

# Lawrence Berkeley National Laboratory

## LBL Publications

### Title

Performance of solar leasing for low- and middle-income customers in Connecticut

### Permalink

<https://escholarship.org/uc/item/6qb7w233>

### Authors

Deason, Jeff  
Leventis, Greg  
Murphy, Sean

### Publication Date

2021-05-04

Peer reviewed

## Performance of solar leasing for low- and middle-income customers in Connecticut

---

Evaluating the financial performance of the Connecticut Green Bank/PosiGen solar leasing program

Jeff Deason, Greg Leventis and Sean Murphy

May 2021

*This work was funded by the U.S. Department of Energy Solar Energy Technologies Office, under Contract No. DE-AC02-05CH11231.*

## Disclaimer

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor The Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or The Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof, or The Regents of the University of California.

Ernest Orlando Lawrence Berkeley National Laboratory is an equal opportunity employer.

## Copyright Notice

This manuscript has been authored by an author at Lawrence Berkeley National Laboratory under Contract No. DE-AC02-05CH11231 with the U.S. Department of Energy. The U.S. Government retains, and the publisher, by accepting the article for publication, acknowledges, that the U.S. Government retains a non-exclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this manuscript, or allow others to do so, for U.S. Government purposes



# Outline of report

---

- Connecticut Green Bank (CGB)/PosiGen program description
- Research questions
- Data and methodology
- Population served by CGB/PosiGen program
- Repayment performance of PosiGen and other CGB solar financing products
- Comparing CGB/PosiGen performance to external benchmarks
- Overall perspective on CGB/PosiGen program



## CGB/PosiGen program description



## Connecticut Green Bank (CGB) and PosiGen

---

- The Connecticut Green Bank (CGB) is a quasi-public financial institution dedicated to supporting the state's energy strategy of achieving “cleaner, less expensive, and more reliable sources of energy while creating jobs and supporting local economic development.” It evolved from the Connecticut Clean Energy Fund and the Clean Energy Finance and Investment Authority. CGB has leveraged public private partnerships to deploy over \$1.6 billion of investment in clean energy projects in CT.
- PosiGen is a private company with the goal of helping low- and middle-income families access solar and energy efficiency to reduce their energy costs. It operates in Louisiana, New Jersey, and Connecticut offering its solar lease and energy efficiency energy services agreement (ESA). Since it began operations in 2011, PosiGen has supported a fair market value of \$387 million in solar and energy efficiency projects.



