

Resources for Valuation Professionals

Information to better understand solar PV appraisal methods, marketplace data to support valuation activities, and inputs for the PV Value® tool

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Fannie Mae Selling Guide – The most recent [selling guide](#) by Fannie Mae was released on December 16, 2014. [Section B2-3-04](#), “Special Property Eligibility Considerations” now has guidance on eligibility for properties with solar PV that are either owned or lease by the homeowner.

Appraisal Institute Resources – These resources are available from the Appraisal Institute and include classroom education, webinars, forms and reference material for training appraisers on how to both recognize the unique aspects of solar PV, and explain methods that can be used by appraisers to develop the value of the PV system.

- [Residential & Commercial Valuation of Solar](#) course – Webpage that shows upcoming courses taught by appraisal professionals. These courses are open to non-appraisers.
- [Case Studies in Appraising Green Commercial Buildings](#) course – Webpage that shows upcoming courses taught by appraisal professionals. These courses are open to non-appraisers.
- [Green Addendum](#) – This pdf file has the same fields used in the PV Value® tool. A [webinar](#) is available from the Appraisal Institute on how to use the Addendum.
- [Valuation of Solar Photovoltaic Systems](#) webinar – This archived webinar is available from the Appraisal Institute.
- [Residential Solar Photovoltaic Leases: Market Value Dilemma](#) – This archived webinar is available from the Appraisal Institute
- [Residential Green Valuation Tools](#) book – This book has many case studies and examples on how to use solar PV valuation tools, including PV Value®

PV Value® Tool – [PV Value®](#) was created by Energy Sense Finance to utilize income, cost and sales comparison approaches to develop the market and fair market value of a solar PV system. The application is web-based and can be used on desktop and mobile computing devices. The tool is currently in a beta version, and can be accessed after creating a user account. New features will be added to allow for the use of the cost and sales comparison approaches. The tool currently utilizes and income approach that can be used to develop the value. The proof-of-concept spreadsheet version that served as a precursor to this web tool was jointly developed by Sandia National Laboratories and Energy Sense Finance. The section below describes that collaborative effort in more detail.

Sandia National Laboratories Resources – The information shown here is available on the [Sandia Labs PV Value® site](#) , 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.

- [PV Value® User Manual](#) – This was the original user manual for the proof-of-concept spreadsheet version. Information is provided on the rationale behind each parameter. It is no longer being updated as the spreadsheet has been depreciated.
- Valuation of Solar PV Systems Using a Discounted Cash Flow Approach – 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 solar PV systems. Click [here](#) to access the Sandia webpage, then scroll down to the Publications and White Papers section to download the document.
- [Market Valuation Perspectives for Photovoltaic Systems](#) paper – This paper presents results of a survey of PV Value® proof-of-concept spreadsheet users to better understand how they were using the tool in the marketplace.
- [How PV System Ownership Can Impact the Market Value of Residential Homes](#) paper – This paper looks at three primary ownership options (customer, third-party, PACE) and discusses the appraisal perspective.
- [Standardizing Appraisals for PV Installations](#) conference paper – This paper was presented at the 39th IEEE PVSC conference in Tampa, Florida on June 21, 2013 and discusses the importance of using proper valuation techniques to capture the value of solar PV systems.
- [Interstate Renewable Energy Council webinar](#) – 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.

Lawrence Berkeley National Laboratory Resources – Lawrence Berkeley National Laboratory (LBNL) has been conducting research on the premium received by residential homeowners when a PV system is sold as part of a real estate transaction. This research originally covered California systems, and has expanded into other states. The research to date only covers PV systems owned by the homeowner and not third-party owned PV systems.

- [An Analysis of the Effects of Residential Photovoltaic Energy Systems on Home Sales Prices in California](#) paper – This was the first research paper that took a statistical look at a large dataset of homes that sold with and without solar PV to develop an understanding of the sales price premium.

- [Residential Photovoltaic Energy Systems in California; The effect on Home Sales Prices](#) journal article – This article was published in Contemporary Economic Policy.
- [Exploring California PV Home Premiums](#) paper – This paper included a more comprehensive look at the dataset in the two papers shown above, and used PV Value® for developing income approach estimates to compare with the hedonic modeling results.

Appraiser-Focused PV Valuation Studies – To date, there are only two publically available studies, though there may be more in the future.

- [Denver, Colorado Metro Area PV Market Value](#) study – This study was paid for by the Colorado Energy Office in 2013 to see what market value impacts PV has in the northwest Denver metro area. It was conducted by an appraiser and uses PV Value® for the income approach.
- [Market-Based Investigation of Residential Solar Installation Values in Oregon](#) study – This study was prepared for the EnergyTrust of Oregon and uses a sales comparison approach to “isolate” the market value of PV systems.

