VALUATION METHODS FOR BUILDING-MOUNTED SOLAR PHOTOVOLTAIC SYSTEMS

Expert Analysis

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INTRODUCTION

The explosion of solar photovoltaic (PV) installations in commercial and residential buildings has created the need for a widely accepted process to determine the value premium they create to their host real estate. Studies show that investments that save energy improve property value, but knowing that there is positive value does not solve the appraiser’s dilemma: What is it worth?

Buyers and sellers use a variety of quantitative methods to answer the value question. This brief relies on field experience and research about the relationship between energy investments such as solar PV installations and property values published over previous decades. It reviews different methods used by appraisers today. While each approach has advantages and limitations, some appraisal methodology trends have appeared recently that may help standardize an industry-wide approach.

U.S. appraisers use several approaches to reflect the actions of market participants when considering the value of a solar PV system installed on a building. The valuation process is not driven by guidelines or regulations as much as by the goal of reflecting the actions of buyers and sellers of assets. The basic approaches are:

- The income approach including net present value calculations
- The cost approach
- Sales comparison and market greenness.

An overview of each approach is given in this paper, along with a discussion of the advantages and disadvantages of each, and the author’s recommendations for how the appraisal industry should value PV systems.

An income approach estimates the income the PV system will produce in the future in terms of avoided energy costs. Income can be calculated using discounted net present value assumptions regarding the solar investment, a net annual cost savings multiplier, or the direct capitalization of net cost savings.

The cost approach recognizes the value to the property based on the up-front cost of the PV system at purchase. For a new system, the up-front cost of the system may provide a very accurate value, and the up-front system cost will always be an upper limit of the value of a system.

PV Systems Have Value:

Buyers and sellers do indeed value saving money on energy, and this has consistently been shown to translate into market value. In the U.S., available data shows increased value for energy efficient buildings compared to standard buildings. That conclusion is based on ever more robust data covering 1.5 billion square feet of LEED-certified space and 2.5 billion square feet of ENERGY STAR-certified space. In comparison with conventional buildings, studies in the U.S. have found that certified buildings have rental rates higher by 2 to 17 percent and resale value improved by 5.8 to 35 percent. Additional support for the relationship between energy savings and market value appears in an Appraisal Journal article from 1999 that relies on results from the annual Cost vs. Value study published by Hanley Wood Remodeling Magazine. The annual Cost vs. Value Survey now covers 35 popular remodeling projects in nine regions and 80 cities. These statistically robust studies unquestionably refute the null hypothesis: that energy savings investments in real estate have no market value.
The sales comparison and market greenness approach uses estimates of the value of the PV system to the building based on resale comparisons to nearby and similar properties with PV systems.

THE ROLE OF THE APPRAISER

Appraisals should mimic the actions of buyers and sellers in the market. Appraisals used to support bank loans must comply with the Competency Rule of the Uniform Standards of Professional Appraisal Practice (USPAP) and the Federal Interagency “market value” definition.5

Market value is the most probable price 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 is the consummation of a sale as of a specified date and the passing of title from seller to buyer under conditions whereby:

1. Buyer and seller are typically motivated.

2. **Both parties are well informed or well advised** and are acting in what they consider their own best interests.

3. A reasonable time is allowed for exposure in the open market.

4. Payment is made in cash in U.S. dollars or in terms of financial arrangements comparable thereto.

5. 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.

An appraiser who lacks the competency to value the energy features of a property may obtain it from a third-party source in order to complete the assignment. The large amount of research in market value of solar PV and energy cost saving upgrades will allow an appraiser to become competent. “Don’t know = zero value” is not an option for the appraiser as they must presume that the buyers and sellers are well informed and/or well advised in accord with the market value definition.

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The following provides a brief overview of several methods that have been or could be used to appraise solar PV systems, along with an overview of their strengths and weaknesses.

