International Journal of Commerce and Management Research
www.managejournal.com
ISSN: 2455-1627
Received: 06-12-2021, Accepted: 22-12-2021, Published: 07-01-2022
Volume 8, Issue 1, 2022, Page No. 13-17

To study the effect of financial structure on the cost of solar energy

Anupam Kumar Gupta[1], Rahul Sharma[2]
[1] Research Scholar, Faculty of Commerce and Business Studies, Motherhood University, Roorkee, India
[2] Professor, Faculty of Commerce and Business Studies, Motherhood University, Roorkee, India

Abstract

To stimulate investment in renewable energy generation projects, the federal government developed a series of support structures that reduce taxes for eligible investors-the investment tax credit, the production tax credit, and accelerated depreciation. The nature of these tax incentives often requires an outside investor and a complex financial arrangement to allocate risk and reward among the parties. These financial arrangements are generally categorized as "advanced financial structures. "Among renewable energy technologies", advanced financial structures were first widely deployed by the wind industry and are now being explored by the solar industry to support significant scale up in project development. Among renewable energy technologies, advanced financial structures were first widely deployed by the wind industry and are now being explored by the solar industry to support significant scale-up in project development. This report describes four of the most prevalent financial structures used by the renewable sector and evaluates the impact of financial structure on energy costs for utility-scale solar projects that use photovoltaic and concentrating solar power technologies.

Keywords: energy accounting, financial data, financial structure investment, investment production, solar energy

Introduction

To stimulate investment in renewable energy generation projects, the federal government developed a series of support structures that reduce taxes for eligible investors-the investment tax credit, the production tax credit, and accelerated depreciation. The nature of these tax incentives often requires an outside investor and a complex financial arrangement to allocate risk and reward among the parties. These financial arrangements are generally categorized as advanced financial structures. The analysis determined that financial structures that include project-level debt generally yield a Lower Levelized Cost of Energy (LCOE) compared to those that rely purely on equity capital, although in practice raising debt at the project level can be difficult, particularly for developers without sizable balance sheets and a strong history of development experience Bolinger, M. (2009) [8].

Other insights from the analysis include: Debt associated with the loan guarantee program can reduce LCOE by approximately 20%, and possibly more, depending on the quantity of debt the project is allowed to take on. Certain financial experts expect "tax equity" capital-incorporated to maximize the use of federal tax credits and depreciation benefits-to increase in cost by 200 to 400 basis points (bp) (or 2%-4%) due to the termination of the current 1603 Treasury grant program at the end of 2011. Such an increase in the cost of tax equity is projected to raise the LCOE from utility-scale solar projects by 3%-20% (Cory, K. *et. al.*, 2009) [7].

The cost of tax equity is particularly critical in all-equity financial structures and can have a significant impact on the cost of energy produced. Even more important in all equity financial structures, the internal rate of return (IRR) target year-the project year in which the tax equity investor is expected to earn the pre-negotiated return-can have a very large impact on the resulting cost of energy. Delaying the IRR target year, for example, from year eight of the project to year nine, can improve the LCOE by 7%-27%, depending on the technology and financial structure employed (Harper, J. *et. al.*, 2007) [6].

Development and operational experience are projected to lead to further financial structure innovation and reduction in required investment returns for various sources of financial capital. These financial structures, such as "partnership flips" and various lease structures, have been instrumental in the maturation of the wind industry. As the photovoltaic (PV) and concentrating solar power (CSP) industries continue to develop utility-scale facilities, advanced financial structures are likely to play an increasingly important role in the allocation of risk and reward among different investor classes (Kolb, G.J. *et. al.*, 2011) [5].

