Residential Solar Energy, Property Values and Real Estate

Ben Hoen
Vote Solar
Webinar
Feb 24, 2016

This work was supported by the Office of Energy Efficiency and Renewable Energy (Solar Energy Technologies Office) of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231
Agenda

- **Background**: Why Is This Important?
- **Previous Literature**: What Needs To Be Studied?
- **LBNL Research**: What Are The Multiple LBNL Efforts In This Area?
- **Other News**: What’s Next?
725,000 US Residential Installations Through Q2 2015

- Residential Total = 4.4 GW (~0.13% generation)
- 725,000 = < 1% of US Housing Stock

Source: SEIA/GTM Research
U.S. Solar Market Insight Q2 2015
In Some Locations 10-20% Of The Homes Have Solar

Example From Massachusetts

Installed PV systems as percent of total Owner-occupied household

- 0.0% - 1.1%
- 1.2% - 3.1%
- 3.2% - 6.9%
- 7.0% - 18.2%
- 18.3% - 32.6%

Source: Massachusetts Clean Energy Center Production Tracking System
In Some Locations 10-20% Of The Homes Have Solar

Example From San Diego

source data - https://www.californiasolarstatistics.ca.gov/data_downloads/
Agenda

• Background: Why Is This Important?
• Previous Literature: What Needs To Be Studied?
• LBNL Research: What Are The Multiple LBNL Efforts In This Area?
• Other News: What’s Next?
But What About The Value Of These Homes?
Host-Owned PV Systems Have Been Shown to Command a Price Premium in the Marketplace

Based on Large Scale Statistical Studies

Farhar & Coburn, 2008; Dastrup et al., 2011; Hoen et al., 2011; 2012

All Conducted in California

And Small Scale Appraiser Studies

Desmarais, 2013 (Colorado); Watkins, 2011 (Oregon)
Having Expanded Valuation Methods Accepted By Practitioners and Institutions Is Needed

Comparing PV to non-PV Homes

Income Approach using PV Value®:
Present value of stream of energy cost savings

Cost Approach:
Installed costs of PV systems at time of sale:
“Gross” or “Net” (less federal, state and utility incentives)

Residential Valuations Have Classically Relied On Sales Comparison
Institutional Support Exists Recognizing Solar’s Value And Encouraging Its Appraisal
Prior To 2015, There Were Still Significant Limitations To The Literature
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• **Previous Literature**: What Needs To Be Studied?
• **LBNL Research**: What Are The Multiple LBNL Efforts In This Area?
• **Other News**: What’s Next?
LBNL Conducted/Is Conducting Multiple Research Efforts To Fill Gaps

1. **Selling Into The Sun:** Price Premium Analysis of a Multi-State Dataset of Solar Homes
   *(2015; See Right)*

2. **Appraising Into The Sun:** Small Scale Analyses (SSAs) using Appraisal Techniques of Host Owned Systems in Six States *(2015)*

3. **Survey of San Diego Buyers/Sellers/Realtors** involved in TPO transactions *(2016)*

4. **Statistical & SSA TPO:** Statistical Analysis and Appraisals of Leased Systems in CA *(Ongoing)*

5. **PV Auto-Pop Roadmap:** Plan for implementing auto-population of solar system characteristics into real estate multiple listing services *(Ongoing)*
2015 Study Examined Largest Dataset Of Host-Owned PV Home Transactions Assembled To-Date