**INCOME APPROACH**

The income approach to PV system valuation is based on estimating the income the PV system will produce for the system owner in the future in terms of avoided energy costs. There are three ways of estimating future income:

**Net Present Value via Discounted Cash Flow**

A discounted cash flow (DCF) can be complex and may be beyond the expertise of some real estate buyers and sellers, but this approach is suited for the numerous cash flow events in solar PV operations. Energy cost and growth rate, PV panel annual output, annual degradation, inverter replacement cost, maintenance expenses and other influences can be individually controlled. Some inputs are a challenge to define precisely, but a DCF can easily check value sensitivity by stressing different assumptions and building a value range based on best, most likely and worst cases.

The proper discount rate depends on instinct and opinion around the overall system reliability risk. While output depends on some highly reliable components (the sun comes up every day, fuel cost is zero, there are no moving parts, the useful life of long-lived components with warranties is well documented) it also depends on some less reliable variables (energy costs and energy cost escalation rate, downtime from equipment failure, future inverter replacement expense, solar renewable energy credits, annual weather variations and changing technologies). Ultimately, a mid-level discount rate in the range of the prevailing market-driven real estate capitalization rate is probably reasonable for the cash flow risk. This risk level assumes the existence of a robust energy output measurement system that can quickly identify subpar performance to trigger a repair and restore performance quickly.

Every owner, buyer and seller might not have the comfort level to build and run a DCF, but in such cases, engaging outside expertise is an option. With new and complex systems like solar PV installations, obtaining expert advice is prudent, normal and permitted by regulation as a proxy for direct decisions by the buyers, sellers and owners.

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**‘PV Value’: A New and Promising Valuation Tool**

Additional confirmation supporting DCF as the best valuation standard comes from Sandia National Laboratories. A research team there has released a Microsoft Excel-based DCF appraisal tool called PV Value® that automates many of the inputs and calculations of the net present value analysis. PV Value has automated links to the National Renewable Energy Laboratory’s PVWatts simulator to estimate the solar array output. It also determines local energy pricing, which is then used to find the annual energy savings and provide the solar PV market value estimate.

The current version 1.0 of PV Value has been supported by the Appraisal Institute. The software intends to link with the Appraisal Institute’s Residential Green and Energy Efficient Addendum form for use with home appraisal reports.
Table 1: Overview of Discounted Cash Flow

<table>
<thead>
<tr>
<th>Description</th>
<th>Best for whom?</th>
<th>Advantages</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net present value of all cash flow including energy savings, inverter</td>
<td>Most accurate for all owners including residential, commercial, third-party</td>
<td>Accurate for numerous cash flow events in PV system life</td>
<td>Owners and appraisers may need expert advice to do this (Sandia’s ‘PV</td>
</tr>
<tr>
<td>replacement cost, and system maintenance</td>
<td>system owners</td>
<td>Can provide a value range based on sensitivity assumptions</td>
<td>Value’ tool may help)</td>
</tr>
</tbody>
</table>

**Net Annual Cost Savings Multiplier**

The Net Annual Cost Savings Multiplier method appeared in the prestigious *Appraisal Journal* of 1998 and is a widely quoted method for valuing solar PV.\(^8\) It approaches the general topic of energy saving upgrades by applying the monetary energy savings as a mortgage expense offset. Using expenditures on heating fuel and value research, the logic has been extended to include money-saving solar PV, presuming that homeowners’ energy consumption habits don’t change going forward. This logic has been supported with nearly identical results in a recent landmark study at Lawrence Berkeley Nation Laboratories that focused on the impact of solar PV on home values.\(^9\)

In the 1998 analysis, savings versus market value calculations were kept simple by applying a multiplier based on the home mortgage rate to the annual energy cost savings. The central tendency multiplier was equivalent to the inverse of a typical prevailing home mortgage loan rate. When using a 5 percent mortgage loan rate, this produced a multiplier of approximately $20 in value for every $1 in energy saved. This “20 times rule” has been a quick way to estimate a solar system’s market value and is often quoted by solar PV installers. While not perfect, this approach has the advantage of speed, a simple and transparent logic, and a pedigree from a peer-reviewed professional journal.

