To Own or Lease Solar: Understanding Commercial Retailers' Decisions to Use Alternative Financing Models

David Feldman and Robert Margolis
National Renewable Energy Laboratory

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

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Technical Report
NREL/TP-6A20-63216
December 2014

Contract No. DE-AC36-08GO28308

To Own or Lease Solar: Understanding Commercial Retailers' Decisions to Use Alternative Financing Models

David Feldman and Robert Margolis
National Renewable Energy Laboratory

Prepared under Task No. SM13.0530

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

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

National Renewable Energy Laboratory
15013 Denver West Parkway
Golden, CO 80401
303-275-3000 • www.nrel.gov

Technical Report
NREL/TP-6A20-63216
December 2014

Contract No. DE-AC36-08GO28308

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Available electronically at http://www.osti.gov/scitech

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: mailto:reports@adonis.osti.gov

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/help/ordermethods.aspx

Cover Photos: (left to right) photo by Pat Corkery, NREL 16416, photo from SunEdison, NREL 17423, photo by Pat Corkery, NREL 16560, photo by Dennis Schroeder, NREL 17613, photo by Dean Armstrong, NREL 17436, photo by Pat Corkery, NREL 17721.

Acknowledgments

Most information in this report is based on in-depth conversations with IKEA and Staples personnel. At IKEA, this includes PV program manager Mark Gasper, who has been with the company's PV program from the start, and public affairs manager Joseph Roth, who worked closely with Mark throughout the process. At Staples, this includes vice president of environmental affairs Mark Buckley, who ran the company's PV program from the beginning.

The authors would like to thank the following individuals for their thoughtful reviews and comments on this work: Justin Baca (Solar Energy Industry Association), Mark Bolinger (Lawrence Berkeley National Laboratory), Carolyn Davidson (NREL), Alan Goodrich (SunEdison), Olayinka Kolawole (DOE), and Stephen O'Rourke (SunEdison). The authors would also like to thank Jarett Zuboy for editorial support. This work was supported by the U.S. Department of Energy under contract number DE-AC36-08GO28308.

Executive Summary

This report examines the tradeoffs among financing methods for businesses installing onsite photovoltaics (PV). We present case studies of PV financing strategies used by two large commercial retailers that have deployed substantial U.S. PV capacity: IKEA, which owns its PV, and Staples, which purchases power generated from onsite PV systems through power purchase agreements (PPAs). We also analyze the financial considerations that influence any company's choice of PV financing strategy. Our goal in this report is to clarify the financial and institutional costs and benefits of financing strategies and to inform other companies that are considering launching or expanding similar PV programs.

IKEA's decision to self-finance its PV systems fits well with its corporate culture. Although the company assumed more risk by owning PV instead of leasing[1] it, IKEA believes that careful process management enables it to reap the benefits of owning long-term, high-quality assets. In contrast, Staples' decision to lease its PV systems through PPAs aligns well with its risk-return preferences. The technical and market expertise of the third-party PV owner has enabled Staples to deploy PV rapidly, and the company is pursuing several strategies for overcoming challenges related to installing PV on leased buildings.

Our modeling quantifies financial drivers that companies like IKEA and Staples consider when choosing a PV financing strategy. If one simply assumes a pre-tax discount rate of 10%, the levelized cost of energy (LCOE) for the modeled self-financed system is approximately 30% lower than the LCOE for the PPA-financed system.[2] However, the attractiveness of the financing methods varies due to different assumptions for cost of capital, different perceptions of PV investment risk, and different perceptions of the risk of using a particular financing method. When the commercial customer's pre-tax discount rate rises to 23%, for example, the LCOE is equivalent under either financing method. If a company assumed a 10% pre-tax discount rate for a PPA and a 23% pre-tax discount rate for self-financing, then the LCOE would be 14% lower using the PPA.

The timeline for customer payback is another consideration. Although, in our model, self-financing provides a better return over the 20-year project lifetime, it is net-cash-flow-negative for about 5-11 years. The PPA, on the other hand, produces positive cash flow quickly and is economically more attractive than the self-financed system for the first 6-14 years. Still, our modeled self-financing is even more attractive over the long term if the PV lifetime is extended to an expected period of 30 years—this assumption lowers the LCOE by 17%. Self-financing might also have advantages over PPAs due to involving fewer parties in the financial transaction and requiring less-expensive electric meters.

That said, PPAs offer potential advantages to some companies. Unlike purchase of a PV system, PPAs are off-balance sheet transactions, which might suit companies unwilling or unable to add the liability of a PV loan onto their balance sheets. In addition, a company can get the full

[1] In this paper we use the term "lease" to refer to both 1) customers that pay a set fee per month for the use of an onsite PV system; and 2) PPA customers that pay per kWh of generated electricity from an onsite PV system. In some jurisdictions there is a legal distinction between the two arrangements; however, for the purposes of this paper, we are using the term "lease" in this broader sense.
[2] See Appendix A for weighted Average Cost of Capital (WACC) calculations.

benefits of a PPA with any amount of tax liability whereas self-financing companies must have sufficiently large tax liability to take full advantage of PV tax incentives. Companies using PPAs also might reduce their exposure to risks related to PV underperformance, unanticipated O&M costs, and delays in receiving incentives and grid-interconnection approval.

Our analysis suggests that the most appropriate PV financing option for a particular business depends on the characteristics and circumstances of that business.

Table of Contents

List of Tables

List of Figures

1 Introduction

Most distributed solar photovoltaic (PV) production capacity in the United States is installed on commercial buildings and property. In October 2013, the top 25 companies had installed approximately 11% of all distributed U.S. PV capacity (SEIA and Vote Solar 2013; SEIA and GTM Research 2014). This likely results from several factors: businesses have large electricity needs, accounting for 36% of all U.S. electricity sales in 2013 (EIA 2014); they occupy substantial real estate, with an estimated total floor space of 88 billion square feet[3] (EIA 2014); and, unlike many individual consumers, they often can make long-term investments or contractual agreements to produce economic benefits.

One of the key decisions a business must make about PV is how to finance its installation. A company can buy a PV system using debt or its own funds. Alternatively, it can sign a long-term contract (15–25 years) to lease the system or purchase the system's electricity (via a power purchase agreement [PPA]) with a third party that purchases, owns, and operates the PV system on the company's property. This third-party-ownership (TPO) model constitutes a significant market share in many U.S. states. In California and New Jersey, two of the top U.S. commercial markets, TPO systems account for approximately 25%–55% of commercial systems (Figure 1).

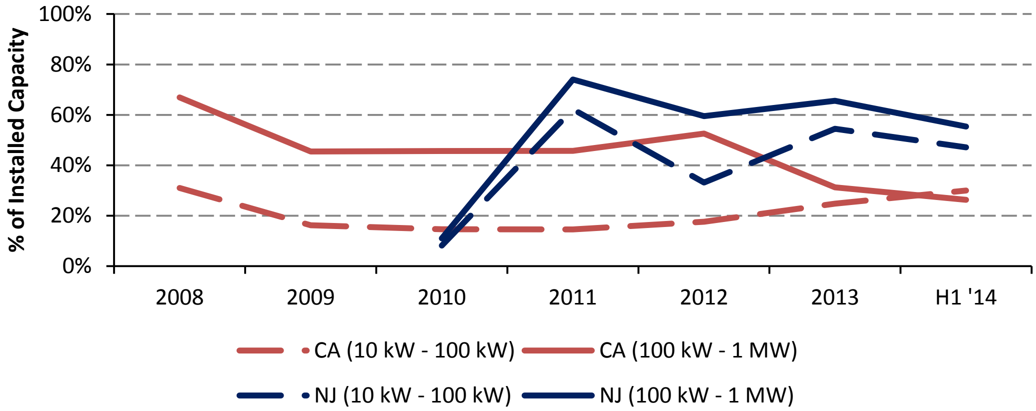

Figure 1. Third-party market share of annual commercial PV installations, by state (California and New Jersey) and system size

Sources: CSI 2014; NJCEP 2014

Each ownership model—self-ownership and TPO—has its own value proposition, with different benefits and limitations. The cost of capital incurred by the host business and the third party is a major factor. However, other factors can affect the economics as well, including the host's need for tax liability to use federal tax incentives, the additional liability and maintenance costs associated with ownership, the complications of adding assets and liabilities onto the company's balance sheet,[4] and the economic time horizon of decision makers.

[3] This figure includes multiple floors within buildings but excludes land.
[4] This is in the case of self-ownership. TPO transactions, in contrast, are off the balance sheet.

