Standardizing Appraisals for PV Installations

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***ABSTRACT* — As PV installations increase across the U.S., there will be a point when an appraiser will have the opportunity to value the PV system as part of a property sale or re-finance. Proper valuation techniques as applied to solar PV are necessary to reflect the increase in market demand for solar PV systems. Appraisers must follow the Uniform Standards of Professional Appraisal Practices (USPAP) when valuing solar PV systems, which means that appraisers must gain competency to 1) accurately recognize the value proposition of a PV system, and 2) develop the PV system's market value as it contributes to the property. The challenges currently faced by property owners with installed PV are whether the PV system adds market value to the property, and finding an appraiser with competency. Not all markets are the same, and PV market values will vary considerably based on many factors that include, but are not limited to the adoption rate in the particular market, the utility rate paid by the customer, the PV system's condition, aesthetics, and obsolescence. This paper will discuss how past challenges with respect to proper PV system valuation are being addressed in a standard fashion, along with the far-reaching benefits that may be available to future PV adopters as valuation concepts are ultimately recognized and adopted by valuation professionals, real estate agents, mortgage lenders and underwriters.**

***Index Terms* — photovoltaic systems, appraisal, market value, fair market value, property transaction**

I. Introduction

There is currently a great deal of effort being made to increase the adoption rate of solar photovoltaic (PV) systems across the U.S. by focusing research to provide solutions that reduce both the hardware (balance-of-system) and soft balance-of-system, or "soft costs" of an installed PV system. In the area of reducing soft costs related to financing as defined by the SunShot Vision Study [1], a strategy to achieve cost goals includes "Expand access to a range of business models and financing approaches." Directly related to the effort at reducing financing costs is the ability to *access* lower cost financing, which indicates that lower cost financing is available, however barriers must be overcome to open up these products to those interested in financing a PV system. The current higher capital cost for financing and inability to access lower rates reflects the potential risk premium perceived by some lenders of both unsecured and secured loan products used to purchase PV systems, as well as their relative lien position.

One area that has not received as much attention in terms of the potential to reduce soft costs has to do with how a PV system is valued in a residential or commercial property transaction. Because PV systems are arguably still in the early adopter's phase of Roger's Bell Curve and are not common across the US [2], most appraisers are unsure about the market value proposition it can provide to property owners. It is this lack of understanding (due to market immaturity and lack of education opportunities), and lack of both support and understanding from lenders, underwriters and government sponsored enterprises (GSE's) that has led to improper valuation techniques as applied to PV systems. It also holds true that not every market has been educated on the benefits of PV systems, which is borne out in how local markets respond either positively or negatively to estimates of value.

Reconciling these challenges to support the proper valuation of PV systems through education efforts aimed at the real estate and valuation professionals will ultimately result in the recognition of the fact that an increase in market acceptance of PV systems is occurring throughout the U.S. The value proposition enjoyed by current PV owners will over time be better understood by future PV adopters and those in the appraisal, real estate and lending industries. This recognition will translate into lower perceived risk and greater access to lower cost financing.

This paper will discuss the efforts to have PV systems recognized in real property appraisals being led by a number of groups that include private industry, professional organizations and national laboratories. Examples of standard appraisal practices will be presented, along with areas of existing research and education efforts currently underway that are designed to gain access to lower financing and reduce existing financing costs through the support of the real estate and valuation industries.

II. Importance of Proper PV System Valuation

One of the main benefits to a homeowner that owns a PV system is the fact that once a PV system is given value in a property sale or re-finance, that value is essentially 'unlocked' allowing the owner to realize some of the initial investment in the PV system, especially if the payback of the PV system has not been realized. Fig. 1. The fact that some PV systems have not been properly appraised or the market did not support the value through comparable sales, results in situations where for example, the property was sold with the PV system, but the payback from the investment was never realized and an economic loss to the original PV system purchaser may have

occurred. Figure 1 indicates that in year 6, if the value is recognized, yet payback has not yet occurred, using an income based discounted cash flow approach, that remaining payback has been recovered. Standard appraisal practices in support of transactions with knowledgeable buyers and sellers can facilitate the unlocking of the PV system's value and remove a barrier that many potential adopters experience have when selling their home before the payback is reached.

