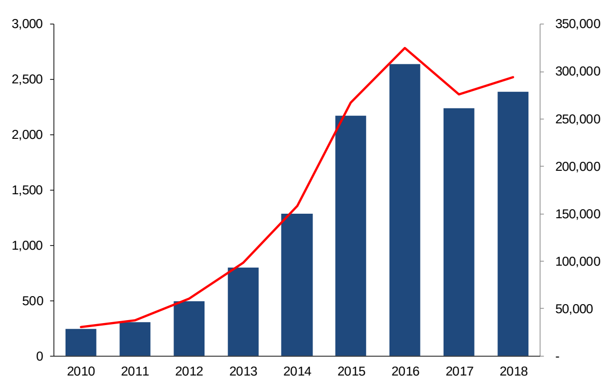
U.S. Residential Solar ABS 101

Introduction

Asset-backed securities (ABS) secured by residential solar financing contracts continue to emerge as a new sector of the U.S. securitization market. The key drivers of expansion are the overall growth of the U.S. rooftop solar market, as well as institutional investors' increasing comfort for this new asset class.

The residential solar sector has experienced solid growth in recent years, with a peak of more than 2.5GW of capacity installed in 2016, representing approximately 325 thousand households. After a 16% decrease in installation in 2017 due to lower customer acquisition in California and Northeastern states, as well as regulatory uncertainty in Nevada, the residential solar market grew by 7% in 2018. Historically leading states seem to be transitioning to more stable growth rates, while Texas, Florida and Nevada are experiencing higher growth.

US PV Installations
GW (left), Number of Households (right)



Source: GTM Research, Wood Mackenzie Power & Renewable, CA CIB

Solar power generation only accounts for 1.9% of US electricity generation in 2017, which underpins a potential for significant growth in the coming years. As equipment costs continue to go down and battery storage technology improves, electricity from solar sources is becoming more competitive, supporting growth in the coming years irrespective of tax reform and the Investment Tax Credit (ITC) sunset.

Solar Contracts

Given the up-front costs associated with installing solar rooftop systems, homeowners typically obtain solar equipment through long-term contracts in the form of either lease agreements, power purchase agreements (“PPAs”), or solar loans. These contracts are for 10 to 25 years with options to renew. The solar developer offering these leases and PPAs contracts is typically responsible for the installation and maintenance of the solar equipment throughout the term of the contract.

Leases

Customers pay a fixed amount per month, generally escalating every year and benefiting from the production of the panels installed by the developer providing the lease, regardless of actual consumption. The contracts typically include a minimum production guarantee to mitigate the risk of equipment underperformance. The minimum production guarantee payments are typically made by the installers to the homeowner and do not reduce lease payments (no netting). In some contracts, true-up payments at year-end may be required for over/under performance.

PPAs

Homeowners pay every month for the actual solar energy consumed with a cost per kilowatt-hour, typically escalating every year. In addition, PPAs often also include a production guarantee where the homeowner is compensated if production falls below a certain threshold.

Solar Loans

Homeowners enter into loans to finance the purchase of equipment as well as installation. Unlike leases and PPAs, the customer owns the equipment and can claim associated tax credits. Solar loans can be structured with payments that mimic PPAs, where monthly payments are tied to production but are typically structured with mortgage-style amortization. Loans are usually structured with the assumption that within 18 months after installation, the homeowner would have claimed the associated tax credits and would prepay to solar loan in an amount equal to the tax credit received.

Under leases and PPAs, the customer does not own the solar equipment, which remains the property of the developer or one of its affiliates. These contractual arrangements, referred to as Third-Party Ownership (“TPO”), allow the sponsor to monetize Investment Tax Credits (“ITC”) and accelerated depreciation associated with the equipment. TPO accounts for approximately 63% of current installations in the US.

In all forms, the fundamental nature of the arrangement is a long-term payment obligation from the rooftop owner that results in cash flow streams appropriate for securitization when aggregated in a sufficiently-diversified pool. In addition, TPO has allowed Sponsors to finance their portfolio with Tax Equity investors willing to monetize ITC and/or accelerated depreciation.