To explore the tradeoffs between PV self-ownership and TPO, this report presents detailed case studies of two companies with contrasting PV-investment strategies: IKEA, a home furnishings retailer that owns all of its systems directly, and Staples, an office-supply chain that purchases power generated from onsite PV systems through PPAs. In 2013, IKEA ranked first in the nation in the percentage of facilities using solar, with 35 MW of PV on 39 (89%) of its U.S. facilities (Figure 2), while Staples ranked ninth in installed PV capacity, with 14 MW of PV on 37 (2%) of its U.S. facilities (SEIA and Vote Solar 2013). At the end of 2013, Staples and IKEA had a combined PV capacity larger than the capacity of 28 individual states (SEIA and GTM Research 2014).

We examine why these two companies chose different ownership and financing structures to achieve significant PV deployment. We also analyze the financial considerations that influence any company's choice of PV financing strategy. Our goal is to clarify the financial and institutional costs and benefits of each strategy from the end user's perspective for the benefit of other companies that are considering launching or expanding similar PV programs. While some of the methods IKEA and Staples pursued were achievable in part because they are multi-national companies with large balance sheets, many of the decisions made and lessons learned are applicable to businesses and deployment strategies of many different sizes. Sections 2 and 3 of this report present the IKEA and Staples PV case studies. Section 4 analyzes the economics of PV self-ownership and TPO, and Section 5 provides conclusions.

2 IKEA

As of June 2014, IKEA had PV on 40 (nearly 90%) of its U.S. facilities in 20 states, representing a total capacity of 39 MW, as part of a global investment allocation of $1.8 billion in renewable energy (IKEA 2014). Approximately half of the company's global PV capacity currently is in the United States. This large-scale deployment resulted from IKEA's global strategy, which in turn was influenced by the company's structure and corporate culture.

Figure 2. IKEA store with substantial PV deployment, Atlanta, GA

Source: StrataSolar 2014

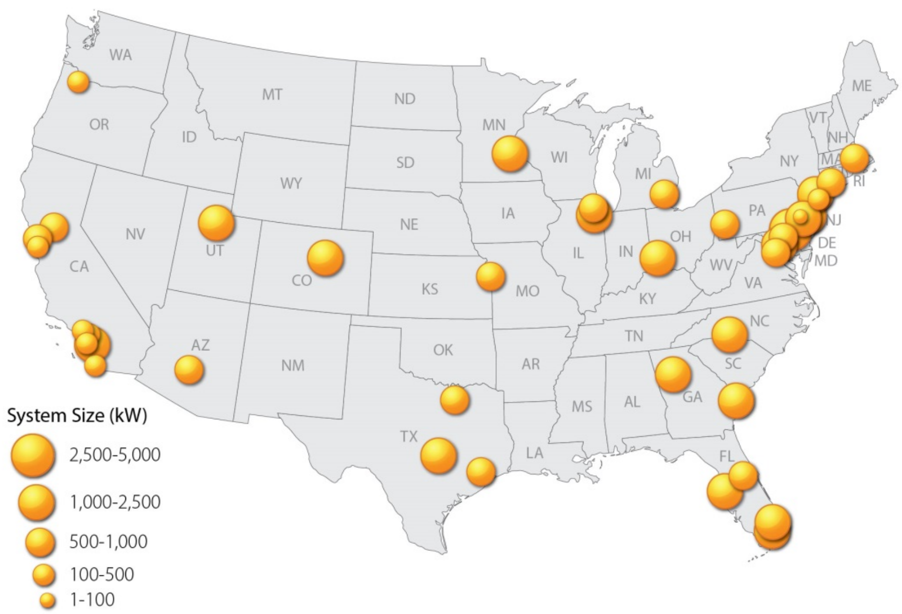

Figure 3. PV Installations at IKEA facilities, by system size

Source: Gasper 2014

2.1 Deciding To Deploy PV

IKEA is a privately-held company, with many of its business activities driven by global offices in Sweden, but its corporate management delegates certain decisions to local headquarters in individual countries or regions.[5] Around 2005, IKEA's global operations reviewed its business costs, including energy costs. IKEA buildings require substantial electricity, and the company viewed this as an uncontrolled cost. To mitigate energy-related risk, IKEA began developing strategies to reduce energy consumption through energy efficiency and reduce exposure to electricity price changes. It determined that using renewable energy could help control these costs. In particular, PV was viewed as a potential long-term hedge against volatile electricity prices.

Although IKEA does not have to worry about public investor sentiment, it wanted to be a better corporate citizen by reducing its carbon footprint. According to company interviews, costs and sustainability are cornerstones of Swedish culture, and everything IKEA does is filtered through the lens of sustainability (Gasper & Roth 2014). IKEA's private status also enables it to have a longer-term planning horizon compared with the horizons of typical public companies. As IKEA public affairs manager Joseph Roth puts it, the company's mindset is, "How can we reduce costs, and do it in a good way? We are constantly looking for ways to be more sustainable in that context" (Gasper & Roth 2014).

IKEA set a global goal of supporting its operations with 100% renewable energy while reducing energy use. It established a global energy program and delegated the particular strategies for achieving the overarching goal to company leadership in each of its countries of operation. In the early years, IKEA's global team took the lead in identifying opportunities. Thresholds for capital investments were established, and in 2006 the company globally began focusing on PV. Four pilot sites were created worldwide, including a store in the United States (Brooklyn, New York), to evaluate module performance by gathering long-term, granular production and cost data. At the same time, IKEA's U.S. team began learning about the technology and potential frameworks for financing it.

2.2 Choosing a Financial Structure

Early on, IKEA determined it had no interest in PPAs for financing PV deployment for several reasons. First, it thought owning the PV would provide a better return. "We had very clear guidance from IKEA globally," says IKEA PV program manager Mark Gasper. "The mindset was that if you look at the PPA model, and what drives companies to be able to get investments to drive that model, there has got to be a reasonable rate of return built into it. If an investor can get a minimum rate of return and can pass some of the savings in the form of an electricity hedge onto the host, then we [IKEA] should be able to cut out the middleman and capture all of the benefits associated with the project, whether those are financial—from a tax perspective, etc.— or environmental attributes (Gasper & Roth 2014).

Second, IKEA believes it operates under a longer investment time horizon than most other organizations are willing to accept. "When IKEA looks at what we consider a minimum of at least 20, or more like a 25-30 year investment, the corresponding payback time –whatever it may

[5] IKEA does have franchises, but it franchises to itself.

be–is not out of line with the time period IKEA expects the asset to be productive for the organization," says Gasper (Gasper & Roth 2014). When IKEA enters a market, it wants to be there a long time, and it typically builds its own buildings, purchases the associated land, and owns or establishes long-term relationships with its suppliers. Roth attributes this desire to own rather than lease to the company's southern Swedish culture. "If you work hard, you can control your own destiny," he says. "Why should we participate in a PPA when we could own it [the PV] ourselves?"

IKEA also can finance capital expenditures through its available balance sheet. It typically tries not to rely on outside financing, whether buying land or buildings or making capital investments. If an investment satisfies a required rate of return and IKEA global approves it, the company can self-finance it.

2.3 PV Ownership Challenges and Solutions

Deciding to own PV presented IKEA with a new set of challenges. The company had no experience procuring, owning, or operating a PV system and therefore had no institutional knowledge to understand the process or assess the risks. To overcome these challenges, IKEA began working with external partners that understood their vision and were willing to work with them. PV program leaders at IKEA also engaged the company's finance and tax departments to understand how they could best take advantage of PV ownership.

IKEA's first U.S. project (not driven by the global pilot program) was in Arizona in 2010. The company, which at the time had little knowledge of U.S. solar markets, partnered with an external engineering, procurement, and construction (EPC) installer who helped guide IKEA through the decision making process. When IKEA's U.S. PV team presented the Arizona proposal, IKEA Global became excited about U.S. PV opportunities. Again partnering with an EPC installer, the U.S. team searched for additional areas with high energy costs and some potential solar incentives and identified a preliminary set of locations that were most financially attractive for PV. With the EPC installer's help, the team enrolled in incentive programs, shifting from Arizona to California and the California Solar Initiative (CSI), which, at the time in 2010, was beginning to reduce its performance-based incentive. Fortunately the team moved fast enough before a flurry of other applications shut down the CSI system for a few weeks later that year. IKEA next analyzed all of its U.S. locations, examining available incentives and local utility rates and then developed a roadmap for the most feasible PV locations. It moved more quickly in locations with high energy costs and available incentives because the team wanted to make sure those opportunities were not missed.

Early on, IKEA wanted to partner with vertically integrated module manufacturers that had a large balance sheet because of their perception that such firms would be less risky than those that were only EPC installers. However, IKEA came to the opinion that modules were a commodity and started focusing on the quality of system installation. Because IKEA would own and manage these systems for 20-30 years, it wanted to minimize maintenance concerns. In addition, roof maintenance is critical to the company, and it was very engaged in the design and construction of its rooftop systems. "We sell wood-based products in flat pack cardboard," says Roth. "If something happens to our roof, we have millions and millions of dollars of inventory at risk." Although IKEA's component and system design requirements were more robust than the requirements of some installers, the company became less stringent on components, especially modules, as long as they met the required specifications. IKEA also tried to use some of the same core equipment throughout its U.S. projects to facilitate O&M.