Financial analysis methodology

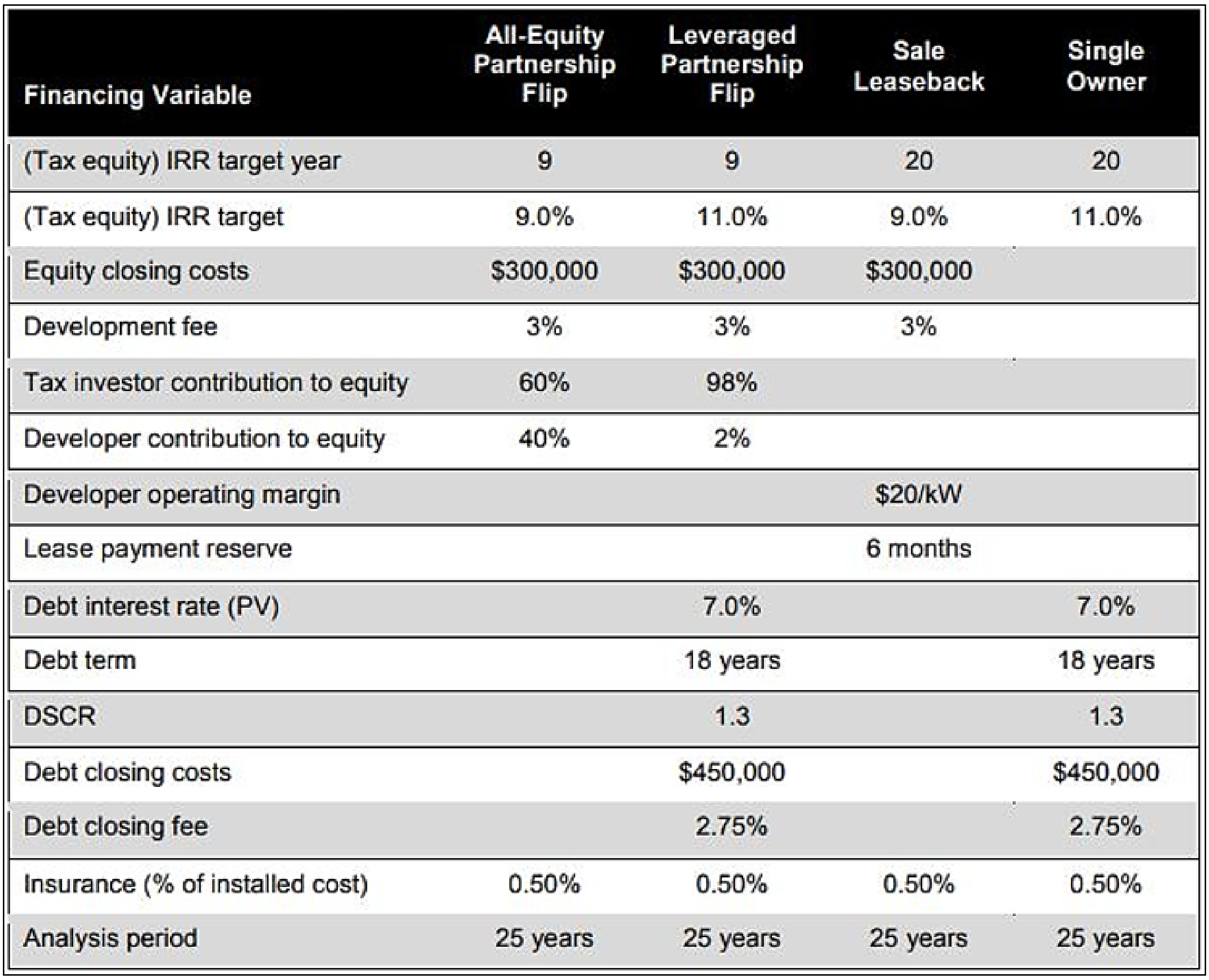
To estimate the relative impacts of financing variables on the resulting cost of solar energy, both single variable sensitivities and scenarios were developed and compared to reference scenarios. Input values for reference and alternative scenarios were chosen based on multiple sources, including:

- Default values within the SAM Advanced Utility IPP models.
- Interviews with a number of industry experts experienced with project development and under writing.
- 2010 Mintz Levin report, Renewable Energy Project

Finance in the U.S.: An Overview and Midterm Outlook, which provides technology-specific debt and equity returns. The financing variables used in the analysis for PV and

