Lawrence Berkeley National Laboratory

Member of the National Laboratory System supported by the U.S. Department of Energy through its Office of Science.
Located in Berkeley, California
Founded in 1931 by Ernest Orlando Lawrence
Annual Budget of $811 Million
4,200 Employees and 800 University Students
11 Nobel Laureates
24 Divisions and Departments

“To achieve our energy and climate goals, we need a strong and sustained commitment to research and development. These investments are needed for our country’s future economic prosperity, energy security, and environmental sustainability”

Steven Chu, Secretary of Energy, January 21, 2010
Do Photovoltaic Energy Systems Increase Home Values?

- Residential PV Market Summary
- There Are Still Significant Market Barriers
- Previous Literature On Impacts To Home Values
- LBNL Research Findings
- Where Do Stakeholders Go From Here?
- Questions?
What is a Watt?

- A Watt is a unit of electrical energy (or “power”).
- PV systems are rated based on the amount of Watts they can produce under perfect conditions.
- The higher the Watt rating, the more energy a PV system will produce.
- PV systems are priced in dollars per Watt or $/Watt.
Average Gross Installed Costs For Residential PV Have Declined Through 2010

Source: Lawrence Berkeley National Laboratory (2011) Tracking the Sun III
Average **Net Installed Costs** Have Remained Fairly Flat Through 2008 Near $5/Watt Yet Declined Sharply Thru 2010 To Near $4/Watt

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**Net Installed Cost** = Average cost of installing PV, after deducting available state/federal incentives

*Source: Lawrence Berkeley National Laboratory (2011) Tracking the Sun III*
Solar PV Installations Have Been Increasing Dramatically In The US, Including Residential

Through 2011 There Are 150,000 Residential Installations. Mostly In California, Yet Other States Are Growing

Cumulative Residential PV Installations as of 2011 Q1

- California: 90,790 (60%)
- Arizona: 9,983 (7%)
- New Jersey: 9,468 (6%)
- Colorado: 7,479 (5%)
- New York: 5,029 (3%)
- Hawaii: 4,902 (3%)
- All Other States: 23,104 (15%)

Total = 150,755

Source: Solar Energy Industries Association
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Barriers To PV Adoption Are Multi-Faceted

- Lack of government policy
- Lack of consumer awareness
- **High cost of solar**
- Difficulty overcoming established energy systems
- Inadequate financing options
- Failure to account for all costs and benefits of energy choices
- Inadequate workforce skills and training
- Lack of adequate codes, standards, and interconnection and net-metering guidelines
- Poor perception by public of renewable energy system aesthetics
- Lack of stakeholder/community participation in energy choices

*Source: National Renewable Energy Lab, 2006*
There Is A Perception That PV Systems Are Expensive

Survey of residents of Santa Clara County, CA

- Santa Clara has 15 MW of PV installed (~3,000 systems), and therefore a high likelihood of PV familiarity
- 82% perceived PV as “expensive”
- 11% perceived PV as “affordable”

Source: www.SolarTech.org
Homeowners/Builders May Be Hesitant To Invest Given Uncertain Resale Values

Is green good for home resale value?

By Kenneth R. Harney, Published: August 26

Home energy efficiency and sustainability have been major policy priorities for the Obama administration, but lurking in the background are two pesky questions: Beyond the documentable savings on utilities bills, do such steps add to the resale value of a home? And do they make it easier to sell your property?

Housing groups and housing officials say definitive data covering multiple regions of the country are scarce. But some localized research projects in Oregon...
Although Change is Proposed, Appraisers Have Been Slow To Account For Energy Features In Their Residential Valuations

The New York Times

August 25, 2011

Strange Bedfellows Back Bill Using Mortgages to Spur Energy Retrofits

By JASON PLAUTZ of

A Senate bill that would allow energy-saving retrofits to be factors in mortgage underwriting has quickly attracted a diverse set of enthusiastic supporters that range from the conservative U.S. Chamber of Commerce to the liberal Center for American Progress.

