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Ryan Hubbell, Travis Lowder,  
Michael Mendelsohn, and Karlynn Cory

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

**Technical Report**  
NREL/TP-6A20-53531  
September 2012

Contract No. DE-AC36-08GO28308

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Prepared under Task No. SM12.3050

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## **Acknowledgments**

The production of this report hinges on a large amount of data collected over a multiyear timeline. Both the gathering and processing of this data involved contributions from many people, including Paul Scharfenberger, Andrew Martinez, Paul Schwabe, Bethany Speer, Claire Kreycik, David Feldman, and Ron Koenig. In addition, the authors would like to thank Jeff Logan, David Kline, Dan Bilello, Robin Newmark, Scott Gossett, and Mary Lukkonen for editorial support.

## **Preface**

This report presents trend analyses of various financial terms for solar photovoltaic (PV) projects and concentrated solar power (CSP) projects as reported in the National Renewable Energy Laboratory's (NREL) Renewable Energy Finance Tracking Initiative (REFTI). REFTI delineates PV systems into two sizes: small ( $<1$  MW) intended to capture residential and commercial systems, and large ( $\geq 1$  MW) intended to capture utility-scale systems.

The data were collected from industry stakeholders over seven analysis periods from the fourth quarter (Q4) of 2009 through the second half (2H) of 2011. All REFTI data are provided voluntarily with respondent confidentiality of paramount importance. Although these limit the scope and granularity of the project, REFTI is still the only publicly available resource for renewable energy project financial terms. It offers renewable energy stakeholders a set of information upon which project terms can be benchmarked.

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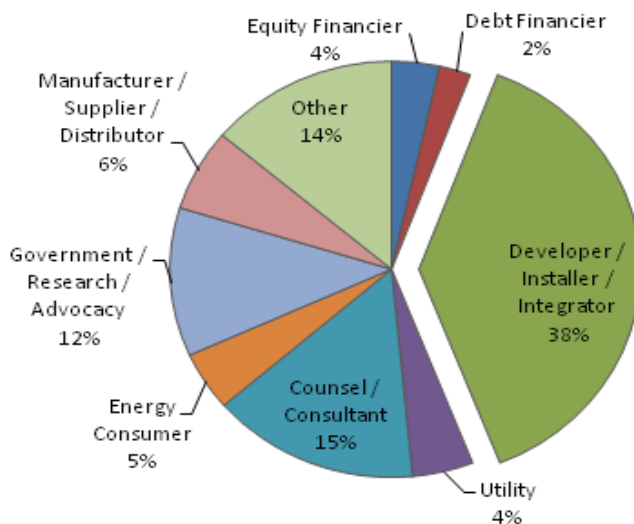
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# 1 The Renewable Energy Finance Tracking Initiative

Successful policy design, financing, and development of renewable energy (RE) projects require information to guide the decision-making process. Much of this information, however, is not widely available. Project financial terms are especially difficult to come by as many of these terms are often negotiated between two or more private entities. This lack of transparency may impede effective policy design, competition, and potentially industry growth if important information is known by only a few market participants.

To improve project finance term transparency and assist public and private RE participants, the National Renewable Energy Laboratory (NREL) created the Renewable Energy Finance Tracking Initiative (REFTI). REFTI data participants include new and existing developers, financiers, insurance companies, policymakers, and market research participants. REFTI data is used by NREL and the U.S. Department of Energy (DOE) and is publicly available for use in financial models and pro formas.

A total of 831 participants disclosed their role in the RE industry during REFTI reporting periods Q4 2009 to 2H 2011.<sup>1</sup> Almost 40% of respondents described themselves as Developers, Installers, or Integrators of RE projects (Figure 1). The second- and third-largest classes of participants were Counsel/Consultants (15%) and those involved in Government, Research, or Advocacy (12%). Equity and Debt Financiers together accounted for a modest 6% of respondents. Information and data constitute competitive advantage for financiers, and it is likely that the seeming risk of compromising that advantage through disclosure limited participation from this group. About 14% of participants selected the “Other” category when asked to disclose their role in the RE industry.



**Figure 1. Proportion of REFTI respondents and their roles in RE industry**  
Total number of respondents: 831

<sup>1</sup> The REFTI questionnaire was administered once per quarter from Q4 2009 through Q4 2010. Beginning in 2011, only two questionnaires were administered: one in the first half of the year and the other in the second half.



## 2 A Word on the Data

The principal method of data collection for REFTI was an online questionnaire distributed to those reporting to be RE stakeholders. All responses are assumed to be faithful reporting from market participants and the analyses should therefore be viewed accordingly. NREL did not confirm the accuracy of participants' responses for a number of reasons, including the assurance of confidentiality. Much of the data collected is considered proprietary and complex in nature.

NREL reports the questionnaire responses and conducts various trend and comparative analysis on the data. Although the online questionnaire restricts participation to once per IP address, it is possible for more than one respondent (e.g., a financier, a developer, and an insurer) to submit data on the same project without NREL's knowledge of the duplication, which could result in an unequal weighting of certain projects over others.<sup>2</sup>

To ensure respondent confidentiality and facilitate questionnaire completion, numerical answer choices were formatted as range-bound, multiple choice questions. To then perform comparative, trend, and aggregate analyses, median values were assigned to each bin range answer choice in order to calculate weighted averages.<sup>3</sup> **Unless otherwise indicated, all numerical values contained in the report are weighted average calculations.**<sup>4</sup>

The granular level of detail reported in REFTI may render some sample sizes too low to be considered statistically significant in comparison to the total number of projects closed in a given time period. Sample size limitations also prevent concentrated solar power (CSP) data from appearing in every section of the report.

A more complete dataset is available for review at: [financere.nrel.gov/finance/refti](http://financere.nrel.gov/finance/refti).

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<sup>2</sup> All REFTI data is provided confidentially unless the participant opts to disclose specific information about his/her project, company, etc.

<sup>3</sup> Weightings applied by response count. Highest answer choice assigned a median value of its numerical value plus the difference between its value and the prior median value. For example, if the answer choice was "10+" and the previous bin range value was "8-10," then a median value of 11 was assigned.

<sup>4</sup> As with all weighted average calculations, the fewer number of responses will increase the influence each response has on the final weighted average.