2.4 Expanding Deployment

Initially, IKEA relied on integrators and developers to offer PV opportunities. In a relatively short time, however, the company built an internal U.S. PV team knowledgeable enough to evaluate opportunities and projects on its own, release requests for proposals (RFPs), and work with multiple EPC firms. Releasing RFPs was especially important when entering a new area, where the team needed to identify quality companies that would fit with IKEA's corporate culture. As it gained experience and confidence, the team developed its own expertise in modeling PV opportunities, examining incentives and other factors that drove decision making. Gaining this expertise required commitment over time, but not a large staff; only one to two people worked on the solar projects at a time.

Through its internal analysis, IKEA started developing solar projects in markets with very little solar deployment. This presented challenges, particularly with respect to the interconnection process. Owing to limited experience connecting large PV systems to their networks, some utilities had concerns about the grid reliability impacts of connecting a 1-MW or larger rooftop installation. While some of these discussions took time, IKEA understood how the systems worked and had long-term historical data from other PV systems it owned; in certain cases IKEA put the prospective utilities in contact with utilities that had worked with IKEA. In several states (including Maryland, Minnesota, Georgia, Virginia, Connecticut, and Michigan), the rooftop systems IKEA installed were the largest built at the time, which required additional effort.

IKEA has been able to install several systems that met its hurdle-rate requirements, but which have received no state or local incentives—historically a situation that has been challenging for most companies. Because the company knew the expected system production and electricity rates, it could identify opportunities that met its long-term requirements. While projects with higher expected returns were pursued first, the company has been able to keep identifying viable projects, in part, because of PV system price declines since its PV program began.

As PV owners, IKEA has more O&M responsibilities than those who lease through a third party. Whereas O&M is typically part of a TPO contract, PV owners must maintain systems themselves or contract O&M to a third party. Currently, IKEA has EPC installers providing O&M, managed by IKEA's facilities group. The company still is evaluating best practices for maintaining the systems in the long term, once the initial O&M contracts expire (none have to date).

IKEA had to learn other aspects of managing PV systems as well. In states that used Solar Renewable Energy Certificate (SREC) programs to incentivize solar adoption, IKEA learned and created processes to comply with the necessary administrative procedures. The company also learned how to evaluate PV installation bids. Initially concerned with per-watt system cost, the company came to realize that the per-kilowatt-hour cost was the most important metric. IKEA now requires EPC installers to provide more detail on their system designs and carefully evaluate the expected system production. Over time, the company secured annual system production guarantees for many of its locations to protect itself from underperformance risk.

PV at a few IKEA locations proved financially unviable due to a combination of rates, lack of incentives, and lack of solar radiation, as well as roof-space/ structural limitations that precluded PV installation. Still, the company has installed PV on roughly 90% of its facilities. As shown in Figure 3, IKEA's PV installation efforts peaked in 2012 when it installed 20 MW at 22 of its locations.

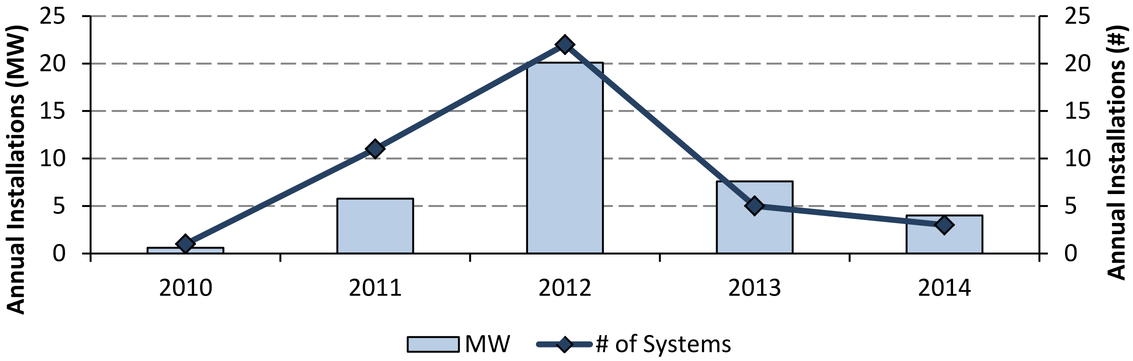

Figure 4. Annual IKEA PV installations, by number of systems and installed capacity

Today, IKEA feels it has gone as far as it can in using U.S. onsite PV at existing locations, but continues to evaluate solar potential on all future buildings, building on its U.S. solar presence and striving toward a 100% renewable energy goal. The company also is exploring other strategies, such as wind farms–two of which IKEA is currently purchasing in Illinois and Texas. It continues to examine energy management and controls to reduce grid electricity use and the associated demand charges. However, much of its peak daily load occurs from 4:00 to 7:00 p.m., which does not align with a typical PV system's production profile. IKEA is exploring ways of shifting its load curve, but as a retailer it must maintain a standard comfort level for customers. In addition, IKEA's buildings typically consume much more energy than its PV systems can generate. Despite filling entire store rooftops with PV (Figure 2), IKEA still typically consumes every kilowatt-hour the systems produce.[6] Thus IKEA's systems do not typically rely on net-metering agreements to make the economics work.[7]

[6] The exceptions to this are the four distribution centers with solar that, due to building size and thus rooftop area, hold very large arrays while also consuming much less energy than IKEA stores do. A big distribution center, unlike a typical store, is mostly a non-air-conditioned warehouse space; stores have display lights, full air conditioning, restaurant components, vertical transport, etc.

[7] Net-metering rules vary significantly across the country, sometimes involving fixed fees, capacity limits, rules on rolling credits forward, and other nuances that can impact the economics of installing a system on a commercial building. Additionally, utility rate structures also vary across the country, sometimes involving fixed fees, capacity fees, or energy fees. PV system economics can change dramatically depending on the applicable net-metering rules and utility rate structures, as well as the load profiles of the building and the PV system. For a detailed discussion of the potential impacts of net metering and utility rate structures on PV system economics see Ong et al. (2010) and Wiser et al. (2007).

3 Staples

As of the end of 2013, Staples had PV on 37 (2%) of its U.S. facilities in seven states, totaling 14 MW of capacity. It has installed PV on retail stores, distribution centers, and its corporate headquarters. These results are due to the company's corporate strategy, its partnerships, its underlying primary business, and its corporate culture.

Figure 5. Staples distribution center with substantial PV deployment, Killingly, CT

Source: CEFIA n.d.

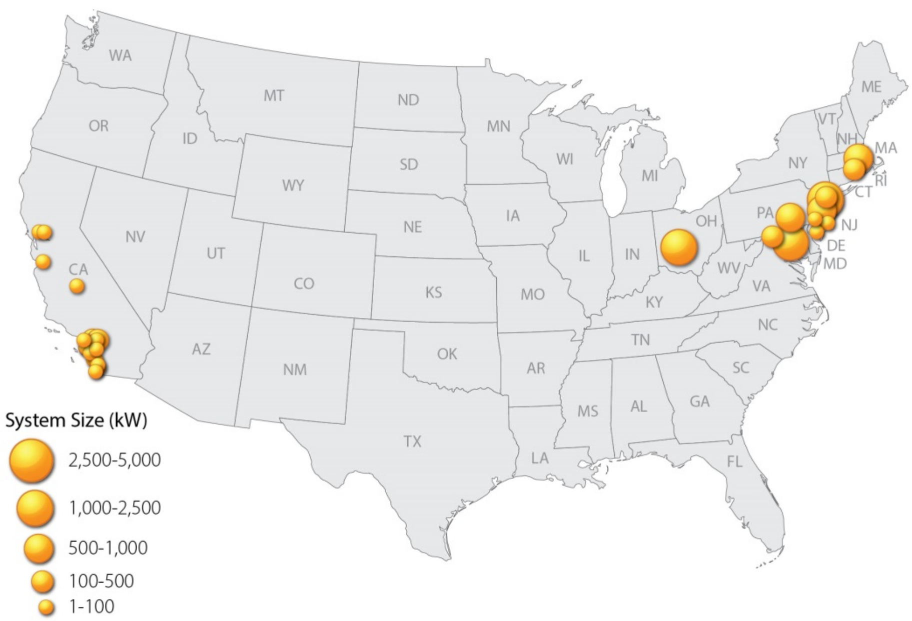

Figure 6. PV Installations at Staples facilities, by system size

Sources: CSI 2014; CEFIA 2014; DOER 2014; PJM-EIS 2014

3.1 Deciding to Deploy PV

Staples is a 28-year-old company with a diverse portfolio of facilities. At the end of 2013, it operated 1,515 retail stores and 55 distribution centers in 48 states and Washington D.C. as well as 654 retail stores and 61 distribution centers abroad. Facilities range in size from distribution centers with 1 million square feet to city stores with a few thousand square feet.