Tax Equity

Tax Equity remains the primary source of financing for leases and PPA-based distributed solar in the U.S. with more than $12BN worth of Tax Equity funds publically announced since 2008.

Market participants have become familiar with Tax Equity structures, and both warehouse facilities and Term ABS have been successfully structured on the back of these arrangements (i.e. “Back-Leverage”).

Tax Equity structures can be fairly complex but usually rely on one of the three structures below:

Partnership Flip

A partnership is formed between the Tax Equity investor and sponsor in which the cash flow allocation varies over time. The partnership is structured such that the Tax Equity investor receives the majority of cash flows, and thus the ITC and accelerated depreciation benefits, for at least the first five years of the transaction. The five-year period is the typical minimum recapture period. After this period, once the tax benefits have been fully monetized, the partnership “flips” and the sponsor receives the majority of the cash flows.

Inverted Lease (Lease Pass-Through)

The simplest explanation is that the TPO provider leases the system to the Tax Equity investor, which then subleases the system to the homeowner. The TPO provider is able to pass through the ITC benefits to the Tax Equity investor, which provides the majority of the upfront capital and receives the ITC benefits and initial years’ customer cash flows, while the TPO provider receives customer cash flows in the out years.

Sale-Leaseback

In this structure, the Sponsor sells the solar systems in their entirety to the Tax Equity investor and then leases back the systems. The Tax Equity investor can fully monetize tax benefits associated to the systems since it is the actual owner of the equipment. The Sponsor then leases back the systems to the consumer.

Historically, partnership flips have been the most common structure used in residential solar but inverted leases have become more widely used in recent years.

Given the relative complexity of the structures and the legal costs associated with them, Tax Equity investors usually require a minimum investment size between $50MM and $100MM, which makes this source of financing unsuited for smaller portfolios. The majority of Tax Equity investors include banks and large corporations.

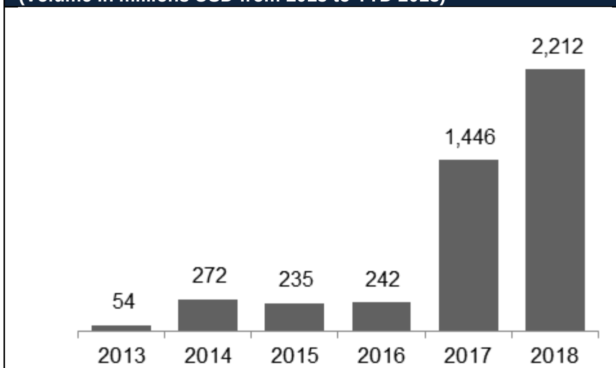
Solar ABS

2018 was a record-breaking year for Solar ABS with approximatively $2.21BN, up from $1.45BN in 2017. Solar ABS continues to establish itself as a reliable source of debt financing for the residential solar industry. 25 precedent Solar ABS transactions have been successfully closed since 2013, for an aggregate issuance volume of over $4.9BN across offerings of different sizes, tenors and ratings. Market highlights include:

- Transaction sizes in the $50-400 million range.
- Credit enhancement provided by a mix of subordinated debt and sponsor equity resulting in an average overcollateralization of 20% for senior tranches.
- Senior tranches rated in the BBB to AA range.
- Subordinated tranches rated in the BBB+ to BB range.
- Mostly-residential portfolios (i.e. ~98% vs. 2% industrial) with average FICO scores in the range of 730-770.
- Securitized contracts have mostly been a mix of Solar Leases and PPAs (57% of the market).

Below we discuss the above overarching trends in further detail.

