U.S. Solar Market Value Report 1st Edition

Further Evidence that Solar Adds Value to Real Estate

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2015 - 2016 Solar Values in CA, AZ, & MA

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Energy Sense Finance, located in Tampa FL, provides datasets and valuation solutions for solar and energy efficient improvements through their Ei Value® platform and PV Value® tool. Ei Value® and PV Value® may be accessed at www.eivalue.com and www.pvvalue.com respectively.

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Executive Summary

Solar photovoltaic systems provide cost savings to the property owner in terms of avoided electricity costs that accrue over the system lifetime. From an investment standpoint, the equipment and the value of the energy generated can potentially increase the underlying property value.

This first-of-a-kind study presents real market data collected from real estate appraisers using the PV Value® tool to develop a market value for solar as part of a property sale or refinance. Aggregated results at the state level are discussed for California, Arizona and Massachusetts, using 2015 and 2016 data where appraisers used the income capitalization approach to develop a market value for solar. Additional data collection using future transaction data could reveal market-specific trends and insights at the zip code, city and metropolitan statistical area (MSA) levels.

California results indicate that for a new solar system installed and sold within 2015 and 2016 (using the appraiser final value), the mean value was $3.76/Watt and $3.93/Watt respectively.[1] For a 12-year old system that sold in 2015 and 2016, the mean value was $1.86/Watt and $1.96/Watt, respectively. The retained market value (not including savings value) between a new and 12-year old residential solar installation is approximately 50% for the system that transacted in both 2015 and 2016.

When comparing the mean appraised value as indicated by the appraiser to the income approach range of values result from PV Value, the *average* income approach value is within 3% of the mean appraised value. One exception to California results is the mean of 12-year old systems appraised in 2015 has a *low* income approach value within 3% of the mean appraised value.[2]

Arizona results indicate that for a new solar system installed and sold within 2015 and 2016 (using the average income value), the mean value was $2.34/Watt and $2.34/Watt respectively. For a 7-year old system that sold in 2015 and 2016, the mean value was $1.58/Watt and $1.68/Watt, respectively.

Massachusetts results indicate that for a new solar system installed and sold within 2015 and 2016 (using the average income value), the mean value was $2.12/Watt and $2.17/Watt respectively. For a 3-year old system that sold in 2015 and 2016, the mean value was $2.09/Watt and $2.09/Watt, respectively. Very few data points contributed to those estimates.

[1] All values presented in this report are in 2015 and 2016 nominal dollars, not adjusted for inflation.

[2] This report does not state that the income approach, in general, is within a certain percentage of the appraised value of solar, but that the PV Value algorithm used to develop the income approach value is within a certain percentage of the appraised value.

Disclaimer

Estimated market values consist of systems of differing sizes, ages and conditions. What the appraiser ultimately determines in their development of the solar market value is market specific and varies considerably both spatially and temporally. Estimates presented at the state level are averages of actual appraisal data at the local level, which upon further inspection represent a distribution of values and not one single value. These values should not be quoted as one value that applies to all systems in a state.

These results are preliminary, and based on anonymized and aggregated data at the state level. The market value of the solar installation does not include the utility bill savings realized by the homeowner; what is presented here is a residual value for owned systems that are attached to the real property based on an appraiser using an income capitalization approach of energy generated.

Introduction

Energy Sense Finance (ESF) developed the PV Value® algorithm in 2009 in response to concerns raised by the real estate and appraisal industries that homes with solar were not being valued correctly in a real estate transaction. Working with Sandia National Laboratories in 2011, a proof-of-concept was released to real estate appraisers and other stakeholders. Based on its success, ESF developed the PV Value web application in early 2014,[3] which is currently assisting real estate appraisers across the U.S. develop the market value for solar.

Early efforts by Sandia and ESF, along with the Appraisal Institute were successful at educating appraisers on how to develop the market value for solar using PV Value.[4] Educational efforts are continuing under the DOE SunShot Initiative to improve solar education to other real estate stakeholders, besides just appraisers.[5]

The tool uses a discounted cash flow analysis approach to value the energy generated over its expected lifetime, typically 25 years. Other approaches such as "cost" and "sales comparison" are being added and will be analyzed in the future as those datasets grow.

As the tool captures the market value developed for properties across the U.S., it is possible to utilize that data to determine how much solar is adding to real estate transactions. This work is complimentary to the research initiated by Lawrence Berkeley National Laboratory comparing a similar house with and without solar to develop the difference in sale price, which they attribute as the market value of solar.[6] Their effort expanded by analyzing paired sales using appraisal methods,[7] though they did not have access to the appraised value during the transaction.