Around 2002, through the initiative of its chief financial officer (CFO) and vice president of environmental affairs, Staples began to look for energy innovation opportunities beyond the standard practice in the retail sector. Similar companies at the time were focusing primarily on lighting retrofits, which made economic sense. Staples' CFO generated the idea of bundling a portfolio of energy-related retrofits over a large number of locations, even in areas without incentives, to make the whole investment attractive. Beyond the economics, Staples was also interested in becoming a more sustainable company. It instituted a long-term carbon reduction goal and made energy efficiency and renewable energy a key part of fulfilling that goal. It has also been involved in other green initiatives, such as the Green Power Market Development Group, which consists of 15 leading U.S. companies and had, among other goals, a 2010 renewable energy deployment goal. Staples also joined the U.S. Environmental Protection Agency's (EPA) Climate Leaders Program, which it felt encouraged companies to be more sustainable.

3.2 Choosing a Financial Structure

Staples viewed PV through sustainability and economic lenses. During its initial examination of PV (2003-2005), the company could not model a case in which PV made economic sense. In addition, 95% of Staples' real estate was leased, thus it did not have control over much of its rooftop space.

In 2003, SunEdison approached Mark Buckley, Staples' vice president of environmental affairs. SunEdison, which was a relatively small company at the time, had been developing a TPO business model to provide solar PPAs to retail and office businesses. It offered to install PV on Staples' property at no cost and sell the system's electricity under a 20-year PPA. The value proposition pitched to Staples was that it did not need to own the asset but, owing to its good credit, could sign the long-term agreement at below-market rates. This proposition intrigued Staples' CFO, John Mahoney Jr., but he had questions. First, why would Staples put assets on a roof it did not own? Second, given that the average lease term Staples holds is 10 years (with a 5-year option), why would Staples sign an agreement that is longer than its lease?

To solve these issues, Staples and SunEdison modified their PPAs to provide more flexibility for the company. While the length of the PPA was 20 years, they implemented rollover provisions that enabled Staples to exit after the first 5 years without difficulties.[8] After that period, Staples could assign the contract to a different company, such as the subsequent tenant of the building. In addition, if Staples moved out of a building and the new tenant did not want to assume the PPA, SunEdison would relocate a certain amount of PV without any cost to Staples. It was very beneficial to have a portfolio when using this approach because the cost built into the PPA price was spread over many projects. In other words, Staples and SunEdison could balance the

[8] Federal tax incentives significantly limit the sale of solar assets in their first 5 years.

potential cost of moving one project against all of Staples' other stores that either did not move or could reassign their PPAs.

With these measures in place and the CFO on board, the Staples PV team had to get buy-in from each of Staples' business departments such as its head of logistics and its head of retail operations. With eventual corporate buy-in, Staples claims they were the first company in the United States to sign a PPA in 2004. Staples did not view purchasing PV systems as an option. It had competing needs for capital and did not think owning PV was part of its core business. PPAs provided the company a hedge against increasing future electricity prices with less risk and responsibility than owning systems outright.

Unlike IKEA, Staples is a public company, which gives it a different perspective on the risks of PV ownership. Staples has more stringent public reporting procedures, thus there was some concern about solar affecting the balance sheet. However, Staples is a very large company with a large balance sheet and a good line of credit; therefore the company's decision regarding solar ownership was primarily associated with the different level of risks. Company personnel hold various views as to the best financing structure, but the current corporate leadership does not have the risk tolerance to be comfortable with PV ownership.

3.3 Deploying PV

Because entering into a long-term PPA is not without risk, Staples developed a deployment strategy to maximize its cost savings and minimize its risk. First, although individual system savings varied, PPA rates had to be equal to or less than retail electricity rates. The contracts included escalators ranging from 0.5% to 2.0%, which was below the rate at which Staples thought retail rates would increase. As new deals moved forward, U.S. PV system prices decreased, which were passed along through lower PPA prices to Staples.

Initially, much time was spent getting building owners to allow Staples to put PV on their roofs, but this became easier as landlords became more familiar with the product. Some owners wanted compensation for allowing PV on their roofs, but Staples did not move forward with those locations. The company was concerned about the potential for PV to cause roof leakage, so it worked with SunEdison, the building owners, and roof manufacturers/installers to ensure that the systems would not damage the roofs or void the warranties.

Early on, Staples was open to using different PV technologies depending on a location's needs. For example, in one location the company installed a thin-film technology due to weight concerns, but their difficulties with the product deterred the company from using the product again. It also installed a large number of ground-mounted arrays, some with tracking technologies, co-located with distribution centers in Maryland, Ohio, and Pennsylvania. However, most of its systems are rooftop installations using standard crystalline-silicon modules. Over time, working in conjunction with SunEdison, the company focused on a set of standard technologies and system designs.

In deciding where to locate the PV systems, Staples and SunEdison looked at all the stores that made economic sense. They focused on states where the cost of energy was high and an RPS or local incentives were in place. The first few stores were built with funding from state grants, and Staples kept the SRECs to fulfill its corporate carbon commitments. However, as states began to reduce upfront subsidies and encourage deployment through SREC programs, the credits became a more important part of financing the installations. In response to this market change, Staples began assigning the SRECs to SunEdison and getting SunEdison to source cheaper RECs from other sources to satisfy its carbon commitments.

Many installation decisions, particularly in the beginning, were handled by SunEdison, which Staples saw as a technical advisor and partner. Staples initially managed the process with one person—its vice president of environmental affairs—but as the portfolio grew, so did the team. SunEdison did most of the market feasibility studies while Staples focused on the building feasibility (e.g., how much weight the building could handle, the roof size and age). Staples also screened all buildings to make sure they had a lease of at least 5-10 years. Collectively, the two companies selected a group of stores that fit these criteria. It was an interactive process. Staples followed trends within the U.S. solar market (such as RPS changes), but it viewed SunEdison as its expert advisor.

Staples has considered other PPA providers and occasionally has released an RFP for a particular installation, but to date it has worked almost exclusively with SunEdison. One of the reasons for this is that Staples values a vertically integrated partner, with expertise and control over installation, operation, and ownership. In the early days of its program, it had heard of third-party system owners contracting out work and the PV systems not working as well as expected (or not completed on schedule). SunEdison now has some strategic partnerships, but this is primarily because they are much larger now, which provides Staples with sufficient confidence in SunEdison's operations.

Staples contracted once with a different company; several years ago, it bought a competitor that was leasing a warehouse. Staples approached the landlord, Hartz Mountain, to put PV on its roof, but the landlord was not interested in allowing a third party to install the system. Instead, the landlord wanted to install the PV itself and offered a PPA coterminous with Staples' lease. Buckley thinks this model makes a lot of sense. "The friction of installing a 100-kW system on a portion of a landlord's roof is so much greater than the landlords doing it themselves for all of their tenants," he says (Buckley 2014).

3.4 PPA Challenges and Solutions

Having the landlord own the PV system would address one of the biggest challenges for retail stores, which is that most companies lease rather than own their property. Staples had to negotiate with the landlord of every store on which it wanted to install PV. This problem has been solved to some extent because Staples has added standard language to all its new leases since 2007 to facilitate installing PV. This language stipulates that Staples must let the landlord know it is going to install PV, but the landlord cannot unreasonably restrict Staples.

Staples has recently encountered another large obstacle to further PV deployment: because of changing market conditions, its retail sites are in flux, and the company recently announced 225 store closures. In general, Staples currently does not want to assume the financial risk related to PV generation at its retail locations. The biggest limiting factor for further PV deployment is the company's leased assets. "Unless we know for certain we are not moving out of the location, it is hard to get approval to put on solar," says Buckley (Buckley 2014). Thus Staples' PV installations have plateaued (Figure 5). The company is still committed, however, to installing

PV systems where financially attractive. In the current economic environment, this means Staples' focus has shifted to installing PV at its large distribution facilities where it has more stability and owns many of the buildings. It has also completed a few projects in distribution facilities in Belgium and the United Kingdom.[9]

Staples is also pursuing virtual net-metering, where it could get credit for electricity generated by an offsite PV system within its electric utility's service territory. This approach would be particularly advantageous for a company like Staples: it could have a PPA to provide solar electricity to a number of facilities within a region and, if it closed one store, it could simply use the power at a different location within that region. Virtual net-metering would also eliminate the need to negotiate with landlords for use of the roof in retail locations.