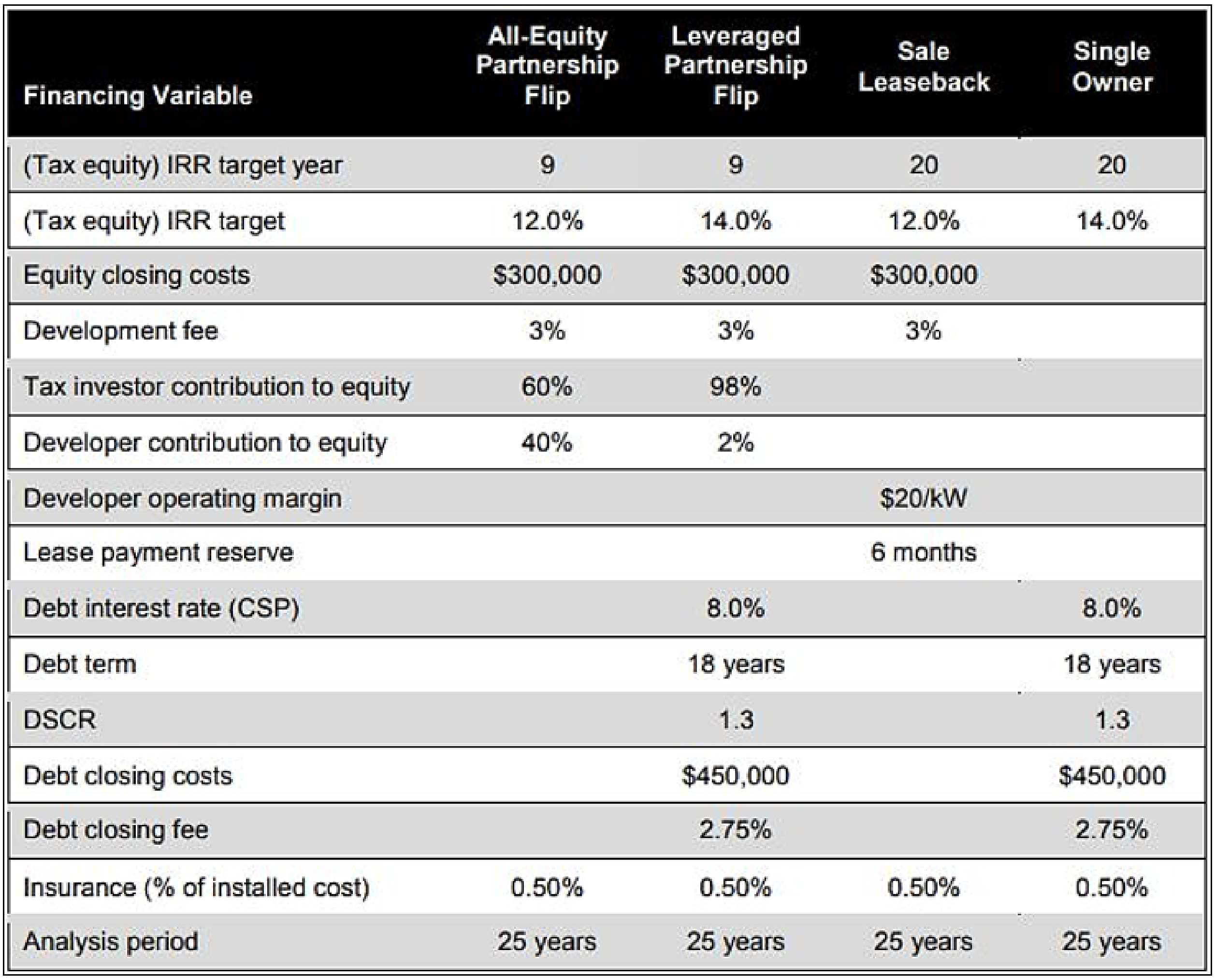
CSP, respectively. One interviewee indicated that the interest rate might be 100 basis points higher for CSP-Tower systems because of the greater technology risk. Accordingly, this incremental return was incorporated in the assumed cost of debt and equity (Scharfenberger, P. 2010) [4]. Also, interviewees indicated that, except for small differences in DSCR, financial variables would not differ significantly for cadmium telluride thin film-the primary commercially available thin-film technology utilized in utility scale installations at present-and crystalline PV technologies. The analysis did not consider financing costs for technologies not currently under development due to the necessary speculation of input assumptions. For both PV and CSP, the partnership-flip structures were assumed to have an IRR target of year nine (i.e., the project's tax investors would reach their target IRRs in year nine of the project if the cash and tax benefits were realized as projected). Equity target returns for PV plants were assumed to be 9% and 11% for the all-equity and leveraged partnership flips, respectively. The equity returns for the leveraged partnership-flip structure are higher because the structure includes a creditor who retains first lien on the project's cash; the tax investor is assumed to require a higher yield because of this added risk (Turchi, C. *et. al.*, 2010) [3]. Interviews and other resources indicate that those spreads are approximately two percentage points (200 basis points). For CSP technologies, the target returns are assumed to be higher due to technology risk given that only a small number of projects have been installed in the United States: 12% for all-equity flips and 14% for a leveraged flip. However, interviewees indicated that there is no real market experience on which to base these rates. For structures that allow for project-level debt, including the leveraged partnership flip and single-owner structures, key analysis inputs include the debt interest rate, term, and fees relevant to acquiring the debt instruments. The PV reference case debt rate is assumed to be 7% for 18 years, while the CSP debt rate modeled is 8% for 18 years. Other primary financial inputs to the structural analysis include the equity closing costs, development fees, and project benefit allocations.