The approach outlined in this paper collects the solar market value that is part of the real estate appraisal, which may or may not be the same as the final sale price. Being able to analyze this data will help pull out more precisely the amount that solar adds to the property during a real estate transaction. As more properties with solar transact, more market-specific trends will emerge, and this data will be made available to solar stakeholders to conduct analysis and refine valuation approaches that reflect local market conditions.

Methodology

The PV Value tool requires multiple inputs to help define lifetime energy production and discount the cash flow as a function of the value of the energy generated over the system's assumed lifetime. This paper will not go into detail about how PV Value works, or the entire set of inputs. However, the reader is encouraged to review the

[3] https://www.pvvalue.com/
[4] Klise, G.T., J.L. Johnson, and S.K. Adomatis, 2014, *Valuation of Solar Photovoltaic Systems Using a Discounted Cash Flow Approach*. The Appraisal Journal (2013, Fall). Available at: http://energy.sandia.gov/download/22767/
[5] https://energy.gov/eere/sunshot/project-profile-elevate-energy
[6] Hoen, B., P. Cappers, R.H. Wiser, and M.A. Thayer, 2011, *An Analysis of the Effects of Residential Photovoltaic Energy Systems on Home Sales Prices in California*, LBNL-4476E. Available at: https://emp.lbl.gov/sites/default/files/lbnl-4476e.pdf
[7] Adomatis, S., and B. Hoen, 2016, *An Analysis of Solar Home Paired Sales across Six States*, The Appraisal Journal (2016, Winter). Available at: https://emp.lbl.gov/sites/default/files/lbnl-1005058.pdf

proof-of-concept user manual for more detail on the assumptions behind PV Value[8] or sign up and use the web application.[9]

The data analyzed in this report is collected from 2015 and 2016 usage of the PV Value tool by real estate appraisers for developing the value of a residential solar system as part of a real estate transaction (home sale or refinance). During that two-year period, it was used by appraisers to value solar in 40 states plus Washington D.C. The dataset was initially cleaned to make sure inputs represented the correct range of values. Generally, the filtering included removing user errors, such as the following:

- Incorrect zip codes
- Valuations with no derate factor
- Negative utility escalation rates
- Filtered residential systems in the range of 1 to 36 kW. The larger systems were primarily in northern latitudes
- Removal of properties with multiple valuations, keeping the last valuation based on the PV Value timestamp
- Results with a negative valuation

As there is a large range in systems sizes and configurations, the analysis below then focused on filtering data that falls outside the standard default values given by PV Value. Data that fell outside 1.5 x IQR (interquartile range) for each year analyzed were also considered outliers and removed. Users can overwrite the default values, though it is only recommended if they have access to documentation prepared by the installer. Due to variability introduced by the appraiser, focusing on results that include default values is necessary as it is not clear if the appraiser had additional information to justify overwriting the defaults.

Values that vary per system size are not filtered as they represent unique characteristics that the appraiser needs to adequately value the system. These include:

- System age
- Array azimuth, and
- Array tilt.

The final dataset was further reduced to focus on three states (Table 1). The first being California which had the most transactions in PV Value, with Arizona coming in second. The next largest market

Table 1 – Final dataset used in the valuation analysis

State	*Count of Data Values*[i]	*Age of Systems Analyzed*[ii]	*Size Range (kW)*
California	889	New to 12 yrs.	1.0 – 20.0
Arizona	310	New to 7 yrs.	1.4 – 16.0
Massachusetts	35	New to 3 yrs.	6.0 – 12.0

i – Sample size based on systems new to 12 years old in California, new to 7 years old in Arizona and new to 3 years old in Massachusetts. Data exists for systems older than 12, 7 or 3 years, however not enough data points were available for analysis.
ii – "New" indicates that the solar installation was new when it was appraised in either 2015 or 2016.

[8] http://energy.sandia.gov/download/23671/
[9] https://www.pvvalue.com/

for valuations was in Massachusetts. As California had more transactions with some of the earliest residential PV installations, the dataset revealed transactions of systems that were 12 years old. In Arizona, systems up to 7 years old were analyzed. And in Massachusetts, systems of up to 3 years old were analyzed.

The system size data in Table 2 presents different median system sizes based on the state, age and year of appraisal. This is intended to show some of the variability in the dataset, as there are many other factors besides system size that can impact the energy production, and ultimately the resulting market value.