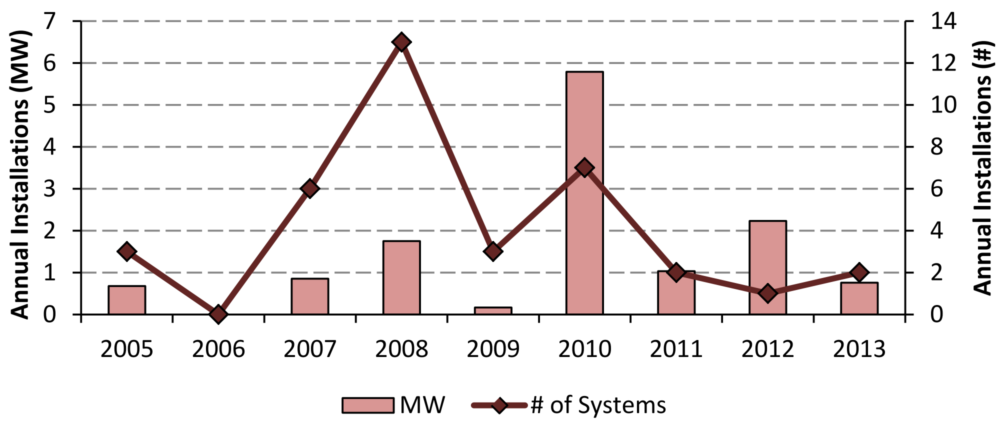

Figure 7. Annual Staples PV installations, by number and capacity

Sources: CSI 2014; CEFIA 2014; DOER 2014; PJM-EIS 2014

Despite these concerns, the turnover of stores with PV systems has been relatively small. Only one system has been transferred to a different party (none have been transferred to a different location), and the company reports that the flip was very smooth to the next tenant, who was creditworthy. If the location had remained vacant or the tenant had not been creditworthy, there might have been a problem, or the system would have been moved, but Staples has never been underwater on a PPA contract.[10] While retail rates have not increased as much as they had earlier in the PPA contracts, Staples still reports a difference between PPA prices and retail rates in part because it contracted relatively low escalation rates (0.5%–2.0%). Staples receives additional benefits where it pays time-of-use rates, and, because its energy load profile matches well with its PV generation profile, it enjoys some demand-charge savings as well.[11] The company has 650 locations participating in demand-response programs. Although it is not actively controlling load in conjunction with PV installations at these facilities (e.g., turning off a building's air-conditioning compressor when clouds pass over and solar output drops), there is still a natural fit between demand-response and solar performance.

[9] The company missed early opportunities in places like Germany, says Buckley (Buckley, 2014).
[10] "Underwater" refers to when the PPA price is higher than current retail electricity rates.
[11] When negotiating its PPAs, Staples expected there would be demand savings but did not know how much, so this was not factored into the original economic analysis or PPA contracts.

Today PV represents a very small percentage of Staples' total energy use. Still, although the company has explored other energy technologies, PV remains the company's focus for renewable energy in the U.S.

4 Economics of Financing PV: PPA versus Self-financing

In evaluating the decision to install PV, IKEA and Staples performed various economic analyses to determine the economic attractiveness of each proposal. The inputs for these analyses are private, and each project has had unique circumstances. In addition, data for these companies' PV systems and those of similar businesses are not uniformly reported. It is difficult, therefore, to analyze the specific economics of Staples' or IKEA's PV portfolio. However, modeling the economic attractiveness of PV ownership versus PPA contracting based on specific circumstances for a typical U.S. company illuminates the variables that might influence a company's decision. This section describes such an economic analysis. It also discusses qualitative factors that might influence a business. The analysis results do not suggest an option that is most efficient for every circumstance; rather, it highlights key factors a company or individual might consider in choosing a financing method.

4.1 Pro-forma Financial Models

4.1.1 Model Descriptions

To compare the economics of financing commercial PV systems through self-financing versus a typical PPA, we built two pro-forma financial models: 1) a model of a commercial PPA and 2) a model of a commercial entity purchasing the PV system directly. Each model solves for the levelized cost of energy (LCOE) that satisfies all assumptions outlined in Table 1. For a more detailed set of assumptions, see Appendix A. In effect, LCOE provides comparisons between the models, acting as a proxy for the local utility retail rates necessary to satisfy the return requirements of investors and customers.[12] Annual payments during the term of the contract were also calculated to estimate how each scenario affects cash flow.

[12] In other words, an LCOE is calculated to give each party (installer, customer, third-party owner) the required return necessary for them to participate in the transaction. These calculated LCOE's represent the minimum retail rate at which these solar projects are economically viable (given the assumptions shown in Table 1); and therefore, the lower the minimum retail rate (LCOE), the larger the potential market (or the more savings a customer can expect).

Table 1. Basic Model Assumptions

Characteristic	Value
Installed PV price	$2.39/W_{DC}$
Location	San Diego, CA
Size	500 kW
Project lifetime (PPA length)	20 years
Incentives	30% federal tax credit, 5-year Modified Accelerated Cost Recovery System (MACRS) depreciation schedule; no state incentives, including REC sales
Third-party capital cost (after-tax)	9.2% return (9.0% tax equity, 10.5% sponsor equity)
Host business capital cost	10% pre-tax return (6% after-tax) with sensitivity cases of 15% and 20% pre-tax returns[13]

All models assume system location in California. Not only is California the largest U.S. solar market, but it is also economically feasible to install systems there without state incentives, allowing for the exclusion of this complicating factor from the models. Systems were assumed to have a 20-year economic life to align with the typical term length of a PPA. The models also calculate cash flows in years 20 through 30 to measure additional benefits beyond the life of the contract but within what is typically considered the lifetime of a PV asset.

The discount rates for commercial customers were assumed to be 10% pre-tax and 6% after-tax based on assumptions and calculations outlined in Appendix A. For a sensitivity analysis, the models used pre-tax discount rates of 15% and 23% as well. Although third-party providers might have additional costs (mostly attributable to the cost of capital associated with deploying TPO systems), we assume that system price and operating expenses are not affected by differences in financing method.[14]

4.1.2 Commercial PPA Pro-forma Financial Model

In the PPA pro-forma model, the contract price per kilowatt-hour given to commercial customers was determined by the calculated LCOE reduced by the customer's discount rate, which is increased by the commercial entity's tax rate so as to provide it with an after-tax return comparable with self-ownership using a loan: PPA = LCOE × [1 – discount rate / (1 – tax rate)].

It was assumed that projects were financed using a sale-leaseback transaction between the developer (sponsor) and a tax equity provider.[15] The sponsor funds 15% of the project cost (in the form of an upfront lease prepayment which the sponsor expenses over the contract lifetime).

[13] The assumptions are not based on specific project details from IKEA or Staples; however, the self-financed scenario is similar to IKEA's financing model in that it does not use any project-level debt to finance the PV system. Instead, debt was assumed at the corporate level, as shown in the WACC calculations in Appendix A.

[14] Self-owned and TPO projects may also differ in other ways, such as different O&M costs, tax rates, as well as the assumed basis for which the tax credit and depreciation are calculated.

[15] There are currently several popular structures for financing a tax equity investment in a solar asset: sale-leaseback, partnership flip, and inverted lease. The choice between these structures is in large part affected by the preferences of the tax equity provider and the needs and ability of the developer or sponsor. The sale-leaseback structure was chosen for this analysis because of its prevalence in the marketplace; however, a different financing structure would not affect the general outcome of this analysis assuming the same financial hurdle rates apply.

The sponsor is required to make yearly lease payments to the tax equity provider and to pay operating expenses associated with the project. In exchange, it receives all PPA revenues from the system host. Based on industry data, the sponsor is assumed to require a 10.5% after-tax rate of return. The tax equity provider funds 85% of the asset, net of lease prepayments, and in exchange, receives lease payments from the developer, an investment tax credit, and 5-year MACRS depreciation associated with the project. Based on industry data, the tax equity provider is assumed to require a 9.0% after-tax rate of return (Martin 2014). In the model, the developer leases the system for 80% of the contract term, at the end of which it purchases the system from the tax equity investor for 20% of the original installed price. This ensures that the arrangement qualifies as an "operating lease" rather than "capital lease."[16] The net cash flow providing the return to each participant is calculated on an after-tax basis.

4.1.3 Commercial Self-financing Pro-forma Financial Model

In the commercial self-financing pro-forma model, the business funds the full cost of the project in year zero, but receives a 30% investment tax credit at that time as well. The business receives no revenue from the PV system, so its yearly benefit is calculated as electricity expense savings, or the calculated LCOE (i.e., comparable utility rate) multiplied by the expected PV system production. The LCOE is adjusted to provide the business with a 6% after-tax return. The business is responsible for all operating expenses, including O&M. It also expenses the cost basis of the PV system using the 5-year MACRS schedule. However, because utility expenses reduce the operating income of a commercial entity, the utility bill savings from PV produce higher operating income and thus higher taxes. The model captures this impact as well.[17]

4.2 Pro-forma Model Results

Commercial retail electricity rates vary dramatically depending on customer load profile; thus we did not compare the calculated LCOE for a PPA or self-financed system to a specific commercial retail rate. However, based on the assumptions outlined in Table 1 and Appendix A, the LCOE for the self-financed system was approximately 30% lower than the LCOE for the PPA-financed system owing to the higher cost of capital necessary for the sponsor and tax equity provider in a PPA transaction (Figure 6).