Solar ABS
(Volume in millions USD from 2013 to YTD 2018)

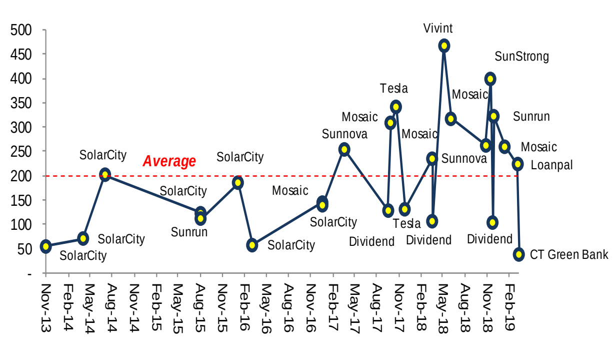


Source: CACIB and Kroll

Transaction Size

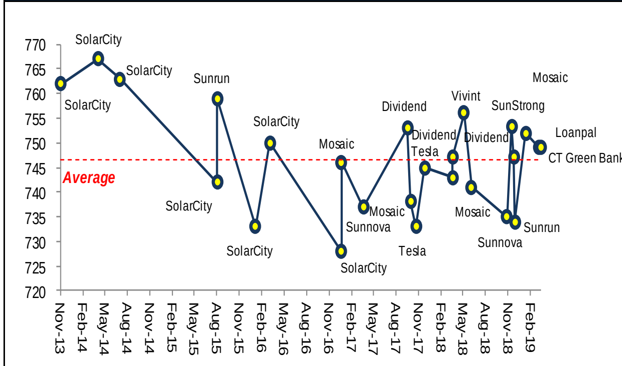
As solar installations accelerate and portfolios grow, transaction sizes of Solar ABS have generally increased since the first transaction in 2013. Investors have also become more experienced with the asset class and larger issuances can now be placed in the Capital Markets. Of note, transactions above $400MM have recently been placed.

Solar ABS
Transaction Size ($MM)



Source: CACIB and Kroll

Solar ABS
Average FICO Score

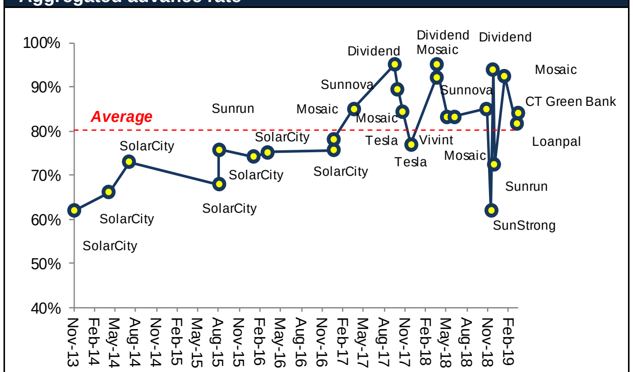


Source: CACIB and Kroll

Advance Rate

The advance rate represents the total debt raised as a percentage of the net present value of the contracted solar cash flows, or aggregate discounted solar asset balance (ADSAB) providing a liquidity cushion through overcollateralization. Issuers typically issue multiple tranches with different credit ratings. Since the first transaction in 2013, aggregate advance rates of Solar ABS have generally increased.

Solar ABS
Aggregated advance rate



Source: CACIB and Kroll

Average FICO Score

So far, the average FICO score of the underlying portfolios has remained at over 730. A minimum FICO score requirement of 650 is also typical for a system to be included in the financed pool.

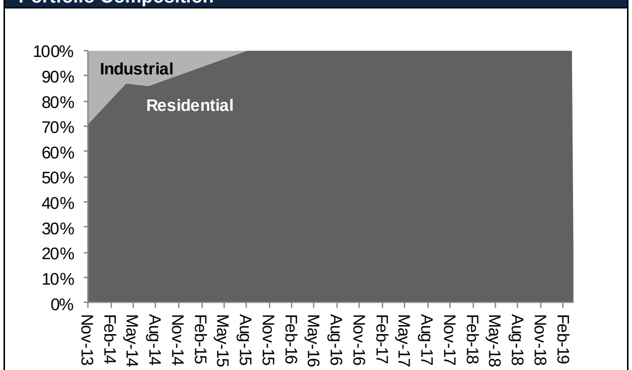
Customers with a FICO equal to or greater than 700 represent typically over 80% of the pool. Per traditional credit metrics, these customers would be classified as "prime".

