income Estimate ($/Watt)	Average Income Estimate ($/Watt)	High Income Estimate ($/Watt)	Sale Price of Solar House	Premium as a % 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%
Mean			**$17,127**	**$4.31**	**$5.96**	**$4.00**	**$3.41**	**$3.67**	**$3.96**	**$562,731**	**3.37%**
Median			**$15,000**	**$4.09**	**$6.11**	**$3.80**	**$3.61**	**$3.90**	**$4.22**	**$500,000**	**2.92%**

Table 3: San Diego Metro Area PV Information, Days on Market, Electric Rates, and Escalation Rates

Paired Sale	Total PV Premium	Size System (kW)	Age System (yrs)	Sale Date	Solar PV Sale-Days on Market	Non Solar Days on Market	Electric Cost ($/kWh)	Est. Yrly Electric Escalation Rate (%)
1	$20,700	4.10	3.6	8/31/2012	10	113	$0.1637	2.89%
2	$11,000	2.99	2.2	4/3/2012	30	7	$0.1637	2.89%
3	$16,800	4.52	2.5	7/21/2012	9	10	$0.1637	2.89%
4	$15,000	4.67	11.41	11/16/2012	50	56	$0.1670	4.24%
5	$5,850	1.43	10.58	4/17/2012	35	8	$0.1637	2.93%
6	$30,850	5.12	7.12	5/24/2012	77	2	$0.1637	2.93%
7	$52,500	6.30	1.2	6/26/2012	18	21	$0.1637	2.93%
8	$16,580	2.72	2.5	6/15/2012	24	35	$0.1637	2.93%
9	$5,000	2.03	1.67	5/13/2013	4	5	$0.1670	2.85%
10	$5,000	3.42	4.75	4/20/2013	10	7	$0.1670	2.82%
11	$11,970	2.10	0.5	5/11/2013	21	9	$0.1670	2.85%
12	$14,500	5.17	1.25	2/11/2013	14	9	$0.1670	2.85%
13	$16,900	3.96	5.33	5/20/2013	22	4	$0.1700	2.80%
Mean	**$17,127**	**3.73**	**4.20**	**10/21/2012**	**25**	**22**	**$0.1655**	**2.98%**
Median	**$15,000**	**3.96**	**2.50**	**8/31/2012**	**21**	**9**	**$0.1637**	**2.89%**

4.3 Florida—Gulf Coast

A local appraiser, study coauthor Sandra Adomatis, narrowed 13 PV home sales occurring in the Gulf Coast area of Florida in 2012 and 2013 to four paired sales (described in Table 4 and Table 5).

All paired sales show a price premium for homes with PV. 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).[13] The premium as a percentage of the sales price is higher than in other states because the price range of the houses studied is lower.

This is a young PV market—the average PV system is around 3 years old, and none were older than 4. Future efforts should be made to understand the market's reaction to these PV systems over the next 5 years, when data should be more prevalent, especially for older systems. PV systems produce more energy in areas with high elevation, low humidity, and clear skies; Florida has plenty of sun but low elevation and high humidity. For this reason, although not shown for this small sample, the premiums found in other states with much different geographical characteristics may differ from those in Florida.

As shown in Table 5, PV homes took longer to sell than non-PV homes for three of the four pairs, but the differences are small.

Table 4: Gulf Coast Paired-Sales Premiums and Contributory-Value Estimates

Paired Sale	ST	Location	Total PV Premium	Sales Price Premium ($/Watt)	Gross Cost ($/Watt)	Net Cost ($/Watt)	Low Income Estimate ($/Watt)	Average Income Estimate ($/Watt)	High Income Estimate ($/Watt)	Sale Price of Solar House	Premium as a % of Sale Price
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%
Mean			**$12,760**	**$3.45**	**$5.13**	**$3.53**	**$1.99**	**$2.14**	**$2.32**	**$227,000**	**6.39%**
Median			**$12,550**	**$3.69**	**$5.45**	**$3.69**	**$1.96**	**$2.12**	**$2.30**	**$176,500**	**5.49%**

Table 5: Gulf Coast PV Information, Days on Market, Electric Rates, and Escalation Rates

Paired Sale	Total PV Premium	Size System (kW)	Age System (yrs)	Sale Date	Solar PV Sale-Days on Market	Non Solar Days on Market	Electric Cost ($/kWh)	Est. Yrly Electric Escalation Rate (%)
14	$17,941	4.950	2.40	4/30/2012	11	1	$0.1320	3.42%
15	$10,100	2.090	3.84	4/1/2013	40	16	$0.1060	1.58%
16	$15,000	4.000	4.00	7/5/2013	9	12	$0.1340	3.75%
17	$8,000	5.040	2.70	8/31/2012	18	10	$0.1040	1.58%
Mean	**$12,760**	**4.020**	**3.235**	**12/8/2012**	**20**	**10**	**$0.119**	**2.58%**
Median	**$12,550**	**4.475**	**3.270**	**12/15/2012**	**15**	**11**	**$0.119**	**2.50%**

[13] For the income estimate, we used the average PV Value® estimate.

4.4 Maryland—Baltimore Metro Area

A local appraiser in the Baltimore metro area, Jay Kimmel, narrowed 13 PV homes sales to three paired sales (described in Table 6 and Table 7).

All paired sales show a price premium for homes with PV. 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).[14]

The premium as a percentage of the sale price is lowest for Pair 1, because that home's PV system is substantially smaller than the PV systems on the other homes analyzed, while all the home prices are reasonably similar. Conversely the premium as a percentage of the sale price for Pair 2 is highest because the home's PV system is largest. Together these elucidate the wide range possible if percent of sale price is used. The PV homes sold more quickly than the paired non-PV homes on average, but only in two of the three cases, and the differences were small.

Table 6: Baltimore Metro Area Paired-Sales Premiums and Contributory-Value Estimates

Paired Sale	ST	Location	Total PV Premium	Sales Price Premium ($/Watt)	Gross Cost ($/Watt)	Net Cost ($/Watt)	Low Income Estimate ($/Watt)	Average Income Estimate ($/Watt)	High Income Estimate ($/Watt)	Sale Price of Solar House	Premium as a % of Sale Price
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%
Mean			**$13,667**	**$3.82**	**$4.80**	**$3.41**	**$2.11**	**$2.36**	**$2.56**	**$507,000**	**2.52%**
Median			**$13,300**	**$3.90**	**$4.80**	**$3.24**	**$2.11**	**$2.51**	**$2.71**	**$535,000**	**2.49%**

Table 7: Baltimore Metro Area PV Information, Days on Market, Electric Rates, and Escalation Rates

Paired Sale	Total PV Premium	Size System (kW)	Age System (yrs)	Sale Date	Solar PV Sale-Days on Market	Non Solar Days on Market	Electric Cost ($/kWh)	Est. Yrly Electric Escalation Rate (%)
30	$3,900	1.000	1.15	2/28/2013	12	26	$0.1357	3.04%
31	$23,800	5.880	2.10	12/6/2013	1	37	$0.1357	2.92%
32	$13,300	3.800	4.95	10/23/2013	12	8	$0.1357	2.92%
Mean	**$13,667**	**3.560**	**2.733**	**8/19/2013**	**8**	**24**	**$0.136**	**2.96%**
Median	**$13,300**	**3.800**	**2.100**	**10/23/2013**	**12**	**26**	**$0.136**	**2.92%**

4.5 North Carolina—Raleigh Metro Area

A local appraiser, Joel Tate, narrowed 23 PV home sales in the Raleigh metro area to seven paired sales (described in Table 8 and Table 9).

All paired sales show a price premium for homes with PV. 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

[14] For the income estimate, we used the average PV Value® estimate.