[16] In capital leases, the lessee effectively owns the asset under tax and accounting rules.
[17] In reality, the reduction in electricity expenses may not result in the full loss of the expense multiplied by the corporate tax rate due to the complexity with which companies pay their taxes.

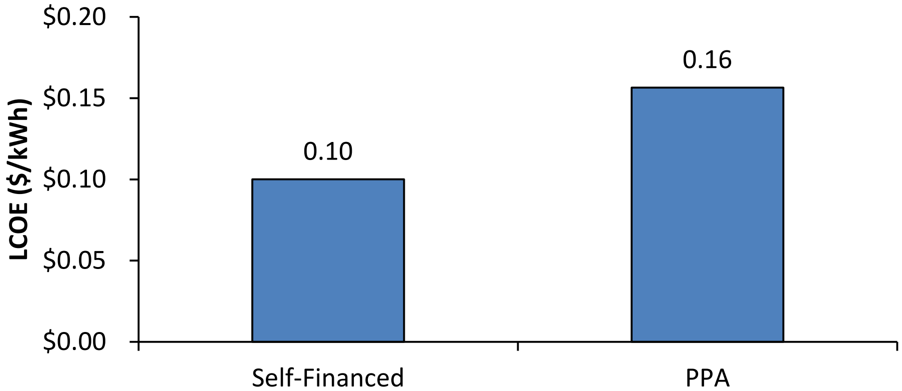

Figure 8. Modeled LCOE of commercial PV systems: self-financed versus PPA

The results in Figure 6 are based on specific assumptions, and changing any of these affects the results. For example, under both financing methods, our base case assumes that the commercial customer has a pre-tax cost of capital of 10% (6% after-tax), which is based on analysis performed for a typical company. However, some companies have higher or lower costs of capital. In addition, a company might view a PV system as a riskier investment and thus require a higher rate of return while other companies might view PV as a safer investment, requiring a lower rate of return. When the commercial customer's pre-tax discount rate rises to 23%, the cost of energy is equivalent under either financing method (Figure 7). In other words, as the perceived risk of the project increases, the required rate of return increases, so future cash flows are discounted, requiring a higher LCOE in order to justify the upfront cash expenditure.

Another factor is the perceived risk of the financing method itself. If a commercial customer perceives system ownership to be riskier than TPO (as Staples did—see Section 3), then the different financing methods would have different discount rates. If, for example, a company assumed a 10% pre-tax discount rate for TPO and a 23% pre-tax discount rate for self-financing, then the LCOE would be 14% lower using a PPA (Figure 7).

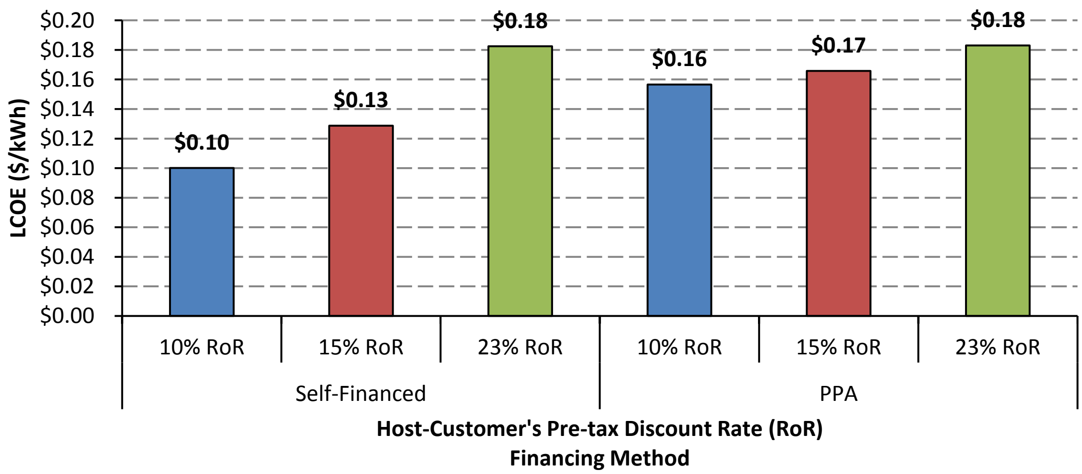

Figure 9. Modeled LCOE of commercial PV systems: self-financed versus PPA, with varying discount rates

The timeline for customer payback is another consideration. A self-financed system is net-cash-flow negative for approximately its first 5-11 years, depending on a company's hurdle rate, and is economically less attractive than a PPA system until year 6-14 (Figure 8).[18] Companies, such as IKEA (see Section 2), that view PV systems as long-term investments might be more likely than companies with a shorter-term planning horizon to accept a long period of negative cash flow in return for a better lifetime return.

[18] Note that companies can get a loan for a PV system, avoiding the upfront negative cash flows. A more detailed discussion of solar loans can be found in *Banking on Solar: An Analysis of Banking Opportunities in the U.S. Distributed Photovoltaic Market* (Feldman & Lowder 2014). Also, the cash flows in the "23% RoR" case of Figure 8 are higher than those in the "10% RoR" case. This is because a higher return requires more cash to achieve this higher rate of return, which is why the required LCOEs are greater as well.

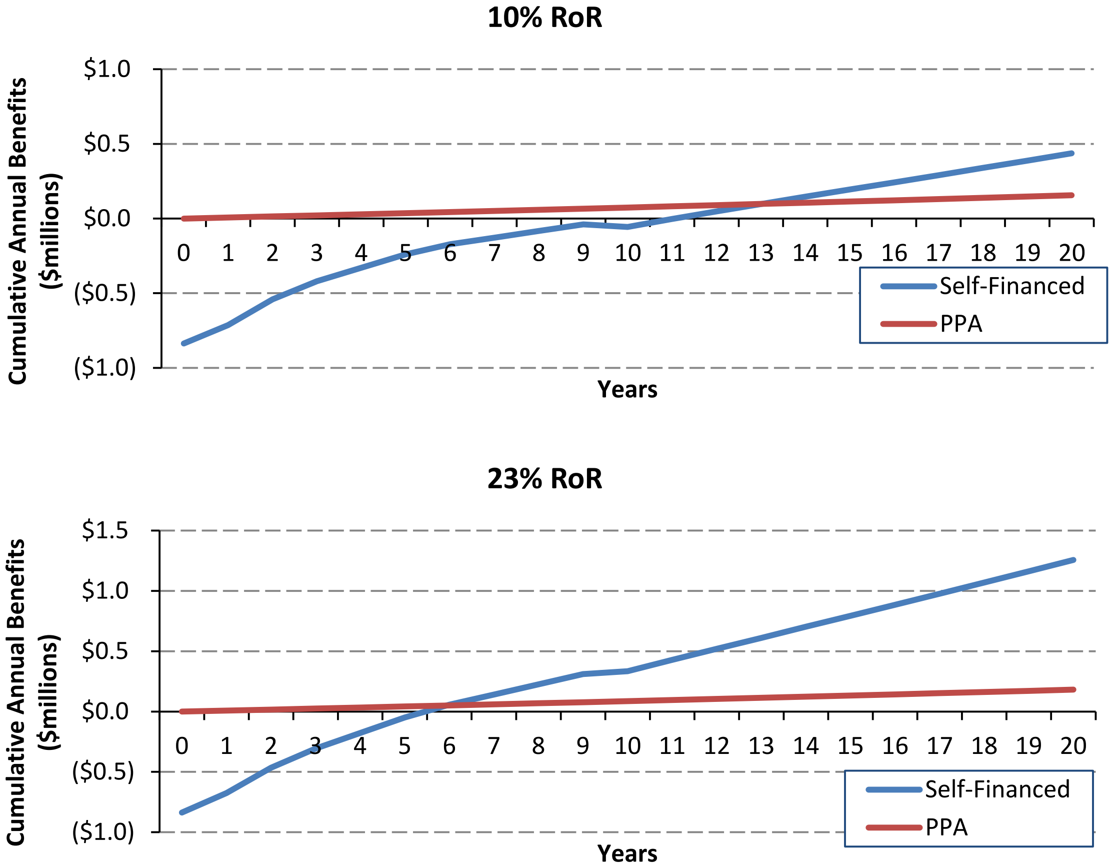

Figure 10. Modeled cumulative annual benefits for commercial PV systems: self-financed versus PPA

4.3 Economic Factors Beyond the Pro-forma Financial Models

The pro-forma models demonstrate that, at commercial host-customer costs of capital below 23% (pre-tax), self-financing provides more attractive returns than a PPA over the long term. This result, however, depends on the assumed rates of return for the third-party financiers and the host-customer, which might vary for several reasons. For example, PPA providers are trying to lower their cost of capital through innovative financing mechanisms, such as securitizing project portfolios. SolarCity, a residential and commercial PPA provider, recently raised funds from three securitizations at coupon rates of 4.0%–4.8%, backed by cash flows from pools of its distributed PV systems—capital that could fund future PV systems. Although the 4.0%–4.8% rates are not exactly comparable to the required returns in the model, as tax equity investors are still more than likely part of the transaction, they represent a significant reduction in the cost of capital normally required for TPO financing of a portfolio of PV assets.