The "Sensible Accounting to Value Energy Act," or SAVE Act, which is expected to be introduced this fall by Sen. Michael Bennet (D-Colo.), would require federal loan agencies to include projected energy costs when financing a house, essentially offering better mortgage values on properties that are more energy efficient.
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Nevin & Watson (1998)
"Evidence of Rational Market Values for Home Energy Efficiency"

Evidence of Rational Market Valuations for Home Energy Efficiency

According to this study, residential real estate markets assign to energy-efficient homes an incremental value that reflects the discounted value of annual fuel savings. The capitalization rate used by homeowners was expected to be 4%-10%, reflecting the range of after-tax mortgage interest rates during the 1990s and resulting in an incremental home value of $10 to around $25 for every $1 reduction in annual fuel bills. Regression analysis of American Housing Survey data confirms this hypothesis for national and metropolitan area samples, attached and detached housing, and detached housing subsamples using a specific fuel type as the main heating fuel.

Investments in high-efficiency heating and air conditioning equipment, insulation, and other energy-efficient home features have historically been justified and promoted based on the present value of fuel cost savings. More recently, the U.S. Environmental Protection Agency initiated a marketing program called "Energy Star Homes." This effort teaches that energy efficient homes produce immediate positive cash flow for home buyers because the reduction in monthly fuel bills more than offsets the higher mortgage payment needed to finance such investments. Some home buyers, however, still hesitate to invest in energy efficiency because they are uncertain that they would stay in their homes long enough to recover their investment through lower fuel bills and that they could recover an investment in energy efficiency when they sell their homes. Standard underwriting criteria for home mortgages can also increase the down payment requirements or mortgage insurance premiums for energy efficient homes.

- Multiple models with sample sizes ranging from 600 to 46,000 across various parts of the country
- Concluded 20:1 reasonable average for sales price to energy savings ratio given a 5% after tax mortgage rate
- This implies for every $1 saved via energy efficiency the home’s value is increased by $20
Farhar and Coburn (2008)  
“A New Market Paradigm for Zero-Energy Homes: A Comparative Case Study”
Dastrop, Ziven, Costa & Kahn (2010)  
“Understanding the Solar Home Price Premium"

- Investigated 279 PV homes that sold in Greater San Diego
- Found significant difference between PV and non-PV sales prices
- Premiums of approximately 3.5% for PV homes found
- Equates to approximately $4.40 per installed watt (DC)
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Hoen, Wiser, Cappers & Thayer (2011)
“An Analysis of the Effects of Residential Photovoltaic Energy Systems on Home Sales Prices in California"

- Build on available literature
- Investigate selling prices of homes with PV relative to comparable non-PV homes
- Concentrate on California PV but across multiple counties
- Use a variety of different tests to determine premiums
PV Sales Data Are Well Arrayed Across California, Among Home Types, Utility Service Areas, And Years

72,319 homes: 70,425 non-PV; 1,894 PV

- 31 Counties
- 4 Different Utility Service Areas: PG&E, SCE, SDG&E, SMUD
- 11 Years: 1999-2009
- 50% New Homes
- 50% Existing Homes
Estimated $/Watt (DC, STC) Premiums For The Full Sample Are Between $3.9 and $6.4
Buyers And Sellers Might Be Using Net Installed Costs As A Price Signal

Mean Net Installed Costs For Residential PV Systems in CA (2001 - 2009)

<table>
<thead>
<tr>
<th></th>
<th>Base Models</th>
<th>Subdivision Robustness Models</th>
<th>Matched Robustness Models</th>
<th>PV Only Robustness Model</th>
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</thead>
<tbody>
<tr>
<td>Fixed Effect</td>
<td>$5.5</td>
<td>$5.4</td>
<td>$3.9</td>
<td>$5.8</td>
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<tr>
<td>Hedonic Model</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Continuous Effect</td>
<td>$5.8</td>
<td>$5.6</td>
<td>$4.8</td>
<td>$6.4</td>
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<tr>
<td>Hedonic Model</td>
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</tbody>
</table>

Estimated Sale Price Premium For Average California PV Home (in $/Watt DC)
Large Differences In Premiums Were Found Between New and Existing Homes