Table 2 – Median system size (kW) by state and year

	2015	*2016*
California		
New	5.2	5.6
3 years old	4.9	5.3
7 years old	5.0	7.1
12 years old	7.0	3.5
Arizona		
New	5.1	6.0
3 years old	3.7	6.0
7 years old	5.0	7.2
Massachusetts		
New	7.8	11.6
3 years old	6.1	7.0

A central feature available to appraisers in the PV Value tool is the ability to verify the final system value they used in the appraisal before printing out a final report. Once PV Value calculates the different income and cost approach[10] estimates of value, the appraiser enters in the final value they will use for the appraisal. This value can be the same as the income approach estimate corresponding to a high, average or low value, or it can be adjusted upwards or downwards from the income approach value due to factors such as solar equipment condition/performance, or market acceptance of solar, for example. When this value is provided, the locational inputs for that system become anonymized in the PV Value database to ensure USPAP compliance.[11]

Working with anonymized datasets has its limitations. If datasets containing a street address were available, more detailed results and comparisons could be made such as between subdivisions, on a bed/bath or square foot basis.

Results

In the discussion below, we present the following results from analyzing the appraiser generated dataset of solar market values:

1. Appraisal estimated final value compared to the appraiser generated income approach 'range of values' aggregated at the state level for California
2. Appraiser generated average income values aggregated at the

[10] As stated above, the cost approach dataset will be analyzed in a future version of this report as not enough appraisers have utilized it within the PV Value tool.
[11] The city, state and zip code are captured for validation purposes. USPAP stands for the Uniform Standards of Professional Appraisal Practice, which guides the use and disclosure of information, to ensure confidential data or results of an individual appraisal assignment are not released to outside parties that are not involved in the real estate transaction. This data is then further aggregated by state before presenting results.

state level for California, broken down to system sizes below and above the dataset median system size

3. Appraiser generated average income values aggregated at the state level for Arizona
4. Appraiser generated average income value aggregated at the state level for Massachusetts

uses the income approach value, or makes an adjustment (recorded as the appraiser final value) is reflected in the results presented in Figure 1.

The income approach is presented as three values, which are a function of the basis point spread around the discount rate. In Figure 1, the appraiser final value generally follows the mean of the average income value. Without adjusting for inflation, the

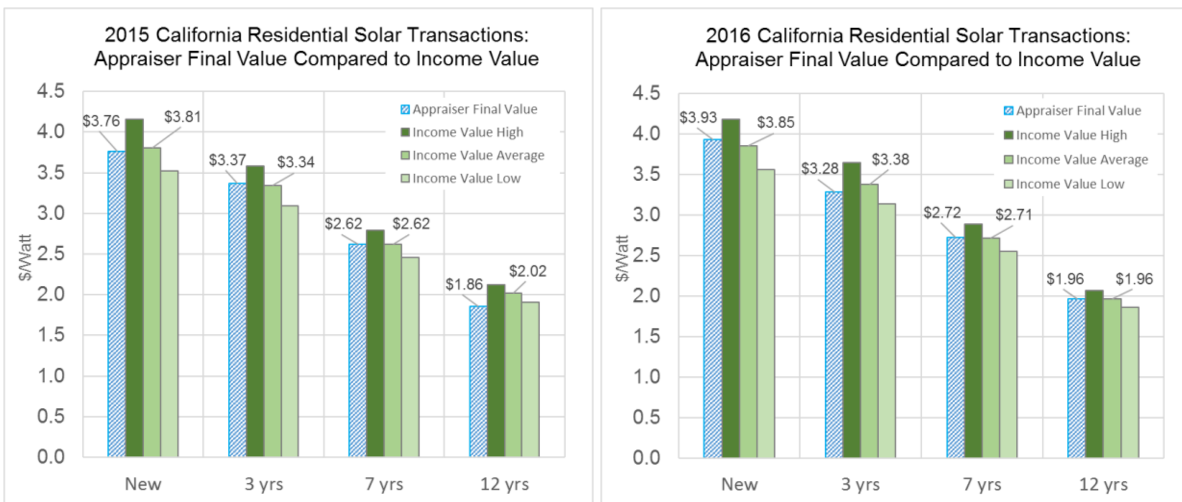

Figure 1 - 2015 and 2016 California market values for new, 3-year, 7-year and 12-year old comparing the appraiser final value with the range of high, average and low income approach estimates

California

The largest solar market in the U.S. is California. It also has the greatest number of residential properties with solar that transacted in the 2015 and 2016 timeframe. As this is the largest dataset in PV Value, we could compare the appraisal estimated final value to the income approach value generated by PV Value as a function of the appraiser inputs. Whether the appraiser

2016 valuation results are generally higher than the 2015 results which is primarily due to the average Fannie Mae discount rate being higher in 2015 (resulting in lower valuations) and lower in 2016 (resulting in higher valuations).[12] It appears that appraisers adjusted the solar market value not too far from the mean of the average income value for both years.

[12] The Fannie Mae 30 year, 90-day commitment daily rate is the default discount rate used at the time the appraiser completes a valuation estimate in PV Value. These values are updated daily by Fannie Mae.

When comparing the difference in values as a function of system age, a 12-year old residential solar system that sold in California in both 2015 and 2016 had a retained value of around 50% of a new system sold in that same year.