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).[15] The range of PV premiums as a percentage of the sales price is very large, again indicating this is not a credible metric.

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. 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, sales price premiums should become easier to identify. Four of the PV home sales experienced less time on the market than their paired sale without PV, and both the mean and median values are considerably lower for PV than non-PV.

Table 8: Raleigh Metro Area Paired-Sales Premiums and Contributory-Value Estimates

Paired Sale	ST	Location	Total PV Premium	Sales Price Premium ($/Watt)	Gross Cost ($/Watt)	Net Cost ($/Watt)	Low Income Estimate ($/Watt)	Average Income Estimate ($/Watt)	High Income Estimate ($/Watt)	Sale Price of Solar House	Premium as a % of Sale Price
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%
Mean			**$11,229**	**$2.68**	**$5.89**	**$2.68**	**$1.59**	**$1.73**	**$1.88**	**$302,041**	**3.61%**
Median			**$6,775**	**$1.83**	**$5.70**	**$2.59**	**$1.54**	**$1.67**	**$1.82**	**$309,999**	**1.92%**

Table 9: Raleigh Metro Area PV Information, Days on Market, Electric Rates, and Escalation Rates

Paired Sale	Total PV Premium	Size System (kW)	Age System (yrs)	Sale Date	Solar PV Sale-Days on Market	Non Solar Days on Market	Electric Cost ($/kWh)	Est. Yrly Electric Escalation Rate (%)
23	$3,400	3.200	1.50	3/7/2011	167	210	$0.1012	1.90%
24	$15,499	4.800	0.70	5/13/2013	10	9	$0.1053	1.90%
25	$8,400	4.600	2.40	11/21/2013	20	154	$0.1053	1.90%
26	$6,775	2.205	0.03	7/27/2012	4	111	$0.1043	1.95%
27	$2,431	2.205	0.06	6/22/2012	2	111	$0.1035	2.11%
28	$4,000	4.160	1.27	5/24/2010	162	25	$0.1035	2.11%
29	$38,100	5.060	1.60	6/24/2013	35	9	$0.1053	1.90%
Mean	**$11,229**	**3.75**	**1.08**	**6/23/2012**	**57**	**90**	**$0.1041**	**1.97%**
Median	**$6,775**	**4.16**	**1.27**	**7/27/2012**	**20**	**111**	**$0.1043**	**1.90%**

[15] For the income estimate, we used the average PV Value® estimate.

4.6 Oregon—Portland Metro Area

A local appraiser, Taylor Watkins, narrowed 38 PV home sales in the Portland metro area in 2012 and 2013 to nine paired sales (described in Table 10 and Table 11).

Eight of the nine paired sales show a price premium for homes with PV. 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.[16] 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 4-year period, although the full amount was included in the net cost estimate. The typical buyer may only be considering the 1st-year incentive amount.[17] Taylor Watkins also suggested the market 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 (Dastrup et al., 2012).

Seven of nine pairs indicate it takes longer to sell a home with PV than a home without PV, and some of the differences were large. Future study of this observation might be warranted.

Table 10: Portland Metro Area Paired-Sales Premiums and Contributory-Value Estimates

Paired Sale	ST	Location	Total PV Premium	Sales Price Premium ($/Watt)	Gross Cost ($/Watt)	Net Cost ($/Watt)	Low Income Estimate ($/Watt)	Average Income Estimate ($/Watt)	High Income Estimate ($/Watt)	Sale Price of Solar House	Premium as a % of Sale Price
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%
Mean			**$10,600**	**$3.92**	**$5.13**	**$1.84**	**$1.50**	**$1.64**	**$1.80**	**$359,711**	**3.25%**
Median			**$8,000**	**$3.33**	**$4.97**	**$1.48**	**$1.64**	**$1.80**	**$1.98**	**$345,000**	**1.97%**

[16] For the income estimate, we used the average PV Value® estimate.

[17] The Oregon 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.

Table 11: Portland Metro Area PV Information, Days on Market, Electric Rates, and Escalation Rates

Paired Sale	Total PV Premium	Size System (kW)	Age System (yrs)	Sale Date	Solar PV Sale-Days on Market	Non Solar Days on Market	Electric Cost ($/kWh)	Est. Yrly Electric Escalation Rate (%)
33	$7,900	2.380	6.50	7/26/2012	30	3	$0.1072	4.25%
34	$6,900	2.940	1.50	7/2/2012	5	2	$0.1072	3.95%
35	$0	3.000	1.00	11/28/2012	46	3	$0.1072	3.95%
36	$7,400	2.870	1.50	7/20/2012	24	5	$0.1072	3.95%
37	$8,000	2.400	2.50	3/29/2013	23	14	$0.1160	3.92%
38	$18,800	3.000	3.00	2/11/2013	200	72	$0.1106	3.98%
39	$14,400	4.140	2.00	6/27/2012	79	9	$0.1072	3.95%
40	$16,100	2.453	4.00	9/20/2013	50	54	$0.1106	4.07%
41	$15,900	2.160	2.50	8/12/2013	4	79	$0.1106	3.92%
Mean	**$10,600**	**2.816**	**2.722**	**12/19/2012**	**51**	**27**	**$ 0.1093**	**3.99%**
Median	**$8,000**	**2.870**	**2.500**	**11/28/2012**	**30**	**9**	**$ 0.1072**	**3.95%**

4.7 Oregon—Bend Metro Area

A local appraiser, Sarah Houston, narrowed 22 PV home sales occurring in the Bend metro area in 2011–2013 to two paired sales (described in Table 12 and Table 13).

Both paired sales show a price premium for homes with PV. 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.[18]

The 2011 sale has a higher premium than the 2013 sale, which is amplified when the percent of sale price is calculated. The disparity relates to the size of the PV systems compared to the prices of the homes. Further research is necessary in this market when more sales data are available to produce a more robust set of pairings.

The electricity cost is at the lower end of the six study states, but the escalation rate is at the upper end. One of the PV homes took more time to sell than its non-PV counterpart, while the other took less.

Table 12: Bend Metro Area Paired-Sales Premiums and Contributory-Value Estimates

Paired Sale	ST	Location	Total PV Premium	Sales Price Premium ($/Watt)	Gross Cost ($/Watt)	Net Cost ($/Watt)	Low Income Estimate ($/Watt)	Average Income Estimate ($/Watt)	High Income Estimate ($/Watt)	Sale Price of Solar House	Premium as a % of Sale Price
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			**$22,775**	**$5.50**	**$4.97**	**$1.74**	**$2.24**	**$2.44**	**$2.66**	**$477,000**	**5.41%**
Median			**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**

[18] For the income estimate, we used the average PV Value® estimate.

Table 13: Bend Metro Area PV Information, Days on Market, Electric Rates, and Escalation Rates

Paired Sale	Total PV Premium	Size System (kW)	Age System (yrs)	Sale Date	Solar PV Sale-Days on Market	Non Solar Days on Market	Electric Cost ($/kWh)	Est. Yrly Electric Escalation Rate (%)
42	$9,500	2.350	2.50	6/14/2013	43	100	$0.1038	4.25%
43	$36,050	5.180	0.00	10/21/2011	221	203	$0.1038	3.95%
Mean	**$22,775**	**3.765**	**1.250**	**8/17/2012**	**132**	**152**	**$ 0.1038**	**4.10%**
Median	**n/a**	**n/a**	**n/a**		**n/a**	**n/a**	**n/a**	**n/a**

4.8 Southeastern Pennsylvania

A local appraiser, John Szymanski, narrowed 22 PV home sales occurring in southeastern Pennsylvania to three paired sales, and he identified a sale of a PV home in 2014 that was not in the original dataset but had two comparable sales, resulting in two additional paired sales. The five paired sales are described in Table 14 and Table 15.

