The Potential of Securitization in Solar PV Finance

Travis Lowder and Michael Mendelsohn

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List of Acronyms

ABS	asset-backed security
C&I	commercial/industrial
CDO	collateralized debt obligation
CLO	collateralized loan obligation
DOE	U.S. Department of Energy
GSE	government-sponsored entity
ITC	investment tax credit
LCOE	levelized cost of energy
LIBOR	London Interbank Offered Rate
MBS	mortgage-backed security
O&M	operations and maintenance
PACE	property assessed clean energy
PPA	power purchase agreement
PV	photovoltaics
QIB	qualified institutional buyer
RPS	renewable portfolio standard
SAPC	Solar Access to Public Capital
SEC	U.S. Securities and Exchange Commission
SPV	special purpose vehicle

Executive Summary

The following report offers a high-level analysis of the immediate potential that securitization and access to the capital markets could offer the U.S. solar photovoltaics (PV) industry. It is not a "vision" study, and accordingly does not provide a roadmap, nor make any projections. All data used to conduct the analyses in this report are from 2012, and all assessments are therefore based on the installed base of securitizable solar assets as of the close of that year.

This report comes as the PV industry is approaching an inflection point of sorts, where the incentives that have driven the recent surge in deployment are either already expired or are set to decline in the near term. Prices for PV technologies and systems continue to decline; however, solar PV remains, in many jurisdictions, a higher-cost source of electricity than more traditional forms of generation on a strictly levelized-cost-of-energy-basis. Faced with diminishing policy support, the PV industry is seeking additional sources of capital (and at advantageous cost) to fund its operations over the mid- to long-term.

As is common of many maturing industries, PV is looking to the capital markets—the global forum where entities buy, sell, and trade debt and equity securities—as a venue to obtain this additional capital. The PV industry may access the capital markets by two general means:

1. Securitization: The process of transforming illiquid assets (such as the cash flows from a solar lease or power purchase agreement) into standardized, tradable instruments (i.e., securities). Security issuers sell the rights to the underlying assets (via the securities), and the proceeds are used to finance business operations. Issuers pay an interest rate to each investor, the percentage of which is typically dictated by the rating of the securities.
2. Bonding: The process of securitizing debt and then issuing it into the capital markets via bonds. By purchasing bonds (and the rights to the cash flows on the underlying debt), investors are in essence lending money to the issuer. The investors are compensated by an interest rate applied to the amount of their purchase payable by the issuer. Bond finance has been used in the marketplace to finance solar projects.

Several challenges complicate the PV industry's path to securitization. Harmonizing the relationship of the tax equity tranche of the capital stack and the debt sourced from a securitization transaction is a challenge which will require some financial engineering. Standardization is another barrier: the solar industry currently abounds in a diverse set of asset contracts, installation and operations and maintenance (O&M) practices, and other features of business that make the task of pooling assets (the precursor to securitization) difficult. However, many securitization markets, including mortgages, required innovation and time to achieve viability, and these hurdles may be more symptomatic of growing pains than of permanent barriers.

The following analysis aims to demonstrate, hypothetically and at a high level, what volumes of solar deployment could be supported given access to the capital markets in the form of security issuance. Securitization is not anticipated to replace tax equity in the near- to mid-term, but it could provide an additional source of funds that would be comparatively inexpensive and could reduce the weighted average cost of capital for a given solar project or portfolio. Thus, the potential to securitize solar assets and seek financing in the capital markets could help to sustain

the solar industry when the investment tax credit (ITC)—one of the federal incentives which has leveraged billions of dollars of private capital in the solar industry—drops from 30% to 10% at the close of 2016.

Findings of this analysis include:

- Securities backed by assets in the residential solar market (namely the customer payments on third-party leases and power purchase agreements) would likely be sold into the esoteric asset-backed securities (ABS) markets, at least initially. Securities backed by commercial assets—because of the differences in the contract offtakers, the system sizes, and other factors—would likely be issued into the collateralized loan obligation (CLO) market. Residential developers may also be able to access capital from the CLO market through alternative structures.
- A $100 million securitization fund (after structuring and fees and assuming no overcollateralization) could fund the development of 72 MW of residential solar systems, *or* 100 MW of small commercial systems, *or* 133 MW of large commercial and industrial (C&I) systems. This is assuming that the securitization debt comprises 25% of the capital stack of each project or portfolio, and without accounting for many of the costs associated with securitization. See Table ES-1.
- An estimated $1.34 billion of potentially securitizable solar assets were installed in 2012 alone (assuming that 50% of the 244 MW of residential solar systems installed in 2012 was third-party financed, and that residential installed costs are assumed to be at $5.5/W).

Table ES-1. Number of PV Systems (by Market Sector) Potentially Financeable Through a Single Securitization Transaction

	Residential	Small Commercial	Large C&I
Assumed System Size	5 kW	100 kW	1 MW
Assumed Installed Costs ($/watt)[1]	5.5	4	3
Assumed System Cost (size x installed cost)	$27,500	$400,000	$3,000,000
System Cost Financed through Securitization Debt (assumed 25%)	$6,825	$100,000	$750,000
Approximate Number of Systems backing the $100,000,000 Securitization Transaction	14,545	1,000	133
Approximate Total MW Financed in the Securitization Transaction (25% of each system)	72	100	133

[1] System costs are based on 2012 figures.

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1 Introduction

1.1 The Need for Additional Lower Cost and Liquid Capital

Solar photovoltaics (PV) have achieved unprecedented levels of deployment in the United States from 2008 – 2012. In that time, the compound annual growth rate of PV capacity additions was over 56%, from 0.35 GW in 2008 to over 3.3 GW in 2012. Some analysts are anticipating another record year for U.S. PV installations in 2013, with over 4 GW of added capacity; this would put the cumulative U.S. market at over 11 GW going into 2014 (SEIA 2009; SEIA/GTM 2013a; SEIA/GTM 2013b; BNEF 2013).

The federal tax incentives extended through the American Recovery and Reinvestment Act of 2008 have played a critical role in driving these levels of deployment. However, these incentives are difficult for developers to take advantage of themselves, as a large corporate tax liability is required to use the credits efficiently (i.e., to their fullest value). Accordingly, solar (and other renewables) finance today is dominated by the necessity for specialized "tax equity" investors to commit capital to projects or project portfolios in exchange for use of the tax credits.

The current roster of tax equity players comprise a small pool of 10–20 large financial institutions and insurance funds. Supply of this form of financing is therefore tight and does not currently meet the demand in the renewable energy market. Moreover, tax equity is a highly complex, illiquid, and thus high-cost source of financing. Regardless, tax equity finance remains one of the only the economic means to finance solar projects in the United States.

The primary federal incentive for which solar PV is currently eligible is the investment tax credit (ITC), which is equal to 30% of a company's investment in qualifying project property. As of this writing, this 30% credit is scheduled to revert to 10% on January 1, 2017, which not only renders the current system of tax equity finance uncertain but also the economic competitiveness of solar power in general.

In addition to the uncertainty of tax equity in solar finance, PV faces other financing challenges. The expiration of the 1705 Loan Guarantee Program has implications for the utility-scale solar market, and the expiration of the 1603 Treasury Grant program has reintroduced some frictional aspects to renewable energy finance, (namely, the transaction costs incurred by the project in the process of monetizing the federal tax credits) (Mendelsohn 2011). Moreover, many state renewable portfolio standards (RPSs)—policies that have been instrumental in driving utility demand for solar and other renewable energy technologies—are near or over capacity, which may dampen PV growth going forward (Mendelsohn 2012).

Each of these policies, in concert with other market factors, contributed significantly to improving the economics of solar power from 2008 onward, thereby making it more attractive to investors. As these supports fall away and financing risk increases, the PV industry has begun looking to the capital markets—a common strategy among maturing industries—as a venue to tap a broader range of investors at an advantageous cost of capital. The principal means of accomplishing this is through securitization, a process that would involve the transformation of solar assets into standardized investment products that would have more liquidity than a direct project or fund investment. This option is only becoming a reality now, as national solar capacity has ramped to levels that would justify securitization and as the advent of third-party finance has brought greater aggregation and standardization to the solar asset class.