Additional factors might make self-financing more attractive than a PPA. Our modeled PV systems have an economic life of 20 years while the average PV system is expected to last for at least 30 years.[19] A PV host that purchases a system owns it from the beginning. At the end of a

[19] As a point of reference, most PV module warranties have 25-year terms.

PPA contract, however, the host must purchase the system, sign a new PPA, or allow the system to be removed from its property. We estimated the additional value of ownership in years 20-30 by comparing the modeled self-financed LCOE after 20 years and after 30 years, and we found that accounting for the full PV life lowers the LCOE by 17%. However, this is dependent on a company remaining in a building for 30 years (or being able to sell the system at some point in the future to the next building occupant/owner based on the remaining value of the system's expected 30-year life). If a company has a shorter time horizon (and/or believes there will be no resale value), a lease may be more attractive.

Although our models assume that system costs remain the same regardless of financing structure, self-financed systems typically involve fewer parties in the transaction than do PPAs and thus might be able to build and finance a system at a lower price. In addition, TPO systems often require the use of industrial-grade electric meters, which may add costs relative to the meters needed for a host-owned system. Feldman et al. (2013) estimate that TPO-related costs add $0.67/W to a commercial portfolio. This is often particularly true for small- to mid-sized commercial systems (100kW-500kW) not part of a larger portfolio. These systems are often more complicated than residential-sized systems (5kW-10kW), but do not provide economies of scale, making them very expensive for TPO.

However, there are also many reasons a company may find a PPA more beneficial than self-ownership. While a system owner may have a lower cost of capital, the high upfront cost and long payback period may be unattractive. This is particularly true for agents with time horizons shorter than the system's lifetime. For example, a company's facilities manager, who is unlikely to remain in the same job for the economic life of the PV, might choose immediate energy savings over potential long-term economic value. A company might also require immediate savings to approve a project.

Commercial entities must also consider how various financing options impact their financial statements. While PPAs and system purchases are both long-term commitments, PPAs are considered off-balance sheet transactions; similar to an operating lease, PPA payments are treated as operating expenses, and the long-term liability of the contract does not appear on a company's balance sheet.[20] Financial statements are used to measure the financial health of a company by internal and external parties, and corporate debt often has covenants that limit the amount of additional debt a company can borrow. Therefore, a company might be unable to add the liability of a PV loan onto its balance sheet and might instead opt for a PPA. Much of this depends on the size of the company relative to the amount of PV it aims to deploy.

In addition, a company that self-finances must have sufficient tax liability to take advantage of the 30% federal tax credit and 5-year MACRS depreciation schedule, which could be worth up to an additional 25%–30%, depending on the company's tax rate. Although the benefits can be carried forward for use in later years, their future worth is lower owing to the time-value of money.[21] Businesses also pay varying amounts of federal taxes, although the degree to which an

[20] There has been an effort within the Financial Accounting Standards Board (FASB), which established Generally Accepted Accounting Principles (GAAP), to refine lease accounting standards to remove the distinction between operating and capital leases--in effect, moving all leases on balance sheet. However, this effort has been underway for a while and no final decisions have been made.
[21] The business tax credit can be carried forward 20 years.

individual business can use a credit largely depends on business size, PV system size, and the business's ability to adjust incurred income.

Businesses that own PV and those that finance it through a PPA also face different risk and reward considerations. To a business with a PPA, the only risk to unexpectedly low PV generation is the cost of additional electricity that must be sourced from the utility. In contrast, a PV owner must pay for the system, including O&M, regardless of system performance (unless there is a production guarantee). If state and/or local incentives are required to make a system economical, system owners may also be exposed to issues such as Renewable Energy Certificate (REC) price volatility and delays in disbursements from grant programs. Further, there is a risk of interconnection delays and lost production while waiting for the utility to approve the system's operation.[22]

A system owner might also incur unforeseen O&M costs. For example, inverters do not typically have warranties for the full life of a PV system (which is why our model assumes an inverter replacement in year 10). While a system with a PPA may similarly require an inverter replacement in year 10, this cost is built into the PPA price. A system owner, on the other hand, must pay all O&M costs and so, in any given year, might incur costs higher than would have been incurred using a PPA.

Many of these risks of PV ownership are small (such as system production), can be hedged against (for example, by selling long-term REC contracts[23]), or can be borne by another party (for example, by requiring a production guarantee from the installer or delaying payment for the system until receipt of state rebates and interconnection). As the PV industry matures, and more historical data is made available, there may be a reduction in the overall perception of risk.[24] Regardless, customers likely must educate themselves about PV risks and benefits more when they are buying a system than when they are entering into a PPA or other TPO contract.

[22] There is also the risk of changing rate structures, such as changes in net-metering provisions, but this risk is mostly shared by system owners and PPA holders.
[23] It should be noted that in many markets it is currently hard to find a counterparty for long-term REC contracts.
[24] NREL and DOE are working on accelerating this process through several initiatives, by making more data available and creating better transparency through improved documentation and procedures. These include, among others, the Solar Access to Public Capital (SAPC) working group. For more information, please see: https://financere.nrel.gov/finance/solar_securitization_public_capital_finance.

5 Conclusion

Although Staples and IKEA are both among the largest PV system hosts in the United States, the companies have used different approaches to PV financing. IKEA owns all of its PV systems, a decision that fits well with its corporate culture and business model. This ownership model spurred the company to engage in the entire PV deployment process, from system feasibility through O&M, identifying opportunities and risks at each stage. Over time, its process evolved, and its personnel gained valuable knowledge and skill. IKEA assumed more risk by owning PV instead of leasing it (for example, if the company had an inability to use the tax credits generated). However, through careful management of its processes, IKEA believes it is receiving the full benefits of owning long-term, high-quality assets.

In contrast, Staples leases all of its PV systems through PPAs, which aligns well with the company's risk-return preferences.[25] Still, Staples has actively managed its PV deployment, developing the skills to analyze the economics and feasibility of PV in relation to its buildings, local electricity rates, government incentives, and the PV market in various locations. It also has benefited from the technical and market expertise of the third-party owner, which has enabled more rapid PV deployment. A high percentage of leased properties and the potential for future site relocation are hindering PV development in some Staples locations. The company, however, is pursuing several strategies for increasing its share of PV-generated electricity, including virtual net-metering, deployment of large systems at distribution centers, solar-friendly leases on new property, and collaboration with building owners who provide PPAs coterminous with their leases.

Our modeling quantifies some of the financial drivers that companies like IKEA and Staples consider when choosing a PV financing strategy. Based on specific assumptions—including a 10% pre-tax cost of capital for the commercial customer—the LCOE for the self-financed system is approximately 30% lower than the LCOE for the PPA-financed system. However, the attractiveness of the financing methods varies due to different assumptions for cost of capital, different perceptions of PV investment risk, and different perceptions of the risk of using a particular financing method. When the commercial customer's pre-tax discount rate rises to 23%, for example, the cost of energy is equivalent under either financing method. If a company assumed a 10% pre-tax discount rate for TPO and a 23% pre-tax discount rate for self-financing, then the LCOE would be 14% lower using a PPA.

The timeline for customer payback is another consideration. Although self-financing provides a better return over the 20-year project lifetime in our model, it is net-cash-flow negative for about 5-11 years. The PPA, on the other hand, produces positive cash flow quickly and is economically more attractive than the self-financed system for the first 6-14 years. Still, our modeled self-financing is even more attractive over the long term if the PV lifetime is extended to an expected period of 30 years—this assumption lowers the LCOE by 17%. Self-financing might also have advantages over PPAs due to involving fewer parties in the financial transaction and requiring less-expensive electric meters.

[25] Staples also began installing systems earlier than IKEA, when PV systems were more expensive, which may have impacted their decision to finance PV through a PPA.

That said, PPAs offer several potential advantages to some companies. Unlike purchase of a PV system, PPAs are considered off-balance sheet transactions, which might be attractive for companies unwilling or unable to add the liability of a PV loan onto their balance sheets. In addition, a company can get the full benefits of a PPA with any amount of tax liability whereas self-financing companies must have sufficiently large tax liability to take full advantage of PV tax incentives. Companies using PPAs also might reduce their exposure to risks related to PV underperformance, unanticipated O&M costs, and delays in receiving incentives and grid-interconnection approval.