Table 2: Overview of Net Annual Cost Savings Multiplier

<table>
<thead>
<tr>
<th>Description</th>
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<th>Disadvantage</th>
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</thead>
<tbody>
<tr>
<td>Applying monetary energy savings as a mortgage expense offset. Rule of</td>
<td>Residential property owners</td>
<td>Simple and transparent based on peer-reviewed studies</td>
<td>Not precise</td>
</tr>
<tr>
<td>thumb: $20 in value for $1 in energy saved.</td>
<td></td>
<td>Often quoted by solar PV installers</td>
<td></td>
</tr>
</tbody>
</table>


**Direct Capitalization of the Net Cost Saving**

While debt relief might be sufficient for the market value calculations of homebuyers, commercial real estate participants look at the value through the lens of investment risk. Direct capitalization of the annual net energy savings has been used to estimate market value, and this approach has the advantage of being quick, simple, and familiar to investors. In fact, it is simply the inverse of the multiplier approach described above. For example, as shown previously, an interest rate of 5 percent equals a multiplier of 20, so a capitalization rate of 10 percent would be equivalent to a 10-times multiplier. The leap from value studies based on the behavior of homeowners to the behavior of commercial property owners is reasonable as long as money has value, but an increase in the rate of return for the investor would be expected. In most cases, commercial property owners have intuitively applied a multiplier based on the real estate capitalization rate to the annual net energy savings, rather than using the mortgage interest rate.

In the past, sophisticated investors have accepted direct capitalization of net annual cost savings as sufficiently accurate in PPA buyout clauses to set the market value. Recently, there has been a shift away from direct capitalization in PPA buyout clauses in favor of a net present value discounted cash flow that measures the value today of a future stream of net annual savings.

This shift is due to the inherent inaccuracies of the direct capitalization as the solar PV investment ages. Up to Year 3 or 4, value estimates through direct capitalization are close to the more granular discounted cash flow (to be discussed next). However, approaching the midterm (around Year 15) at which a capital expense for inverter replacement is required, this approach is less accurate. In addition, direct capitalization assumes that income and expenses trend approximately with the general consumer Price index – not always the case with electricity pricing. This method also assumes that the cash flow conditions go on in perpetuity, and that does not happen with solar PV.

**Table 3: Overview of Direct Capitalization of Net Cost Saving**

<table>
<thead>
<tr>
<th>Description</th>
<th>Best for whom?</th>
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<th>Disadvantages</th>
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</thead>
<tbody>
<tr>
<td>Applying the real estate cap rate to annual net energy savings</td>
<td>Commercial property owners</td>
<td>Quick, simple, familiar to investors</td>
<td>Inaccurate as PV system ages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Used for PPA buyouts in the past</td>
<td>Assumes income and expenses trend with the consumer price index – not always the case</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More accurate valuation of investment risk than the net annual cost savings multiplier</td>
<td>Assumes cash flow in perpetuity</td>
</tr>
</tbody>
</table>
COST APPROACH

The Cost Approach bases PV system value on the up-front cost of the system. The Cost Approach to value seldom gets respect, as cost often does not equal value. However, as seen in the annual results of the Hanley Wood Cost vs. Value study, cost can indicate the credible market value range of well-documented, recent, bona fide, long-lived upgrades.

This appraisal practice intends to mimic the real-world behavior of buyers and sellers, including their reaction to an object’s cost. Cost is most influential when the expenditure is recent, so that it can exclude the questions of depreciation and considerations of replacement cost changes.

Examining the fully considered cost (after all rebates and tax events) of a solar PV system also raises the fundamental question: Is this a good idea or not? The initial decision to install solar panels is not approached in the same way as determining the solar PV array resale value. All forms of energy generation enjoy tax and government incentives, and solar PV is no exception. The first purchaser might have federal, state, city and utility incentives, accelerated depreciation, and waived assessment increase (generally for the first owner only), while a subsequent owner of the solar PV system might enjoy none of these.

Cost (investment) exists on several levels. Gross cost is the cost of the system before any rebates. Net cost is the cost after rebates and early-stage incentives (excluding depreciation). Net cost including depreciation includes the accelerated depreciation of solar PV, which is a powerful influence in the investor’s decision. However, because depreciation depends on the individual tax situation, it is not typically addressed in a real estate appraisal. DCFs can be run with depreciation as an aid to the loan underwriter, providing a better view of the investor’s motivation.