Access to the capital markets via securitization could, over time, afford solar more abundant and lower-cost capital than it can currently access in the debt and tax equity markets. Reduced financing rates would put downward pressure on the ultimate price of solar energy, enhancing its competitiveness relative to conventional sources of generation. A recent NREL analysis projected that solar levelized cost of energy (LCOE) could be reduced by 8%–16% if a portion of a project or portfolio's typical capital stack were replaced with public capital vehicles (a class that includes securitized instruments) (Mendelsohn and Feldman 2013). Reducing solar financing costs through access to the capital markets would thus help to achieve the U.S. Department of Energy's (DOE) SunShot goal of making solar energy cost-competitive with other forms of electricity (DOE SunShot 2012).

The following analysis aims to demonstrate, hypothetically and at a high-level, what levels of solar deployment could be supported given access to the capital markets in the form of debt security issuance. Securitization is not anticipated to replace tax equity, at least in the near- to mid-term (see Section 3.2), but it could provide an additional source of funds that would be comparatively inexpensive and could reduce the weighted average cost of capital for a given solar project or portfolio. Thus, the potential to securitize solar assets and sell them off to investors in the capital markets could help to sustain the industry as tax equity finance downshifts with the expiration of the 30% ITC. Moreover, it could propel the economics of solar to be more competitive with fossil generation and drive demand in the absence of robust policy support.

This report will begin with an overview of the securitization process and conclude with an analysis of the potential for securitizing the installed base of third-party financed solar assets as of the close of 2012. It is not a "vision" study, and accordingly does provide a roadmap, nor make any projections on what the value of the solar securities market, the deal sizes, or the cash flows from each system could look like given various cost scenarios and market forecasts. The authors do perceive the value of such a study, however, and are undertaking further research.

2 Securitization at a Glance

Securitization is the process by which illiquid assets are pooled and processed into financial vehicles (securities), which are then sold to investors. This process not only confers liquidity by providing investors a standardized, tradable product, but it can also reduce various risks associated with the individual assets (see Section 2.1).

Cash flows generated through contracts—for example, installments on debt, payments on a lease, or royalties paid on protected property—form the basis of securitizable assets. Investment in a security is akin to buying a claim on the underlying assets or cash flows (Moynihan 2011). For example, the purchase of stock entitles the purchaser to a portion of the earnings (and losses) of a particular company.

When a security is issued, it can be sold either bilaterally to a small group of investors, or it can be issued in the marketplace where entities can purchase and trade it freely. If investors respond favorably to a particular security (i.e., if that security has strong liquidity demonstrable through investor purchase and trading), this can create a demand-pull for the underlying asset. Investor demand for mortgage-backed securities, for example, was one of the major drivers of the explosive growth in the U.S. housing market from the late-1990s until the mid-2000s.

While selling shares of capital pools has been a financial practice for centuries in the form of stocks and bonds, structured finance in its modern incarnation began with the securitization of mortgages in the 1970s. The first asset-backed products were executed in the 1980s and other structured products soon followed. The development of these markets was the result of several decades-worth of evolution in business structures, financial innovation, changing regulations, and other factors (Altarescu et al. 2013; Monynihan 2011; Adelson 2012).

In 2006–2007, the two years preceding the financial crisis, structured financial products such as mortgage-backed securities (MBSs), asset-backed securities (ABSs), collateralized loan obligations (CLOs), and collateralized debt obligations (CDOs), were collectively issued in volumes exceeding $3.5 trillion. [2] Volume dropped precipitously in 2008 when the financial crisis hit and has since remained below $500 billion per year through 2011 (Adelson 2012). Notwithstanding, there are signs that some securitization markets (such as auto loan ABSs and CLOs) have been picking back up since 2011, though issuance levels are far below the 2006–2007 peak (Adelson 2012; Culp et al. 2013). This reduced level of activity relative to the boom years, in combination with new financial regulations (largely codified through the Dodd-Frank legislation), the collapse of some facilitating industries (such as monoline insurance), and stricter underwriting and ratings standards, suggest that the speculative practices that contributed to the financial crisis[3] have been tempered.

[2] This figure reflects both commercial and residential MBSs. It does not account for "agency" MBSs or securities issued by government-sponsored enterprises (GSEs), such as Fannie Mae or Freddie Mac.

[3] While structured finance played a major role in precipitating the financial crisis of 2008–2009, it was not the technique of securitization *per se* that was responsible for the damage. Rather, it was a host of factors, including but not limited to, faulty forecasts on the trajectory of U.S. home prices, miscalculated risks, fraudulent lending practices, lack of oversight, and highly complex synthetic securitizations (a process of combining a derivative contract with a security), which, in combination, brought on the massive financial losses that led to the crisis (Moynihan 2011).

Structured finance is a highly complex discipline, and it has only become more so since the 1970s. Accordingly, this report does not aim to provide an in-depth, technical analysis of how securitization would apply to the solar industry; it instead aims to familiarize non-experts with the basic concepts of structured finance and offer some hypothetical examples of how certain financial techniques could benefit the solar industry in its drive to reduce soft costs (specifically, the cost of accessing inexpensive capital). The descriptions and analyses in this report have therefore been simplified to provide a clear picture of the potential that access to the capital markets has for solar deployment.

2.1 Benefits of Securitization

Securitization affords asset originators several advantages over more traditional forms of equity and debt financing. Generally speaking, securitized assets can reach a broader base of capital because they have been structured as products that better conform to investor requirements. For example, solar projects have proven a difficult asset in which to invest because of the complications of the tax credits, the illiquidity of the investment, and several other factors. However, through the process of securitization—where a portfolio of solar project cash flows are pooled into one fund, the fund is isolated from the developer/sponsor's corporate risk, and standardized investment vehicles are issued against the capital in that pool—then investors have a tradable and relatively secure product through which they can commit capital to the solar industry.

Table 1 offers an overview of securitization benefits.

Table 1. Selected Benefits of Securitization

Benefit	Explanation
Risk Mitigation	Assets are removed from their originator's balance sheet and are thus insulated from the parent's corporate risk. The assets are then said to be made "bankruptcy remote."
	The process of pooling assets diversifies credit risk, as well as geographic and other concentration risks, and it spreads costs associated with asset assessment, performance management, and reporting over a larger base.
	Securitization structures allow for several forms of credit enhancement, which can improve the credit risk of the assets and their resulting credit rating (and thus cost of capital). See Section 2.3 for more on credit enhancement instruments.
Access to Broader Capital Pool	Securitization can open up businesses and industries to investors that might otherwise be out of reach by standardizing assets, introducing them into the capital markets, and affording them liquidity.
Improvements in Financing Terms	Capital markets can offer asset originators more favorable financing terms than they may otherwise be able to obtain from traditional sources. These include longer tenors and lower cost of capital.
Opportunities for Market Growth	Originators have a means to free up balance sheet capacity with the option to offload their assets into a special purpose vehicle (SPV). Moreover, when securities are issued against the assets in the SPV, originators have a means of monetizing assets that were previously illiquid. With an unburdened balance sheet and additional capital, businesses may be free to originate more assets, fund expanded operations, and generally grow their market share.
	Investor demand for a particular securitized asset may create demand pull, which can incentivize the upstream market to originate more assets (e.g., more solar systems).

Source: Tavakoli 2008; Moynihan 2011

2.2 Risks of Securitization

Securitization figured prominently in the financial crisis of 2008, a fact which has created a great deal of wariness among regulators, policymakers, the general public, and market participants over the last several years. However, it was less the technique of securitization itself that brought on the historic financial losses of the crash, and more its abuse (Joshi 2009).

Securitization is a powerful tool that can free up capital for companies to grow their businesses while providing investors—particularly institutional investors such as pension and insurance funds whose health are in the public's best interest—with the yield they need to maintain and grow their portfolios. Consumers can also reap the benefits of securitization markets through lower costs in some goods and services, as well as in more loan capital available for higher education, homeownership, and others (Joshi 2009). However, by its very nature, securitization spreads risk. If enough risk from a single asset class or correlated asset classes becomes systemic to the financial system, then a single credit event (e.g. a counterparty default, such as Bear Stearns or Lehman Brothers) could touch off a fire sale of assets in the marketplace as institutions are required to de-lever their balance sheets. These fire sales, or "runs on the bank," can lead to dangerous levels of loss in the financial system.

Generally speaking, this is what happened with the subprime mortgage crisis, the credit event that precipitated the 2008 financial crisis. Because these securities comprised a significant portion of several large financial institutions' portfolios, the mass-scale disruptions in capital flows via subprime-backed securities triggered losses throughout the financial markets, and from there, the global economy. Complicating matters, many of these "toxic" subprime securities were not actually backed by the mortgages themselves, but rather on the cash flows of derivative contracts—specifically, credit default swaps—that had been packaged as securitized products. Because they were not collateralized by assets, these "synthetic securitizations" could not be called in the event that a widespread reduction in the value of U.S. homes forced many obligors into default, and thus plunged the value of securities backed with their mortgages (Moynihan 2011).