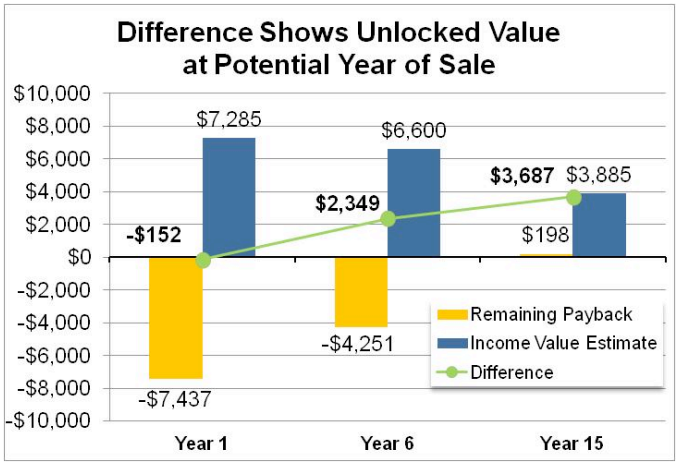

Fig. 1 Example of value unlocked from a 2.4 kW PV system with a net cost of $7,631 and a payback (as a function of utility bill savings) around year 14. PV system value determined using PV Value® tool, payback (simple) calculated using SAM.

It is also important for appraisers to understand ownership of the PV system, as that will determine if value can be developed and what other components of value may have to be considered.

PV systems in states with fixed contract renewable energy credits or certificates (REC), and production based incentives can add value based on the guaranteed income stream. Other states that have these RECs that can be sold or traded in REC markets have varying prices, making it difficult for an appraiser to consider value beyond what the REC is worth at the time the appraisal is completed. A proper understanding of these differences will ensure value is developed correctly.

III. How PV Systems Are Appraised

This section will discuss concepts around appraising PV systems, provide examples of early practices, and show standard practices are currently being implemented. Appraisers use variations of three approaches: cost, income and sales comparison [3] to develop the potential market value. Most importantly, they must demonstrate "competency" before accepting an assignment otherwise they must acquire competency during the assignment or "withdraw from the assignment" [4]. However, if the appraiser's client is selling the loan on the secondary mortgage market that falls under the Government Sponsored Enterprises (GSEs) such as Fannie Mae or Freddie Mac, the appraiser must have competency prior to accepting the assignment [5]. These guidelines indicate the appraiser must have knowledge of the PV systems, understand how PV systems work and have sufficient appraisal methodology knowledge to complete the assignment.

In the early 1980s, appraisers published papers that suggested using combinations of a cost and income approach to estimate the value of a PV system, recognizing back then there were not enough comparable properties with solar to use a paired sales approach [6] [7]. Those observations still hold true today; comparable properties with PV are still far and few between making it difficult for an appraiser to weigh the market for PV systems on comparable properties alone.

A. Comparable Sales

A typical comparable sales analysis traditionally utilized by an appraiser compares the subject property to other similar properties nearby, and within a specific timeframe. As solar is a new feature, an appraiser relying on comparable sales may not find a PV system and erroneously conclude that since no existing homes sold with PV nearby within a certain time-frame, there is no market demand or support for value. Some underwriters are insisting on no value placed on a PV system if the appraiser cannot find a sale of a similar property that has a PV system. As appraisers are required to also consider cost and income approaches [3], a comparable sales only approach may not be appropriate in most U.S. markets.

A comparable sales analysis that reveals homes sold with solar PV could be conducted. Understanding the characteristics of the PV system is necessary to make adjustments to comparable sales based on the differing size of the PV system. It is highly unlikely that each comparable will have the same size PV system; and therefore, the value of the produced energy would have to be determined to make a proper adjustment. This is also important considering whether the PV system is working optimally, or if it is being shaded and output is reduced. Evaluating the condition of the comparable PV systems would alleviate these concerns, however, data may be difficult to obtain.

A large study in California completed by Lawrence Berkeley National Laboratory compared sales of homes with PV and without to determine what premium, if any, existed on homes sold with PV systems. Their results indicated that depending on whether the home was new construction, or existing, the price per watt premium varied between $2.30 - $2.60/watt, and $3.90 and $6.40/watt, respectively for homes with PV systems, as compared to comparable homes without PV [8]. Energy savings was not analyzed in this study, though estimates in California were used to develop a ratio. It is worth mentioning that the premium identified in this study could also include other features or condition of the homes, which were not completely disentangled from the value of the PV system. In addition, there was no information that stated what

method appraisers used to develop value. As this study presented premiums in California for a limited sample size, this data shows *evidence* of market reaction to PV systems, however, relying exclusively on these premiums is not an acceptable basis for the value of the PV system without other appraisal techniques. An appraiser should understand the PV system's condition, existing market demand and other factors necessary to develop the PV system's contributory value to the property.