Portfolio Composition

Portfolio Composition by Customer Type

Residential contracts account for the vast majority of portfolios financed with Solar ABS. While some of the first transactions included some non-residential systems (C&I), the most recent portfolio includes solely residential systems.

Solar ABS
Portfolio Composition

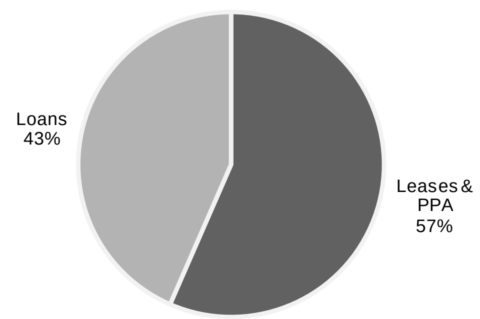


Source: CACIB and Kroll

Portfolio Composition by Underlying Asset Type

There are two types of Solar ABS, securitized by Lease/PPAs and securitized by Solar Loans. From 2013 to 2018, Solar ABS securitized by PPA/Leases accounted for almost 65% of total Solar ABS transactions. Loans, which have recently become the largest source of financing for residential solar, can be sold directly to financial institutions such as Fannie Mae or Freddie Mac without going through capital market transactions.

Solar ABS
Underlying Asset Type



Source: CACIB and Kroll

Structural Features

Credit Enhancement

Solar ABS transactions generally benefit from different types of credit enhancement. Credit enhancement typically consists of overcollateralization, excess cash flow, and subordination.

Overcollateralization

Seeding of Issuer with additional assets that are used to cover potential shortfalls under stressed scenarios.

Excess Cash Flow

Resulting from the difference between the discounted cash flows expected from the aggregate distributions and the weighted average interest rate on the debt issued.

Subordination / Tranching

Most structures consist of the issuance of senior and subordinated securities, which are typically rated based on both overcollateralization and subordination of interest and principal payments. Structures typically include a senior tranche (Class A) and, one or more subordinated tranches (Class B, C, etc.). Subordinated tranches may receive interest only payments until principal for the Class A is amortized.

Transaction Structures

Solar ABS transactions typically include the following structural features:

Priority of Payment

Priority of payments based on the seniority of the tranches. The following order is usually applicable: Class A interest, Class B interest, Class A principal, Class B principal, deferred interests.

Early Amortization Period

Early Amortization Period typically commences if the portfolio is performing below expectations. It can be triggered by DSCR being less than a specific level, or if the notes are still outstanding after the Anticipated Repayment Date (see below). During an Early Amortization Period, all funds are usually applied to the repayment of principal of the senior tranche.

Reserves

Reserve accounts are funded at closing and/or during the life of the transaction:

> *Liquidity Reserve Account:* A liquidity reserve account typically funded at closing to cover six months of interest on each tranche.
>
> *Supplemental Reserve Account:* A supplemental reserve account generally funded at closing, and accumulating additional funds over time. This reserve typically covers needs for future inverter replacement costs, and sometimes accumulates funds for the purchase/withdrawal options associated with the related Tax Equity Funds. This account can also be used to cover the deductibles relatives to Tax Loss Insurance Policies.

Anticipated Repayment Date (ARD)

ARD means the payment date when the Issuer expects to prepay the notes in full. The ARD is generally between 6 and 11 years while the final maturity is over 20 years. The failure of the Issuer to reduce the outstanding note balance to zero on the ARD will not be an event of default, but usually triggers an Early Amortization Period.

Post-ARD Additional Note Interest

Post-ARD Additional Note Interest will begin to accrue during each interest accrual period on the notes at the related Post-ARD Additional Interest Rate, if the outstanding note balance of the notes has not been paid in full on or before the Anticipated Repayment Date.