**Total 22,822 Homes**
- 3,951 PV
- 18,871 Non-PV

Spanning 12 years and 8 states

<table>
<thead>
<tr>
<th>Sale Year</th>
<th>Non-PV Homes</th>
<th>PV Homes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>107</td>
<td>18</td>
<td>125</td>
</tr>
<tr>
<td>2003</td>
<td>196</td>
<td>31</td>
<td>227</td>
</tr>
<tr>
<td>2004</td>
<td>238</td>
<td>53</td>
<td>291</td>
</tr>
<tr>
<td>2005</td>
<td>197</td>
<td>56</td>
<td>253</td>
</tr>
<tr>
<td>2006</td>
<td>348</td>
<td>64</td>
<td>412</td>
</tr>
<tr>
<td>2007</td>
<td>818</td>
<td>242</td>
<td>1,060</td>
</tr>
<tr>
<td>2008</td>
<td>1,251</td>
<td>453</td>
<td>1,704</td>
</tr>
<tr>
<td>2009</td>
<td>1,762</td>
<td>429</td>
<td>2,191</td>
</tr>
<tr>
<td>2010</td>
<td>2,751</td>
<td>504</td>
<td>3,255</td>
</tr>
<tr>
<td>2011</td>
<td>3,341</td>
<td>642</td>
<td>3,983</td>
</tr>
<tr>
<td>2012</td>
<td>3,928</td>
<td>694</td>
<td>4,622</td>
</tr>
<tr>
<td>2013</td>
<td>3,934</td>
<td>765</td>
<td>4,699</td>
</tr>
<tr>
<td>Total</td>
<td>18,871</td>
<td>3,951</td>
<td>22,822</td>
</tr>
</tbody>
</table>
What Did We Find?

Error bars represent 95% confidence intervals.
We Find Similar Relationships In California And In The Rest Of The US

<table>
<thead>
<tr>
<th>$ Per Watt (DC) Installed of PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>$8.00</td>
</tr>
<tr>
<td>$7.00</td>
</tr>
<tr>
<td>$6.00</td>
</tr>
<tr>
<td>$5.00</td>
</tr>
<tr>
<td>$4.00</td>
</tr>
<tr>
<td>$3.00</td>
</tr>
<tr>
<td>$2.00</td>
</tr>
<tr>
<td>$1.00</td>
</tr>
<tr>
<td>$0.00</td>
</tr>
</tbody>
</table>

Error bars represent 95% confidence intervals.

- PV Premium ($/watt)
- PV Value - Income ($/watt)
- Net Cost ($/watt)
- Gross Cost ($/watt)

<table>
<thead>
<tr>
<th>Category</th>
<th>PV Premium</th>
<th>PV Value - Income</th>
<th>Net Cost</th>
<th>Gross Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Homes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>California</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rest of US</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
There Is A Clear Decrease In Price For Older Systems

There is less clarity as systems age into their second decade
LBNL Conducted/Is Conducting Multiple Research Efforts To Fill Gaps

1. **Selling Into The Sun**: Price Premium Analysis of a Multi-State Dataset of Solar Homes
   *(2015; See Right)*

2. **Appraising Into The Sun**: Small Scale Analyses (SSAs) using Appraisal Techniques of Host Owned Systems in Six States *(2015)*

3. **Survey of San Diego Buyers/Sellers/Realtors** involved in TPO transactions *(2016)*

4. **Statistical & SSA TPO**: Statistical Analysis and Appraisals of Leased Systems in CA *(Ongoing)*

5. **PV Auto-Pop Roadmap**: Plan for implementing auto-population of solar system characteristics into real estate multiple listing services *(Ongoing)*
Appraisers Examined Dataset Of Host-Owned PV Home Transactions Across Multiple States

Study #2

- Completed late 2015
- Involved 7 appraisers
- Covered sales in 6 states
- Used sales analyzed in “Selling Into The Sun”
- Used a paired-sales technique
- Focused on Host-Owned Systems
Meet The Appraisers

Sarah S. Houston, Oregon CRA & Accredited Green Appraiser (AGA)
Sam Houston Appraisers

Jay Kimmel, SRA, Kimmel Appraisal Group
Kimmel Appraisal Group

Joel G. Tate, SRA, RAA
Tate & Company Inc.