### 3 Overview of Solar Projects in REFTI

#### 3.1 Solar Project Information

Between 1,400 and nearly 3,200 projects were reported to have reached some form of financial closure<sup>5</sup> through the REFTI process (Figure 2). Not surprisingly, over 75% of these projects were reportedly below 1 MW in size and can likely be assumed to be small-scale residential systems. Of the remaining larger-scale systems, approximately nine were reported to be CSP. As illustrated, these projects accounted for a slightly higher range of capacity.<sup>6</sup> Given that 1,076 MW of solar capacity was added in the United States between 2009 and 2011 (SNL Financial), it is likely much of the REFTI-reported capacity will be installed in 2012.

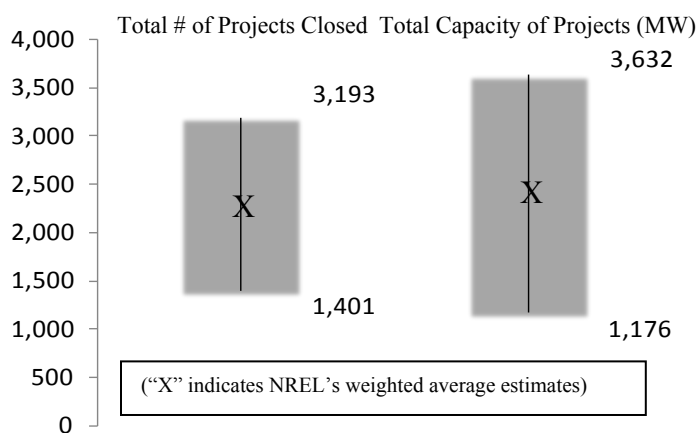


Figure 2. Ranges for total solar projects and megawatt capacity financially closed

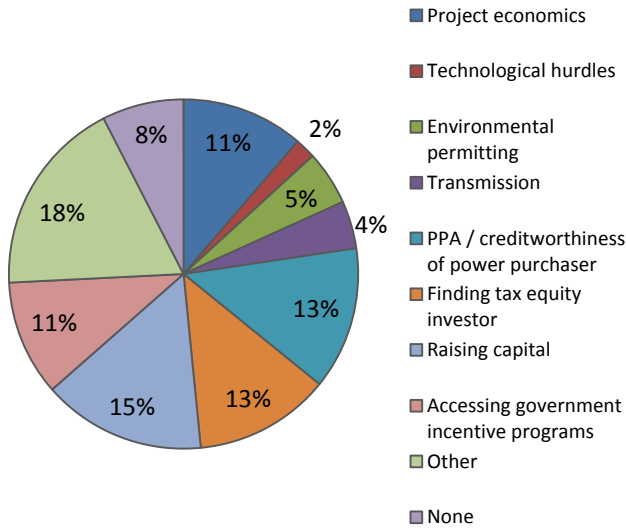
#### 3.2 Solar Project Development Barriers

Although solar projects can experience numerous development barriers, the largest reported barriers for REFTI participants were financial in nature. Both small- and large-scale PV reported raising capital and tax equity to be top barriers to development (Figures 3, 5, and 7). Since the investment tax credit (ITC) would likely have been taken in the form of an upfront 1603 Treasury grant payment, it is presumed raising tax equity was primarily utilized to monetize accelerated depreciation benefits. This may not be the case going forward following the expiration of the grant program.

No CSP respondents indicated finding tax equity investors as a top barrier but instead identified the inaccessibility of government incentive programs as the chief development hurdle. This is likely due to CSP projects not yet reaching a level of maturity to consider how best to monetize the tax benefits and heavy reliance on the 1703 federal loan guarantee program. Altogether, power purchase agreements (PPA), finding tax equity investors, raising capital, and accessing government incentives accounted for over 38% of the top barriers reported by CSP respondents and over 50% of both small and large PV respondents.

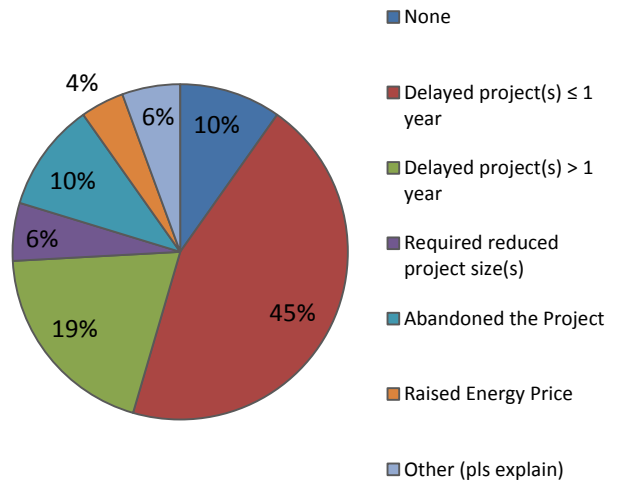
<sup>5</sup> Note, the above numbers include projects that *closed financing* and do not include projects that came online or were in the pre-financing stages of development.

<sup>6</sup> Because of limitations in the dataset having to do with the confidentiality concerns, no direct correlation can be drawn between projects reported and megawatt-capacity development in REFTI.



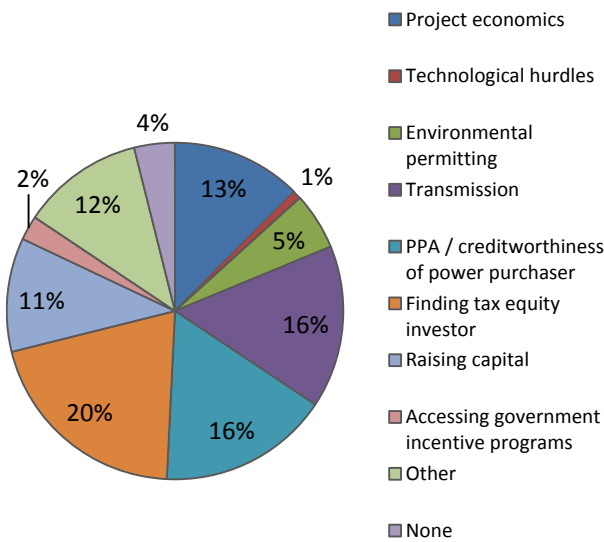
**Figure 3. PV <1 MW barriers to development**