B. Cost

The Cost approach is a way of developing value though an understanding of what it would cost to replace the item. The age-life method is one way that residential appraisers can use a cost approach. The challenge when using this approach for an appraiser, which currently limits its effectiveness, is the presence of many different types of rebates and tax credits, some of which can only be used one time by the property owner.

This method is shown in Table 3 in the comparison of different appraisal techniques for a residential property. As the PV modules have a 25-year useful warranty life, the age of the system is divided by the useful life (physical age/life method) to return a depreciation percentage. This amount is then multiplied by the cost of a system purchased today less incentives except tax related incentives to apply the depreciation amount, which is then subtracted from the cost to get the final depreciated value. However, this method only addresses the physical depreciation and requires the appraiser to consider obsolescence that exists in markets where cost exceeds what the market is willing to pay. This results in a superadequacy. The physical age/life method does not include the obsolescence; therefore, the appraiser must measure the obsolescence and also subtract it from the cost. Due to each individual's different tax rate, the use of tax credits in a depreciated cost framework is not recommended for developing a market value for the PV system [9].

The appraiser must always consider cost of the PV System as of the effective date of value and not the cost paid by the purchaser when it was new. Therefore, with the cost of PV systems decreasing, the cost may eventually not have the problem of a superadequacy to consider. Also, if the PV system is not working "optimally" due to shading or other issues, this approach may result in a value estimate that is too high unless the appraiser can adjust the physical depreciation to account for the physical deficiency.

C. Income Approach - Gross Rent Multiplier

A Gross Rent Multiplier (GRM) is essentially a simplistic income capitalization approach to translate the value of a monthly energy savings from energy efficient features into a contributory value, or adjustment to value [10], based on the appraisal technique of dividing the sales price of a building by the monthly rent, which is then multiplied by the monthly energy savings. The GRM is property specific and is discussed as an appropriate technique to develop value for energy efficient features. Having rental data nearby is necessary, though a proxy method could be developed for that market.

Efforts were made to tie a study about energy efficiency in the 1990s [11] to the value of PV systems. This metric has been used by installers and touted as evidence that every dollar of energy saved by using a PV system translates to an increase in property value of $20, though this was disputed [12] based on the premise that applying this ratio to PV systems (which generate electricity) from a study where PV systems were not analyzed does not provide enough support to suggest a 20:1 premium for houses with PV systems. This type of study is good for finding *evidence* of value in a certain market at a certain time period; however, studies do not necessarily apply to all markets, and would not satisfy USPAP requirements if relied on solely to develop value.

Can a Gross Rent Multiplier (GRM) be applied to solar PV? It is possible; however, the appraiser must not rely solely on this method. This method is one tool from the appraiser's toolbox that must be used along with other methods and reconciled to mirror the reactions of buyers and sellers in the market.

D. Income Approach – Discounted Cash Flow

Currently, based on the challenges presented with the other approaches and the unique 'income' producing features of a PV system, an income approach using a discounted cash flow (DCF) to develop the present value of the energy produced is a recommended technique.

The benefit of this approach is that it considers the details of the PV system, and validates whether it is working correctly and delivering electricity as designed. For a residential appraiser, this approach can take more time and effort to perform, however if the data is available, an estimate of value can be made quickly. The key here is that an appraiser needs knowledge of how a DCF works, how to set one up properly and how to provide support for each input. One minor error in the DCF can result in a larger error in value.

The PV Value® tool (www.pvvalue.com) developed in 2012 as a proof-of-concept that can help appraisers use the DCF approach as it has the necessary inputs for an appraiser to develop a value for the PV system [13] [14]. Due to the challenges with the other approaches, the tool is being widely used across the U.S., with over 2500 downloads in the past 18 months, and early evidence that appraisers are successfully utilizing it in appraisals. Current collaboration with LBNL will involve validating the methodology using existing sales data in multiple U.S. markets.

With this greater level of accuracy in translating energy produced to a market value, what are the typical parameters needed by an appraiser to develop the value? An appraiser needs the following:

- zip code

- system size
- degradation rate
- derate
- tilt
- azimuth
- discount rate
- utility rate & utility escalation rate
- estimate of O&M expenses, and
- system age.