Taylor Watkins
Watkins & Associates

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

John F. Szymanski
John F Szymanski, Appraisers

Sandy Adomatis
Adomatis Appraisal Services
Many Transactions Were Not Usable For Paired Sales Analysis

We Gave Appraisers 208 PV “Most Recent” Sales Across Their Markets

No Pair Could Be Found

Not in MLS  80%
Foreclosure  20%

Final Dataset: 43 PV Sales In 6 States
A Paired Sales Analysis Was Conducted On Each Transaction

![Image of a table with data on paired sales analysis](image-url)

**Six State Study of Solar PV Sales Price Premiums**

**Paired Sale #34 - 3222 NE 51st Ave.**

<table>
<thead>
<tr>
<th>Features</th>
<th>3222 NE 51st Ave. 97213</th>
<th>3215 NE 45th Ave. 97218</th>
<th>Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLS/Tax IS/Source</td>
<td>1234668</td>
<td>1235613</td>
<td></td>
</tr>
<tr>
<td>Date of Sale</td>
<td>7/7/2012</td>
<td>7/7/2012</td>
<td></td>
</tr>
<tr>
<td>Sale Price</td>
<td>$467,900</td>
<td>$481,000</td>
<td>$13,100</td>
</tr>
<tr>
<td>SQF of Living Area</td>
<td>3304</td>
<td>294</td>
<td></td>
</tr>
<tr>
<td>SP of Living Area</td>
<td>1416</td>
<td>1358</td>
<td>-58</td>
</tr>
<tr>
<td>Lot Size</td>
<td>5000</td>
<td>5000</td>
<td></td>
</tr>
<tr>
<td>Site/View</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>House Style</td>
<td>1 1/2 story</td>
<td>1 1/2 story</td>
<td></td>
</tr>
<tr>
<td>Number of Stories</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Actual Age - EST Age</td>
<td>87</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>Good</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Room Count - Total Bedroom-Bathroom</td>
<td>7/7/2</td>
<td>7/7/2</td>
<td></td>
</tr>
<tr>
<td>Basement Sq. Ft.</td>
<td>750</td>
<td>896</td>
<td></td>
</tr>
<tr>
<td>Finished Basement Sq. Ft.</td>
<td>750</td>
<td>910</td>
<td></td>
</tr>
<tr>
<td>Heat/Air Conditioning</td>
<td>FA/None</td>
<td>FA/None</td>
<td></td>
</tr>
<tr>
<td>Garage # Cars</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Amenity/porches/patio/pool</td>
<td>Por/None</td>
<td>Por/Pool</td>
<td></td>
</tr>
<tr>
<td>Solar PV-Size Age</td>
<td>2.94 kW</td>
<td>2.94 kW</td>
<td></td>
</tr>
<tr>
<td>Other-outBuildings</td>
<td>1FP</td>
<td>1FP</td>
<td></td>
</tr>
<tr>
<td>Adjusted Sales Price</td>
<td>$467,900</td>
<td>$481,000</td>
<td>$13,100</td>
</tr>
<tr>
<td>Indicated Price/Watt</td>
<td>$6900 or $2.35 per Watt</td>
<td>$6,900</td>
<td></td>
</tr>
<tr>
<td>Gross Cost/Watt</td>
<td>$5.46/Watt</td>
<td>$5.46/Watt</td>
<td></td>
</tr>
<tr>
<td>Net Cost/Watt</td>
<td>$1.83/Watt</td>
<td>$1.83/Watt</td>
<td></td>
</tr>
</tbody>
</table>

Reconcile: (Provide brief summary of paired analysis) These properties are extremely similar in design, build quality, size, condition, and location. Cost Approach: Solar PV System Cost = $5.46/Watt (Cost New as of the date of sale) $16,052

Source for cost: Neil Kelly/Mr. Sun Solar, Energy Trust of Oregon Incentives or rebates available as of that date if known: Source for cost: Solar Oregon and Energy Trust of Oregon Incentives or rebates available as of that date if known: 30% Federal (minus utility incentive (ETC incentive)) - $3,977 Oregon State ($1.90/ watt up to $6,000) $5,586 Energy Trust Incentive $0.95/watt = $2,793 Total Cost $5,371+/- (not all state credits taken before sale)
Premiums Are Clearly Evident Across All States

Note: Premiums apply to average 2012 sales. Sales today, and in other markets, would be based on their respective market characteristics.

correlation of premium (in $) to size (in watts): 0.54 (p-value 0.000)
Premiums Are Higher Than Income Estimates (Especially OR)

Income Could Be Considered Conservative

Premium to income correlation: All cases 0.20 (p 0.18); No OR 0.38 (p 0.03)