Total responses: 159



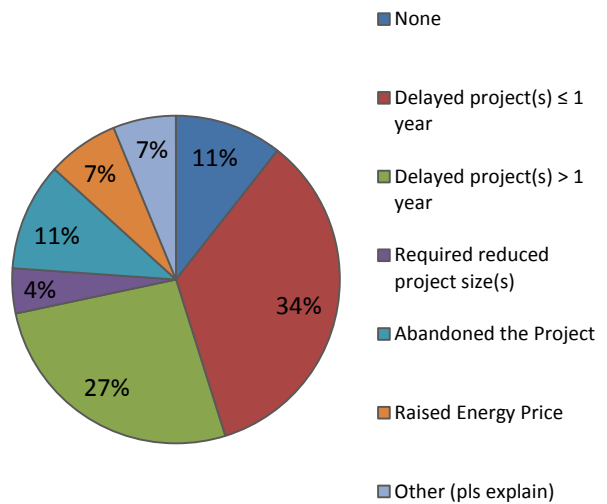
**Figure 4. PV <1 MW barrier impacts**

Total responses: 143



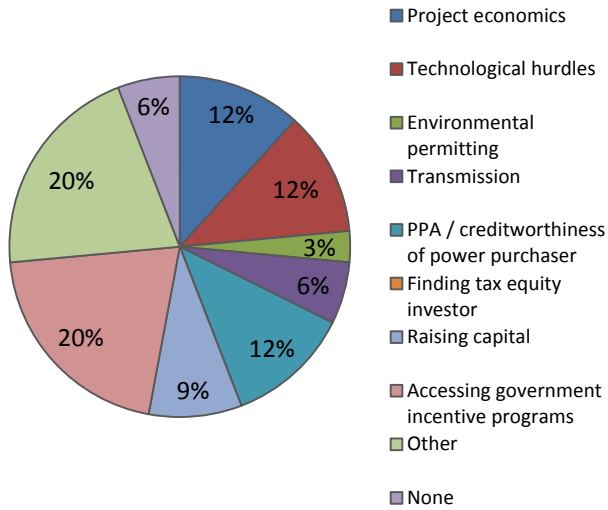
**Figure 5. PV ≥1 MW barriers to development**

Total responses: 128



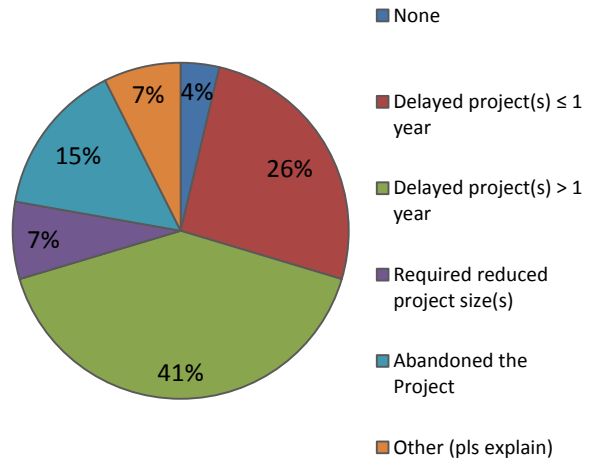
**Figure 6. PV ≥1 MW barrier impacts**

Total responses: 113



**Figure 7. CSP barriers to development**

Total responses: 34



**Figure 8. CSP barrier impact**

Total responses: 27

### 3.3 Impact of Solar Development Barriers

Figures 4, 6, and 8 show the impacts these barriers had on project development by technology. Project delays accounted for well over a majority of responses across all three categories; however, the majority of PV project delays were less than one year. Although project abandonment occurred for roughly 10%–15% of reported solar projects, this figure could be understated as it is possible some long-term delayed projects may transition to abandonment in the future.

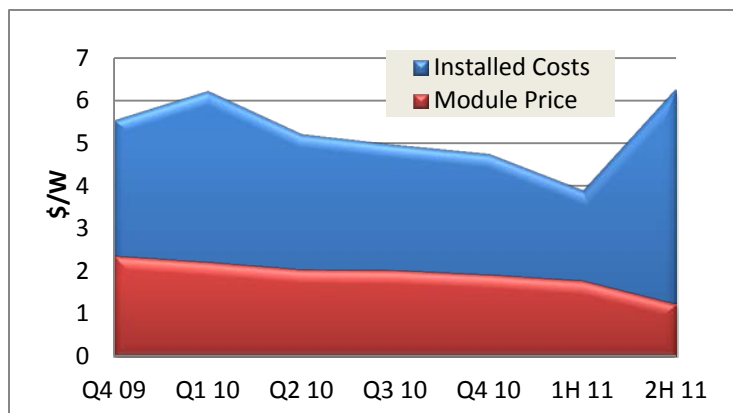
Not surprisingly, CSP projects showed a high percentage (41%) of long-term delay (>1 year) given the capital intensity, siting, and permitting requirements of many CSP projects. Also notable was the significantly higher number of responses to the “Barriers” section (36) in relation to other sections of the questionnaire (6 for most others), which seems to indicate a low track record for project completion from CSP respondents.

Also of note is the considerable portion of large-scale solar respondents that opted for the “Other” category when selecting development barriers. Further explanations ranged but were mostly centered on high upfront capital costs, limited investor pools, and legal and regulatory challenges. Three respondents did specify difficulties raising equity in the earlier project phases, which could have been categorized under the “Raising Capital” category.