The technology for pooling and structuring cash flows into securities had become progressively more complex throughout the early part of the 2000s, and by the time the crisis hit, many people in the market did not know what these instruments were truly worth, or even how to adequately assess the risks beyond what the credit rating implied (Culp et al. 2013). When these securities lost significant portions of their value, many of the largest financial institutions which had large holdings were too overleveraged to withstand the resulting losses. These banks either failed, merged with healthier banks (e.g. ones with consumer accounts, such as Bank of America), or received several forms of aid from the U.S. government (Moynihan 2011).

Securities markets have cooled significantly since the crash in 2008, though, as mentioned, activity is picking back up. New regulations codified in the Dodd-Frank legislation of 2010, as well as the Basel III international banking regulations have put constraints on some of the practices that led to the financial crisis. Notably, limits on proprietary trading in investment banking in Dodd-Frank and new capital requirements instituted by the Basel III Accord will make it more difficult for banks to leverage beyond their means. These regulations also attempt to bring the interests of issuers, bankers, and ratings agencies in line with those of the investors. Previously, the former parties would receive their compensation upon the execution of the deal and had no "skin" in the securities once they were sold; this was ineffective in guaranteeing due diligence, and many toxic securities consequently were sold off with impunity. In reaction to new regulations and other effects of the crisis, the financial markets today feature greater transparency of investment information, greater retention of risk by equity holders, sponsors, and/or originators, and more robust investor evaluation of financial instruments (Culp et al. 2013).

It is unlikely that solar would achieve the market size and origination volume that could make it a systemic risk to the financial system. However, it is nonetheless crucial to ensure asset class quality in order to protect solar consumers and investors, maintain market confidence, and afford developers continued access to securitization as a means of low-cost funding.

To facilitate the development of quality standards and strengthen the integrity of the solar asset class, NREL has convened over 100 key solar, financial, legal, and advisory stakeholders together in the Solar Access to Public Capital (SAPC) working group (see Sections 3.4 and 5).

The working group has released standardized lease and power purchase contracts to unify asset origination across developers and mitigate due diligence requirements. It is also currently drafting best practice guidelines for system installation, operations and maintenance (O&M), and independent engineering procedures. These are intended to promote the sound, standardized development and operation of solar assets so that investors can have a high degree of confidence in the long-term performance of systems and the securities backed by them. This effort is proceeding in coordination with similar best practice activities conducted by other stakeholders, such as Sandia National Labs.

SAPC is also attempting to illuminate the ratings process that could accompany an offering of solar securities, and which would largely determine the issuer's cost of capital. This work is being accomplished through the development transaction of legal structures, offering documents, and portfolio evaluation methodologies to determine loss curves. SAPC will submit these materials for unofficial ratings agency comment (a "mock filing") and will use the knowledge gained to drive risk reduction strategies in the market.

2.3 The Securitization Process

Securitization requires a cash flow tied to an asset. These cash flows could be down payments on a particular type of debt (e.g., mortgages or credit card loans), installments on a lease contract, royalty payments on a particular song, or some other form of receivable. If the originator of these assets can meet certain criteria as specified by the market where it will sell its securities (e.g., those relating to credit quality, size of asset pool, or business practices consistent with underwriting standards) it may contract with a legal team, an investment bank, a servicing entity, and others to execute a securitization transaction.

The investment bank and legal counsel will assist the originator in creating an SPV into which assets will be pooled and against which securities will be issued. This SPV is structured as a trust and is exempt from taxes. The transfer of the assets into the trust is treated as a "true sale," which reduces the liability for the originator of the assets and ensures that investors have and will retain legal rights to ownership. The sale price must be for the market value of the assets, and the proceeds go to the originator. The originator receives the cash and, in many cases, a removal of the assets from its balance sheet.

Once the assets are pooled and isolated in the SPV, an investment bank or other underwriting entity will perform a number of services, including but not limited to:

- Assist in structuring[4] the deal
- Market the offering to potential investors who may be interested in the risk/return profile of the assets
- Execute the sale to investors (i.e., make the market)

[4] Elements of structure include, but are not limited to: optimizing the asset payments to create a security that is appealing to an investor in terms of the maturity (i.e., debt term) of the debt; ordering a priority of payments to different classes of investors, otherwise known as waterfall payments; implementing credit enhancement in the form of overcollateralization, tranching, and others (see Section 2.3); choosing pass-through payments or a revolving collateral pool; diversifying the credit stratification of assets in the pool; and choosing fixed interest or a floating rate (interest rate swap).

- Take on the risk of holding the securities on-balance sheet before they are offloaded in the marketplace (this is the essence of underwriting).

A credit rating for the securitization transaction may either be required by Securities and Exchange Commission (SEC) regulations or be desired by the originator or issuer as a way to create investor interest in the offering. Ratings are provided by ratings agencies (Fitch, Moody's, and Standard and Poor's are considered the "Big Three," though there are many others). Credit ratings determine the interest, or coupon, rate of the securitization transaction, and this is the cost of capital that the originator or issuer must pay to investors on an annual or semi-annual basis. Scores for long-term obligations range from AAA or Aaa (reserved for virtually risk-free investments such as U.S. Treasury Bonds) to C.

For a fuller list of securitization processes and associated participants, see Table 2 and Figure 1.

Table 2. Securitization Transaction Participants

Deal Participants	Role
Obligor	Makes payments on the assets (e.g., loans, leases, and contracts) to the originator. These payments will be pooled with others, and will collectively form the basis of a securitization transaction. In a solar securitization, the obligors are the solar customers who have leased the solar equipment.
Originator (Could Also be Servicer/Issuer)	Creates and contract loans or accounts receivable (i.e., the assets). In the solar industry, this role would be filled by the developers/third-party finance providers or the project owners (if the project is not developer owned).
Special Purpose Vehicle (SPV)	The trust entity into which assets are sold (from the originator's balance sheet) and held. Assets pooled in the SPV form the collateral basis against which securities are issued.
Servicer	Ensures that assets are maintained, enforces compliance on certain agreements of the asset contract, and collects payments to the originators from the obligors (i.e., solar customers).
Issuer	Transfers assets in the SPV and contracts with the legal counsel and investment bank to initiate the securitization process. The issuer may also be the originator—for example, in the case of a solar securitization, a residential third-party finance provider that also develops its own systems would be an originator/issuer. In rarer cases, one entity may serve as the issuer, originator, and the servicer in a securitization transaction.

Underwriter/ Investment Bank	Structures the securitization transaction, creates the securities, and executes their sale in the marketplace. Underwriters are typically entitled to a fee, also called an “underwriter’s discount” because these entities adopt the risk of holding all the securities on-balance sheet before they are sold to investors.
Trustee	Has fiduciary duty to the investors, ensures compliance of all parties with the terms of the securitization transaction, and administers the SPV and manages accounts associated with the transaction (e.g., payments from the investor to the issuer from a security sale or payments from the issuer to the investor in the form of interest). Trustees also compile reports for investors detailing the asset portfolio performance.
Credit Enhancement Provider (Optional)	Provides some form of guarantee, loss reserve, or other structure to improve the credit rating and thus the required yield on the securitization transaction. Providers can be banks, insurance carriers, financial institutions, the federal government, or other entities.
Credit Rating Agency	Runs evaluations on securities offerings using their own methodologies, and issues a rating. Ratings are essentially an assessment of the “likelihood” that a given investor will receive payment from the securities it purchased, as specified in the offering documents. Higher ratings will generally carry a lower cost of capital (i.e., interest rate) for issuers.
Investor	Purchases the rights to the securitized cash flows in the form of a fixed income security. This purchase is essentially a borrowing transaction, whereby the investor allocates capital, indirectly, to the originator and receives a fixed rate of return as that originator repays its securitization debt.