Many of the parameters in PV Value® including the utility rate, utility escalation rate and O&M expenses are pre-determined, however the appraiser can overwrite that data with more accurate estimates that may be necessary for the market that is being considered. The discount rate is determined using a risk-free rate tied to the Fannie Mae daily Net Yield rates for 15-and 30-year mortgages. These were chosen for residential appraisals as these rates are most reflective of the always fluctuating cost to borrow money at the time the appraisal is conducted. The basis point spread on top of that risk free rate can be changed by the appraiser if needed, to reflect other market conditions that speak to issues around obsolescence, PV system condition, roof repair, shading, and markets that are supportive, or not supportive of PV. The resulting Appraisal Range of Value Estimate provides the appraiser with a general range to use along with other methods to reconcile to a value contribution for the solar PV system.

What are the biggest challenges for appraisers when using this tool? Appraisers and underwriters first need to understand how a discounted cash flow analysis works. Currently, with the exception of a few residential appraisers and underwriters that understand how to value accessory dwelling units and apartments, most all residential appraisers and underwriters rely exclusively on the sales comparison approach. USPAP guidelines do not say that the sales comparison approach is to be exclusively used for residential properties, therefore the use of an income approach to develop the contributory market value to the property is valid. USPAP states all applicable methods should be used. An appraiser should explain when reconciling their report, whey he/she did *not* use an income or cost approach according to USPAP.

Underwriters often reject the use of the income approach for the solar PV; however, the appraiser should be the one making the decision on which approach(s) are applicable and not the underwriter. The use of this tool (DCF) will help standardize the appraisal process, especially for residential properties if the market data reveals it mirrors the reaction of buyers and sellers. Improvements to the other approaches can be made over time as the PV industry matures with more PV systems installed, subsidies and tax credits decrease and education efforts aimed at the appraisal and real estate industry resulting in a greater understanding of PV system benefits.

IV. How Does This Apply to Third-Party Owned PV?

Many homeowners believe a PV system adds value to their property, and as shown above, it does for customer owned systems. However, does this hold true for third party owned systems? Much of the answer lies in the difference between residential and commercial underwriting and the ability to recover collateral if the PV system is removed from the property.

For commercial systems, the PV system can be located on the rooftop, with the building owner charging rent for the use of the space by the third party PV system owner. This rent can be capitalized and a value developed by an appraiser. The Appraisal Institute course materials for valuing PV systems have many more case studies that discuss how an appraiser can develop value for PV systems on commercial rooftops, considering different ownership structures and PPA agreements [9].

For a residential property with a third-party owned PV system, the customer is not "renting" their rooftop to the third party owner to generate income, they are renting the equipment or entering into a power purchase agreement to reduce their electricity bill and pay for the use of the PV system to attain that savings. When a PV system is included in a valuation estimate, the underwriter will carefully analyze the additional value developed by the appraiser. In some cases, the underwriter may exclude the value even if the appraiser attributes value to the system. For third-party owned PV systems, the PV system will most likely be listed as an asset on the Lessors balance sheet and can be removed subject to the terms of the lease or PPA agreement as it is not owned by the homeowner.

If an appraiser develops a value based on the energy produced by the third party owned system, this could also create a problem in a foreclosure if the PV system were removed between the time of valuation and time of foreclosure. Once removed, that collateral evaporates with no remedy for the lender, and no future energy production for a potential home purchaser.

A. Fair Market Value

What is fair market value (FMV), and how does it differ from the market value of a PV system? Related to PV systems, this is a new opportunity for appraisers that is different from the way an appraiser considers market value, as a fair market value appraisal for solar PV may be done to satisfy the tax rules and regulations when property is transferred between owners; in the case of PV systems, when a third party owned PV system is purchased by to the homeowner or is removed and re-sold by the third party.

FMV can be determined by the appraiser, with an understanding that this is a transaction between a willing buyer and seller. When a lease is broken either due to early buyout clauses, home sale (if home buyer does not want to assume the PV system lease terms), end of lease term or early

termination, there are opportunities for an appraiser to help develop that fair market value. The result may be the same or different from the market value. An appraiser may consider the cost of a new PV system in their analysis, or the remaining useful lifetime of the existing system using a tool such as PV Value®. It is important to note that in many current lease contracts, the value ultimately paid by the customer in these transactions is the higher of the value in the buyout or early termination table within the lease terms, or the fair market value determined by an independent appraiser.

Ultimately, as more lease transactions enter these potential ownership transfers and appraisers are brought in to determine fair market value, a better understanding how this value is developed can be analyzed and conveyed to help standardize the process by which appraisers conduct FMV determinations.