Permanent Documentation – In some jurisdictions, permanent documentation is required for safety purposes, to let a utility worker or emergency response personnel aware there is a photovoltaic 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 –
<https://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 - <http://www.nrel.gov/docs/fy10osti/46078.pdf>

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

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

- Anaheim, CA - <http://anaheim.solarmap.org/>
- Arizona Solar Map - <http://arizonagoessolar.org/SolarMap.aspx>
- Berkeley, CA - <http://www.cityofberkeley.info/solarmap/>
- Boston, MA - <https://www.mapdwell.com/en/boston>
- Cambridge, MA - <https://www.mapdwell.com/en/cambridge>

- Denver, CO - <http://solarmap.drcog.org/>
- Los Angeles, CA - <http://solarmap.lacounty.gov/>
- Madison, WI - <http://solarmap.cityofmadison.com/madisun/>
- Milwaukee, WI - <http://milwaukee.gov/milwaukeeeshines/Map.htm>
- New Jersey - <http://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 - <http://www.portlandoregon.gov/bps/article/446449>
- Riverside, CA - <http://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/>
- Silicon Valley Energy Map, CA - <http://www.sanjoseca.gov/index.aspx?NID=1504>
- Seattle Puget Sound Area - <http://solarizewa.org/our-progress>
- Tallahassee, FL - <http://www.talgov.com/you/you-learn-utilities-electric-solar-map.aspx>
- Vermont Energy Atlas - <http://www.vtenergyatlas-info.com/solar> and www.vtenergyatlas.com
- Washington County, OR - <https://www.mapdwell.com/en/energytrust>
- Washington DC - <https://www.mapdwell.com/en/dc>
- Wellfleet, MA - <https://www.mapdwell.com/en/wellfleet>

Solar PV Installation Databases – The information presented here comprises of databases collected by many public and private entities. Some are driven by incentives offered, where PV system data is collected as part of the incentive application. Others have some 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 from each site, with some providing general installation detail, and others providing performance information.

- [Open PV](#) – The National Renewable Energy Laboratory has a database of installed PV systems by zip code. Many of these PV systems are 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](#) – This site collects and displays solar PV information across the world. A solar 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.
- [California Solar Statistics](#) – This site has all of the California Solar Initiative (CSI) and California Public Utilities Commission (CPUC) 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 [here](#).
- [NYSERDA PV Incentive Program](#) – 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 this data.

- [Massachusetts Clean Energy Center](#) – Their incentive program data includes 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](#) – This map shows the status of large-scale solar PV systems across the U.S. that are operating, under construction and under development.
- [Campus Solar Photovoltaic Installations Database](#) – This site provides location and detail on solar PV systems installed on college and high school campuses across the U.S. Information provided includes cost, size, production estimates, installation type, and module and inverter manufacturer.
- [Enphase](#) – This company develops inverters and maintains a public-facing website of solar PV installations utilizing their 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](#) – This company develops inverters. Their public-facing website of solar 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](#) – This company develops inverters. Their public-facing website of solar 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 cities and states across the U.S. These studies are different than the system-specific costs associated with rebates as shown in the links for California, Massachusetts, and New York incentive programs and the OpenEI database.

- [LBNL Tracking the Sun](#) – This report series looks at the installed *price* (paid to developers or installers before incentives) of photovoltaics starting in 1998. The report is published annually and is in its 7th year with data available up to 2013. Prior versions of this report can be found by searching the Energy Markets and Policy Group [publications](#) website.
- [SEIA / GTM Solar Market Insight](#) – This report series is done quarterly to break out costs by market and location. Summary data is available for free. More specific information by state and market is available to purchase.

- [The Interstate Renewable Energy Council \(IREC\)](#) prepares an annual [U.S. Solar Market Trends](#) report that outlines different market forces shaping the adoption of PV in states across the U.S. PV pricing is included in these reports, and archived reports back to 2008 can also 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 solar PV as well as changes where new incentives are being brought in, or old incentives are being phased out. Where solar is more widespread, incentives are slowly disappearing. However in new markets, solar incentives are relatively new and are intended to grow that market.

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

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

- EnergySage – [Selecting Solar Panels](#) – This site places a classification on many of the major manufacturers of solar modules, starting with Premium, then Standard, down to Economy. More detail from EnergySage is available on the parameters published on the modules and [how to evaluate](#) those from a quality and durability perspective.
- Fraunhofer [PV Durability Initiative](#) – This testing group founded in Germany, recently released a paper on scoring for five different solar manufacturers from accelerated life testing and long-term field exposure data.