When comparing the mean appraised value as indicated by the appraiser to the income approach range of values result from PV Value, the *average* income approach value is within 3% of the mean appraised value. One exception to California results is the mean of 12-year old systems appraised in 2015 has a *low* income approach value within 3% of the mean appraised value.

Figure 2 below presents the same results as Figure 1 (2016 only) for just the average income value (a) and appraiser final value (b) showing the data variance in more detail.

When splitting out market values by system size, we find that there are differences between years, and between larger and smaller systems. Figure 3(a) has average income values for new installations in California that were appraised in 2015, with smaller (up to 5.2 kW) systems on the left and larger (greater than 5.2 kW) systems on the right. Figure 3(b) has average income values for new installations in California that were appraised in 2016, with smaller (up to 5.6 kW) systems on the left and larger (greater than 5.6 kW) systems on the right. These divisions are based on the median system size values shown in Table 2.

The average income values as determined by PV Value in Figure 3 are higher for 2016 when compared to 2015. The most likely explanation for why the larger systems have a higher value than the smaller systems is that the default O&M expenses are higher for smaller systems, but decrease for larger systems. In addition, Fannie Mae discount rates were on average higher in 2015 (resulting in a lower valuation) and lower in 2016 (resulting in a higher valuation).

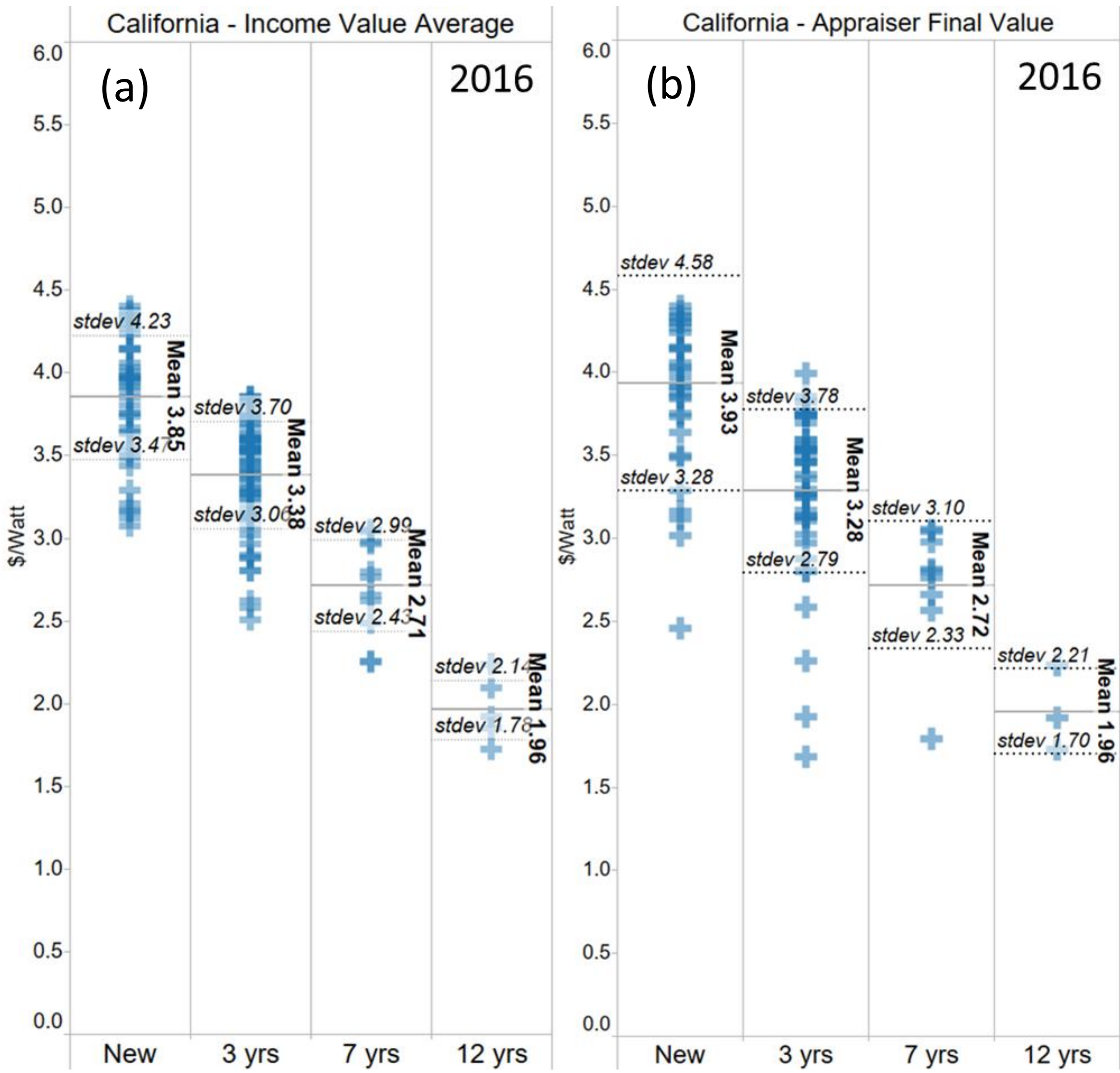

Figure 2 – 2016 California market values, showing the mean and one standard deviation from the mean for new, 3-year, 7-year and 12-year old systems for a) average income value and b) appraiser final value