## 4 Energy Costs

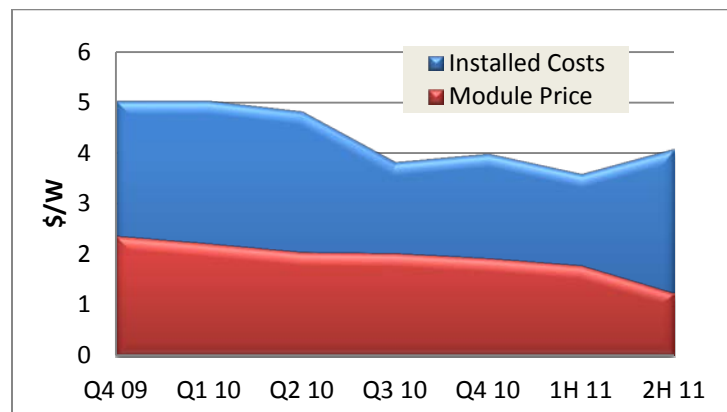
### 4.1 Solar Installed Costs

Figures 9 and 10 illustrate a general decline in installed costs for PV projects with the exception of the most recent REFTI reporting period. This overall trend is consistent with declines in global average PV module prices; however, the recent upticks reported in small-scale PV installed costs is much more pronounced than the slight increases reported by GTM in Q4 2011, by comparison.<sup>7</sup> It should be noted that installed system prices can range significantly; REFTI 2H 2011 data still falls within the range reported by GTM a full six months later in Q2 2012. Survey results also appear to indicate module price declines are outpacing balance-of-system (BOS) cost declines.<sup>8</sup> As margins get squeezed, industry consolidation may have a significant impact on future installed cost reductions.



**Figure 9. PV <1 MW weighted averages for installed costs versus PV module prices**

Total responses: 80



**Figure 10. PV ≥1 MW weighted averages for installed costs versus PV module prices**

Total responses: 61

<sup>7</sup> Only three respondents reported 2H 2011 data, one of which reported a very high \$7/W, increasing the weighted average significantly.

<sup>8</sup> For purposes of this paper, BOS costs are defined as installed costs minus module prices

Installed costs for CSP averaged \$3.70/W over the five quarters (this calculation includes an “outlier” of \$1.80/W in Q4 2009). Because of limited data, CSP installed costs could not be trended.

#### 4.2 Power Purchase Agreement

Similar to installed costs, reported PPA terms and price escalation for both PV scales generally declined until substantial rebounding was reported in 2H 2011 (Figures 11 and 12). First-year PPA prices for small-scale projects were variable throughout the analysis time period with the lowest levels reported in 2H 2011 of \$0.07/kWh. The PPA term, price, and escalation rates—combined—represent the ability of the project to ensure sufficient cash flows. It is possible the longer PPA terms and lower prices are a reflection of the effects of reduced installation costs.

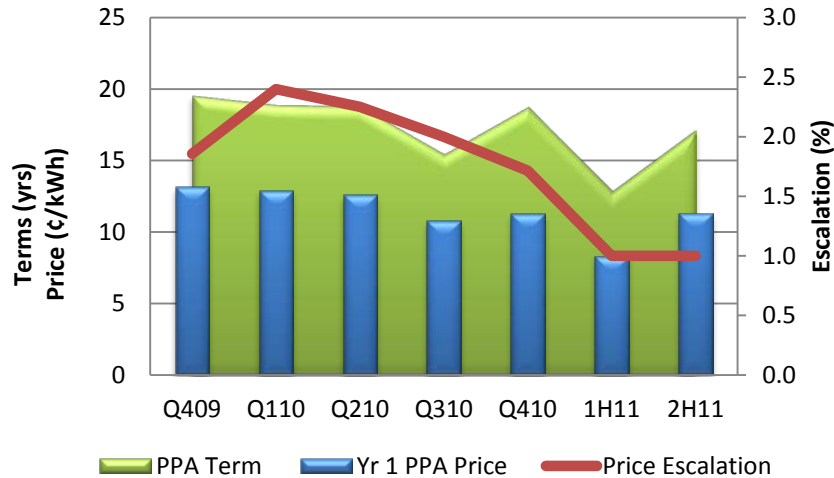


**Figure 11. PV <1 MW PPA price, escalation rate, and term weighted averages**

PPA responses: 53

Escalation rate responses: 55

All three large-scale PPA metrics tracked declined through 1H 2011, then both prices and contract term years subsequently increased in 2H 2011 (Figure 12). This indicates some short-term revenue challenges for large PV as lower electric demand and future economic uncertainties may be tempering off-takers’ willingness to guarantee future price increases. Rapid renewable portfolio standard (RPS) compliance and cost curve reductions (including natural gas generation) is also likely driving down solar PPA terms. Despite these trends, the duration of PPA terms have remained relatively stable in the 15–20 year range.



**Figure 12. PV ≥1 MW PPA price, escalation rate, and term weighted averages**

PPA responses: 52

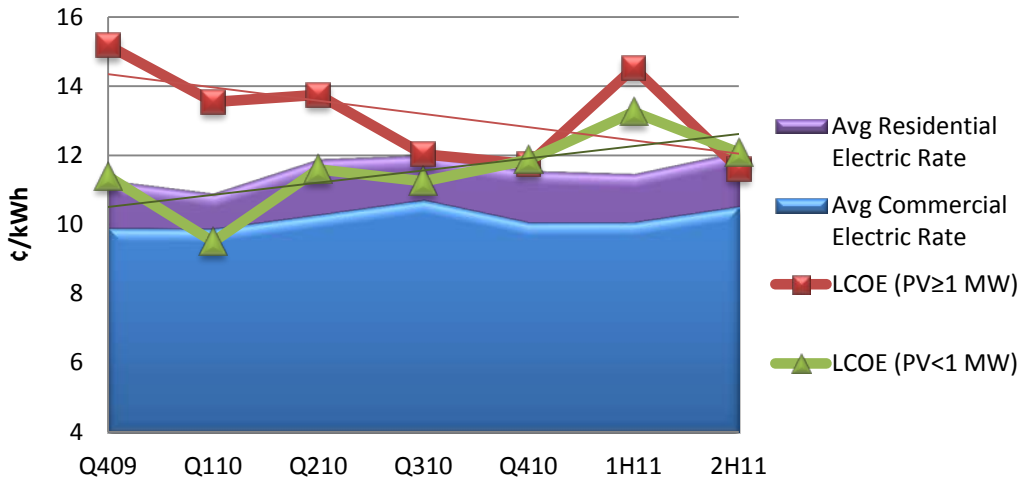
Escalation rate responses: 52

Weighted average first-year PPA prices for CSP were \$0.079/kWh with escalation rates of 1.6%. These figures are based on seven responses during the REFTI analysis period.