V. Example Residential Appraisal

In this section, an example of an appraisal is presented along with a treatment of value developed using comparable sales, cost and income approaches. This is intended to illustrate how an appraiser should consider the three approaches when developing value. For the sake of discussion, there are multiple assumptions here that will vary depending on the market, as this does not represent an actual appraisal of a home with a PV system, the available listing data, and the varying knowledge of buyers and sellers in different markets.

For this example, a house with PV is listed on the market. It has a 6 kW, 5-year old PV system, no shading and performs as designed, according to the homeowner. The local MLS system that this home is entered into just recently adopted fields that match the Appraisal Institute's Green Addendum [15] with PV fields that also match the inputs in the PV Value® tool. The appraiser that accepts the assignment has taken courses on valuing PV systems and has appraised property with PV systems prior to this assignment, and therefore, meets the definition of having competency according to USPAP and GSE rules. Details on the price paid for the example PV system and today's price are shown in Table 1.

TABLE 1
Subject Property PV System Characteristics

Size	Age	Price paid $/Watt	Gross cost	Net cost
6 kW	5 yr	$7.00	$42,000	$40,000[a]
If purchased 6 months ago[b]				
6 kW	6 mo.	$4.25	$25,500	$16,450[c]
If purchased now – current estimated costs[b]				
6 kW	0 yr	$4.00	$24,000	$15,400[c]

a - Installed before 2009, cap on federal tax credit was $2,000.
b - From appraiser survey of local installers.
c - The utility offers a $2,000 rebate. Current federal tax credit is $30% with no cap.

A. Information Discovery

The appraiser starts searching for comparable properties to value just the property without the PV system, and found that one property that has sold within the past 6 months had a PV system; however, none of the other houses had a PV system. The comparable property is listed in Table 2. Since the more detailed data that is now available in this local MLS (following AI Form 820.04) was *not* implemented and available when the comparable property sold, there were no information fields that captured the PV system characteristics. Fortunately, the appraiser knew where to potentially find information on PV systems, and discovered that a permit was pulled 3 years ago to install a 4.5 kW PV system on that comparable property, with a listing of the installing company. Research revealed there were no rebates offered when it was installed but there is one currently offered and that the investment tax credit of 30% was applied with no cap. During the drive-by of Comp 1, the appraiser also noticed shading on the PV system during the mid-day, realizing that will reduce the PV system production.

TABLE 2
Comparable Properties[1]

	Subject	Comp 1	Comp 2
Sold Price	N/A	$220,000	$204,000
Date Sold	N/A	6 mo. ago	5 mo. ago
PV System	6 kW	4.5 kW	none
Age of PV System	5 yrs.	3 yrs.	N/A
Current Installed Cost (date of sale)	$4.00/Watt (eff. date of value)	$4.25/Watt (6 mo. ago)	N/A
Gross Total	$24,000	$19,125	N/A
Rebates Available Today	$2,000	$2,000	N/A
Parking	2-Car Gar.	2-Car Gar.	1-Car Gar. +$3,000
Gross Living Area	1,600 sq. ft	1,550 sq ft.	1,625 sq. ft
Adjusted Home Sales Prices		$220,000	$207,000
Value of PV System	Comp 1 ($220,000) less Comp 2 $207,000 = $13,000 value for 4.5 kW system, or $2,888 per kW ($2.89/Watt)		
Shading	None	Partial	N/A
Adjustment for PV System		$2,888 x 1.5 kW (6 kW – 4.5 kW) = $4,400 rd	6 kW x $2,888 = $17,300 rd
Value of Home with PV		$224,400	$224,300

1 – For educational purposes only, not actual data

Going beyond the radius of comparable properties, the appraiser found a PV system located 2 miles away using an aerial image search, which is available in many mapping programs available on the internet. After determining that address, the appraiser checked to see if the permit was pulled and found that the same company installed this system. This home had not sold; however, the appraiser wanted to know if any other PV systems were nearby to help understand the market. The appraiser then contacted the installer and found out that the 4.5 kW PV system, located close to the property for sale was purchased by the homeowner, and the one 2 miles away was a newer 6 kW PV system, but owned by a third-party. From that information, the appraiser was able to understand there is some demand for PV systems in this area with different ownership options.

B. Analyzing Comparable Sales

The two comparable sales provide good support for a value of the subject property. Comp 1 deserves most consideration because it has a PV system; however, it is a smaller system with some shading that will negatively affect the energy production. Pairing Comp 1 to Comp 2, a similar house without a solar PV system, provides good support for the $2,888 adjustment per kW. The only other adjustment is for the garage size difference. The adjustment is based on market extraction. After adjustments are applied, the two sales closely support a value conclusion at $224,400 for the value of the home. Using the $2,888/kW the value of the PV system is $17,328.