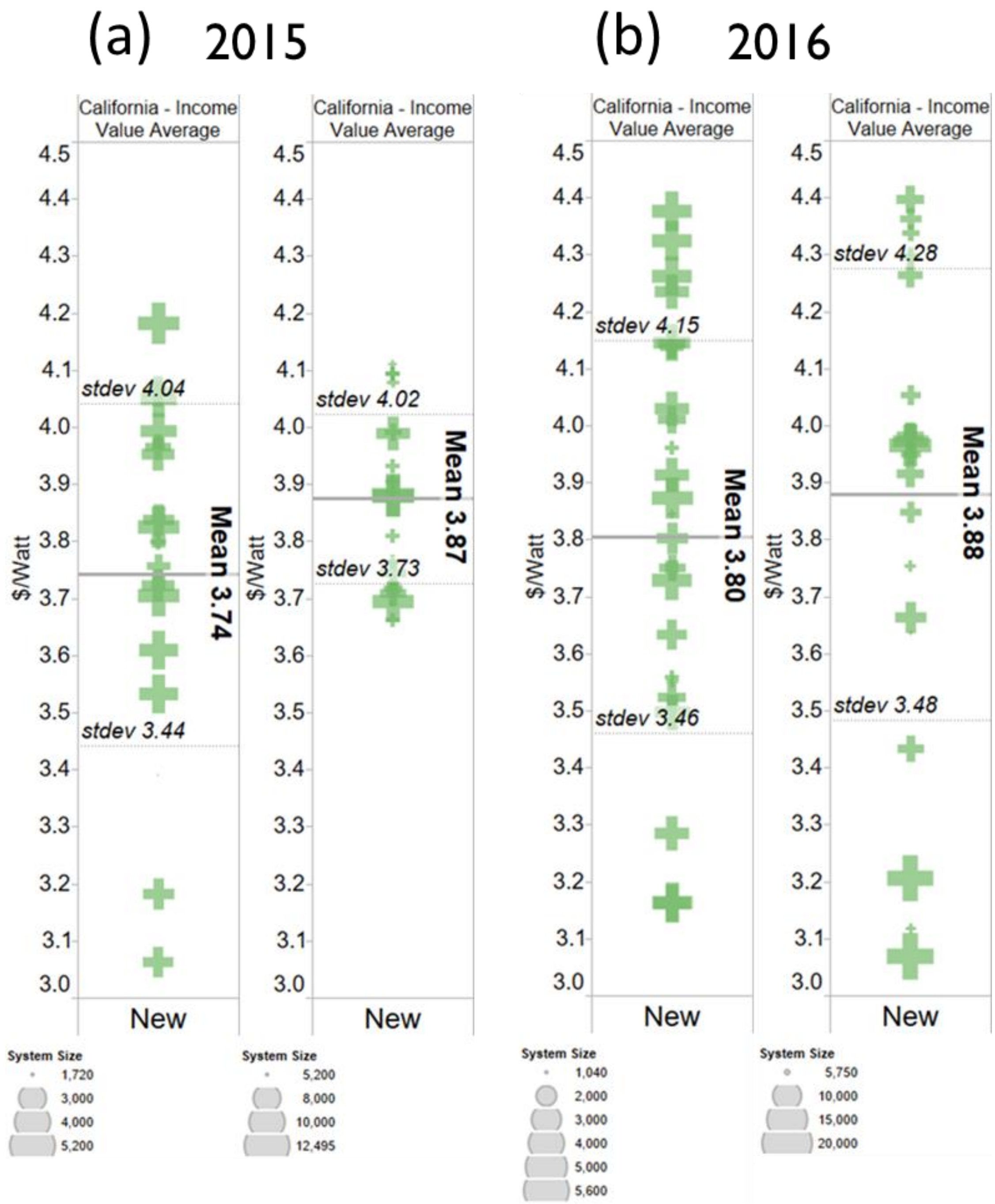

Figure 3 – California average income values binned by system size with a median of a) 5.2 kW for valuations in 2015 and b) 5.6 kW for valuations in 2016

Arizona

Arizona has less data to work with when compared to California. The appraiser final value data is not yet large enough to allow for a comparison with the income approach range as presented for California in Figure 1. The older systems with enough data to analyze only go back 7 years. Comparing between years, there is no variation between the mean of the average income value for new systems, though for 3- and 7-year old systems, it's approximately $0.10/Watt higher in 2016 when compared to 2015 (Figure 4).