Our analysis suggests that the most appropriate PV financing option for a particular business depends on the characteristics and circumstances of that business. Our modeling results and discussion, as well as the case studies of the IKEA and Staples PV experiences, might provide useful insights to other companies that are considering launching or expanding onsite PV programs.

6 References

Bolinger, M. (2014). *An Analysis of the Costs, Benefits, and Implications of Different Approaches to Capturing the Value of Renewable Energy Tax Incentives*. Berkeley, CA: Lawrence Berkeley National Laboratory.

Buckley, M. (Aug. 14, 2014). Telephone conversation with Feldman, D. and Margolis, M., National Renewable Energy Laboratory. Staples Inc., Framingham, MA.

Clean Energy Finance and Investment Authority (CEFIA). (undated). "Staples, Inc." Accessed October 2014: http://www.ctcleanenergy.com/YourBusinessorInstitution/CommercialInstallations/DistributionFacilityInstallations/StaplesKillingly/tabid/442/Default.aspx.

Credit Suisse Research Institute. (2013). "Credit Suisse Global Investment Returns Yearbook 2013." Accessed November 2014: http://www.investmenteurope.net/wp-content/uploads/2014/07/2013_yearbook_final_web.pdf.

CSI (California Solar Initiative). (2014). Current CSI Data. Accessed April 4, 2014: www.californiasolarstatistics.ca.gov/current_data_files/.

DOE (U.S. Department of Energy). (2012). *SunShot Vision Study*. DOE Report No. DOE/GO-102010-3037. Washington, DC: U.S. Department of Energy.

EIA (U.S. Energy Information Administration). (2014). Form EIA-861, Annual Electric Power Industry Report; and Form EIA-861S, Annual Electric Power Industry Report (Short Form). Table 5.1. Retail Sales of Electricity to Ultimate Customers. Accessed September 3, 2014. http://www.eia.gov/electricity/data.cfm#sales

Feldman, D.; Friedman, B.; Margolis, R. (2013). *Financing, Overhead, and Profit: An In-Depth Discussion of Costs Associated with Third-Party Financing of Residential and Commercial Photovoltaic Systems*. NREL Report No. NREL/TP-6A20-60401. Golden, CO: National Renewable Energy Laboratory.

Feldman, D.; Lowder, T. (2014). *Banking on Solar: An Analysis of Banking Opportunities in the U.S. Distributed Photovoltaic Market*. NREL/TP-6A20-62605. Golden, CO: National Renewable Energy Laboratory.

"Federal Reserve Economic Data (FRED)." (2014). Economic Research Division. Federal Reserve Bank of St. Louis. Accessed November 2014: http://research.stlouisfed.org/fred2.

Gasper, M.; Roth, J. (May 15, 2014). Telephone conversation with Feldman, D. and Margolis, M., National Renewable Energy Laboratory. IKEA Property, Inc., Conshohocken, PA.

Gasper, M. (Nov. 17, 2014). Email to Feldman, D. National Renewable Energy Laboratory. Ikea Property, Inc., Conshohocken, PA.

IKEA. (2014). "IKEA US Renewable Energy Commitment Included In President Obama Announcement of Commitments and Executive Actions to Advance Solar Deployment and Energy Efficiency." IKEA Corporate News, May 8, 2014: http://www.ikea.com/us/en/about_ikea/newsitem/President_Obama_renewable_energy.

Martin, K. (2014). "Cost of Capital: 2014 Outlook." *Chadbourne & Parke Project Finance News*, February 2014.

Massachusetts Department of Energy Resources (DOER). (2014). "RPS Solar Carve-Out Qualified Units." Accessed March 26, 2014: http://www.mass.gov/eea/docs/doer/rps-aps/solar-carve-out-units.xlsx.

Newell, S.; Spees, K.; Pfeifenberger, J.; Mudge, R.; DeLucia, M.; Carlton, R. (2012). *ERCOT Investment Incentives and Resource Adequacy*. The Brattle Group.

NJCEP (New Jersey Clean Energy Program). (2014). NJCEP Project List as of March 31, 2014. Accessed July 9, 2014: http://www.njcleanenergy.com/renewable-energy/home/home.

Ong, S.; Denholm, P.; Doris, E. (2010). *Impacts of Commercial Electric Utility Rate Structure Elements on the Economics of Photovoltaic Systems*. NREL Report No. TP-6A2-46782. Golden, CO: National Renewable Energy Laboratory.

Peterson, L. (2012). "Primary Tax Equity Finance Structures Common to the U.S. Domestic Solar Energy Industry: June 2012." Reznick Group.

PJM Environmental Information Services (PJM EIS). (2014). "Generation Attribute Tracking System (GATS): Renewable Generators Registered in GATS." Accessed November 12, 2014: https://gats.pjm-eis.com/gats2/PublicReports/RenewableGeneratorsRegisteredinGATS.

SEIA and GTM Research (Solar Energy Industries Association and GTM Research). (2014). *U.S. Solar Market Insight Report: 2013 Year-In-Review*. Washington, D.C.: Solar Energy Industries Association.

SEIA and GTM Research. (2014b). *U.S. Solar Market Insight Report: Q2 2014*. Washington, D.C.: Solar Energy Industries Association.

SEIA and Vote Solar. (Solar Energy Industries Association and The Vote Solar Initiative). (2013). *Solar Means Business 2013: Top Commercial Solar Users*. Washington, D.C.: Solar Energy Industries Association.

StrataSolar. (2014). "IKEA – 1 MW – ATLANTA." Accessed October 2014: http://www.stratasolar.com/spotlight/commercial-retail-atlanta-ga/.

Shah, V.; Booream-Phelps, J.; Min, S. (2013). "Distributed Generation to Herald New US Growth Era." Deutsche Bank Market Research.

Wiser, R..H.; Mills, A.D.; Barbose, G.L.; Golove, W.H. (2007).*The Impact of Retail Rate Structures on the Economics of Commercial Photovoltaic Systems in California*. LBNL-63019. Berkeley, CA: Lawrence Berkeley National Laboratory.

7 Appendix A

Table A-1. Basic Assumptions for Commercial Pro-forma Financial Models

Installed Price	$2.39/W$_{DC}$ [a]
Capacity Factor	17.3% [b]
Inverter Replacement	$0.13/W [c]
Combined Federal & State Tax Rate	40.2%
Annual Degradation Rate	0.50% [d]
Project Lifetime (PPA length)	20 years
O&M (% of installed cost)	0.50% [e]
Inflation	2%
Federal Tax Incentives	30% Investment Tax Credit & MACRS Depreciation Schedule

[a] Source: SEIA (2014b).
[b] Capacity factor calculated by PVWatts (version 1) for a PV system in San Diego, with a derate of 0.85, azimuth of 180 degrees, and tilt of 5 degrees.
[c] Assumes that, when inverter replacement occurs in year 10 of the project, prices have dropped to targets outlined in *The SunShot Vision Study*, adjusted for inflation (DOE 2012).
[d] Source: Bolinger (2014).
[e] Source: Shah et al. (2013).

Table A-2. Assumptions Specific to PPA Pro-forma Financial Models Using an All-equity Sale-leaseback Transaction for Commercial Projects

	Tax Equity	Sponsor Equity
Ownership Percentage	85% [a]	15%
After-tax Rate of Return	9.0% [b]	10.5% [c]
Lease Length	16 years [d]	
Residual Value	20%[e]	

[a] Source: Bolinger (2014).
[b] Source: Martin (2014).
[c] After-tax cost of capital for SolarCity as calculated by the Capital Asset Pricing Model (CAPM); see below for calculations.
[d] Source: Peterson (2012).

Table A-3. Assumptions for Commercial Customer's Cost of Capital Using Capital Asset Pricing Model (CAPM)

Variable	Value	Explanation
Risk-free Rate (1)	3.6%	20-Year Treasury Bill Constant Maturity. December 1, 2013. Source: FRED 2014.
Equity Beta (2)	1.00	Assumes an equity beta equal to the market as a whole.
Debt/Asset Ratio (3)	50%	Source: Newell et al. 2012.
Tax Rate (4)	40.2%	Assumes a federal corporate income tax rate of 35% and state corporate income tax rate of 8%.
Equity Risk Premium (5)	5.3%	Source: Credit Suisse 2013.
After-tax Cost of Equity (6)	8.9%	(6) = (1) + (2)*(5)
Debt Premium (7)	1.4%	(7) = (8) - (1)
Pre-tax Cost of Debt (8)	5.1%	Annual Moody's Seasoned Aaa Corporate Bond Yield, 2004-2013. Source: FRED 2014.
Nominal After-tax Weighted Cost of Capital (9)	6.0%	(9) = (1-(3))*(6)+(3)*(8)*(1-(4))
Nominal Pre-tax Weighted Cost of Capital (10)	10.0%	(10) = (6) / (1-(4))*(1-(3))+(8)*(3)