### 4.3 Levelized Cost of Energy

Levelized cost of energy (LCOE) weighted averages for small- and large-scale PV display opposite trend lines (Figure 13), suggesting that the cost advantage of larger systems has been gradually realized over the REFTI analysis period. This could be the function of several market conditions including the realization of economies of scale and/or centralized procurement via utilities or large commercial entities driving competition and cost reductions. In total, declining module prices and nascent BOS cost reductions are registering more perceptibly in larger-scale systems.

Small-scale PV roughly tracks average U.S. residential electricity rates, suggesting that overall (excluding regional variations in power prices), PV is a competitive option for residential rate payers. However, despite one dip below commercial electricity rates in Q1 2010, smaller PV systems registered less competitive for lower-tiered commercial rate off-takers.



**Figure 13. Weighted average LCOE (after incentives) for both PV scales versus average retail and commercial electricity prices (from U.S. EIA)**

PV < 1 MW responses: 57

PV ≥ 1 MW responses: 46

The weighted average LCOE estimate for CSP projects during the timeframe was \$0.093/kWh.<sup>9</sup> Because only four CSP projects came online between the last quarter of 2009 and end of 2011 (SEIA 2011), it is likely the projects reported were still in the development phase. Responses from the same project across multiple timeframes are also possible.

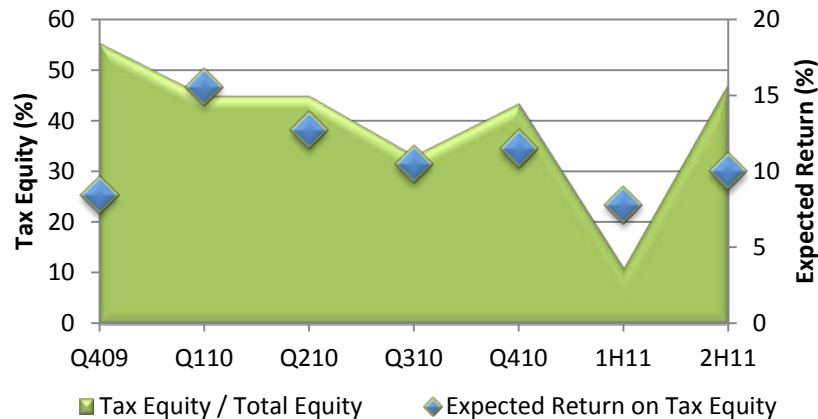
<sup>9</sup> Based on 10 responses.



## 5 Equity Structure

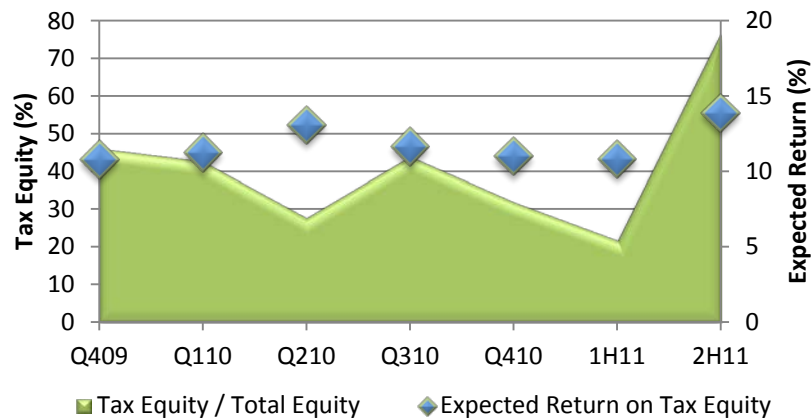
### 5.1 Tax Equity

Expected tax equity returns for both small and large PV projects rose higher in the back half of 2011 (Figures 14 and 15). Returns on both small- and large-scale projects rebounded from their 2011 first-half lows, reaching 10% and almost 14%, respectively. In aggregate, larger PV exhibited a higher expected return rate. This trend could reflect the expectation that required tax equity yields (minimum return a tax equity partner would require) would increase as a result of the 1603 Treasury grant expiration or the growing incorporation of debt into the project financial structure, which raises yields because tax equity partners take a subordinate position to creditors.



**Figure 14. PV <1 MW weighted average tax equity percent and expected returns**

Tax equity responses: 63  
Return responses: 58

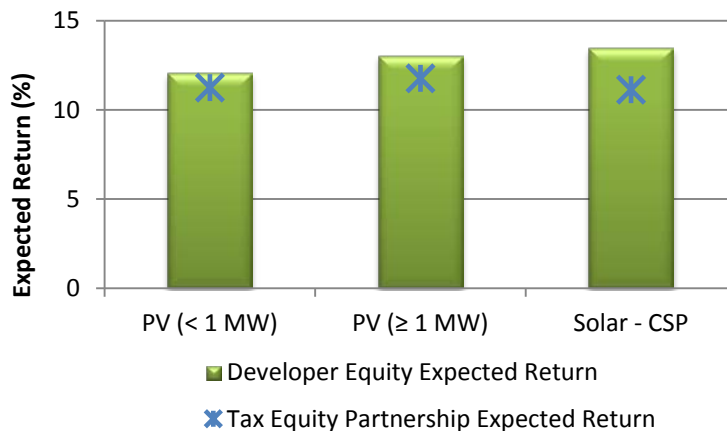


**Figure 15. PV ≥1 MW weighted average tax equity percent and expected returns**

Tax equity responses: 55  
Return responses: 52

## 5.2 Developer Equity

In aggregate, expected developer returns exceeded tax equity returns by roughly 1%–2% over the REFTI timeframe (Figure 16). This evidence seems to run counter to many developer claims that tax equity partner yields are excessive or well above developer yields. It also indicates risk alignment between the investor parties is most equitable at the smaller PV project investment level. Results may be skewed slightly lower due to question design.<sup>10</sup>



**Figure 16. Weighted average expected solar developer and tax equity returns**

## 5.3 Financial Structure

The variance in reported financial structures between small- and large-scale solar is representative of market conditions. Smaller PV projects—mostly commercial and residential installations—typically do not have the size or scale of projects sufficient to attract large tax equity investors. As third-party ownership models (from solar lease companies such as SunRun and SolarCity) have grown, however, so have residential and commercial installers’ abilities to achieve larger scales and thus attract more capital. In contrast, larger PV projects are more attractive to tax equity investors due to the transactional costs associated with the investment as well as the projects greater need and ability to support these costs.