If Arizona residential solar systems follow the same trend as 7- and 12-year old California systems (losing market value at the rate of ~4% per year), the energy

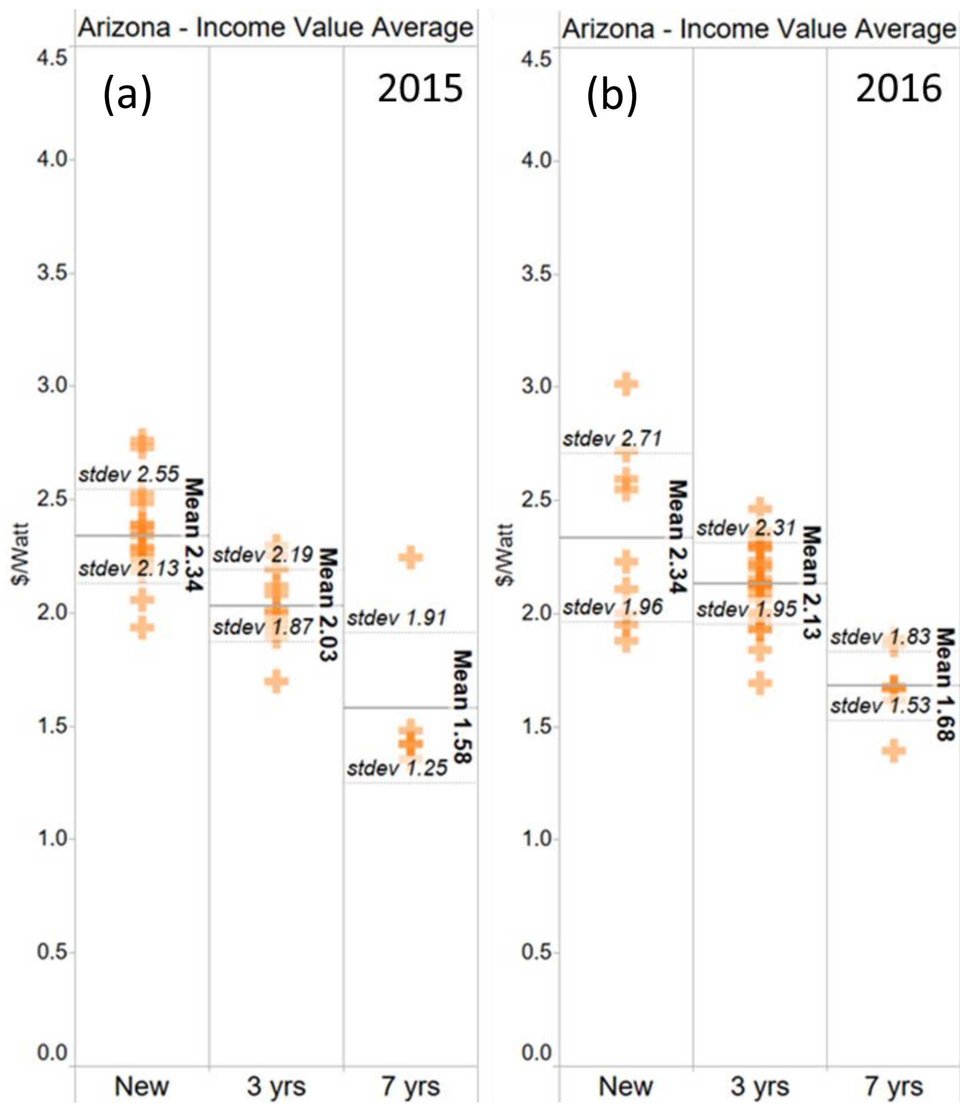

Figure 4 – Arizona market values using the average income value, showing the mean and one standard deviation from the mean for new, 3-year and 7-year old systems for a) 2015 appraisals and b) 2016 appraisals

savings value on a customer's utility bill would still benefit the homeowner.

Massachusetts

Data in Massachusetts were reduced significantly from the raw dataset of 35 transactions in 2016 and 2016. Therefore, the data presented below can only provide limited insight into valuation trends in that state. Massachusetts is a state with renewable energy credits (RECs) that can add value for the owner of that REC. However, the results below do not include any additional value from RECs. There is not much of a difference between new and 3-year old values for both 2015 and 2016.