The DSCR was modeled for all PV and CSP references; a level selected after consulting with industry experts. This means that cash flows must be 1.3 times the amount of debt owed per payment period. One interviewee suggested that, though CSP projects have higher technology risk, energy flows are quite stable. A debt margin for CSP technology risk can be built into the interest rate, reserve requirements, or the DSCR (Wilson Sonsini. 2009) [2].



Financing Variable	All-Equity Partnership Flip	Leveraged Partnership Flip	Sale Leaseback	Single Owner
(Tax equity) IRR target year	9	9	20	20
(Tax equity) IRR target	9.0%	11.0%	9.0%	11.0%
Equity closing costs	$300,000	$300,000	$300,000	
Development fee	3%	3%	3%	
Tax investor contribution to equity	60%	98%		
Developer contribution to equity	40%	2%		
Developer operating margin			$20/kW	
Lease payment reserve			6 months	
Debt interest rate (PV)		7.0%		7.0%
Debt term		18 years		18 years
DSCR		1.3		1.3
Debt closing costs		$450,000		$450,000
Debt closing fee		2.75%		2.75%
Insurance (% of installed cost)	0.50%	0.50%	0.50%	0.50%
Analysis period	25 years	25 years	25 years	25 years

Fig 1: Key financial variables by finance structure-PV reference case



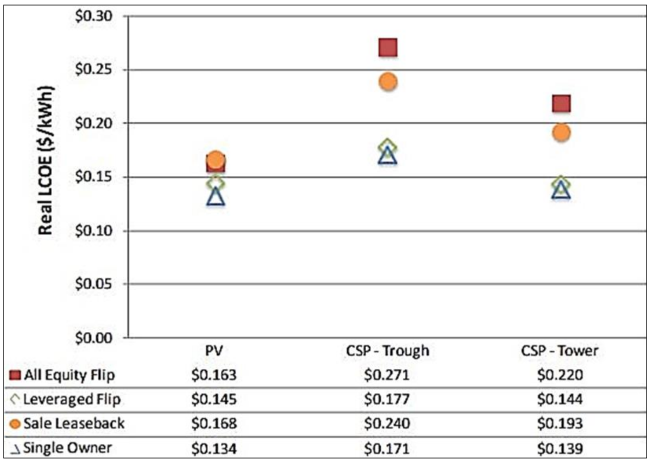
Financing Variable	All-Equity Partnership Flip	Leveraged Partnership Flip	Sale Leaseback	Single Owner
(Tax equity) IRR target year	9	9	20	20
(Tax equity) IRR target	12.0%	14.0%	12.0%	14.0%
Equity closing costs	$300,000	$300,000	$300,000	
Development fee	3%	3%	3%	
Tax investor contribution to equity	60%	98%		
Developer contribution to equity	40%	2%		
Developer operating margin			$20/kW	
Lease payment reserve			6 months	
Debt interest rate (CSP)		8.0%		8.0%
Debt term		18 years		18 years
DSCR		1.3		1.3
Debt closing costs		$450,000		$450,000
Debt closing fee		2.75%		2.75%
Insurance (% of installed cost)	0.50%	0.50%	0.50%	0.50%
Analysis period	25 years	25 years	25 years	25 years

Fig 2: Key financial variables by finance structure-CSP case

Results

Reference case

LCOE is highly dependent on cost and performance inputs, but financial structure and cost of capital can also have a significant impact. Highlights the range of results by technology. The difference in cost of energy between the technologies is more pronounced in the all-equity financial structures (represented with filled-in markers) in large part due to the cost-of-equity assumptions for PV versus CSP technologies (reference case equity returns for CSP were three percentage points higher than for PV).