All paired sales show a price premium for homes with PV. 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).[19]

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. Two PV homes spent considerably more time on the market than their non-PV counterparts. The appraiser is not certain why this occurred.

Table 14: Southeastern Pennsylvania Paired-Sales Premiums and Contributory-Value Estimates

Paired Sale	ST	Location	Total PV Premium	Sales Price Premium ($/Watt)	Gross Cost ($/Watt)	Net Cost ($/Watt)	Low Income Estimate ($/Watt)	Average Income Estimate ($/Watt)	High Income Estimate ($/Watt)	Sale Price of Solar House	Premium as a % of Sale Price
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%
Mean			**$16,377**	**$3.24**	**$5.23**	**$3.66**	**$2.00**	**$2.17**	**$2.35**	**$504,850**	**3.73%**
Median			**$15,960**	**$3.53**	**$5.44**	**$3.80**	**$1.85**	**$1.99**	**$2.15**	**$600,000**	**2.66%**

[19] For the income estimate, we used the average PV Value® estimate.

Table 15: Southeastern Pennsylvania PV Information, Days on Market, Electric Rates, and Escalation Rates

Paired Sale	Total PV Premium	Size System (kW)	Age System (yrs)	Sale Date	Solar PV Sale-Days on Market	Non Solar Days on Market	Electric Cost ($/kWh)	Est. Yrly Electric Escalation Rate (%)
18	$15,224	4.284	1.20	10/23/2014	7	39	$0.1575	2.00%
19	$15,124	4.284	1.20	10/23/2014	7	7	$0.1576	2.00%
20	$18,000	6.264	1.50	7/11/2011	299	33	$0.1375	1.63%
21	$17,575	3.850	2.50	9/23/2012	200	44	$0.1159	2.21%
22	$15,960	9.600	1.30	7/12/2011	6	12	$0.1040	1.95%
Mean	**$16,377**	**5.656**	**1.54**	**1/29/2013**	**104**	**27**	**$0.1345**	**1.96%**
Median	**$15,960**	**4.284**	**1.30**	**9/23/2012**	**7**	**33**	**$0.1375**	**2.00%**

4.9 Six-State Combined Results

Table 16 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).

Figure 1 summarizes the results by state. Average income estimates are shown with the error bar representing the low and high estimates. The sales price premiums closely follow the net cost in five of the six states, with Oregon being the exception. None of the premiums follow (i.e., are statistically identical to) the gross cost or income estimates, regardless of whether low, average, or high values are used.[20] 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.[21] 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 PV credibly. Some underwriters and some representing the secondary

[20] 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.

[21] 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 not when Oregon is included (r = 0.20, *p*-value 0.18). The premiums are not correlated with gross cost estimates with Oregon (r = -0.07, *p*-value 0.63) or without Oregon (r = 0.01, *p*-value 0.95) included.

mortgage market believe that the paired-sales method is the only viable method, but these results show the cost approach and the income approach are both worthy replacements.

Turning back to the full set of results, Table 17 shows days on market information for all the paired sales as well as 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). Figure 2 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 (Table 17). In summary, there appears to be no clear days-on-market difference in this sample between PV and non-PV homes.[22]

Figure 3 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.[23] This is not surprising, because the retail rates and the escalations of those rates are only a portion of the factors that would likely influence premiums.

Finally, Table 18 shows the location of the PV system on the study homes. Most of the systems are on the rear of the structure. We found no statistically significant correlation between sales price premium and system location. Exploring this relationship is an area for future research.

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

[23] 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).

Table 16: Combined Set of Paired-Sales Premiums and Contributory-Value Estimates

Paired Sale	ST	Location	Total PV Premium	Sales Price Premium ($/Watt)	Gross Cost ($/Watt)	Net Cost ($/Watt)	Low Income Estimate ($/Watt)	Average Income Estimate ($/Watt)	High Income Estimate ($/Watt)	Sale Price of Solar House	Premium as a % 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	$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%**

Table 17: Combined Set of Days on Market, PV Information, and Electric Rate Information

Paired Sale	Total PV Premium	Size System (kW)	Age System (yrs)	Sale Date	Solar PV Sale-Days on Market	Non Solar Days on Market	Electric Cost ($/kWh)	Est. Yrly Electric Escalation Rate (%)
1	$20,700	4.10	3.6	8/31/2012	10	113	$0.1637	2.89%
2	$11,000	2.99	2.2	4/3/2012	30	7	$0.1637	2.89%
3	$16,800	4.52	2.5	7/21/2012	9	10	$0.1637	2.89%
4	$15,000	4.67	11.41	11/16/2012	50	56	$0.1670	4.24%
5	$5,850	1.43	10.58	4/17/2012	35	8	$0.1637	2.93%
6	$30,850	5.12	7.12	5/24/2012	77	2	$0.1637	2.93%
7	$52,500	6.30	1.2	6/26/2012	18	21	$0.1637	2.93%
8	$16,580	2.72	2.5	6/15/2012	24	35	$0.1637	2.93%
9	$5,000	2.03	1.67	5/13/2013	4	5	$0.1670	2.85%
10	$5,000	3.42	4.75	4/20/2013	10	7	$0.1670	2.82%
11	$11,970	2.10	0.5	5/11/2013	21	9	$0.1670	2.85%
12	$14,500	5.17	1.25	2/11/2013	14	9	$0.1670	2.85%
13	$16,900	3.96	5.33	5/20/2013	22	4	$0.1700	2.80%
14	$17,941	4.950	2.40	4/30/2012	11	1	$0.1320	3.42%
15	$10,100	2.090	3.84	4/1/2013	40	16	$0.1060	1.58%
16	$15,000	4.000	4.00	7/5/2013	9	12	$0.1340	3.75%
17	$8,000	5.040	2.70	8/31/2012	18	10	$0.1040	1.58%
18	$15,224	4.284	1.20	10/23/2014	7	39	$0.1575	2.00%
19	$15,124	4.284	1.20	10/23/2014	7	7	$0.1576	2.00%
20	$18,000	6.264	1.50	7/11/2011	299	33	$0.1375	1.63%
21	$17,575	3.850	2.50	9/23/2012	200	44	$0.1159	2.21%
22	$15,960	9.600	1.30	7/12/2011	6	12	$0.1040	1.95%
23	$3,400	3.200	1.50	3/7/2011	167	210	$0.1012	1.90%
24	$15,499	4.800	0.70	5/13/2013	10	9	$0.1053	1.90%
25	$8,400	4.600	2.40	11/21/2013	20	154	$0.1053	1.90%
26	$6,775	2.205	0.03	7/27/2012	4	111	$0.1043	1.95%
27	$2,431	2.205	0.06	6/22/2012	2	111	$0.1035	2.11%
28	$4,000	4.160	1.27	5/24/2010	162	25	$0.1035	2.11%
29	$38,100	5.060	1.60	6/24/2013	35	9	$0.1053	1.90%
30	$3,900	1.000	1.15	2/28/2013	12	26	$0.1357	3.04%
31	$23,800	5.880	2.10	12/6/2013	1	37	$0.1357	2.92%
32	$13,300	3.800	4.95	10/23/2013	12	8	$0.1357	2.92%
33	$7,900	2.380	6.50	7/26/2012	30	3	$0.1072	4.25%
34	$6,900	2.940	1.50	7/2/2012	5	2	$0.1072	3.95%
35	$0	3.000	1.00	11/28/2012	46	3	$0.1072	3.95%
36	$7,400	2.870	1.50	7/20/2012	24	5	$0.1072	3.95%
37	$8,000	2.400	2.50	3/29/2013	23	14	$0.1160	3.92%
38	$18,800	3.000	3.00	2/11/2013	200	72	$0.1106	3.98%
39	$14,400	4.140	2.00	6/27/2012	79	9	$0.1072	3.95%
40	$16,100	2.453	4.00	9/20/2013	50	54	$0.1106	4.07%
41	$15,900	2.160	2.50	8/12/2013	4	79	$0.1106	3.92%
42	$9,500	2.350	2.50	6/14/2013	43	100	$0.1038	4.25%
43	$36,050	5.180	0.00	10/21/2011	221	203	$0.1038	3.95%
Mean	**$14,329**	**3.783**	**2.74**	**11/17/2012**	**48**	**40**	**$0.1308**	**2.92%**
Median	**$14,500**	**3.850**	**2.20**	**11/16/2012**	**21**	**12**	**$0.1160**	**2.89%**