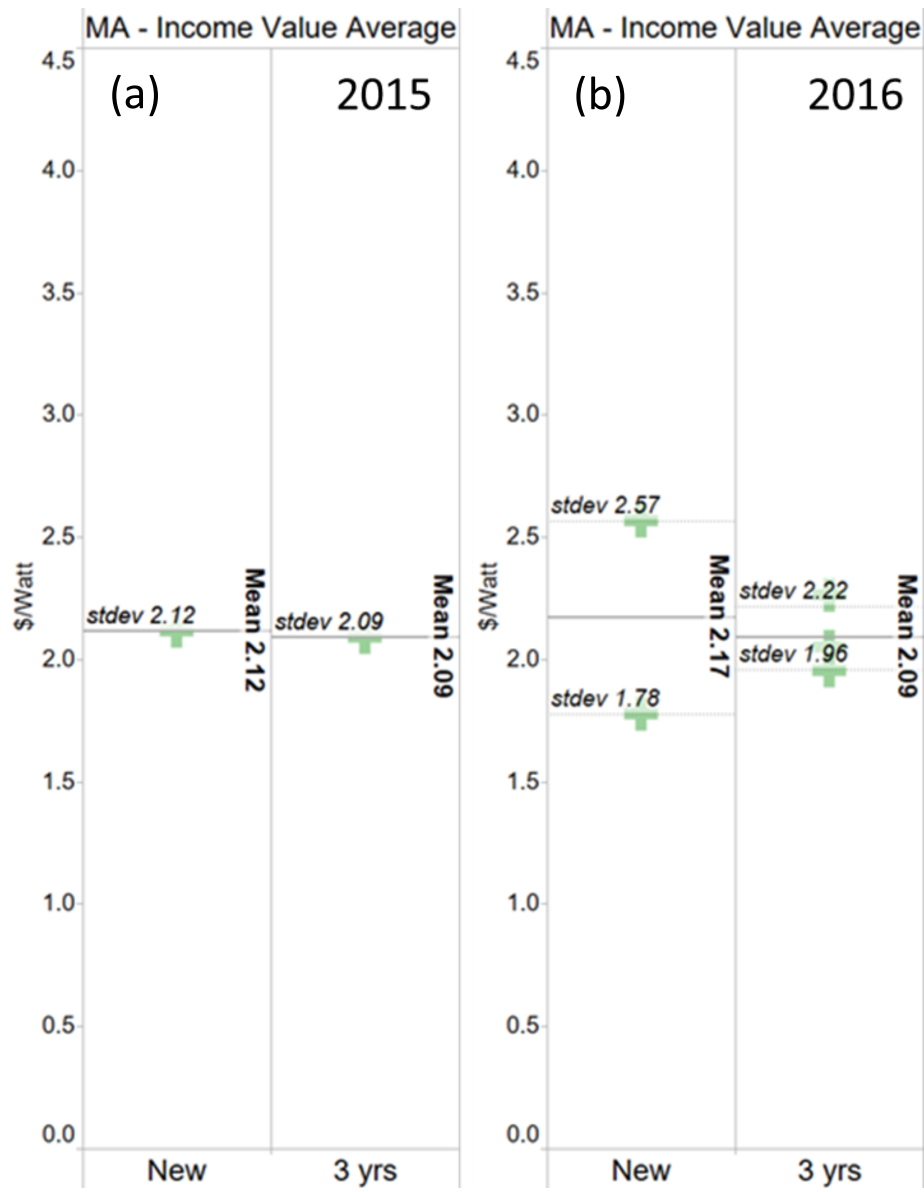

Figure 5 – Massachusetts market values using the average income value, showing the mean and one standard deviation from the mean for new, and 3-year old systems for a) 2015 appraisals and b) 2016 appraisals