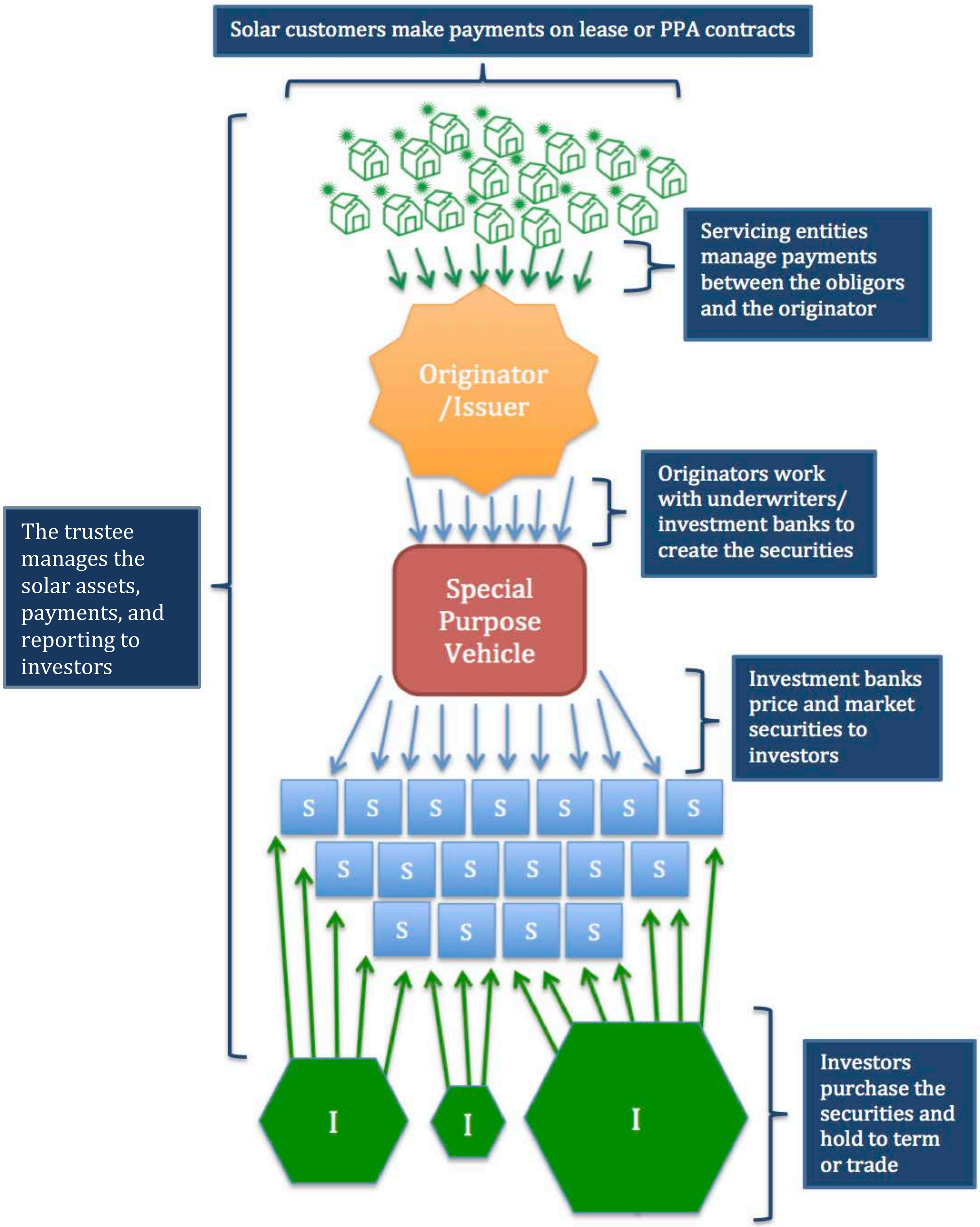

Figure 1. Generalized solar securitization transaction

Securitizations may be structured as "pass-throughs," which means that the payments made to investors are tied directly to the underlying asset payments made by the obligors. That is, obligors pay down their assets (e.g., a rooftop solar system) and the servicer collects and pools these payments, and, after deducting a fee, passes them through to investors. Their payments, securitizations that are not pass-through, will have independent payment schedules on the investor side and the asset side, so that investors receive a fixed payment that does not represent fluctuations in the underlying asset pool (e.g., late payments or defaults from the obligors). These structures are typically backed by a revolving pool of assets so that a consistent level of investor payouts can be achieved.

2.4 Credit Enhancement

Many securitization transactions make use of credit enhancements to improve credit ratings and therefore decrease required yield, reassure investors, and protect issuers. While third-party guarantees are currently either difficult or impossible to find in the marketplace, other forms of credit enhancement are available to assist solar issuers in obtaining an advantageous cost of capital and stoke investor interest. These include tranching and overcollateralization.

2.4.1 Tranching

A technique that separates the asset pool into different segments (or tranches) by risk, tenor, and other characteristics. Each tranche will have its own credit rating and yield. The highest-rated tranche will be the first paid, with each successive tranche being senior next in the payment hierarchy. This is referred to as a senior/subordinated structure. Investors will purchase the rights to the cash flows in a particular tranche, provided that the tranche meets their risk/return/repayment horizon requirements (see Figure 2).

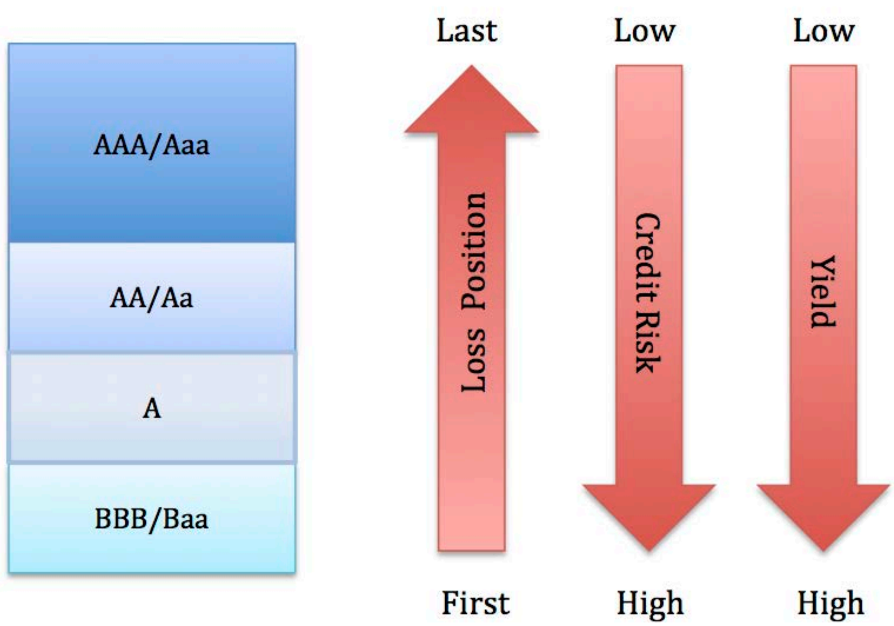

Figure 2. Generalized depiction of tranching

2.4.2 Overcollateralization

A technique whereby additional assets are placed in the SPV but not with the intention of securitization. If a fund includes $100 million in assets, but $10 million of those are allocated as additional collateral, securities will only be issued against the $90 million, with the additional $10 million serving as a backstop in the case of excessive losses in the pool (see Figure 3).

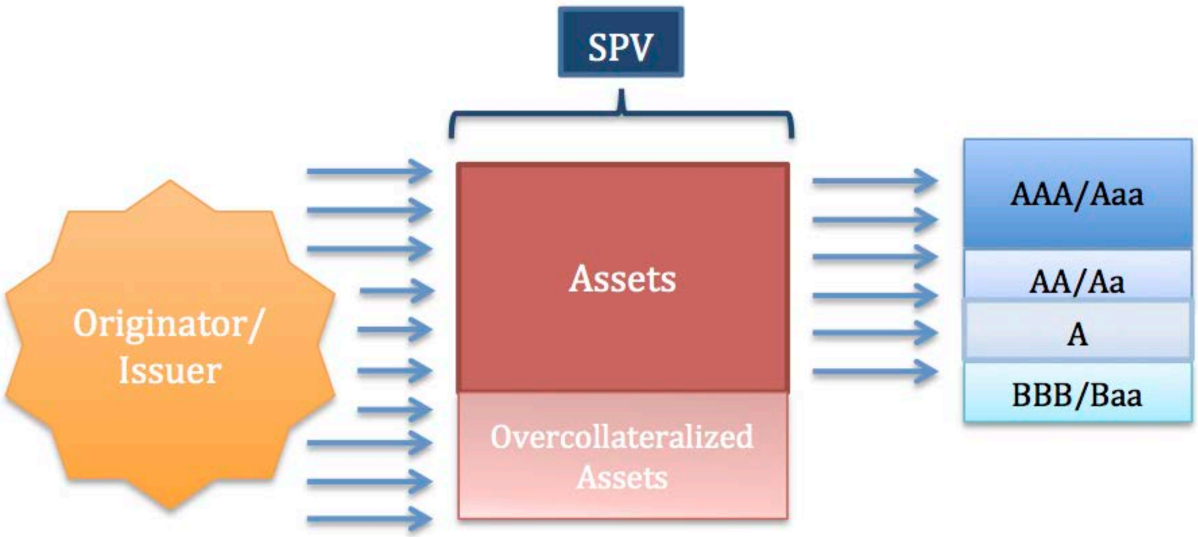

Figure 3. Generalized depiction of an overcollateralized asset pool (SPV)

Additionally, public credit enhancements in the form of a first-loss reserve, a co-investment, or a mezzanine investment made by a government or non-governmental entity may be a potential option to assist the initial solar securitizations in gaining marketplace traction. NREL has been investigating this subject with various industry stakeholders and will be publishing a report in late 2013–early 2014 (Mendelsohn and Joshi, forthcoming).