	PV	CSP - Trough	CSP - Tower
■ All Equity Flip	$0.163	$0.271	$0.220
◇ Leveraged Flip	$0.145	$0.177	$0.144
● Sale Leaseback	$0.168	$0.240	$0.193
△ Single Owner	$0.134	$0.171	$0.139

Fig 3: Financial structure impact on CSP and PV real LCOE (reference case)

Additionally, the PV system demonstrated a more consistent LCOE across financing structures than both CSP-Trough and CSP-Tower systems. A $0.03 variation in real LCOE was noted for PV across financing structures, while real LCOE results varied by $0.08 for CSP-Tower and $0.10 for CSP-Trough. Overall, the CSP technologies were found to be more sensitive to financing assumptions due to their capital intensity. For all of the technologies examined, structures with project-level debt (represented with open markers) provide cost savings over their all-equity counterparts, despite the higher equity returns of 2%, or 200 basis points, required by tax investors when debt is introduced. CSP-Trough appears to be more expensive under most financial structures tested, but the results should be viewed cautiously as they are highly dependent on cost and other assumptions applied (certain sensitivities were assessed below).

This analysis assumes the default values for cost and power-generation embedded in the SAM model. This analysis also provides no energy value premium for the CSP technologies associated with their energy storage and dispatchability, although recent analyses have shown time-of-day production scheduling can improve project economics (Denholm 2011). For a generic PV plant, holding project-level debt reduced LCOE by $0.03-$0.07/kWh (20%-50%) relative to the all-equity structures simply due to the availability of low-cost credit at a 7.0% interest rate. CSP-Trough and CSP-Tower structures with project-level debt-assuming a debt interest rate of 8%-provided an advantage in LCOE relative to all-equity structures of \$0.06-\$0.12/kWh (29%-35%), even with significant debt closing costs of \$450,000 and debt acquisition fees representing 2.75% of the debt principal. Compares three commonly used metrics for the assessed PV project: real LCOE, nominal LCOE, and first-year PPA price.

Real LCOE represents a level price over the analysis period, which produces the required IRRs that excludes the effect of inflation (i.e., represents current purchasing power). Nominal LCOE is similar to real LCOE but includes the effect of inflation. The first-year PPA price incorporates a 1% annual increase in the price-of-power produced. In all cases, all power is valued the same regardless of time-of-day or season it is produced. Similar comparisons of nominal LCOE, real LCOE, and first-year PPA are in the appendix. Only real LCOE is used in the remaining main body of the report.

Scenario and sensitivity analysis

Numerous single-and multi-variable scenario analyses were run to test the impact of alternative financial inputs and other key parameters on the LCOE. The following section describes scenarios examining the impacts of:

1. Low interest rates such as those that could be obtained through a DOE loan guarantee,
2. Changes in the IRR target year, and
3. Increased cost of tax equity. Additionally, multi-variable low-and high-financing costs scenarios were developed.

Conclusion

This analysis is intended to shed light on the direction and magnitude of the impact of solar project financial variables on LCOE when using four common renewable-financing structures. Differences in LCOE between PV, CSP-Trough, and CSP-Tower technologies are highly dependent on technology cost and performance assumptions as well as project-specific factors. Note that this study considered only the cost of energy generated, with no adjustments for time of-delivery or power dispatchability. Some results are not surprising because they are not unique to renewable projects or specific to these financing structures.

Overall, this analysis found that all-equity structures yield higher LCOEs for CSP-Troughs, CSP-Towers, and PV than do financial structures that include project level debt. Also, the all-equity structures are more sensitive to changes in key equity-related variables, such as expected return on equity and flip-target year. The LCOE for debt structures is less sensitive to changes in debt rates, as evidenced by the DOE loan guarantee case, where a substantial reduction in debt rate results in a relatively modest change in the overall LCOE (this ignores the other non-cost implications of the loan guarantee, such as potentially increased debt availability).