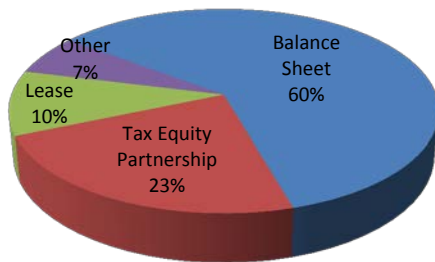
Figures 18 and 20 illustrate project finance structure trends across the REFTI timeframe. Most notable is the increased reporting of “other” financing structures, indicating project financial structure innovation continues.<sup>11</sup> Through the first half of 2011, the proportion of tax equity to total equity declined for both small- and large-scale PV (not pictured); large PV was more variable across the analysis period and the general trend was downward. This apparent decline in

<sup>10</sup> Until 2H 2011, the answer choices did not allow respondents to select “N/A” or “None” for tax equity percentages or returns. Approximately 13% of PV respondents reported 0%–10% tax investor equity to total equity before 2H 2011, and NREL expects that some portion of this 13% would have opted for the “N/A” category had it been available. Because these responses were included into quarterly weighted averages as 5% tax equity (instead of not counted at all, as would have been the case if there were an “N/A” option), REFTI’s tax equity calculations may be skewed low.

<sup>11</sup> The “Other” answer category was added in Q3 2010.

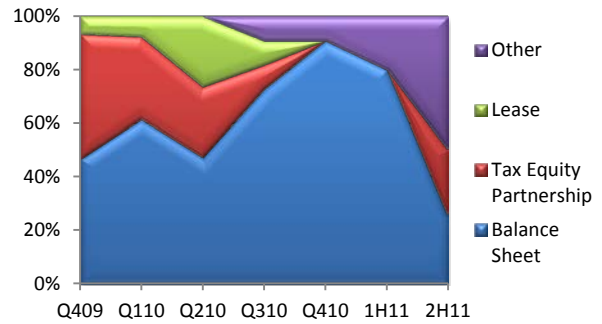
tax equity partnership percentages could reflect an increasing reliance on the 1603 Treasury grant instead of the ITC during the REFTI timeframe (Mendelsohn and Harper 2012).<sup>12</sup>

The majority of CSP respondents leveraged their balance sheets to finance projects (Figure 21), implying the projects either had well-capitalized sponsors or experienced difficulties tapping the tax equity market.<sup>13</sup> Additionally, it may indicate the utilization of the 1603 Treasury grant (an incentive that does not require a tax equity partner to monetize).



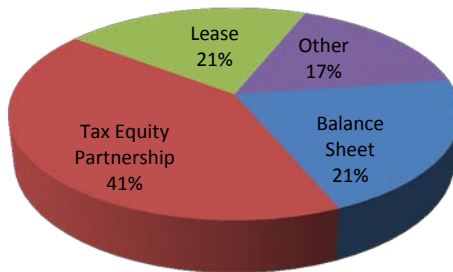
**Figure 17. PV <1 MW aggregate financial structure**

Total responses: 78



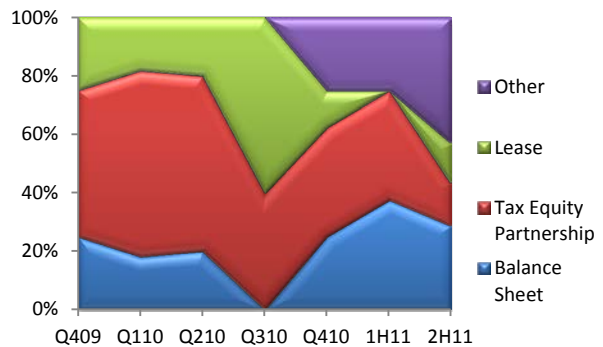
**Figure 18. PV <1 MW financial structure trend**

Total responses: 78



**Figure 19. PV ≥1 MW aggregate financial structure**

Total responses: 48

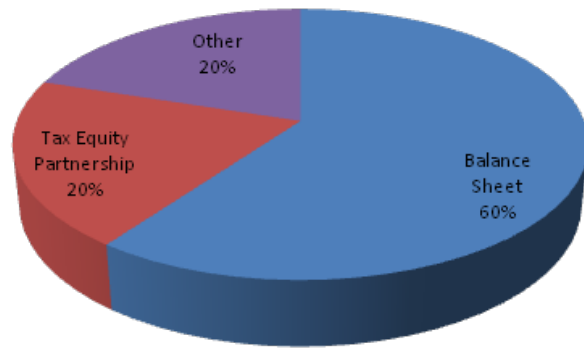


**Figure 20. PV ≥1 MW financial structure trend**

Total responses: 48

<sup>12</sup> The 1603 Treasury grant allows developers to monetize the value of the ITC, effectively reducing the need for tax equity.

<sup>13</sup> CSP is regarded as a higher risk technology with more capital intensive project costs than PV.



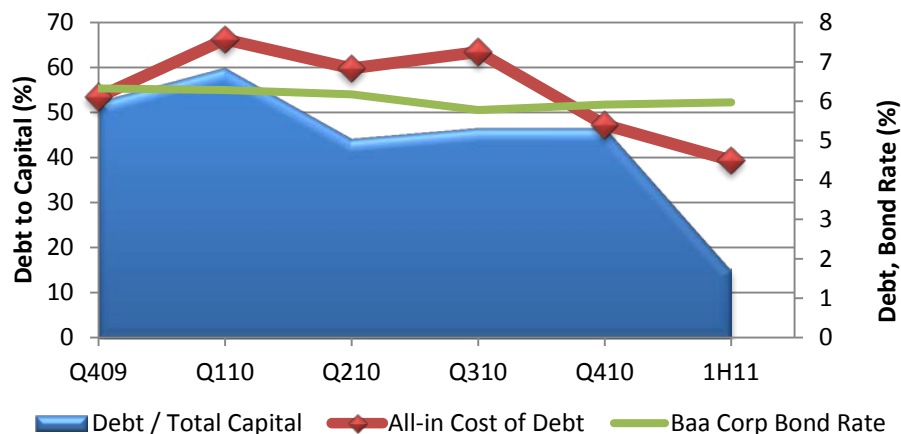
**Figure 21. CSP aggregate financial structure**