2.5 Public Versus Private Markets

An investment bank may issue securities either in the public or private markets. The decision is based on a number of factors, including the nature of the securities' underlying assets, the size (in dollars) of the securities offering, the business needs of the originator or issuer, and the professional judgment of the investment bank.

Public offerings must be registered with the SEC, which carries significant costs in terms of time, diligence, and capital. Notwithstanding SEC registration, public offerings may confer several benefits, including: (1) they are sold into the broader public market, and thus potentially have access to more capital relative to private issuances; (2) they can enjoy greater levels of liquidity because there are more investors and more trading in public markets; and (3) they can achieve an advantageous cost of capital for the originators because they reach more investors and are commonly more liquid investments.

Private offerings do not require SEC registration and are executed under "safe harbor "clauses of the Securities Act, such as Rule 144A (see text box). While these safe harbors allow securitization transactions to avoid the costs associated with SEC registration, they are accordingly only available to a limited number of sophisticated investors ("qualifying institutional buyers" [QIBs]), which are theoretically more knowledgeable and responsive to their specific risks and requirements than the regulators.

Securities offered under 144A and other safe harbor provisions do not require the same issuance volume as public offerings, as the costs of executing this type of transaction are lower (i.e., the ratio of offering size to total costs is lower). Securitization experts that have consulted with NREL seem to agree that the lower bound issuance volume for a 144A transaction is in the $50 million–$100 million range. This is an accomplishable range for some originators or issuers in the solar asset class.

Typically, 144A issuances are used for esoteric assets and carry premiums that increase the originator's cost of capital. These premiums reflect the risks associated with: (1) trading in assets that are understood less and have smaller markets; (2) limited liquidity; and (3) possibly lower credit ratings. So, while private offerings may allow originators to save on the costs associated with SEC registration, there is an offset penalty in the pricing of the risk that these securities pose. Some securitization experts anticipate that once solar achieves greater market penetration (in both the commercial and residential sectors) and as investors become more familiar with the asset class, originators can transition away from private offerings and seek financing in the public markets.

In conversations with NREL, securitization experts seemed to agree that solar, as an esoteric asset class (see Section 3.1) that will likely be issued on the private markets, may come in at lower credit ratings and higher yields than securities based on more conventional forms of collateral, at least for the initial transactions. Interviews with securitization professionals identified three premiums that would figure into the solar asset class's cost of capital in its first securitization transactions:

1. **Risk premium:** As an esoteric asset class with low volumes and a long contractual lifespan (20–25 years), solar will likely be required to pay a higher coupon rate to compensate investors for taking on such risks.
2. **Liquidity premium:** As long as solar securities are issued in the private markets, originators will be required to compensate investors for the lack of liquidity that exists in this space.
3. **Rating premium:** The solar asset class will probably receive a lower credit rating from the ratings agencies, at least initially. A lack of historical performance and credit data, the anticipated complexity of the deal structures (owing to the complications with tax equity interest—see Section 3.4), and the restrained liquidity expected from private issuance will likely all contribute to the ratings agencies' assessments. A lower rating will increase the coupon rate and therefore the cost of capital to be paid by originators.

Safe Harbor Provisions: Regulation D and Rule 144A

In the United States, securities may be issued under Regulation D and/or Rule 144A of the SEC. These are both "safe harbor" provisions, which means that they allow issuers and buyers certain exemptions from SEC regulations, provided that they and the securities meet certain conditions. Regulation D allows qualified issuers to bypass SEC registration, which can hasten their time to market and reduce costs associated with executing a securities offering. Moreover, Regulation D does not require the bonds to be rated, which can further reduce time and monetary costs.

Securities issued under Regulation D can only be sold to "accredited investors." The regulation identifies several types of accredited investors, ranging from institutional investors, to businesses, to charitable organizations, to "natural" persons. Several of these types have a capitalization or net worth requirement, and must apply with the SEC to receive accreditation. This ensures that only sophisticated investors that have demonstrable capability to manage their own risks are participating in the market, as there is limited SEC oversight (SEC 2012, 2009).

In contrast, Rule 144A applies to the bondholders, not the issuer or the underwriter(s) that executed the issuance. The rule eliminates the two-year holding period required under the Securities Act of 1933 for certain qualified investors (referred to as QIBs under the rule) and allows them to trade 144A securities freely among themselves. QIBs must meet the same requirements as accredited investors as specified under Regulation D, with the similar justification that if they are large and sophisticated enough, they may forgo registration with the SEC to trade in certain securities. In contrast to accredited investors, however, QIBs must be institutions and cannot be individuals. Rule 144A has allowed for greater liquidity among the securities issued under its provisions, thus providing issuers with greater potential marketability for their offerings (Investopedia ND).

Because of the buyer and reseller requirements specified under Regulation D and 144A, bonds issued under these provisions are referred to as "private placements." That is, these bonds are only sold and distributed (i.e., "placed") among a limited group of investors and are not available on the public markets. Private markets are, by necessity, smaller than the public markets, and this can limit liquidity (even after the effects of 144A), increases risk, and drive up the cost of capital for issuers. These constraints and costs are a tradeoff for easier access to market.

Securitization experts interviewed for this report agreed that the solar asset class should seek a credit rating of no lower than BBB if it is to reap any advantages from seeking capital in this market relative to its current access to financing. Because it is a new and esoteric asset class whose risks are not well understood and whose operating history is shallow, the emphasis will be on structuring the initial solar securitizations so as to mitigate some of these risks.

After time, with several initial transactions, a growing presence in the capital markets, and greater investor and ratings agency familiarity, the solar asset class could enjoy higher credit ratings and therefore a lower cost of capital for originators. Conversely, a growing capital markets presence could also influence originators to adopt business standards and best practices so that they too may access the capital markets. Theoretically, this could drive a virtuous circle, which would improve the solar third-party finance business model, decrease solar's risk perception among market participants, bring more capital to the solar industry, and generally lay the groundwork for heightened levels of solar deployment.

3 Securitization and the Solar Industry

The PV industry may access the capital markets by two general means:

1. **Securitization**: The process of transforming illiquid assets (such as the cash flows from a solar lease or PPA) into standardized, tradable instruments (i.e., securities). Security issuers sell the rights to the underlying assets (via the securities), and the proceeds are used to finance business operations. Issuers pay an interest rate to each investor, the percentage of which is typically dictated by the securities' ratings.
2. **Bonding**: The process of securitizing debt and then issuing it into the capital markets via bonds. By purchasing the bonds (and the rights to the cash flows on the underlying debt), investors are in essence lending money to the issuer. The investors are compensated by an interest rate, payable by the issuer, which is determined by the bonds' ratings.

Securities are issued in many different forms, from bonds to stocks to various types of asset-backed products. However, in conversations with securitization professionals, NREL has determined that ABS and CLO structures will likely be the initial vehicles through which residential and commercial solar assets are securitized. Bond finance has already been used by some utility-scale solar developers/project sponsors to finance project development and operations.

Other security types may also be relevant to the solar industry. For example, once the solar market matures, issuers may wish to securitize particular tranches of several solar-backed securities. In this case, the resulting security would be a CDO. The three security types identified below are, according to discussions with several securitization experts, the structures most immediately available to the solar asset class (see Section 4.2.3).