ITC Recapture Risk

The IRS may attempt to recapture a portion of the ITCs of a Project Company to the extent it concludes the claimed FMV of the PV Systems on the Project Company's tax return was overstated.

Tax Loss Insurance Policies can be used to mitigate any reduction in the distributions associated with potential IRS recapture of ITCs. If a policy payment is required under a Tax Loss Insurance Policy, the associated deductible will be paid by the Issuer via proceeds deposited in the Supplemental Reserve Account.

Backup/Successor Servicer

Backup Servicer agrees to provide certain backup servicing services in the event of a servicer termination event. Backup Servicer will manage assets following termination of a servicing and/or maintenance agreement, as applicable.

Make Whole

The Issuer is typically required to pay a Make Whole Amount if it decides to repay the notes before the ARD. The yield for calculating Make Whole Amount is generally equal to the yield on US Treasury securities having a remaining term to maturity that is closest to the weighted average remaining life of the notes plus 0.5%.

Rating Agencies

Rating Process

Rating agencies rely on their generic ABS and project finance methodologies to rate solar Term ABS. All Solar ABS transactions executed to-date have been rated by at least one rating agency.

Standard and Poor's (S&P) and Kroll have the most experience in rating Solar ABS with 5 and 15 transactions rated, respectively.

While Moody's and Fitch have not yet publically rated a transaction for this asset class, they have published specific reports on the solar securitization market.

Rating Agencies: Experience and Methodologies

	Standard & Poor's Ratings Services	KBRA Kroll Bond Rating Agency	Moody's	FitchRatings
Analysts	• Erkan Erturk • Kate R Scanlin • Jesse Sable • Belinda Ghetti	• Andrew Giudici • Cecil Smart • Andrew Lin • Usman Khan	• Tracy Rice • Benjamin Shih • Dipanshu Rustagi	• Gregory J. Kabance • Suzanne Albers • Glen Grabelsky • Daniel Neama
Applicable Methodologies & Publications	• "Global Methodology For Solar ABS Transactions" (May 2019) • "Key Credit Factors For Power Project Financing" (Sept 2014)	• "Global General Rating Methodology for Asset-Backed Securities" (Nov 2017) • "Global Project Finance Rating Methodology" (Nov 2017) • "Evaluating Credit Risks in Solar Securitizations" (Oct 2012)	• "Moody's Global Approach to Rating ABS Backed by Production-Dependent Solar Contracts" (Nov 2018) • "Approach to Rating Consumer Loan-Backed ABS " (Sep 2015) • "Solar Securitization Is Emerging as an ABS Asset Class" (Jan 2015) • "Generic Project Finance Methodology" (Dec 2010)	• "Global Structured Finance Rating Criteria" (May 2019) • "Distributed Generation Dashboard" (Jan 2015)