Table 4: Overview of the Cost Approach

<table>
<thead>
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<th>Best for whom?</th>
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<th>Disadvantage</th>
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</thead>
<tbody>
<tr>
<td>Cost of the PV system</td>
<td>PV system purchaser, both residential and commercial property owners</td>
<td>Up-front cost is key to the initial investment decision</td>
<td>As a system ages, inverter replacement and maintenance costs become more important and so future cash flow needs to be considered.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Includes rebates and incentives if net cost is used</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can include depreciation</td>
<td></td>
</tr>
</tbody>
</table>
SALES COMPARISON AND MARKET GREENNESS APPROACH

The Sales Comparison and Market Greenness approach estimates PV system value based upon comparison to nearby and similar properties with PV systems. While the Sales Comparison Approach is the general rule in residential appraisal reports and is also intuitive, this approach has the least merit for determining the value of a solar PV system. It is highly unusual to find a recent arm’s length sale of a nearby and similar property with a like-sized solar PV system. Thorough market research for sales and listings is a required part of due diligence, even with a slim chance of finding comparables. Importantly, this research should include interviews with market participants to gauge market interest and identify experience with solar systems, so that a qualitative sense of the “market greenness” can be determined.

The level of market sophistication on “green” structures is an important consideration on where solar PV should land within the expected value range. This market awareness factor is clearly shown as a value influence in the numerous studies on solar PV. Survey interviews that build qualitative data are a typical method used in appraisals where hard quantitative data is lacking. These interviews might be with solar installers, a local chapter of the U.S. Green Building Council, or real estate agents who are promoting themselves as having this specialty (such as the EcoBroker network).

Table 5: Overview of the Sales Comparison and Market Greenness Approach

<table>
<thead>
<tr>
<th>Description</th>
<th>Best for whom?</th>
<th>Advantages</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimation of PV system value based upon comparison to nearby and similar</td>
<td>Residential property</td>
<td>Required in residential appraisals</td>
<td>Hard to find recent sales of similar properties in most cases</td>
</tr>
<tr>
<td>properties with PV systems</td>
<td>owners</td>
<td>Includes interviews to determine an area’s market greenness or sophistication</td>
<td></td>
</tr>
</tbody>
</table>

CASE STUDY: STUDENT HOUSING PV INSTALLATION

A 10-building student housing complex in a small college town installed 732 solar panels on its rooftops, generating an effective annual energy savings of nearly $54,000 per year. The solar panel output annual decrease rate used was 0.5 percent, a typical industry standard. The panel output projections are based on standard methodologies and on location, using the National Renewable Energy Lab (NREL) database of solar intensity. Integrated into the design was an alert system in case any component performance fell below set thresholds. Notifications were by emails to multiple parties with fixed maintenance expectations.

Table 6 shows the estimated value of the system using two of the five valuation methodologies discussed in this paper.
Table 6: PV System Value Using Each Valuation Approach

<table>
<thead>
<tr>
<th>Valuation Approach</th>
<th>Value</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discounted Cash Flow (Net Present Value)</td>
<td>$692,466</td>
<td>This is the NPV in year 2. It is higher than the actual system’s up-front cost given the very high electricity rates ($0.22/kWh) in the location of the panels.</td>
</tr>
<tr>
<td>Cost Approach</td>
<td>$465,450</td>
<td>This is the Net Effective Solar PV System Cost, net of credits and incentives (including just over $200,000 from federal tax incentives and smaller state and utility incentives).</td>
</tr>
</tbody>
</table>