3.1 Asset-Backed Securities

The term ABS generically refers to any financial instrument that is collateralized by a pool of cash-flow-generating assets other than real estate and mortgages. Typically, these instruments are based on consumer receivables, such as payments on auto loans, credit card debts, and student loans (to name three of the more conventional asset types). A sub-class of ABS include "esoteric assets," which are typically understood by and traded among a smaller group of investors, may have a smaller market share than their conventional counterparts, and whose securities may carry a higher yield. These assets include cell phone towers, franchise fees, song royalties, and others. According to the structured finance professionals that NREL interviewed for this report, solar ABS will likely fall into the esoteric category.

3.2 Collateralized Loan Obligations

CLOs are securitizations backed by a pool of loans, typically to businesses and other commercial entities. Payments made on the interest and principal by a company or business comprise the cash stream in a CLO. This means that CLO investors are essentially bearing the credit risk of the businesses that are paying down the loans that comprise the securitization pool. Ratings for CLO securitizations are therefore heavily influenced by the credit ratings of the underlying businesses.

3.3 Project Bonds

Solar project bonds are debt securities that can be issued by the project sponsor (the developer or owner) to fund project construction, operations, or pay down other sources of finance (e.g., a bridge loan debt or equity). The principal and interest on the bonds are amortized by the sponsor (or other issuing entity) using the energy payments made via the PPA. If the bonds are issued prior to project operation (in which case there is no PPA to furnish the payments), then the issuer must pay down the notes using its own corporate funds until the project begins selling electricity.

As mentioned, solar project bonds have already been issued in the marketplace, with recent offerings from MidAmerican for their Topaz and Antelope Valley projects and NextEra for their St. Clair projects in Ontario, Canada. International developers have also issued bonds in various foreign markets to finance PV project development and construction or refinance other loans for the project term (Project Finance 2013a; Project Finance 2013b; Project Finance 2013c).

3.4 Solar Securitization and Tax Equity

As mentioned in the introduction, securitization will likely not replace tax equity as a source of financing for solar projects, even after the ITC reverts to 10% at the beginning of 2017. The value of the accelerated depreciation deduction in combination with the 10% ITC may still be large enough to justify the involvement of a tax equity investor (Mendelsohn 2011). However, the presence of tax equity in a project or a portfolio's capital stack complicates the issuer's ability to incorporate securitization debt into that project or portfolio. The financial structures utilized to monetize federal tax credits—namely partnership flips, sale leasebacks, and inverted leases—are highly complex and highly sensitive. Some of the legal processes required in a securitization transaction—including the "selling" and pooling of assets in off-balance sheet vehicles and the sale of the rights to these assets to investors—can trigger certain taxes that would foul up the value of the credits to the tax equity investors.

Various security structures could possibly mitigate some of the complications attendant to the combination of securitization debt and tax equity. For example, issuer firms may choose to back-lever the securitization debt, or in other words, treat it as corporate debt instead of incorporating it into the project or portfolio's capital stack. Another option may be to arrange for a securitization as "take out" financing after the recapture period.[5] That is, issuers would execute a transaction to repurchase the project or portfolio's assets from the tax equity investor after the recapture period has elapsed and the tax equity partner would like to exit. If developers would like to access capital market finance indirectly before the recapture period has elapsed, it may be possible to do so by taking out loans against their partnership interests in the project entity[6] (in a partnership flip structure). Assuming that a lender were to make this type of a loan to developers

[5] The recapture period of a project extends from year one (operation) through year five, and represents the timeframe that a tax equity partner must remain invested in a project if it is to receive the full amount of the federal tax credits. If the investor exits before the fifth year has elapsed, then the IRS will "clawback" the value of tax credits that have not yet vested.

[6] The project entity is one of the features of project finance. Project finance is non- or limited-recourse, which means that lenders and other investors do not have or are limited in their rights to step in and take over a developer's assets. The project entity is similar to an SPV in a securitization transaction, in that it is an off-balance sheet vehicle that holds assets (in this case, it holds the project's assets, which will eventually be used to generate revenue and pay off investors).

in sufficient volumes, [7] it might then issue securities against its loan pool in the form of CLOs. These lenders, likely a commercial or investment bank, can access securitization debt at low costs in the capital markets, and they may be able to pass on this on to the developers in the form of a reduced interest rate (Lowder and Borod, 2013a 2013b).

Other structures are indeed possible. However, the variations discussed above were devised by a team of tax and structured finance attorneys participating in the NREL SAPC working group (see Sections 2.2 and 5) as the highly viable and replicable means of incorporating securitization debt into a project or portfolio's capital stack alongside tax equity. None of these structures has yet been tested in the marketplace.

3.5 Solar Securitization and Operations and Maintenance

As of this writing, the operations and maintenance (O&M) landscape in the PV market comprises a patchwork of providers and practices. O&M work may be performed by the installer or contracted out to an EPC and managed by third-party finance providers. O&M requirements, practices, and other terms are generally negotiated and vary with the size and type of installed system. There are no national standards or best practices, nor are there any O&M providers with a national footprint that would be capable of servicing several pools of assets regardless of originator. Without any providers that could step in as a replacement for a pool of securitized assets if the original O&M provider filed for bankruptcy, ongoing system performance and cash flows are at risk.

According to several solar industry stakeholders and securitization experts, applying uniform standards and having dedicated O&M providers are crucial to the likelihood of an asset pool generating the expected level of cash flows for a securitization deal. This, in turn, is crucial to obtaining a credit rating that will positively affect the originator's cost of capital. NREL is aware of at least two entities that are currently in the process of developing O&M businesses which would be capable of servicing the assets behind securitization pools. It may be some time, however, before these entities build their reputations and track records in the market. The initial solar securitizations will likely prove test cases as to how the role of the O&M provider or backup provider function in a deal, and what effect this would have on the credit rating.

[7] As of this writing, the authors are not aware of any loans of this nature having yet been made. However, lending against developer partnership interests may become more of a common practice if banks determine over time that: (1) the loans are generally low-risk; and (2) there is a market for securities backed by pools of these loans.

4 Solar Securitization Potential

4.1 Portfolio Application

The size of securitization deals will depend on the type of instrument, the underlying assets, market demand, originator business volume, and other factors. NREL has pegged the general range for ABS deal sizes from around $0.5 billion to $1.5 billion and CLOs in the $400 million to $500 million range[8] (Guru 2013; Robinson 2013). Through reviewing a number of offering documents for public securities offerings, through discussions with securitization professionals, and through market research.

An initial solar-backed issuance is, however, expected to be much smaller, likely in the range of $50 million–$100 million according to some structured finance and solar professionals. The economics of small deal sizes can be difficult to justify. All securitizations have fixed costs that are paid at deal closing, and these costs are consistent for deals that are $50 million or $500 million. When these costs are divided by the total amount of the securities issued, small deals pencil out to a higher cost of capital and therefore a reduced benefit (comparative to other sources of capital such as bank debt or even equity) for issuers. Small deals are also less liquid in the market because there are fewer securities for investors to trade among themselves. Accordingly, investors that buy into these small-issue, low-liquidity type of deals typically hew to a "buy and hold" strategy.

Given the limitations in current solar market volumes, it may be realistic to assume that the first securitizations will not obtain an optimal spread between the cost of capital of securitization debt and, say, that of a commercial loan. However, many stakeholders anticipate that the solar securitization market will develop over time as more assets are originated and as more deals are executed. The initial securitizations will therefore serve as foundational to the development of this market.[9]

Assuming an initial securitization is sized at $100 million, and these funds cover 50% of the system cost for each project in a portfolio of installations, roughly 7,273 residential solar systems, *or* 333 small commercial systems, *or* 44 larger commercial/industrial (C&I) systems could be financed through a single issuance (see Table 3). Of course, any adjustments in installed cost, portion of the system cost financed through securitization, overcollateralization of the asset pool (see Section 2.3), and other transaction-specific details will alter these figures.

[8] These figures were developed through reviews of a number of offering documents for publicly issued securities, discussions with securitization professionals, and market research.
[9] One of the efforts of the SAPC working group convened by NREL is to prime the solar securitization market and thereby reduce the barriers to its development. See Section 5 of this report for more information on SAPC.