Total responses: 5

## 6 Debt

### 6.1 Debt-to-Capital Ratio and Cost of Debt

As shown in Figure 22, debt-to-capital ratios and cost-of-debt trends for smaller-scale PV have been in decline since Q1 2010. This chart seems to indicate that the third-party ownership model, which does not utilize debt to finance PV systems, has grown to a significant share of the market. In fact, out of the four participants that responded to the debt-to-capital ratio and cost-of-debt questions for small-scale PV in the latter half of 2011, all four indicated that no debt was used to finance their systems (hence, 2H 2011 data is not displayed).



**Figure 22. PV <1 MW weighted average debt-to-capital ratio, all-in cost of debt, and Baa corporate bond yields (St. Louis Federal Reserve)**

Debt ratio responses: 44

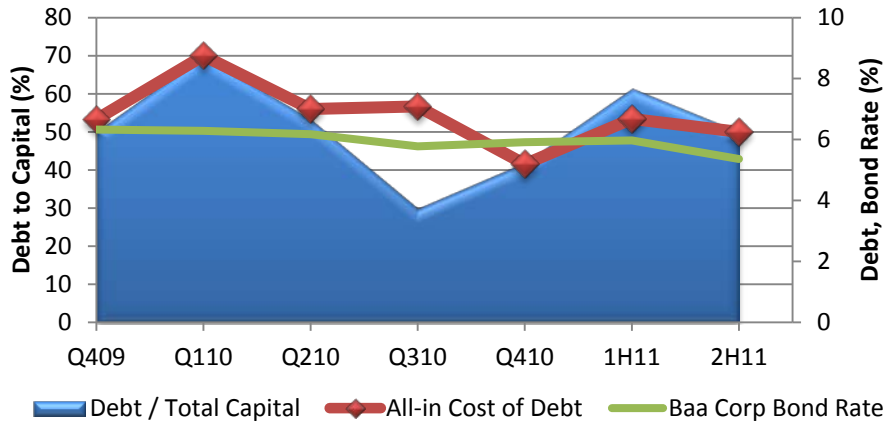
Debt cost responses: 40

Debt-to-capital ratios for large-scale PV varied, ranging from 70% to 30% (Figure 23). The cost-of-debt trend is more telling in Q1 2010, reaching a high of 8.8% before gradually settling just above 6%. This declining cost of debt could indicate the increasing use of one or more of the incentives authorized in the American Recovery and Reinvestment Act of 2009, such as the 1703 loan guarantee program.<sup>14</sup>

The cost-of-debt trends for smaller-PV categories generally tracked above Baa bond yields until Q4 2010 when both small and large PV reported declines in debt interest rates.<sup>15</sup> This could reflect improved financial market conditions or a reduction in perceived project risk from the financial community as more solar projects come online.

<sup>14</sup> Debt ratios may be skewed as projects receiving loan guarantees from DOE might have supplemented tax equity investment with debt given the more favorable terms.

<sup>15</sup> Moody's Baa-rated corporate bonds were chosen to illustrate debt spreads because of their comparable level of perceived risk. Baa is the lowest rating still considered to be "investment grade."



**Figure 23. PV ≥1 MW weighted average debt-to-capital ratio, all-in cost of debt, and Baa corporate bond yields (St. Louis Federal Reserve)**

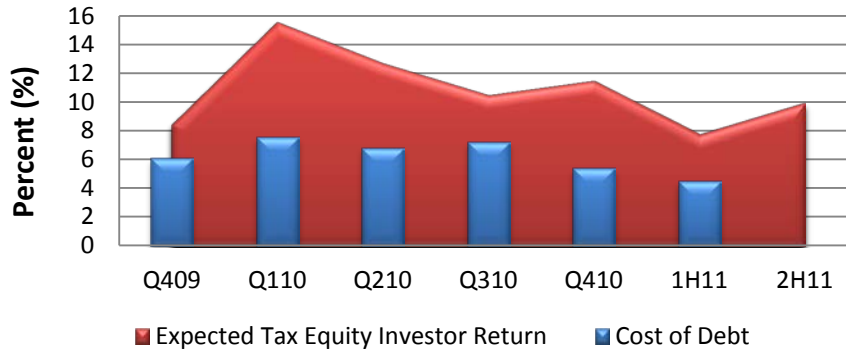
Debt ratio responses: 47

Debt cost responses: 45

## 6.2 Cost of Debt Versus Cost of Tax Equity

Figures 24 and 25 illustrate debt is a less-expensive financing option for developers. Interestingly, tax equity yields for the two project scales appear to be trending in opposite directions. This could be occurring for a number of reasons: tax equity investors are becoming more comfortable with the risk profiles of smaller-scale pooled projects, transactional costs are declining (likely due to increased standardization), and/or competition is increasing among the investment community.

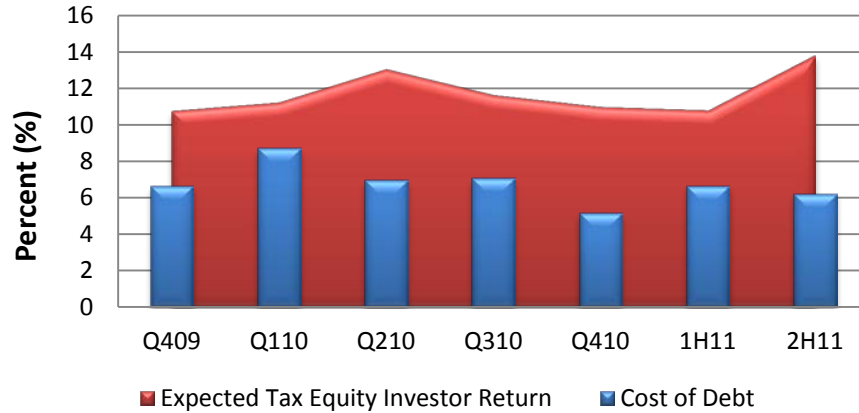
The gradual decline from Q1 2010 and rebound in later time periods will be interesting to follow for small-scale PV going forward, especially if panel prices continue to get squeezed and project sizes decline after the expiration of the 1603 grant and the loan guarantee program. (No small-scale PV respondents indicated debt load in 2H 2011.)