Figure 1: Average PV Home Premium and Contributory-Value Estimates ($/W)

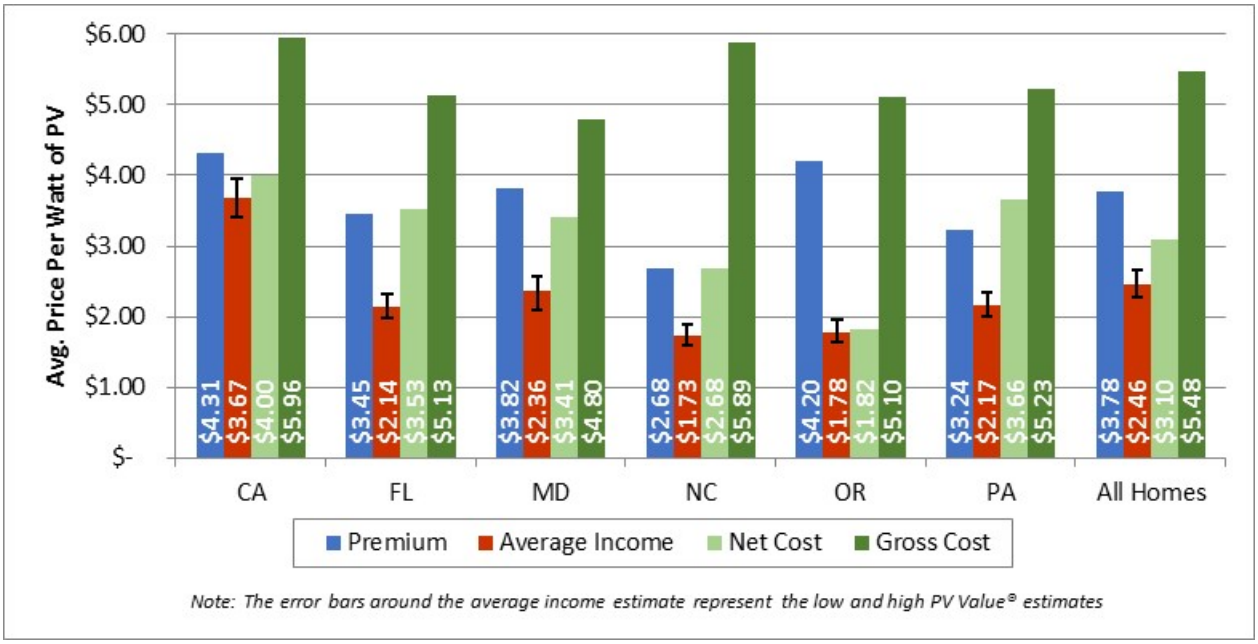


Figure 2: Average Days on Market for PV and Non-PV Homes by State

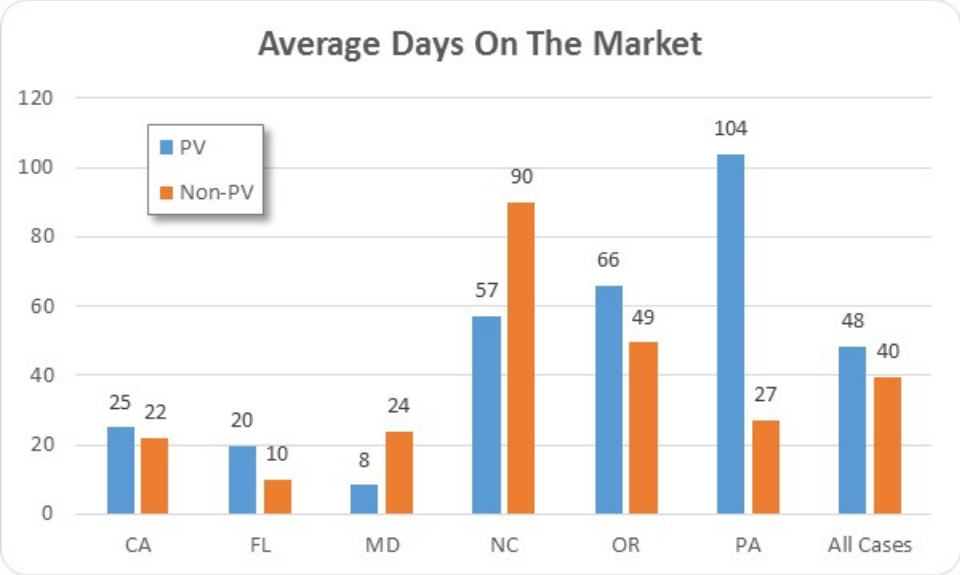


Figure 3: Average Premiums, Income Estimates, and Electricity and Escalation Rates by State

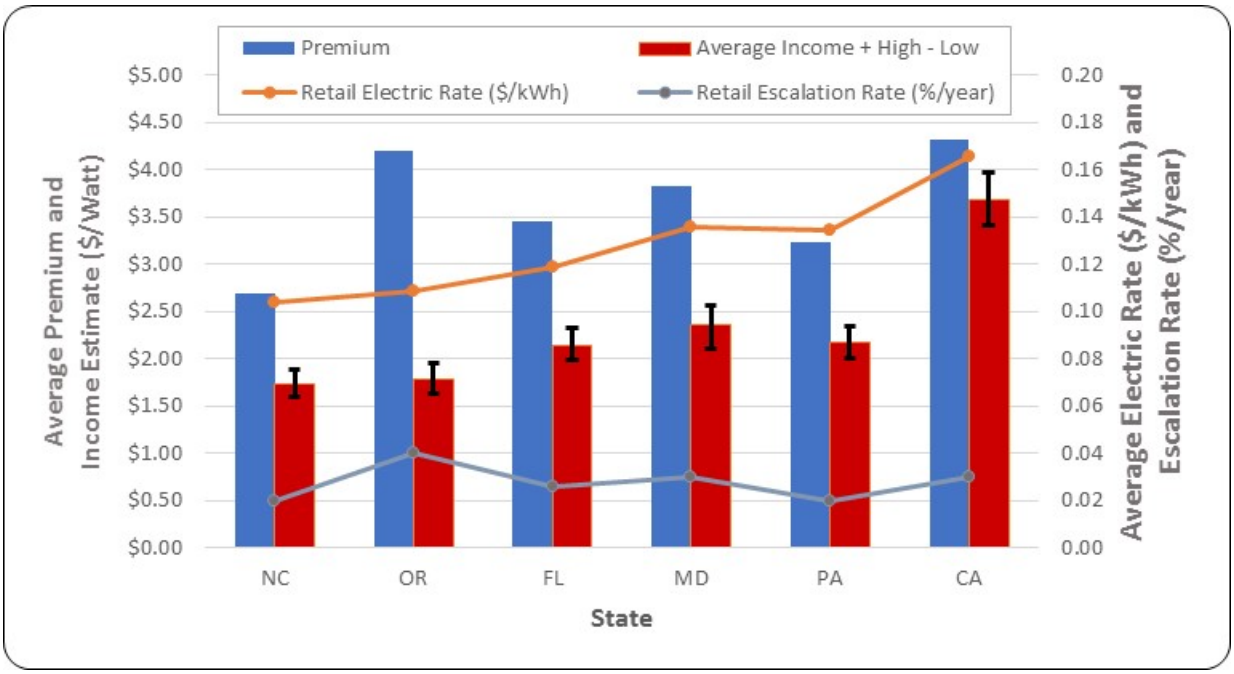


Table 18: Location of PV System on Site

Solar System Location	Count
Front	9
Front/Side	1
Ground	1
Side	9
Rear	23
No. of Paired-Sales Sets	43