Table 3. Number of PV Systems (by Market Sector) Potentially Financeable Through a Single Securitization Transaction[10]

	Residential	Small Commercial	Large C&I
Assumed System Size	5 kW	100 kW	1 MW
Assumed Installed Costs ($/watt)[11]	5.5	4	3
Assumed System Cost (size x installed cost)	$27,500	$400,000	$3,000,000
System Cost Financed through Securitization Debt (assumed 25%)	$6,825	$100,000	$750,000
Approximate Number of Systems backing the $100,000,000 Securitization Transaction	14,545	1,000	133
Approximate Total MW Financed in the Securitization Transaction (30% of each system)	72	100	133

To put these numbers in perspective, 72 MW represents almost 15% of the total U.S. residential installations in 2012, or over a month's worth of residential installations in California, the largest U.S. solar market. In small commercial, 100 MW represents almost 10% of small commercial installations in 2012. And 133 MW represents over 7% of total large-scale (defined as projects of 1 MW and above) installations in 2012 (SEIA/GTM 2012).

This is a simplified analysis that assumes the total value of the securities issued will equal 100% of the value of assets pool, which is not always the case in practice. Overcollateralization and, in some instances, rotating assets in the SPV will change the value of the pool relative to the total bonds outstanding. Moreover, this analysis does not account for the structuring, legal, registration, and other fees associated with executing a transaction, nor the ongoing payments made to the servicer, the trustee, and other parties in the cash flow waterfall. These costs will diminish the total value to the issuer of the debt sourced from the securitization.

4.2 Market Evaluation

4.2.1 The Residential Solar Market

The U.S. residential solar market added about 488 MW of capacity in 2012 (Feldman 2013; SEIA/GTM 2013a). Using the assumptions that U.S. third-party residential installation costs

[10] System costs are based on 2012 figures. Residential system prices vary widely by size, state and market, installer, whether or not the system is third-party financed, appraisal methodologies, and other factors. Current estimates span from the high $3/W range to over $8/W (SEIA/GTM 2012; Barbose 2012; Feldman 2013). This figure was derived from an internal NREL analysis (Feldman 2013).
[11] System costs are based on 2012 figures.

averaged $5.50/W and that third-party solar financing penetration was at 50%[12] nationwide over that time period, then over $1.34 billion in potentially securitizable residential solar contracts were originated in the residential sector from 2012–2013 (see Figure 4).

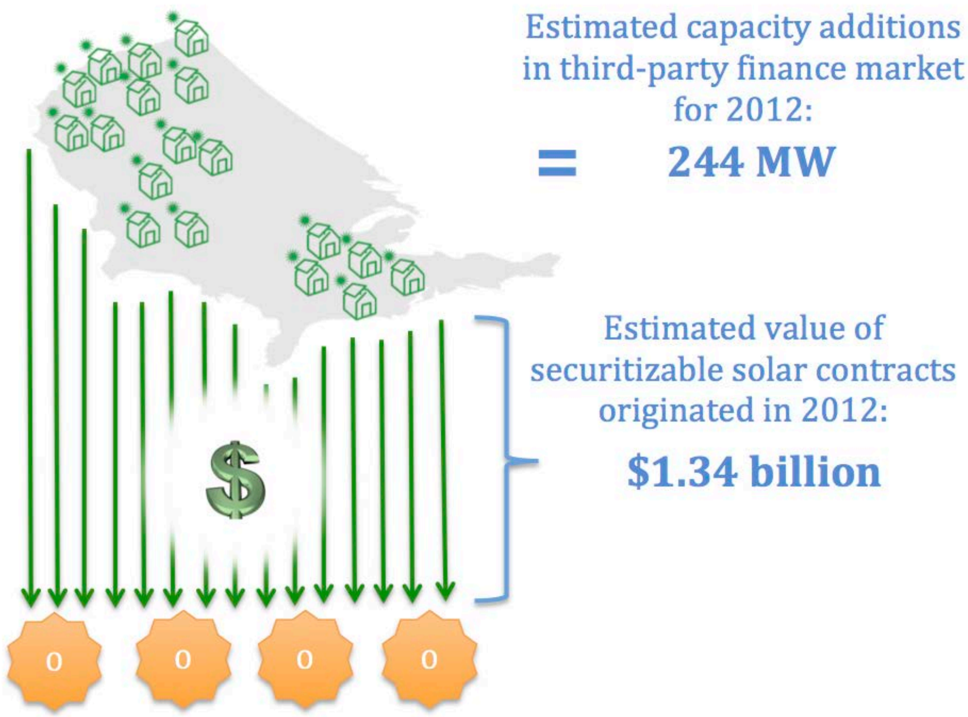

Figure 4. Estimated size and value of potentially securitizable residential solar assets originated in 2012

Most securitization professionals with whom NREL has spoken in researching this report agree that the cash flows in the residential solar sector, as a consumer receivable, most closely resemble the assets in the ABS market. Figure 5 provides some context on the size of some other ABS markets (by 2012 issuance) as compared to the total amount of potentially securitizable solar assets in the residential sector originated in 2012. The entire U.S. market for esoteric ABS (the market in which solar would likely trade) saw just over $19 billion in 2012[13] (Moody's 2013).

[12] This estimate is highly conservative, and based upon a weighted average of the percentage of third-party systems in Arizona, California, Colorado, Hawaii, Massachusetts, Maryland, and New Jersey. Together these states accounted for over 80% of the installations in the residential sector in 2012, and each one hosts a third-party solar finance market. Data for the percentage penetration of third-party systems is available for Arizona (88%), California (69%), Colorado (80.5%), Massachusetts (35%), and Maryland (52%) (Feldman 2013; SEIA/GTM 2013a); conservative assumptions of 25% penetration were made for both Hawaii and New Jersey. The 50% nationwide figure quoted above does not account for any additional third-party residential solar financing outside of these markets, though in it is available to consumers in nine additional states (Kann 2013). These nine states represented 10% of the U.S. residential market in 2012 (SEIA/GTM 2013a).

[13] Moody's includes "commercial" assets in this figure as well. This estimate only includes publicly rated deals.

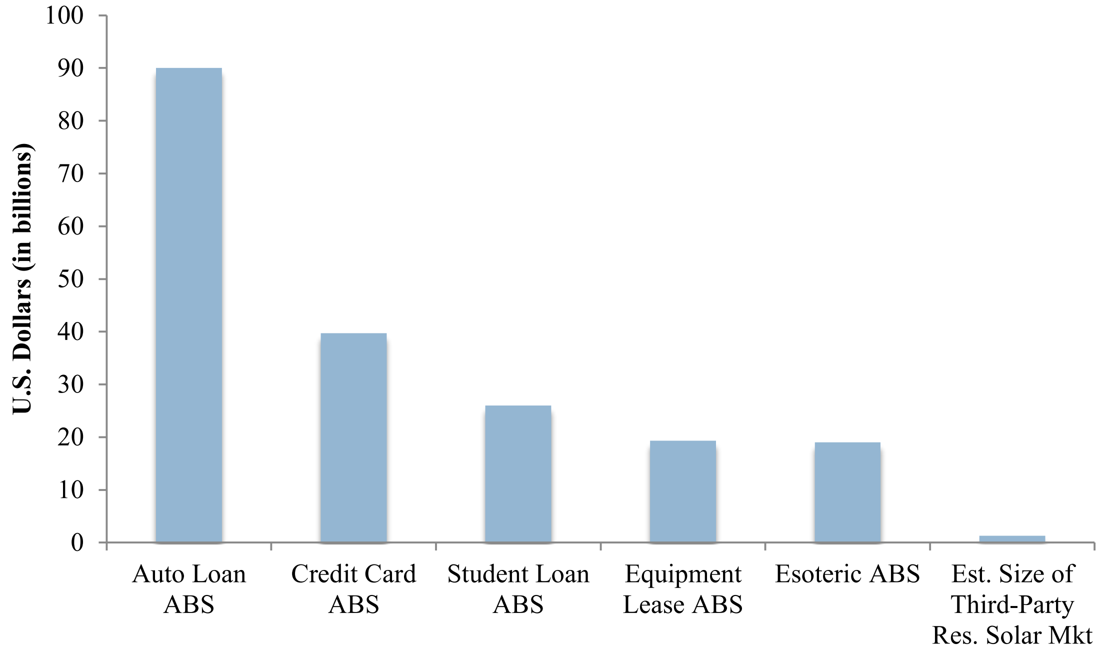

Figure 5. Volume of U.S. ABS instruments outstanding with NREL estimate for U.S. residential solar asset origination

Source: SIFMA 2013; Moody's 2013

One securitization professional who is currently structuring a solar transaction estimated that the first solar deal to hit the market could have a coupon (i.e., interest) rate of around 6%. While solar can access a comparable cost of capital in the debt markets[14] (see Table 4), seeking funds in the capital markets can offer several advantages over loan financing, including:

1. Tenor, or duration of cash flow, can be longer in the capital markets. Loan tenors are currently in a range of 7–15 years, and many carry refinance risk. In the capital markets, solar assets can obtain financing for the entirety of their contractual lifetime (i.e., 20–30 years).
2. Securitization transactions can bring more capital to one deal than commercial lenders may be willing to commit. Thus, capital markets can allow for larger financings for a portfolio of assets.
3. The capital markets allow issuers to take advantage of floating interest rates, which are commonly pegged to U.S. Treasuries, LIBOR (the London Interbank Offered Rate), or some other index. The advantage of floating interest rates on long-term debt is that it can reduce inflation risk for the borrower.