$t$-Test: All cases 1.23 (p 0.00); No OR 0.82 (p 0.00)
Premiums Are Most Similar To Net Cost Estimates (But Not OR)
And Not Similar To Gross Cost

Premium & Net t-Test: All cases 0.65 (p 0.05); No OR 0.09 (p 0.75)
Premium & Gross t-Test: All cases -1.72 (p 0.00); No OR 1.98 (p 0.00)
Average Days On The Market Are Not Different For These PV Homes

In Some States PV Homes Sell Slower, In Others Faster

![Bar chart showing average days on the market for PV and Non-PV homes in various states and all cases.]

$t$-Test: All cases -3.72 days (p 0.76)
Comparison Of Methods
Hedonic Pricing Model Vs. Paired Sales

- Overlapping datasets but different methodologies
- Similar approaches: premiums vs income/cost
Both Studies Tell A Similar Story: Premiums Are Clearly Evident

And Premiums Are Most Similar to Net Cost, Somewhat Similar To Income, And Not To Gross Cost

Note: Results do not include Oregon
Analysis Conclusions – Host Owned

- PV consistently adds value, regardless of approach and sub-sample.
- PV’s value should be considered in transactions.
- PV systems buyers can have greater confidence that systems should retain value well into the first decade.
- But actual values will depend on individual markets, retail rates, installed costs, incentives, etc.
- Practitioners have multiple approaches and tools to value solar.
- Net Cost Estimates should be used if divergent from Gross Costs.
- Institutional changes are happening but much more needs to happen:
  - PV system characteristics in MLS.
  - Leased systems should be statistically studied.
  - Commercial valuation of Solar should be investigated.
Outreach
LBNL Conducted/Is Conducting Multiple Research Efforts To Fill Gaps

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Why TPO Systems?

Source: SEIA/GTM Research U.S. Solar Market Insight 2014
Homes With TPO Systems Have Been In The News

**npr**
Leased Solar Panels Can Cast A Shadow Over A Home's Value
*Jul 15, 2014*

**Bloomberg Business**
Rooftop Solar Leases Scaring Buyers When Homeowners Sell
*Jun 24, 2014*

**Los Angeles Times**
Leased solar panels can complicate - or kill - a home sale
*Mar 22, 2015*
Survey Of Buyers, Sellers and Realtors of Homes With TPO Systems

Sales from 2010 through 2013
44 Responses In Total

<table>
<thead>
<tr>
<th>Audience</th>
<th>Instrument</th>
<th>Invites/calls received</th>
<th>Total Responses</th>
<th>Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Realtors</td>
<td>Semi-structured phone interview</td>
<td>49</td>
<td>15</td>
<td>31%</td>
</tr>
<tr>
<td>Sellers</td>
<td>Online survey; email invite</td>
<td>77</td>
<td>11</td>
<td>14%</td>
</tr>
<tr>
<td>Buyers</td>
<td>Online survey; mail invite</td>
<td>113</td>
<td>18</td>
<td>16%</td>
</tr>
</tbody>
</table>

In collaboration with Center for Sustainable Energy
Mixed Reactions To TPO Systems

- 77% leases transferred, 23% bought out
Other News: What’s Next?

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Statistical and Small Scale Analysis of TPO Transactions

- Analyze a ~500 transactions of homes with TPO PV systems in CA
- Appraiser led analysis of small sample of TPO transactions
- Analysis of lease/PPAs involved in TPO transactions
PV Auto-Pop Roadmap Project: Plan For How To Auto-Pop PV Data (Like Tax Data)

- MLS Listing is started
- Address is entered
- Address is automatically matched to PV Database
  - Does address match PV System Database?
    - No
    - Listing agent is prompted with PV system fields to manually fill
    - Yes
  - Does listing agent want PV fields to auto-populate?
    - No
    - Listing agent continues with listing
    - Yes
    - PV System fields are auto-populated
    - Listing agent edits fields as desired
Thank You

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Links
Selling Into The Sun
Appraising Into The Sun
TPO Buyer/Seller/Realtor Survey
LBNL Renewable Energy Publications
PV Value®
References