5. 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. (2015) with those made by appraisers. Hoen's group analyzed almost 4,000 PV home sales, while the present study investigated 43 sales. Table 19 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. Figure 4 shows estimates from both analyses using the "All Homes" samples.

The table and the figure 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. (2015) are higher, in part reflecting the earlier period of the sample from that study, when installed prices were higher.

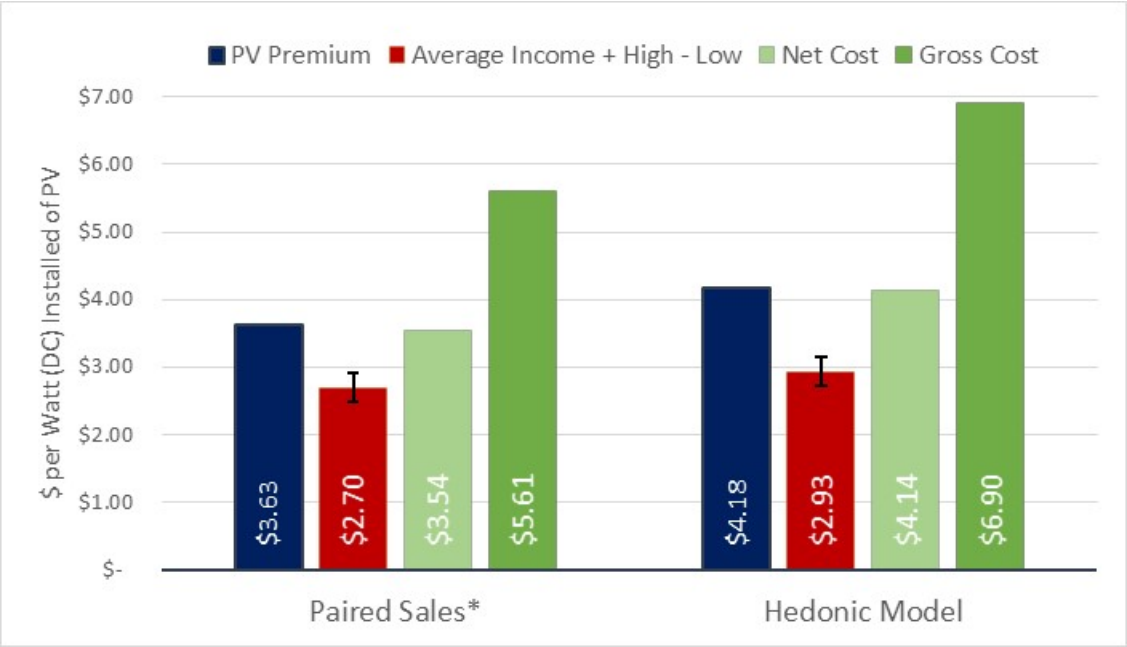
Each approach has strengths and weaknesses. For example, hedonic modeling produces a statistically defensible set of results, while paired sales are easier for most practitioners to understand. In any case, they reach similar results, which bolsters the suitability of both approaches for estimating PV 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.

Table 19: 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

The hedonic model results are from Hoen et al. (2015), 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.

Figure 4: PV Home Premiums from Paired-Sales and Hedonic Pricing Model Studies



The hedonic model results are from Hoen et al. (2015), and the paired-sales results are from the present study. *The paired sales estimates do not include Oregon, because Oregon was not included in the Hoen et al. analysis. All values are shown in dollars per watt. Error bars represent the high and low income estimates.

6. 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 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 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.
- 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 the 30% federal Investment Tax Credit is not continued after December 31, 2016 and other state/local incentives also expire without renewal, the market may reveal sales price premiums that are closer to gross costs.
- 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 approach overvalues PV.[24] This study suggests that, instead, the income approach values PV conservatively, at least if the default parameters are used. This implies the income 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.

[24] Based on personal conversations between Adomatis and appraisers and members of the lending/underwriting industry.

- Paired-sales analysis results from this study accord with the hedonic modeling results from Hoen et al. (2015), 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 PV no value.[25] 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.

[25] A premium is also known as an adjustment in the sales-comparison grid of an appraisal.

7. 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 are identified with black bullets and possible solutions with white bullets below.

- Verifiable documentation of houses with PV systems and their characteristics must be made available for the real estate market.
    - 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[26] (see Appendix 10.4), making a permanent record onsite.
    - Develop a public database—regularly updated by system installers, utilities, and permitting authorities—that allows PV Value® users 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.
- 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 sales price premium and the net cost, appraisers should have access to net system costs. Appraisers report that some PV sales companies were reluctant to provide a system cost as of the sale date.
    - It would be ideal to develop a cost component to the PV Value® tool linked to current U.S. gross and net costs.[27]
    - Gross costs are also available by zip code through the Open PV[28] website.
    - In all cases the values used should be verified for a specific market and sale date.
- 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.
    - Ideally, the PV installer would place this information in the electrical box so it would be accessible to the owner, appraiser, or real estate agent.

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[26] http://www.appraisalinstitute.org/assets/1/7/Interactive820.04-ResidentialGreenandEnergyEffecientAddendum.pdf

[27] This component is currently available for some markets through the licensed version of PV Value® and will be available for more markets over time.

[28] https://openpv.nrel.gov/

- Green the MLS[29] 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 (CNT & NHPC, 2014; NAR, 2014).

- Education is needed in the real estate and PV industries. Without communication between these industries, better marketing of homes with PV systems and more accurate appraised values of those homes are unlikely.
  - Real estate sales agents need education on the use and importance of completing page 3 of the AI Residential Green and Energy Efficient Addendum[30] upon listing a house with PV. The Addendum should be placed in the MLS as an attachment for potential buyers, other sales agents, and appraisers to use in understanding or valuing the system. It is difficult for appraisers to compare sales accurately if the size of each system is not known. Appraisers report they rarely have the PV system size on all comparable sales and often assume all PV systems are the same. This assumption can affect the appraised value results substantially. For example, if the sales price premium is $3/W, an appraiser who assumes all PV systems are equal would equate a 5-kW system worth $15,000 to a 1-kW system worth $3,000.
  - Real estate appraisers are required to have competency prior to accepting an assignment, according to FHA, Fannie Mae, and Freddie Mac. Competency suggests the appraiser has knowledge of the property type and education to allow them to produce a credible report. The Appraisal Institute offers a 2-day course, Residential and Commercial Valuation of Solar,[31] to assist appraisers in attaining competency. Though to date, only a few hundred appraisers have taken the course. This might be because of dismissive lender attitudes toward PV in general and corresponding noncompliance with the requirement to choose competent appraisers.
  - The previous item suggests that, without lender education on PV systems and appropriate appraisal methods, little will change in the PV home mortgage process. However, homeowners, builders, and real estate agents choose their lenders, and it is important that they both understand that right and ask to have a competent appraiser from their lender.
  - 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.