[14] A 6% coupon may not be ideal for developers that can access this cost of capital in the bank market, though it could possibly be attractive to investors looking for higher-yield products in an interest-starved environment (Adelson 2012).

Table 4. Cost of Capital from Various Sources of Financing

Capital Source	Cost of Capital
ABS	**3%–7%** depending on credit rating, liquidity, perceived risk, and other factors. Other costs include structuring and fees and possible SEC registration.
Debt	**5.5%–7%** depending on tenor, project phase, track record of the development team, and other factors. Other costs include an upfront fee, usually 2%–3% of the principal.
Floating Debt	**225–300 bps over LIBOR**. Other costs include swap fees.
Tax Equity	**7%–18%** depending on investor IRR, financial structure, presence of debt, and other factors.

Source: Chadbourne & Parke 2013, Mintz and Levin 2012, Mendelsohn and Feldman 2013

As mentioned in Section 3.4, it may also be possible for residential developers to access capital market finance through CLO structures, assuming that banks would lend against their interest in the project partnership. Banks would then securitize a pool of these loans in the form of a CLO.

4.2.2 The Commercial Solar Market

Aside from these hypothetical bank-sponsored securitizations, developers may also issue CLOs if their collateral pool consists of commercial PPA payments. This is because the collateral pool of a commercial securitization will be less diverse than in a residential securitization (commercial contracts are larger so there will be less in a pool), and the risks will be more closely associated with each offtaker as opposed to spread out across the portfolio. CLOs are evaluated on the basis of the businesses backing the loans in the collateral pool, and a securitization of commercial solar assets will likely be evaluated by the businesses behind the power purchase payments.

Average offering sizes in the CLO market have been $400 million–$500 million over the last several years (Guru 2013; Robinson et al 2013). If commercial solar securitizations will be trading in the CLO market, and would eventually be issued at the average offering size, a single commercial solar securitization transaction could cover up to 250 systems of 400 kW capacity at 25% of the capital stack, assuming an installed cost of $4/W. In other words, a $400 million CLO could account for over 100 MW of development, which is just under 10% of the total megawatts added in the commercial solar sector in 2012.

According to some securitization experts and solar industry professionals, the challenge in securitizing assets in the commercial market lies in the one-off nature of the PPA contracts signed between offtakers (system hosts) and developers. The risks associated with assessing a range of offtakers in a single pool—each with various unique requirements and power purchase terms, and several without credit ratings—are too great for most investors. Thus, the commercial solar market would benefit highly from standardized PPAs, which could allow it to more readily access the capital markets.

Currently, there are several offtake entities in the commercial solar market which, having standardized or nearly standardized PPAs across their stores, are well-positioned for securitization. Namely, these are large companies, typically big box stores, with abundant rooftop space and locations spread across the United States; these include Costco, IKEA, Walmart, and Walgreens.

4.2.3 The Commercial/Industrial and Utility-Scale Markets

Institutional investors typically speak of a minimum debt size of $200 million as the point at which they take interest in a project. Assuming installed costs of $2.50/W at the utility-scale, $200 million translates to roughly 80 MW of a project or portfolio. Now, assuming that project's capital stack also includes tax equity (without which the project's economics would likely not pencil out if it is in the United States), the investor will likely seek to deploy a large quantity of capital into the deal to maximize its returns. This would require that projects or portfolios most eligible for bond finance be appreciably larger than 80 MW.

In 2012, NextEra Energy successfully found buyers for a US $175 million bond issuance backed by two 20-MW (40 MW total) PV projects in St. Clair, Ontario. However, these projects were already operational at the time of issue (the bonds will pay down a bridge loan taken out to complete construction) and are supported by Ontario's feed-in tariff, which offers above-market rates for a guaranteed 20-year purchase of the electricity. The quality of the cash flows supporting these bonds, as well as the rating of BBB obtained from Toronto-based DBRS likely made it an attractive offering, despite being below the generally favored $200 million threshold. Moreover, there is no tax equity financing in Canada, as the Canadian government does not use its tax code to incentivize renewables development.

As of this writing, MidAmerican Energy Holdings Co., the utility holding company subsidiary of Berkshire Hathaway, has successfully executed two bond offerings to back two of its massive solar developments: the 586-MW Topaz project and the combined 579-MW Solar Star 1 and 2 projects, purchased from First Solar and SunPower, respectively. The first offering hit the market in February 2012, and though it was originally sized at $700 million, investor demand was such that MidAmerican upped the amount by another $150 million shortly after issuance (Lowder 2012). Another $1 billion in bonds have been issued to finance construction of the Solar Star development, representing the largest bond offering ever executed on behalf of a solar project (Business Wire 2013).

The MidAmerican example is singular in U.S. renewable energy project finance. MidAmerican is a well-capitalized entity that can afford to finance several very large solar projects on its balance sheet and internalize the ITC to apply to its own tax liability. Moreover, it is a rated entity with experience in the capital markets, and it bears the stamp of Warren Buffet, whose presence inspires investor confidence. There are a limited number of entities operating in the renewable energy space that could execute a bond offering, especially to finance project construction and obtain a commensurate cost of capital while generating investor demand. Moreover, the pipeline of utility-scale projects may become less populated in the near-term as the effects of the 1705 Loan Guarantee and 1603 Treasury Grant programs wear off, and as utilities continue to meet or surpass their RPS requirements (Engblom 2013, Testa 2011). In this case, solar project bonds may become an even more niche form of finance than they are today.

5 Summary: NREL's Ongoing Contributions

There are several challenges that the solar PV industry faces in accessing the capital markets through securitized instruments. Limited availability of performance data and credit metrics; lack of standardization in power purchase contracts and leases; short operating histories and currently low portfolio volumes; technology risks; and other headwinds will be difficult for some originators or issuers to navigate. These barriers will also set interest rates on securitization debt at a high bar for those originators or issuers that are able to access the market. However, with time, several initial securitizations, and continued risk mitigation efforts, the solar industry is expected to advance up the securitization learning curve. As it does, capital market finance will become a more feasible option for solar originators or issuers, and likely at terms that can meaningfully reduce the cost of solar energy.

To speed the solar industry's advance up the securitization learning curve, NREL has convened the SAPC working group, which draws upon the experience and insights of over 100 professionals from the solar, financial, regulatory, legal, analysis, and advisory industries. To facilitate solar's transition to capital market finance, and also to generally improve the industry's access to funds, SAPC has targeted three areas of engagement:

1. The creation and adoption of standard power purchase contracts and leases in the residential and commercial solar sectors. This will allow for more transparent evaluation of solar assets by ratings agencies and investors and also enforce more robust origination and underwriting practices that could become market standards for originators or issuers.
2. The collection of system-level performance data and customer credit data to provide ratings agencies and investors with the necessary materials to conduct their due diligence and evaluate solar-backed securities.
3. The completion of a mock filing process with the ratings agencies, which is intended to better understand the risk assessment of these vital entities. Understanding the rationale and methodologies of the ratings agencies could go a long ways toward preparing the solar industry for a capital markets strategy and establishing a "best practices" pathway to securitization.

The SAPC working group, this report, and other forthcoming analyses are part of NREL's effort to meet the DOE's SunShot goals through the reduction of "soft" or non-hardware solar PV system costs. Financing is a critical component of solar's soft-cost makeup, and as such represents an opportunity to capture significant reductions in the cost of solar energy. If the levels of deployment achievable through single securitizations as indicated in this report are realistic, then the solar industry could make great strides toward a sustainable future with minimal policy support.

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