C. Analyzing the Cost Approach

The appraiser has enough information to apply the physical age-life method in the cost approach. Table 1 shows the cost to install that same system today, the effective date of the appraised value. The appraiser finds out that the PV panels have a 25-year warranty and the inverter has a 10-year warranty. Assuming the useful lifetime of 25 years, the appraiser develops potential contributory values, showing the depreciation of the PV system and the gross and net costs (Table 3). Comp 1 and Comp 2 are not used in this analysis.

TABLE 3
AGE-LIFE DEPRECIATION – 6 KW PV SYSTEM

Useful Life	25 yrs
Age	5 yrs
Physical Depreciation %	20%
6 kW Gross Installed Cost today	$24,000
6 kW Net Installed Cost today	$15,400
Gross Cost Today - Depreciation Amount	$4080
Net Cost Today - Depreciation Amount	$3080
Final Gross Depreciated Value	$19,200[a]
Final Net Depreciated Value	$12,320

a – value does not include obsolescence due to superadequacy.

As discussed above, when looking at the net value, the tax situation is very different between owners and years; in the year it was purchased, there was a federal tax credit, however it was capped at $2,000 and for this system the tax credit was only able to reduce the price paid by $2,000, from $42,000 to $40,000, with a resulting net depreciated value of $12,320. A new system now costs less than it did 5 years ago, and the amount of tax credit available today is greater. However, that tax credit is not available to seller if the entire system had to be replaced. The gross depreciated value would be more applicable here with an amount showing less than the cost of purchasing a new system, however there is more to this approach than just depreciation.

A challenge with using this approach exclusively is that it does not consider potential obsolescence that may exist due to superadequacy. In other words, the market is not willing to pay full gross cost. For instance, a swimming pool on a brand new house costs $35,000 and one year later the owners sold the house. Upon the sale of this one-year old house it sold for only $10,000 more than the same house without a pool. The difference between the $35,000 one year ago and $10,000 on resale is due mainly to obsolescence due to a superadequacy. Only a small amount of the $15,000 in loss is attributed to the physical depreciation. (Physical age/life method provides physical depreciation and does not consider obsolescence.)

To get a better understanding of how this cost approach value may fit with the other methods, it should be compared to the value developed using an income approach, which considers the geographic variability of energy produced and price paid for the energy.

D. Analyzing the Income Approach – Discounted Cash Flow

The appraiser was able to gather the necessary information from the homeowner to populate the solar PV section in AI Form 820.04 and from there, was able to utilize the PV Value® tool to develop an income approach to value. The appraiser did not have access to utility savings information before or after the PV system was installed or information about rents paid in the vicinity of the subject property and determined the gross rent multiplier method would not be appropriate. The information about the PV system is presented below in Table 4 along with the results of the DCF analysis using PV Value®.

TABLE 4
DISCOUNTED CASH FLOW – 6 KW PV SYSTEM

System Size	6 kW
System Age	5 yrs
Remaining Energy	20 yrs
Derate	0.77
Degradation Rate	20%
Array Type	fixed
Array Tilt	latitude
Array Azimuth	180

30-year fixed 60 day Conv.	3.51
Avg. Discount rate (50-200 bp spread)	4.76
Utility Rate	11.50 c/kWh
Utility Escalation Rate	1 %
O&M Expenses	55 c/Watt
Annual PV Production – start year 6	9975 kWh
Avg. appraisal range of value estimate	$13,800

The result here indicates that based on all of these unique characteristics that are a function of the location of the PV system and energy it produces, the value estimate is $13,800. If this system were shaded, then the derate value could be changed, as shading is included in the PVWatts® derate definition. This approach gives the knowledgeable appraiser a number of options to develop value in light of many aspects that reduce the optimal energy output from the PV system.

If the appraiser had more detailed information about the PV system on Comp 1, PV Value® could be utilized to better understand the income value for that PV system, and make adjustments accordingly. This information could be made available from the installer, if the appraiser was able to determine the installation company from the filed permit, or it may eventually be in the MLS system, as the example here stated that the MLS in this location just started adding fields that can help capture the inputs for developing value using a discounted cash flow analysis.