[29] http://www.greenthemls.org/
[30] http://www.appraisalinstitute.org/education/green_energy_addendum.aspx
[31] http://www.myappraisalinstitute.org/education/course_descrb/Default.aspx?prgrm_nbr=844&key_type=C

- 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.
    - 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 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.

8. Meet the Appraisers

Sarah S. Houston, Oregon CRA & Accredited Green Appraiser (AGA)
Sam Houston Appraisers
61307 Robin Hood Lane, Bend, OR 97702

http://www.bendorappraisers.com

Jay Kimmel, SRA, Kimmel Appraisal Group
Kimmel Appraisal Group
4634 Potomac Road, Pasadena, MD 21122-5457

http://www.kimmelappraisers.com

Joel G. Tate, SRA, RAA
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http://www.tateandcompanyinc.com

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Watkins & Associates
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Lynn A. Dordahl, MBA
31915 Rancho California Road, Suite 200, Temecula, CA 92591

John F. Szymanski
John F Szymanski, Appraisers
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http://www.greaterphiladelphiaappraiser.com

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10. Appendix

10.1 PV System Facts

1 kilowatt (kW) = 1,000 watts (W)

PV systems are usually rated in kilowatts, requiring a conversion to watts for applying cost or sales price premiums. For instance, a 3.6-kW PV system is equal to 3,600 W.

PV panel ratings range from 80 to 400 W. It is not appropriate to assume all panels are the same wattage. Counting the number of panels in a system will not provide an accurate size of the system without knowing the wattage of each panel.

The energy produced varies with the number of sunlight hours, elevation, atmospheric conditions, tilt, azimuth, system age, and quality and type of solar cell. All these items can be found in the PV installation documentation. Some building permits provide details. A good, free resource on PV systems is the PV Value® User Manual (see www.pvvalue.com, create account and log-in to receive user manual).

Obtaining credible results using PV Value® requires accurate PV systems details, knowledge of discount rates, and a test of reasonableness using another method identified in this study. To eliminate underwriting rejection, appraisers must articulate the basis for the inputs to allow an understanding of this approach. Appendix Section 10.5 shows a completed PV Value® worksheet used by licensed appraisers. At the time of this study, the worksheet was being updated because of changing the tool to a web-based application that can be used with a mobile device, enterprise tablet, tablet, smartphone, or personal computer. The original PV Value proof-of-concept® was based on an Excel spreadsheet, requiring appraisers to have a recent version of Excel and know how to use it, which was not always the case. Thus the new web-based application is a major improvement and will continue to be upgraded to allow access to more recent data.

10.2 Solar Resources

Fannie Mae Selling Guide – The most recent selling guide available at the time of this report (https://www.fanniemae.com/content/guide/selling/) by Fannie Mae was released on July 28, 2015. Section B2-3-04 (https://www.fanniemae.com/content/guide/selling/b2/3/04.html), "Special Property Eligibility Considerations," now has guidance on eligibility for properties with PV owned or leased by the homeowner.

Housing and Urban Development (HUD) – The most recent *Single Family Housing Policy Handbook 4000.1 (FHA)* (http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/sfh/handbook_4000-1) was released June 24, 2015 and will become effective September 14, 2015. The handbook gives mortgage allowances for PV systems. FHA is very clear that all three approaches to value are acceptable in valuing energy features including PV. See the following section of the *Policy Handbook* for further details:

4000.1: FHA Single Family Housing Policy Handbook

II. ORIGINATION THROUGH POST-CLOSING/ENDORSEMENT

B. APPRAISER AND PROPERTY REQUIREMENTS FOR TITLE II FORWARD AND REVERSE MORTGAGES (09/14/15)

12. Programs and Products (09/14/15)

d. Special Energy-Related Building Components (09/14/15)

Residential Green Valuation Tools (www.appraisalinstitute.org/residential-green-valuation-tools/) – A publication by the Appraisal Institute, written by study coauthor Sandra K. Adomatis, provides valuation guidance for appraisers, builders, real estate agents, home owners, and lenders. Pages 120–122 provide sample wording appraisers may consider when using PV Value®, resources, and guidance in supporting adjustments to sales.

Sandia National Laboratories Resources – The information shown here is available on the Sandia PV Value® site (http://energy.sandia.gov/energy/renewable-energy/solar-energy/photovoltaics/solar-market-tranformation/pv-value/), which housed the proof-of-concept spreadsheet from December 2011 to August 2014. Journal articles, papers, and webinars discussing appraisal practices and PV Value® research can be found on this page.

"Valuation of Solar PV Systems Using a Discounted Cash Flow Approach" (http://energy.sandia.gov/download/22915/) – This peer-reviewed journal article was published in the Fall 2013 issue of the *Appraisal Journal* and outlines the case for how to apply appraisal techniques to PV systems. Once you access the Sandia webpage, scroll down to Publications and White Papers (click the box) to download the document.

"Market Valuation Perspectives for Photovoltaic Systems" (http://energy.sandia.gov/download/23657/) – This paper presents results of a survey of PV Value® proof-of-concept spreadsheet users to understand how they were using the tool in the marketplace.

"How PV System Ownership Can Impact the Market Value of Residential Homes" (http://energy.sandia.gov/download/23081/) – This paper looks at three primary ownership

options (customer, third-party, property assessed clean energy [PACE] financing) and discusses the appraisal perspective.

"Standardizing Appraisals for PV Installations" (http://energy.sandia.gov/download/22767/) – This paper was presented at the 39th IEEE PVSC conference in 2013. It discusses the importance of using proper valuation techniques to capture the value of PV systems.

Interstate Renewable Energy Council webinar (http://vimeo.com/40703731) – This webinar was broadcast just after the rollout of the original proof-of-concept spreadsheet to explain the PV Value® tool and importance of properly valuing PV systems.

Permanent Documentation – In some jurisdictions, permanent documentation is required for safety purposes, to make utility workers or emergency response personnel aware there is a PV system on the property. The benefit of this documentation is that it may outlive paper or digital documentation that may not always pass from one property owner to the next.

Examples of permanent labeling and documentation: www.pnm.com/one-line-diagram-storage-examples

Solar Ready Homes – Documentation is available for builders on what types of planning and construction methods to consider when building a solar-ready home. This information can be useful for valuation professionals by pointing out specific features to look for when valuing the property.

Solar Ready Buildings Planning Guide: www.nrel.gov/docs/fy10osti/46078.pdf

Renewable Energy Ready Home:
www1.eere.energy.gov/buildings/residential/pdfs/rerh_pv_guide.pdf

PV Mapping Applications – The following links contain maps of installed PV systems in different U.S. cities and counties. The level of detail provided in each will differ, though an appraiser can use this information to get an idea of PV adoption rates and potential comparable properties with PV systems.