The choice of financing structure is influenced by a variety of factors that are project dependent and mostly influenced by the investing parties. These include risk tolerance, comfort with the financing structure, ability to use tax credits efficiently, project size, and projected output. Interviews with financial experts indicated that the selection of a financial structure is frequently based on non-cost considerations or project-specific risk parameters. According to the analysis, financial structures employing project-level debt generally allow for a lower overall cost of capital and power costs. However, project-level debt can complicate the deal structure and is often available only to the largest, most secure developers.

Although debt leverage can increase profitability of the project to the developer, equity investors view the presence of debt-and the lender’s senior title to the assets-as a source of increased risk in the case of bankruptcy or underperformance of the project. Accordingly, tax equity investors require increased compensation through higher equity returns when debt is present. Further, the due diligence and negotiation processes can be more complex, potentially placing the project’s success at greater risk. One interviewee in the PV industry indicated that it is difficult to negotiate debt with tax equity investors, but as deals get larger in the future, there could be more reason to bring in debt. One interviewee indicated that debt lenders prefer to be engaged only in larger projects of \$25 million-\$50 million or larger (Zhang, Y. *et. al.*, 2008) [1].

Interviewees indicated that all four of the financing structures have been used in the PV industry, although only limited data are available on the distribution of usage. In particular, sale leasebacks are common in the PV industry where, in some cases, it is leveraged and others not. For CSP projects, most current projects benefit from the federal loan guarantee program, so all equity structures are not currently being utilized. The substantial reduction in borrowing rates from the loan guarantee program will also affect the debt-to-equity ratio and differ from a ratio based on market rates. However, scenarios based on market rates can have relevance for future projects once the loan guarantees are no longer available.

One key issue for the industry is potential increases in the cost of tax equity when the 1603 Treasury cash grant program expires. Interviewees suggest that tax equity investor returns will increase by perhaps 2%-4% (200-400 basis points) due to the increased demand for limited tax equity and expectations of shortage in the market. This analysis suggests that a significant change in tax equity rates can have a significant impact on the LCOE of projects using all-equity financing. Thus, potential increases in tax equity returns due to market shortages could lead to an increased interest in debt structures.

References

1. Zhang Y, Smith SJ. Long-Term Modeling of Solar Energy: Analysis of Concentrating Solar Power (CSP) and PV Technologies. PNNL-16727. Richland, WA: Pacific Northwest National Laboratory, 2008.
2. Wilson Sonsini. Analysis of and Commentary on DOE's Financial Institution Partnership Program, 2009, 28. http://www.wsgr.com/WSGR/Display.aspx?SectionName=publications/PDFSearch/wsgralert_FI PP.htm. Accessed November 21, 2011.
3. Turchi C, Mehos M, Ho CK, Kolb GJ. Current and Future Costs for Parabolic Trough and Power Tower Systems in the US Market. NREL/CP-5500-49303. Golden, CO: National Renewable Energy Laboratory, 2010. http://www.nrel.gov/docs/fy11osti/49303.pdf. Accessed March 19, 2012.
4. Scharfenberger P. “Normal Accounting Rules Limit Utility Ownership of Renewable Energy Projects, 2010. https://financere.nrel.gov/finance/content/normal-accounting-rules-limitutility-ownership-renewable-

energy-projects. Accessed November 21, 2011.
5. Kolb GJ, Ho CK, Mancini TR, Gary JA. Power Tower Technology Roadmap and Cost Reduction Plan. SAND2011-2419. Albuquerque, NM: Sandia National Laboratory, 2011.
6. Harper J, Karcher M, Bolinger M. Wind Project Financing Structures: A Review & Comparative Analysis. LBNL-63434. Berkeley, CA: Lawrence Berkeley National Laboratory, 2007. http://eetd.lbl.gov/ea/emp/reports/63434.pdf.
7. Cory K, Schwabe P. Wind Levelized Cost of Energy: A Comparison of Technical and Financing Input Variables. NREL/TP-6A2-46671. Golden, CO: National Renewable Energy Laboratory, 2009. http://www.nrel.gov/docs/fy10osti/46671.pdf.
8. Bolinger M. Financing Non-Residential Photovoltaic Projects: Options and Implications. LBNL-1410E. Berkeley, CA: Lawrence Berkeley National Laboratory, 2009. http://eetd.lbl.gov/ea/ems/reports/lbnl-1410e.pdf.