E. Reconciliation

At this stage, the appraiser will consider all approaches used to estimate value. The strengths and weaknesses of each approach are carefully weighed to form an opinion of the value of the PV system. The appraiser considers data available to support each of the steps and reliability of the data sources. Whether the market will support any of these estimates is a large part of what value the appraiser will determine. An underwriter may choose to remove the value from the equation but cannot force an appraiser to remove value without accepting a value subject to a hypothetical condition that the PV system has no value when in fact the appraiser determined that it does.

In reconciling the sales comparison approach, Table 5 gives an idea of the values the appraiser will consider when developing the value. The two comparable sales provide good support for a value of the subject property. Using the $2,888/kW from Table 3, the value of the PV system is $17,328. Currently, in most markets comparable properties that have sold with PV systems may be non-existent, and relying exclusively on this approach may not accurately reflect market demand for the income producing benefits of a PV system.

The cost approach was only applied to the subject property and done to show the limitations of this approach due to the need to better understand obsolescence due to superadequacy, which for PV systems is essentially due to the gross price not being paid due to the presence of incentives. Currently in most all markets in the U.S., these incentives are still important in attracting new market participants.

If the appraiser determines this market supports PV systems based on willingness from the buyer in this transaction, or other studies available in the subject area, the appraiser may reconcile more closely to the Income Approach indication. It is important to note however that the current installed cost sets the upper limit of value. It is usually less reliable for PV systems because of its uniqueness in the market leaving the depreciation estimate less reliable. Also, the partial shading in the comparable property example makes it difficult to understand the percentage reduction in energy production. For this example, in a supportive market with a knowledgeable and willing buyer and seller that understand the income benefits provided by a PV system, the income approach makes more sense and has more support for the conclusion.

TABLE 5
RECONCILIATION

Sales Comparison	$17,328
Cost Approach[a]	$19,200
Income DCF	$13,800

a – physical depreciation only, could be much less if obsolescence due to super adequacy is included

VI. STANDARD DOCUMENTATION

Based on the example appraisal presented above, the potential lack of documentation available to an appraiser can be a challenge. An area that is currently lacking any standard approach is the concept of how a PV system's characteristics are documented, what is being collected, by whom, and where can the data reside in a way that can streamline the home sales process.

This process is more commonplace for commercial PV systems that undergo a commissioning process as there is a benchmark for comparison to meet conditions in a performance guarantee, or if the system has to be repaired [16]. Many states and municipalities collect PV system data as part of incentive program applications, though as incentive programs start phasing out, the only places to find data will include the PV system installers as well as local building permit databases. Trying to track down this data could prove time consuming and a hindrance for an appraiser developing an accurate value estimate.

This problem could be remedied if PV system data is readily available, either at the property or from when the house is listed in the local multiple listing service (MLS).

If the data is available at the property, there could be a way to provide permanent documentation similar to what NEC 690 or the IAPMO Uniform Solar Energy Code requires for disconnect labeling. For example, the Public Service Company of New Mexico requires a weatherproof and easily

accessible location for a one-line diagram and site map. Currently, PV systems in the U.S. are not required to have this data easily accessible, though if the homeowner no longer can find the PV system paperwork, having it permanently located near the PV system interconnection point would help an appraiser determine the PV system characteristics.

Using the MLS, a real estate agent can capture PV system data during a home sale as the fields (if available in the MLS) will be available for the listing agent to fill out with information provided by the homeowner. Having the MLS fields populated has the added benefit of giving appraisers additional data points for determining where PV may exist, especially when conducting a comparable sales analysis. There are multiple challenges with setting up an MLS to capture this information, though there is work that is focusing on this effort to include solar as well as energy efficient features [17].

Another effort being made to collect PV system data either before or during an appraisal is to fill out the AI Residential Green & Energy Efficiency Addendum, which helps support the valuation of features that are not included on the Uniform Residential Appraisal Report (URAR) Form 1004 required by Fannie Mae. The Appraisal Institute created AI Form 820.04 to capture the necessary information to develop an estimate of value for solar PV systems [15]. Home builders and real estate agents can also fill out this form and give to assist the appraiser. A database application that can capture the information filled out on this form and make it available to appraisers and real estate agents would be one way to make PV system information more readily available to help facilitate real estate transactions with PV systems.

VII. Link Between PV Market Value and Financing

If there are lower cost financing products available to purchase a home, why are low rates not available to prospective purchasers of PV systems? Consider for example the long-term trend in mortgage interest rates (30-yr fixed) has shown a decrease in the past 10 years from around 8% to just below 4% [18]. Also, home equity is starting to "reappear" in many homes [19] as home prices nationally appear to be increasing [20]. Borrowing against the home's equity provides access to these lower rates, though even these home equity rates are not as low as a standard conforming first mortgage.