The discounted cash flow approach shows the present value of future energy savings from the solar panels, as well as the present value of any future costs, including inverter replacement and maintenance. Usually the value based on discounted cash flow would be comparable to or lower than that based on the cost approach, but in this case it is higher because of the very high electricity rates where the university is located — the utility rate structure affects the solar system’s value. In this case, the fact that the complex was master metered affected the utility rate applied, resulting in an advantage to the owner. The high electricity rates mean that every kWh generated by the solar panels saves more in avoided energy costs. The cost approach simply looks at the cost of installing the system. In this case, the installation costs were particularly low because they included just over $200,000 in federal tax incentives and smaller state and utility incentives. Anyone purchasing the building would be unlikely to pay more for the solar panels than the original cost of the system. Though the cost approach provides a useful data point, the discounted cash flow approach is a more accurate assessment of the future energy savings and value the solar panels will provide to the building. It is unusual to have such a large discrepancy between the cost approach and the value via the DCF. The large difference in this case was caused by the unusually high electricity rate and an exceptionally good deal on the solar system. In most cases, these two values would be much closer together.

In this case, the property owner recovered the initial investment by Year 9, but that does not include the value of the remaining benefits of the system. When the tax advantages of the depreciation are included, the investment is recovered by Year 6. A buyer who purchased the building in Year 6 or 9 would be expected to pay the value of the remaining benefits. Therefore, the value of a PV system is a combination of the benefits during ownership and the reversion, or the value, when the building is sold. If the building sold in Year 9, the buyer would pay the net present value of the remaining benefits.
CONCLUSION: THE CASE FOR DISCOUNTED CASH FLOW

The increase in the number of PV systems in the residential and commercial real estate markets has created the need for a widely accepted process to determine the value premium a solar system provides to its host real estate. Various methods have been developed, and some best practices have started to emerge.

Discounted cash flow is the most common approach currently used by knowledgeable market participants, including solar PV investors in sophisticated PPAs. Increasingly, appraisers are also gathering around this approach. While using the net present value of future energy savings is more complex than other methods, DCF is the most nuanced and accurate method. Including a direct capitalization in the value analysis and showing the multiplier ratios supports the final results and is a good reality check. Additionally, confirming the net cost (plus a developer’s profit) against the final value verifies the result and determines a range, since a buyer is generally not expected to pay much more than replacement cost. Market participants have shown that the value proposition is mostly gauged on cost savings, with a nod to net costs.

The sales comparison approach is generally the least valid approach due to the often very limited selection of close, recent and similar data points. No prevailing evidence has shown that comparable sales of solar PV systems is a common method for determining market value. However, it is normal to check if any sales or listings of buildings with solar PV have occurred. Interviews with local market participants to gauge a market's understanding of green real estate factors are a key part of the analysis.

Adding sensitivity analysis for input ranges on values will provide best-, middle- and worst-case ranges. Logically, discount rates with new and proposed solar systems should be higher than for systems with proven performance. In any sizeable system, an automated power monitoring and outage alert system (usually via email notices) is an obligatory part of the design.
<table>
<thead>
<tr>
<th>Methodology</th>
<th>Description</th>
<th>Best for whom?</th>
<th>Advantages</th>
<th>Disadvantage(s)</th>
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</thead>
<tbody>
<tr>
<td><strong>Discounted Cash Flow</strong></td>
<td>Net present value of all cash flow including energy savings, inverter replacement cost, and system maintenance</td>
<td>Most accurate for all owners including residential, commercial, third-party system owners</td>
<td>Accurate for numerous cash flow events in PV system life</td>
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ABOUT THE AUTHOR

James F. Finlay, MRICS, VP, Sr. Commercial Appraisal Manager, is the principle appraisal manager supporting Wells Fargo Bank loans collateralized by high-performance, LEED, and ENERGY STAR buildings, including those with solar PV systems. He can be reached at james.f.finlay@wellsfargo.com.

The Institute for Building Efficiency is an initiative of Johnson Controls providing information and analysis of technologies, policies, and practices for efficient, high performance buildings and smart energy systems around the world. The Institute leverages the company’s 125 years of global experience providing energy efficient solutions for buildings to support and complement the efforts of nonprofit organizations and industry associations. The Institute focuses on practical solutions that are innovative, cost-effective and scalable.

If you are interested in contacting the authors, or engaging with the Institute for Building Efficiency, please email us at: InstituteforBE@jci.com.