Anaheim, CA - http://anaheim.solarmap.org/

Arizona - http://arizonagoessolar.org/SolarMap.aspx

Berkeley, CA - www.cityofberkeley.info/solarmap/

Boston, MA - www.mapdwell.com/en/boston

Cambridge, MA - www.mapdwell.com/en/cambridge

Los Angeles, CA - http://solarmap.lacounty.gov/

Madison, WI - http://solarmap.cityofmadison.com/madisun/

New Jersey - www.njcleanenergy.com/files/file/CS%20Marketing/Solar5000.pdf

New Orleans, LA - http://neworleanssolarmap.org/

New York, NY - http://nycsolarmap.com/

Orlando, FL - http://gis.ouc.com/solarmap/index.html

Portland, OR - www.portlandoregon.gov/bps/article/446449

Riverside, CA - www.greenriverside.com/green-map

Sacramento Municipal Utility District - http://smud.solarmap.org/

Salt Lake City, UT - http://solarsimplified.org/solar-resources/solar-map

San Diego, CA - http://sd.solarmap.org/

San Francisco, CA - http://sfenergymap.org/

Seattle Puget Sound Area - http://solarizewa.org/our-progress

Tallahassee, FL - www.talgov.com/you/you-learn-utilities-electric-solar-map.aspx

Vermont Energy Atlas - www.vtenergyatlas-info.com/solar and www.vtenergyatlas.com

Washington County, OR - www.mapdwell.com/en/energytrust

Washington DC - www.mapdwell.com/en/dc

Wellfleet, MA - www.mapdwell.com/en/wellfleet

PV Installation Databases – The information presented here comprises databases collected by many public and private entities. Some are driven by incentives offered, where PV system data are collected as part of the incentive application. Others have free viewing features but require a login to see more detail or to download the data in other formats. The level of information available varies by each site, with some providing general installation detail and others providing performance information.

Open PV (https://openpv.nrel.gov/index) – NREL has a database of installed PV systems by zip code. Much of this information is provided to NREL by state incentive programs, installers, utilities, and individuals. Information can be sorted by zip code, pre-incentive (gross) cost, and installation date.

PVOutput (http://pvoutput.org/) – This site collects and displays PV information across the world. A PV system owner gives PVOutput permission to gather data from their own PV monitoring system to allow for comparing production data in a regional setting or across different components. Anyone can query the site for PV systems by zip code.

California Solar Statistics (www.californiasolarstatistics.ca.gov/) – This site has all of the California Solar Initiative and California Public Utilities Commission data on installed PV systems. Spreadsheet data on PV systems installed under the state incentive programs can be downloaded. Information includes a great deal of information on cost, ownership, and installation detail that can be found at http://csi.powerclerk.com/ProgramDocs/CSI/PowerClerk_Glossary.pdf.

NYSERDA PV Incentive Program (https://data.ny.gov/Energy-Environment/Solar-Photovoltaic-PV-Incentive-Program-Beginning-/3x8r-34rs) – The New York State Energy Research and Development Authority (NYSERDA) displays PV incentive program data, including location (by city), PV system size, costs (gross and incentive), module and inverter manufacturer, incentive amounts, and whether the PV systems are customer or third-party owned. Chart, table, and map views can be generated in the web browser with these data.

Massachusetts Clean Energy Center (www.masscec.com/content/commonwealth-solar-installers-costs-etc) – Their incentive program data include a spreadsheet on installed PV systems through

their Commonwealth Solar incentive program. Information includes building type, city, ownership, system size, installation costs, and rebate approved.

SEIA Major Solar Projects (www.seia.org/map/majorprojectsmap.php) – This map shows the status of large-scale PV systems across the United States that are operating, under construction, and under development.

Campus Solar Photovoltaic Installations Database (www.aashe.org/resources/campus-solar-photovoltaic-installations/) – This site provides location and detail on PV systems installed on U.S. college and high school campuses. Information includes cost, size, production estimates, installation type, and module and inverter manufacturer.

Enphase (https://enlighten.enphaseenergy.com/public_systems) – This company develops inverters and maintains a public-facing website of PV installations utilizing its microinverter technology. Some sites in this interface will show actual production over the lifetime of the PV system, multiple tilt and azimuth configurations, array layout, module manufacturer, and the company that installed the PV system and/or provides the monitoring service.

SMA America (www.sunnyportal.com/Templates/PublicPagesPlantList.aspx) – This company develops inverters. Its public-facing website of PV installations may include detail on the PV system name and address, the PV system's size, site photo, date commissioned (operational), inverter specifications, energy production and specific yield, and performance ratio.

Solectria Renewables (www.solrenview.com/) – This company develops inverters. Its public-facing website of PV installations is available if the PV system uses a Solectria inverter and the site name or installer name is known.

PV Price and Cost Data – This section provides links to a number of reports that have looked at past prices paid and ultimate gross and net costs of PV systems from a number of different research institutions. This information can provide appraisers with historic market support information in specific U.S. cities and states. These studies are different from the system-specific costs associated with rebates as shown in the links for California, Massachusetts, and New York incentive programs and the Open PV database.

LBNL Tracking the Sun (https://emp.lbl.gov/publications/tracking-sun-viii-install) – This report series looks at the installed *price* (paid to developers or installers before incentives) of PV starting in 1998. The report is published annually and is in its 8th year with data available up to 2014. Prior versions of this report can be found by searching the Energy Markets and Policy Group publications website (https://emp.lbl.gov/reports).

SEIA/GTM Solar Market Insight (http://www.seia.org/research-resources/us-solar-market-insigh) – This report series is done quarterly to break out costs by market and location. Summary data are available free. More specific information by state and market is available to purchase.

The Interstate Renewable Energy Council (IREC, www.irecusa.org/) prepares an annual *U.S. Solar Market Trends* report (www.irecusa.org/annual-u-s-solar-market-trends-report/) that outlines different market forces shaping the adoption of PV in U.S. states. PV pricing is included in these reports, and archived reports back to 2008 can be downloaded.

PV Regulatory and Incentives Environment – Understanding what incentives are available at the national, state, and local level can help better understand the market maturity for PV as well as changes where new incentives are being brought in or old incentives are being phased out.

Where PV is more widespread, incentives are slowly disappearing. However, in new markets, PV incentives are relatively new and are intended to grow that market.

Database of State Incentives for Renewables & Efficiency (DSIRE, www.dsireusa.org) – This website and associated database of incentive information houses the most up-to-date information on incentives associated with PV. It provides information on federal, state, local, and utility incentives.

PV Module/Panel Quality – Many independent laboratories test PV modules for specific customers to ensure they meet design criteria. However, not much information is available to the public from that testing. In addition, long-term durability information is not readily available, because many manufacturers are no longer in business, and new manufacturers are entering the marketplace. Some sites, however, rank specific modules based on initial quality.

EnergySage: Selecting Solar Panels (www.energysage.com/solar/buyers-guide/selecting-solar-panels) – This site places a classification on many of the major manufacturers of PV modules, starting with premium, then standard, and down to economy. More detail is available on the module parameters and how to evaluate those from a quality and durability perspective (www.energysage.com/solar/buyers-guide/evaluating-solar-panel-quality).

Fraunhofer PV Durability Initiative (http://cse.fraunhofer.org/publications/the-pv-durability-initiative/) – This testing group, founded in Germany, recently released a paper on scoring for five different PV manufacturers from accelerated life testing and long-term field exposure data.

Proper PV-to-Inverter Sizing – It is common in the industry to oversize the PV array by using a PV-to-inverter-sizing ratio of around 1.15. A well-designed system will typically have end-to-end system losses of about 15%–16%. Oversizing the array ensures the inverter is driven to its maximum output, at least during the best sun hours of the day. System designers who are looking at a 20-year design life for the system will usually size the array-to-inverter using a 1.2 to 1.25 ratio. Some PV system integrators even routinely use a 1.3 ratio. See this article by Allan Gregg of Satcon of Boston: http://solarprofessional.com/articles/design-installation/optimal-pv-to-inverter-sizing-ratio.