<table>
<thead>
<tr>
<th>Estimated Sale Price Premium For All, New &amp; Existing California PV Homes (in $/Watt DC)</th>
<th>Base Hedonic Models</th>
<th>Subdivision Robustness Hedonic Models</th>
<th>Matched Robustness Hedonic Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Homes</td>
<td>$2.3</td>
<td>$2.6</td>
<td>$2.6</td>
</tr>
<tr>
<td>Existing Homes</td>
<td>$7.7</td>
<td>$6.5</td>
<td>$6.4</td>
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</table>
Differences **Might** Be Partly Explained By Disparity In Net Installed Costs

Estimated Sale Price Premium For All, New & Existing California PV Homes (in $/Watt DC)

<table>
<thead>
<tr>
<th>Model Type</th>
<th>Mean Net Installed Costs For Residential PV Systems in CA (2007 - 2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Homes</td>
<td>$7.7</td>
</tr>
<tr>
<td>Existing Homes</td>
<td>$6.5</td>
</tr>
<tr>
<td>Base Hedonic Models</td>
<td>$2.3</td>
</tr>
<tr>
<td>Subdivision Robustness Hedonic Models</td>
<td>$2.6</td>
</tr>
<tr>
<td>Matched Robustness Hedonic Models</td>
<td>$2.6</td>
</tr>
</tbody>
</table>

Base Hedonic Models

Subdivision Robustness Hedonic Models

Matched Robustness Hedonic Models
## Disparities Might Be Explained By Other Factors Besides Net Installed Cost

<table>
<thead>
<tr>
<th>New Homes</th>
<th>Existing Homes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased sales velocity?</td>
<td>Highest price?</td>
</tr>
<tr>
<td>Sales agent less familiarity with PV?</td>
<td>Homeowner more familiarity with PV?</td>
</tr>
<tr>
<td>Group PV with other features?</td>
<td>Differentiate PV from other features?</td>
</tr>
<tr>
<td>Less expensive homes = less discretionary income?</td>
<td>More expensive homes = more discretionary income?</td>
</tr>
</tbody>
</table>
LBNL Report Conclusions

- CA PV homes sold for more than non-PV homes
- Average premiums were ~$5.5 per Watt
- Existing home premiums were even higher, and new home premiums were lower
- New vs. existing premiums may be partly explained by net installed costs, but also related to varying buyer/seller motivations (e.g., sales velocity)
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Residential Solar Leasing Allows Consumers To Pay Very Little Yet Have A PV System On Their Home

Residential Solar Leasing

JOIN THE ROOFTOP REVOLUTION

A Sungevity solar plan can set your home free from rising electricity costs.

- Put $0 down
- Get free installation
- Many customers save from day one

Request your free iQuote today—get it tomorrow.
Enter your home address. Get an iQuote the very next day by email.

CT Solar Lease

What’s CT Solar Lease?
Eligible Solar PV Systems
Find an Eligible Installer
Apply Now Online
Apply By Phone

Connecticut’s Special Solar Energy Leasing Plan for Homeowners

Program Highlights

Affordable Solar Energy Systems for Qualifying Connecticut Homeowners

$0.00 Down Payment, Low Fixed Monthly Payments

August 16, 2011

IMPORTANT NOTICE: AFC First will no longer be accepting new CT Solar
For Homeowners Who Want to Own A PV System
Low-Interest Loan Options Are Often Available

Database of State Incentives for Renewable Energy

www.dsireusa.org
For California Homeowners Who Own A PV System Or Are Considering It, A Valuation Tool Is Available

http://www.gosolarcalifornia.org/tools/save.php
A National PV Valuation Tool Will Be Available Soon

Appraisal Institute Has A Variety Of Courses On How To Analyze The Value of “Going Green”

www.appraisalinstitute.org
Therefore Finding A Local Appraiser With Experience In Valuing Green Building and Energy Efficiency Features Is Easier

www.appraisalinstitute.org
Conclusions

• PV Costs are coming down
• Installations are increasing but there are still barriers
• Perceived price and ROI are important
• New data suggests PV home selling price premiums near net installed costs
• Options are emerging to pay $0 down, and finance at a low interest rate.
• New tools are available to estimate selling price based on energy savings
• Growing number of appraisers with experience are available
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Link to report, 2-page summary, and presentation
http://eetd.lbl.gov/ea/emp/re-pubs.html
Citations