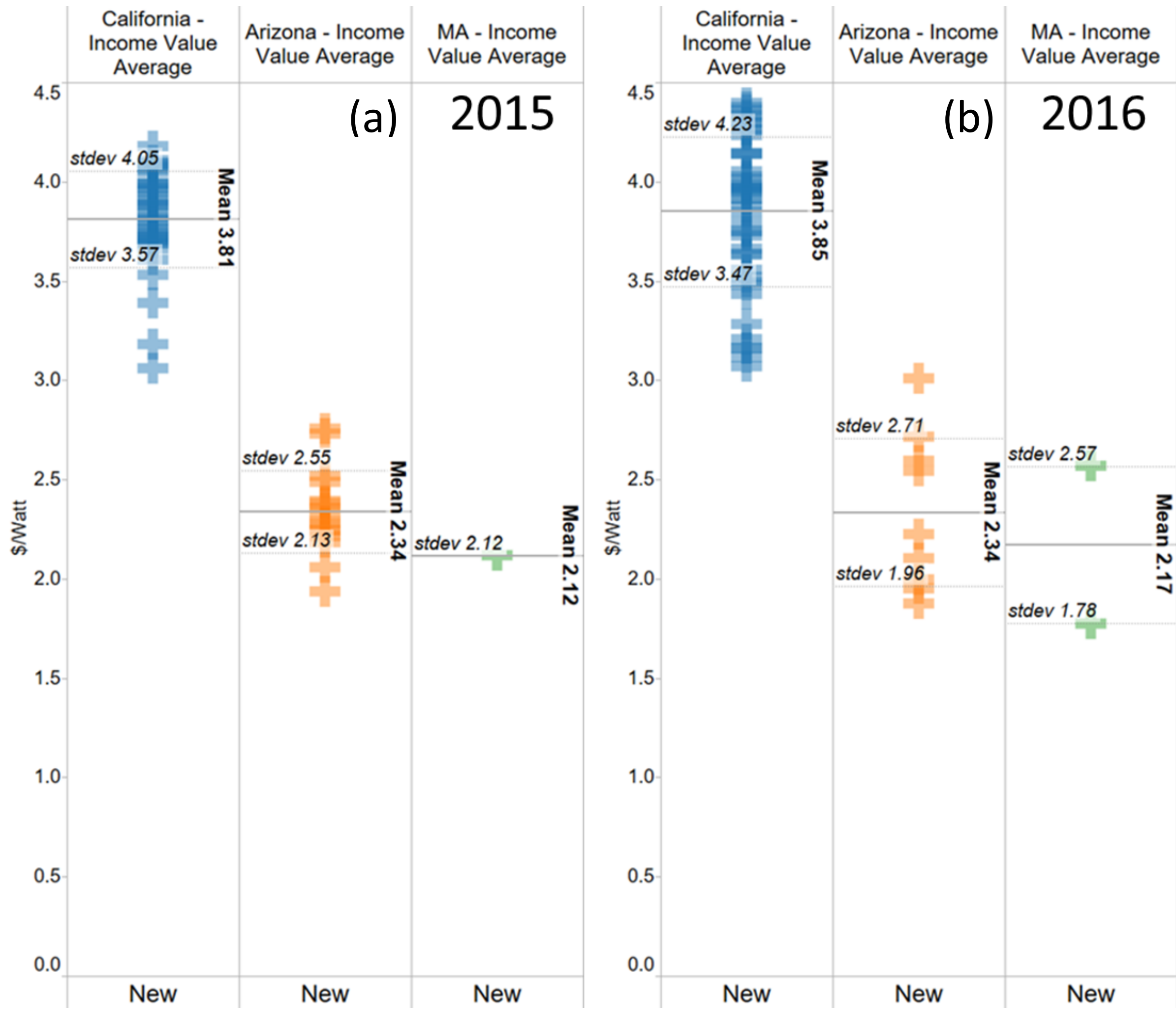

Figure 6 – All three states, showing the mean and one standard deviation from the mean for average income values of new systems that were a) appraised in 2015 and b) appraised in 2016

All Three States

The difference in the values between states is driven by many factors, including the discount rate at the time of transaction, available solar insolation and utility rate. The largest driver between the three states for new systems is primarily the utility rate. There is more solar insolation in Arizona, however values in Arizona for a new PV system that transacted in 2015 or 2016 are around 40% lower than California.

Considering the utility data used by appraisers, the average California utility rate in the 2015 and 2016 timeframe was $0.157/kWh. In Arizona, it was $ 0.113/kWh, and in Massachusetts it was $0.141/kWh. Massachusetts receives much less insolation, though has larger appraised PV systems (on average) than both California and Arizona (though a smaller sample size), and a utility rate being slightly less than California. The resulting values in Massachusetts are slightly lower than Arizona, which has a much larger amount of insolation, though lower utility rate and smaller median system size than Massachusetts.

Conclusions

This first-of-a-kind analysis provides additional evidence that solar adds value to a residential property during a real estate transaction. By comparing appraiser final values and income approach value ranges as calculated in the PV Value tool at the time of the appraisal, residential solar in California had the highest market values for different age systems when compared to other states where solar also transacted that same year.

In California, despite the older technology of a 12-year old system, it still retains approximately 50% of the value of a new system that transacted the same year.

Differences in market value between years where the same system is present can be attributed to inputs in the PV Value tool such as O&M costs, which are assumed to be higher for smaller systems and lower for larger systems, and the discount rate, which varies daily and impacts to a large degree the value of solar at the time of the real estate transaction.

Future research will allow analysis into the relationship between home price index and market value to present results in real, not nominal dollars. Local market trends can be extracted at the zip code and Metropolitan Statistical Area (MSA) unit level, and market value differences for different tilt and azimuth configurations can be explored.