**Figure 24. PV <1 MW weighted average cost of debt and tax investor equity**

Debt responses: 40

Equity responses: 58



**Figure 25. PV ≥1 MW weighted average cost of debt and tax investor equity**

Debt responses: 45  
Equity responses: 52

### 6.3 Debt Term and Coverage Ratio

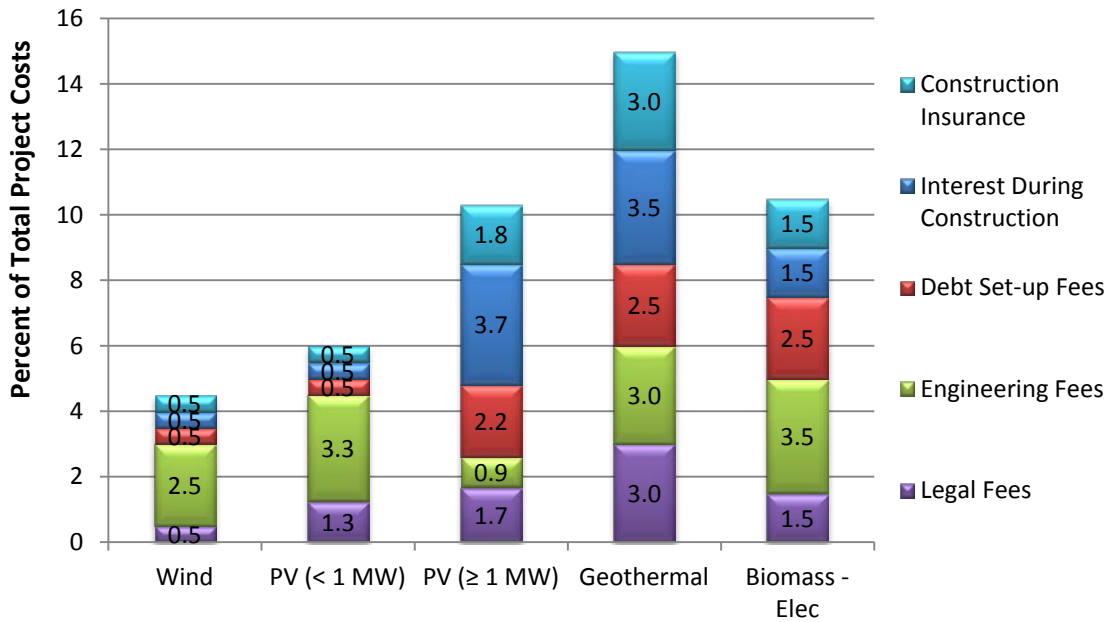
Response limitations prevented trend analysis on debt service coverage ratios (DSCR), so weighted averages for the entire REFTI timeframe (by technology) are presented in Table 1. The lower debt terms for small-scale PV and CSP are interesting to note. Shorter debt terms usually imply higher perceived risk; thus, the similarity in debt terms between small PV and CSP projects would seem to indicate similar project risk—both of which are higher than large PV. The shorter terms may also be a reflection of the lower credit quality of the off-takers for non-utility-scale PV (typically commercial entities or homeowners) and/or the increased technology risk in the case of new CSP projects. While CSP off-takers (typically utilities) mostly have investment-grade ratings and can borrow for longer tenors, they still must contend with technology risks.

**Table 1. DSCR Weighted Averages for Solar Technologies**

Project Type	Debt Term (yrs)	DSCR
PV <1 MW	12.1	1.3
PV ≥1 MW	18.3	1.3
CSP	12.1	1.4

## 7 Soft Costs

In 2H 2011, REFTI began collecting data on “soft costs” (i.e., project costs deriving from engineering, construction, and legal fees—not module costs). For small PV, soft costs totaled 6% of all project costs; engineering and legal fees accounted for almost three-quarters of this (Figure 26). Larger PV projects reported higher soft-cost ratios around 10%, on par with biomass electric. “Interest During Construction” registered as the highest cost at 3.7% of total project costs. Higher project soft costs can also increase the potential for cash leakages to occur if the project is delayed or takes longer than originally planned.



**Figure 26. Total project “soft costs” as a percentage of total project costs**

Small PV responses: 6

Large PV responses: 14



## 8 Summary

The goal of REFTI has been to increase the transparency of the RE project finance realm through the requisition and voluntary reporting of market participants. REFTI has collected a significant amount of non-publicly available RE project finance information since Q4 2009. The majority of participants have been from the solar market. Respondents to the questionnaires that eventually feed into the REFTI dataset provide their information on a confidential and voluntary basis and responses are not validated by NREL.

The following are some of the key solar project finance metrics and trends recorded since REFTI began in late 2009. A much larger dataset can be reviewed at [financere.nrel.gov/finance/refti](http://financere.nrel.gov/finance/refti).

- An estimated 2,300 projects reported closing financing in REFTI from Q4 2009–2H 2011, accounting for 2,400 MW of capacity additions.
- Financing-related challenges (e.g., PPA issues, tax equity, raising capital, and access to government incentives) accounted for the majority of reported barriers to solar development for all projects. Innovations in project financial structure continue to occur, inferably as a response to these barriers.
- LCOE for small-scale systems appear to be tracking U.S. average retail electricity rates. Large-scale systems exhibit declining LCOE (perhaps realizing cost advantages as the market matures) on a course to grid parity with commercial electricity rates.
- REFTI shows installed cost reductions falling at a faster rate than module price decline; this may indicate BOS cost reductions at work.
- The proportion of tax equity for both large- and small-scale PV rebounded significantly in 2H 2011. Expected returns trend higher for large PV and remain above debt costs on a comparative basis.

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*For a glossary of project finance terms used in this report, please visit the NREL Renewable Energy Project Finance website at <https://financere.nrel.gov/finance/content/glossary>.*