Source: Rating Agencies, CA CIB

Kroll Rating Scenarios: Lease/PPA

Category	Description	Base Case	A-	BBB	BB
Energy Production	*Production assumption for the portfolio*	P50	P90	P90	P75
Panel Degradation Rate	*Year-on-year reduction of the panel production*	0.64~0.75%	1.07~1.26%	1.25%	0.90~1.00%
Availability	*Availability assumption*	98.00~99.00%	95.50%	96.00~97.00%	97.50~97.75%
Permanent Default Rate	*% of defaulted customers. Customers never pay again*	3.42~5.56%	11.00~30%	9.30%	5.70~6.30%
Renegotiation Rate	*% of customers who resume payments at lower renegotiated rate*	5%, 10%, 15% customers on years 5, 10, 15	30%, 40%, 50% customers on years 5, 10, 15	22.5%, 30%, 37.5% customers on years 5, 10, 15	10%, 15%, 20% customers on years 5, 10, 15
Renegotiation Lag	*No cash collected during this period*	After 3 months downtime	After 12 months downtime	After 9 months downtime	After 6 months downtime
Renegotiation Haircut	*Assumes customers renegotiate based on their estimated utility rate*	5% below prevailing utility rate in state	19% below prevailing utility rate in state	15% below prevailing utility rate in state	10% below prevailing utility rate in state
O&M Expenses	*O&M assumptions*	$24~25 / kW DC increasing at 2% annually	$ 27 kW DC increasing at 2% annually	$ 26.5 kW DC increasing at 2% annually	$ 24.5~25 kW DC increasing at 2% annually
Inverter Replacement Frequency	*Inverter replacements schedule*	During years 10-12	During years 10-12	During years 10-12	During years 10-12
Inverter Replacement Cost	*Replacement cost assumption*	$1,000~1,100 per inverter	$1,325 per inverter	$1,275 per inverter	$1,150 per inverter
Flip Dates	*For IRR-based TE funds*	Flip dates occur as anticipated	Flip dates extend by one month	NA	Flip dates occur as anticipated
Purchase Option	*For TE funds with call options*	Exercise the purchase options for the respective Project Companies	Exercise the purchase options for the respective Project Companies	NA	Exercise the purchase options for the respective Project Companies

Source: KBRA Pre-sale Reports, CA CIB

Green Rating

Solar ABS can be considered for green certification as the underlying assets securitized contribute to climate change mitigation. Obtaining a green rating label opens access to a broader investor base including investors with sustainable investment mandates. Green certifications also support issuers' communication surrounding their renewable strategy.

Conditions to be granted a certification are in line with the Green Bond Principles. Key criteria include use of proceeds to be dedicated to financing renewable projects, and independent periodic audit on impacts metrics related to the Environmental Social and Governance performance of the assets such as the CO2 emissions avoided.

Recent green-labelled Solar ABS include the $400 "SunStrong 2018-1 Issuer, LLC" offering which was given the highest Green Bond Assessment of GB1 by Moody's.

Conclusion

The rise in residential solar installations has led to a growing securitization market for distributed solar assets.

Market participants are now familiar with this asset class and large transactions have successfully been placed.

The U.S. residential solar market is expected to continue growing despite the phase out of the ITC incentive for residential solar, which will expire in 2021. The recent residential solar mandate in California, making solar systems mandatory to new homes, is a good example of how local authorities can continue to support the solar energy market even if ITC incentives disappear.

While Solar ABS secured with C&I contracts have been scarce, the increasing size of C&I portfolios will likely result in more Capital Narkets transactions.

Furthermore, the deployment of Property Assessed Clean Energy (PACE) financing programs across the country will support the growth of renewable and solar projects. PACE ABS have already been issued and were well received by investors.

This market acceptance, coupled with the improved competitiveness of solar energy, should continue to support the Solar ABS market for the years to come.