Part of the challenge is that the price paid for PV systems is still high, with the national average at $5.04/Watt [21] equating to approximately $25,200 before incentives or tax credits for a 5 kW PV system. These additional loan amounts with modified paybacks that range from a few years to 15 years can be financed through secondary secured and unsecured loan products with interest rates much higher than the current conforming loan rates. If home prices continue to increase and PV system prices decrease, the homeowner will be better positioned to use the equity in their home to finance solar with lower rates, and current secondary mortgage and loan products may respond with lower rates to remain competitive with home equity refinancing.

The discussion about interest rates available for financing begs the question about the role of appraisers in helping homeowner's access lower interest rates typically available for first mortgages. Consider a loan product that allows for the inclusion of a PV system value into the loan to value ratio for the borrower based on the understanding the PV system will reduce electricity costs as a function of the market value of the energy produced.

The SAVE Act [22] has outlined this process for energy efficiency, however for solar if an as-installed value could be developed *before* the solar is installed with current appraisal approaches, new conventional 1st mortgage loan products could then be developed with lower rates that allow for the installation of a PV system after the home is purchased or refinanced. For example, strict risk-based rules would most likely need to be implemented to protect the interest of both the lender and borrower such as: 1) escrowing of funds with bonded escrow agent, 2) approval of bonded and licensed contractor to install the system, 3) funds should be subject to normal program LTV guidelines, 4) additional loan payment $\leq$ 90% of estimated monthly savings from PV energy generation (proof of positive economic benefit), or percent acceptable to GSE's, 5) roof less than 5 years old, or determination that remaining useful roof life $\geq$ (reasonable %) useful life of PV system, and 6) no mortgage funds allowed to monetize incentives (rebates or tax credits, etc.).

The product discussed above is an example of how access to lower rates could be achieved specifically for PV systems, and further dialogue between the GSE's and the Appraisal industry would need to take place. In addition, costs would most likely need to decline further from current levels and value for PV systems would need to be recognized before these products could be created and offered to consumers. It is anticipated, according to lending industry sources, that a minimum of US $400M per quarter would be required to develop a new product which based on current average national loan size of ~$230k would translate into ~1,800 new loans per quarter in demand from interested consumers who want to own and finance a PV system with the purchase of refinance of their home. As underwriters begin to accept valuations of PV systems developed by appraisers then products like this would be feasible.

VIII. Conclusions

This paper presents a case for why it is important that standard appraisal techniques be utilized and accepted for developing value for PV systems. One of the most pressing challenges is train appraisers to first understand how PV systems operate, and concurrently, educate them on certain techniques that are appropriate for certain markets depending

on how well PV is understood and desired in that community. This is currently being done with the Appraisal Institute offering a comprehensive course that covers both residential and commercial PV system appraisal techniques; though it will take some time to educate all appraisers on the benefits and value provided by PV systems.

There are many areas that could help appraisers gather the necessary data, and as the example appraisal shows, there is not one central database that appraisers can use that has both past and current cost information for PV systems in that market, or has site-specific information on the installation properties of existing PV systems. As PV systems age, documentation may be even more difficult to obtain and it is important that PV systems are captured in real estate multiple listing databases, or other databases that could be developed for the benefit of appraisers to help them more efficiently gather information they need to develop an opinion of value. As this paper focused primarily on residential topics related to appraising PV systems, many of these areas of concern and study also apply to commercial PV systems. The techniques utilized by commercial appraisers make it technically easier to value PV systems, as the use of the income and cost approaches are better understood and readily accepted by lenders in the realm of income producing properties. To value PV systems with a recognition of the income producing aspects that make these systems desirable in many markets in the U.S., residential appraisers will learn to use these approaches and develop accurate estimates of value that will help facilitate real estate transactions with PV systems.

Ultimately, as PV systems increase in popularity and become more commonplace in most markets in the U.S., appraisers will be ready to help facilitate homes sales with PV systems as they have data more readily available to employ the proper methods of valuation taught in appraiser education courses. Supporting the value of a PV system will be more accurate due to the abundance of market data and that will result in acceptance by underwriters. Partnerships with the real estate, appraisal, lending and underwriting industries are just now beginning to develop, which will help speed up this process and essentially give appraisers the professional and technical support needed to develop values for PV systems.

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