10.3 Sample Paired-Sales Table for PV Sales Compared with Non-PV Sales

Paired Sale #_____

Features	PV Sale - Address	Similar Non-PV Sale - Address	Adjustment
MLS/Tax ID/Source			
Date of Sale			
Sale Price	$		$
$/SF of Living Area	$		$
SF of Living Area			
Lot Size			
Site/View			
House Style			
Number of Stories			
Actual Age - Eff. Age			
Condition			
Room Count - Total Bedroom-Bathroom			
Basement Sq. Ft.			
Finished Basement Sq. Ft.			
Heat/Air Conditioning			
Garage -# Cars			
Amenities/Porches/Patio			
Pool – Tennis Courts			
PV - Size - Age			
Other - Outbuildings			
Other			
Adjusted Sale Price	$		$
Sale Price Premium	$		

10.4 Green Addendum

Solar Panels				
The following items are considered within the appraised value of the subject property:				
Description	Array #1 ○ Leased ◉ Owned	Array #2 ○ Leased ○ Owned	**Description**	**Solar Thermal Water Heating System**
kW (size)	4.95		**If Active System - type**	○ Direct ○ Indirect
Manufacturer of Panels	Renesolar America		**If Passive System - type**	○ Integral collector ○ Thermosyphon
Warranty on Panels	25		**Storage Tank Size**	# Gallons:
Age of Panels	2		**Collector Type**	○ Flat-Plat Collector ○ Integral Collector ○ Evacuated-Tube Solar
Energy Production kWh per Array	6,700			
Source for Energy Production Estimate	Installer		**Back-Up System**	○ Conventional Water Htr ○ Tankless On Demand ○ Tankless Heat Pump
Location (Roof, Ground, Etc.)	Roof		**Age of System**	
Tilt/Slope for Array	27		**Warranty Term**	
Azimuth per Array	180		**Manufacturer**	
Age of Inverter(s)	2		**Solar Energy Factor (SEF)** (Rating range 1 to 11 - higher number is more efficient)	
Manufacturer	SolarEdge			
Warranty Term	15 years			
Name of Utility Company: FPL		Cost per kWh charged by Company: $ 0.106 /kWh		
Comments (Discuss incentives available for new panels, condition of current panels, and any maintenance issues. If leased, provide the lease terms.) A free online tool and manual for valuing the energy production of the Solar PV System is available at www.pvvalue.com Download the PV Value™ Manual for explanation of the solar terms on this form and inputs used in the PV Value Tool.	Discuss source of information and define other renewable energy sources, such as wind, hydropower, biomass power, etc. A 30% Federal Tax Credit is available until 12/31/2016. All solar energy systems are exempt from Florida's sales and use tax. No additional incentives are available at this time. This system is monitored.			

http://www.appraisalinstitute.org/education/green_energy_addendum.aspx

10.5 PV Value Example

PV VALUE	Beta Version 0.8.1	File #:	Appraiser Indicated Value:	$9,009.00	$1.82 /watt
	03/06/15 9:15:44 AM	NA	Report Prepared By:	Sandra Adomatis	

Subject Property Data

Address:	[redacted]				
City:	[redacted]	State:	FL	Zip Code:	[redacted]
Property Type:	Residential	PV Project Type:	Existing	PV Ownership:	Owned

Cost Approach Method | Physical Age / Life | Depreciated Cost

Source:	ESF 3-6-15 FL	Gross Replacement Cost New:	$0.00	$0.00	/watt
Life:	25	Straight Line Depreciation:	$0.00	$0.00	/watt/yr
Age:	2	Accumulated SL Depreciation:	$0.00	$0.00	/watt
Additional Depreciation:	None		$	$	/watt
Additional Depreciation:	None		$	$	/watt
Estimated Depreciated Value		Cost Approach:	$0.00	$0.00	/watt

Income Approach Method | Energy Value DCF

Solar Resource		O & M Expense		Utility Rate	
System Size Watts:	4,950	Inverter Size Watts:	4,950	NREL Utility Co:	Florida Power & Light Co
Module Warranty Yrs:	25	Inverter Warranty Yrs:	15	NREL Utility Rate:	10.40 ¢/kWh
System Age Yrs:	2	Inverter Age Yrs:	2	User Provided Utility Rate:	10.60 ¢/kWh
Remaining Yrs:	23	Inverter Replaced:	No	Utility Rate Used:	10.60 ¢/kWh
Derate Factor:	0.77	Inverter Replacement Cycle Yrs:	15	EIA Escalation Rate:	1.91% CAGR
Degradation Rate:	0.50%	Inverter Replacement Cost		User Provided Esc Rate:	1.55% CAGR
Array Tilt:	26.6 °	Survey Data:	75 ¢/W	Escalation Rate Used:	1.55% CAGR
Array Azimuth:	180 °	User Provided:	- ¢/W	Comments:	
Annual kWh Est:	6,654	Replacement Cost Used:	75 ¢/W		
		O & M Exp (future):	$3,712.50		
		O & M Exp (discounted):	$2,040.89		

Cost of Capital		WACC Used	+ Risk Premium	= Discount Rate ➡	Estimated Energy Value / Income Aproach	
Fannie Mae Date:	March 6, 2015		200 Basis Points	5.46%	$8,322.03	$1.68 /watt
Fannie Mae Rate:	30 Yr 90 day 3.46%	3.46%	125 Basis Points	4.71%	$9,031.84	$1.82 /watt
User Provided Interest Rate:	- %		50 Basis Points	3.96%	$9,821.84	$1.98 /watt

Estimate of Accumulated Energy Production / Income Aproach

		Low Estimated Value		Avg Estimated Value		High Estimated Value	
Year	Annual kWh	Annual Value	Accumulated Value	Annual Value	Accumulated Value	Annual Value	Accumulated Value
1	6,621	0.00	0.00	0.00	0.00	0.00	0.00
2	6,587	0.00	0.00	0.00	0.00	0.00	0.00
3	6,554	694.74	694.74	694.74	694.74	694.74	694.74
4	6,521	665.59	1,360.33	670.36	1,365.10	675.19	1,369.94
5	6,488	637.64	1,997.98	646.81	2,011.91	656.18	2,026.11
6	6,454	610.85	2,608.83	624.07	2,635.99	637.68	2,663.79
7	6,421	585.17	3,194.00	602.12	3,238.11	619.68	3,283.48
8	6,388	560.56	3,754.56	580.92	3,819.03	602.18	3,885.66
9	6,355	536.96	4,291.53	560.46	4,379.49	585.16	4,470.82
10	6,321	514.35	4,805.87	540.70	4,920.18	568.60	5,039.42
11	6,288	492.67	5,298.55	521.62	5,441.80	552.50	5,591.92
12	6,255	471.90	5,770.44	503.20	5,945.01	536.83	6,128.75
13	6,221	451.98	6,222.42	485.42	6,430.43	521.60	6,650.35
14	6,188	432.90	6,655.32	468.25	6,898.68	506.78	7,157.13
15	6,155	414.61	7,069.93	451.68	7,350.36	492.37	7,649.50
16	6,122	397.08	5,426.11	435.68	5,745.15	478.36	6,086.97
17	6,088	380.28	5,806.39	420.24	6,165.39	464.73	6,551.70
18	6,055	364.18	6,170.57	405.33	6,570.71	451.48	7,003.18
19	6,022	348.75	6,519.31	390.94	6,961.65	438.59	7,441.76
20	5,989	333.96	6,853.28	377.04	7,338.69	426.05	7,867.82
21	5,955	319.79	7,173.07	363.63	7,702.33	413.86	8,281.68
22	5,922	306.22	7,479.29	350.69	8,053.02	402.01	8,683.69
23	5,889	293.21	7,772.50	338.20	8,391.21	390.49	9,074.18
24	5,856	280.74	8,053.24	326.14	8,717.35	379.28	9,453.46
25	5,822	268.80	8,322.03	314.50	9,031.84	368.38	9,821.84
26	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-

For more information see: www.pvvalue.com