Solar ABS Issuances

US Issuances To-Date

Name	Originator	ADSAB ($MM)	Bond Size ($MM)	Underlying Asset Type	Residential / C&I	Capacity (MW)	ARD	Average FICO Scores	Aggregated Advance Rates	Coupon (Class A)	Pricing (Class A)	Ratings Agency	Ratings (Class A)	Date
SHREC 2019-1	CT Green Bank	45.88	38.60	SREC	100% / 0%	109	N/A	749	84.13%	5.09%	285	Kroll	A-	Mar-19
MCSLT 2019-1	Loanpal	272.21	222.39	Loans	100% / 0%	N/A	N/A	749	81.70%	4.34%	190	Kroll	A	Mar-19
MSAIC 2019-1	Mosaic	281.29	259.70	Loans	100% / 0%	N/A	N/A	752	92..32%	4.37%	175	Kroll	A	Jan-19
SUNRN 2018-1	Sunrun	547.23	322.00	Leases & PPA	100% / 0%	249	N/A	734	72.36%	5.31%	265bps	Kroll	A-	Dec-18
DIV 2018-2	Dividend	N/A	103.45	Loans	100% / 0%	N/A	N/A	747	94.04%	3.72%	75bps	Kroll	AA	Dec-18
SunStrong 2018-1	SunPower	586.00	400.00	Leases & PPA	100% / 0%	318	10.0	753	62.07%	5.68%	265bps	Kroll	A	Nov-18
SNVA 2018-1	Sunnova	309.00	262.70	Leases & PPA	100% / 0%	108	10.0	735	85.02%	4.87%	175bps	Kroll	A-	Nov-18
MSAIC 2018-2	Mosaic	381.55	317.52	Loans	100% / 0%	N/A	N/A	741	83.22%	4.20%	135bps	Kroll	A-	Jun-18
VSLR 2018-1	Vivint	466.00	466.00	Leases & PPA	100% / 0%	N/A	N/A	756	83.22%	4.73%	175bps	Kroll	A-	May-18
MOSAIC 2018-1	Mosaic	255.54	235.25	Loans	100% / 0%	N/A	N/A	743	95.15%	4.01%	N/A	Kroll	A	Apr-18
DIV 2018-1	Dividend	111.34	104.66	Loans	100% / 0%	N/A	N/A	747	92.06%	2.61%	N/A	Kroll	AA	Apr-18
TESLA 2017-2	Tesla	170.10	130.92	Leases & PPA	100% / 0%	96	7.1	745	76.96%	4.12%	185bps	Kroll	A-	Dec-17
TESLA 2017-1	Tesla	403.20	340.00	Leases & PPA	100% / 0%	249	10.5	733	84.33%	4.33%	200bps	Kroll	A-	Nov-17
MOSAIC 2017-2	Mosaic	343.65	307.50	Loans	100% / 0%	N/A	N/A	738	89.48%	3.82%	185bps	Kroll	A	Oct-17
DIV 2017-1	Dividend	135.74	128.95	Loans	100% / 0%	N/A	N/A	753	95.00%	4.05%	N/A	Kroll	A	Sep-17
SNVA 2017-1A	Sunnova	299.60	254.75	Leases & PPA	100% / 0%	94	6.4	737	85.03%	4.94%	293bps	Kroll	A	Apr-17
MOSAIC 2017-1	Mosaic	177.90	138.95	Loans	100% / 0%	N/A	11.4	746	78.11%	4.45%	255bps	Kroll	A	Jan-17
SOCTY 2017-A	SolarCity	191.61	145.00	Loans	100% / 0%	55	6.2	728	75.67%	4.97%	290bps	Kroll	A-	Jan-17
SOCTY 2016-1	SolarCity	76.40	57.45	Leases & PPA	100% / 0%	36	6.5	750	75.20%	5.25%	N/A	S&P / Kroll	BBB / BBB+	Mar-16
SOCTY 2015-A	SolarCity	249.50	185.00	Loans	100% / 0%	64	7.0	733	74.15%	4.80%	N/A	S&P / Kroll	BBB / BBB	Jan-16
SUNRN 2015-1	Sunrun	146.50	111.00	Leases & PPA	100% / 0%	56	9.0	759	75.77%	4.40%	230bps	Kroll	A	Aug-15
SOCTY 2015-1	SolarCity	182.00	123.50	Leases & PPA	100% / 0%	108	6.5	742	67.86%	4.18%	230bps	Kroll	A	Aug-15
SOCTY 2014-2	SolarCity	275.86	201.50	Leases & PPA	86% / 14%	118	8.0	763	73.04%	4.02%	180bps	S&P	BBB+	Jul-14
SOCTY 2014-1	SolarCity	106.17	70.20	Leases & PPA	87% / 13%	47	8.0	767	66.12%	4.59%	230bps	S&P	BBB+	Apr-14
SOCTY 2013-1	SolarCity	87.80	54.43	Leases & PPA	71% / 29%	44	N/A	762	61.99%	4.80%	N/A	S&P	BBB+	Nov-13

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