## CGB/PosiGen program summary

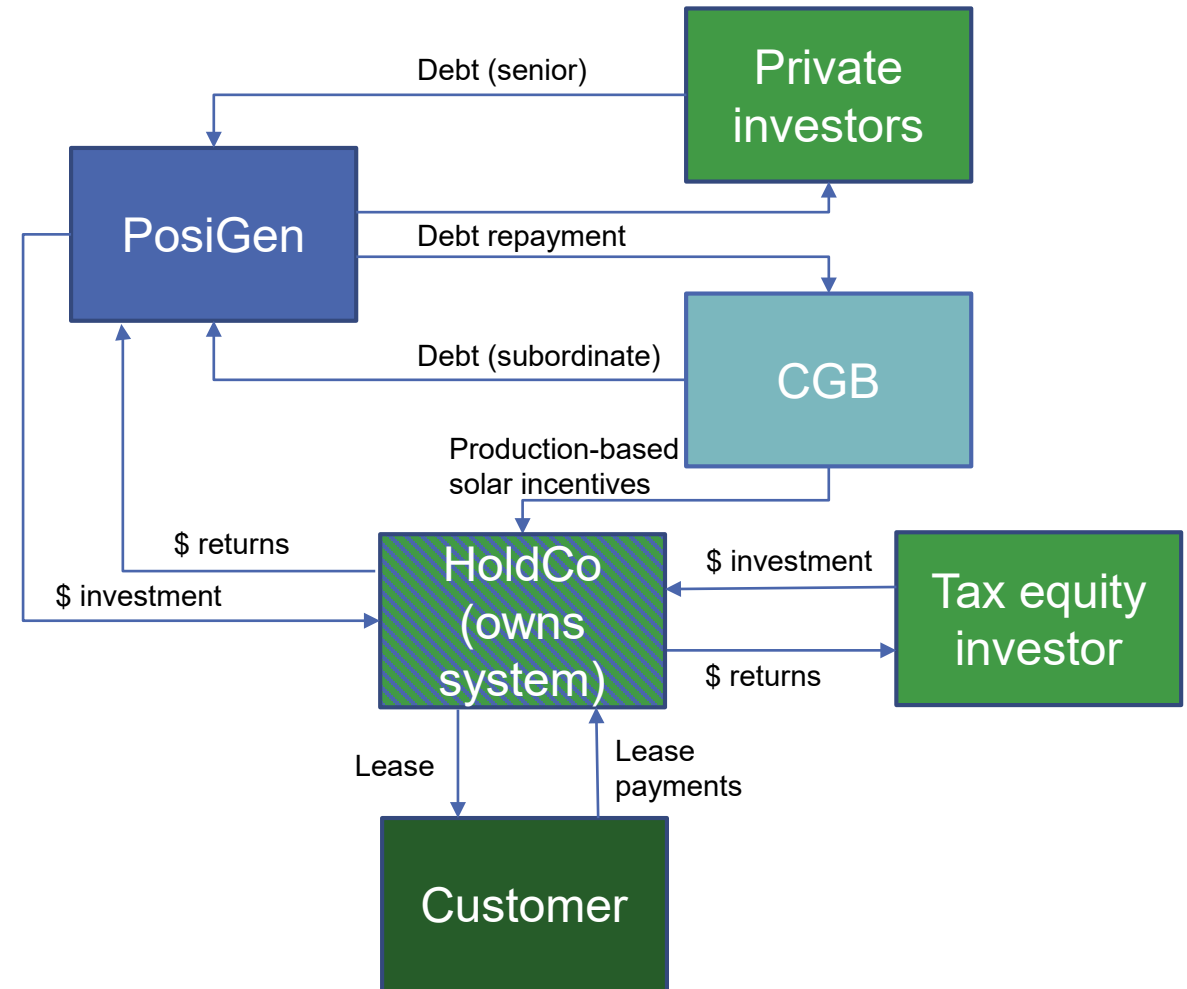
---

- The CGB/PosiGen program seeks to support access to solar PV for low- and moderate-income (LMI) customers. The program began in 2015. It offers single family homeowners a package that includes a leased solar PV system and select energy efficiency improvements. In Connecticut, efficiency measures were initially optional (for a flat \$10/month additional charge) but are now included in all projects. PosiGen efficiency measures go beyond the efficiency upgrade requirements for CT's Residential Solar Investment Program and include measures such as insulation, advanced air sealing and duct sealing.
- The package has a 20-year term with no down payment and no escalator. The leases are structured to provide immediate energy cost reductions to participants. The program provides a 1<sup>st</sup> year savings guarantee to reduce risk to customers that the solar PV system does not deliver anticipated level of production.
- Unlike most standard consumer lending underwriting approaches, there are no credit or debt-to-income criteria for eligibility. Customers must:
  - prove home is theirs and is not subject to foreclosure or bankruptcy proceedings
  - provide identification, personal references and utility bill showing prior months' consumption



# CGB/PosiGen model

PosiGen, a private company, operates and manages customer leases as the managing member of a holding company (HoldCo) that owns the systems. Tax equity investors also own shares of the HoldCo in order to monetize tax benefits created by the systems. The CGB extends below-market-rate debt to PosiGen and pays production-based incentives into the HoldCo. Private investors also extend debt to PosiGen; subordination of the CGB's debt helps attract these investors. The HoldCo returns revenues to PosiGen and tax equity investors from customer lease payments and incentives. PosiGen primarily bears risk associated with customer non-payment; CGB is not affected unless PosiGen becomes unable to service the CGB debt.





# CGB financial support for the CGB/PosiGen program

---

- The CGB pays production-based incentives (PBI) – which are higher for LMI customers – to the HoldCo. PBI payments are based on the actual production of the PV system. These incentives allow PosiGen to offer lower lease prices to their customers.
  - Current LMI PBI are \$0.081 per kWh. PBI has stepped down over time.
  
- The CGB provides below market-rate debt to PosiGen to facilitate lower pricing for customers and encourage the participation of market-rate capital providers. Terms of CGB's initial debt agreement with PosiGen were:
  - Debt (with the potential to be subordinated to a private capital provider) in the amount of up to \$5,000,000
  - Yield: 5% per annum
  - Term: 6 years



# Risks in CGB/PosiGen model

---

Risks to parties in the CGB/PosiGen model include:

- Participating customers
  - Must make lease payments and might suffer some consequences of non-payment
  - The PosiGen program structure includes important customer risk mitigations, notably the presence of a first-year net savings guarantee and the fact that PosiGen leases are not reported to credit bureaus
- The public program partner (in this case, CGB)
  - CGB is not exposed to risk of individual customer non-payment
  - CGB extends below-market debt to PosiGen, and that debt could be at risk if PosiGen as a company cannot repay
  - Other public partners might structure their participation differently, and experience different risks or different levels of risk
- The private program partner (in this case, PosiGen)
  - PosiGen bears most of the risk of customer non-payment (via the HoldCo), and also must make customers whole if the first-year guarantee is not met
  - We do not have enough information to consider other company-wide risks to PosiGen
- External investors
  - External investors in PosiGen are at low risk given the subordination of CGB's debt. Again, in a different structure, the level of risk might be different.
  - Tax equity investors likely bear very little risk associated with HoldCo participation, though we are not privy to the details



## Research questions



# Our research questions

---

- Is the CGB/PosiGen program successfully reaching its intended audience (LMI and LI households)?
- How are CGB/PosiGen leases performing? How does that performance vary by:
  - Household income?
  - Credit score?
  - PV system size and cost?
- How does CGB/PosiGen performance compare with:
  - Other CGB solar loan and lease products?
  - Other forms of similar consumer debt?

*Note: The terms PosiGen is able to offer its customers likely depend on the level of support offered by a potential public partner. We do not have sufficient information to assess how LMI participation or performance is affected by program terms (e.g., monthly payment amounts per kW) that might depend on the level of public partner support.*



## Data and methodology



# Data and methodology

---

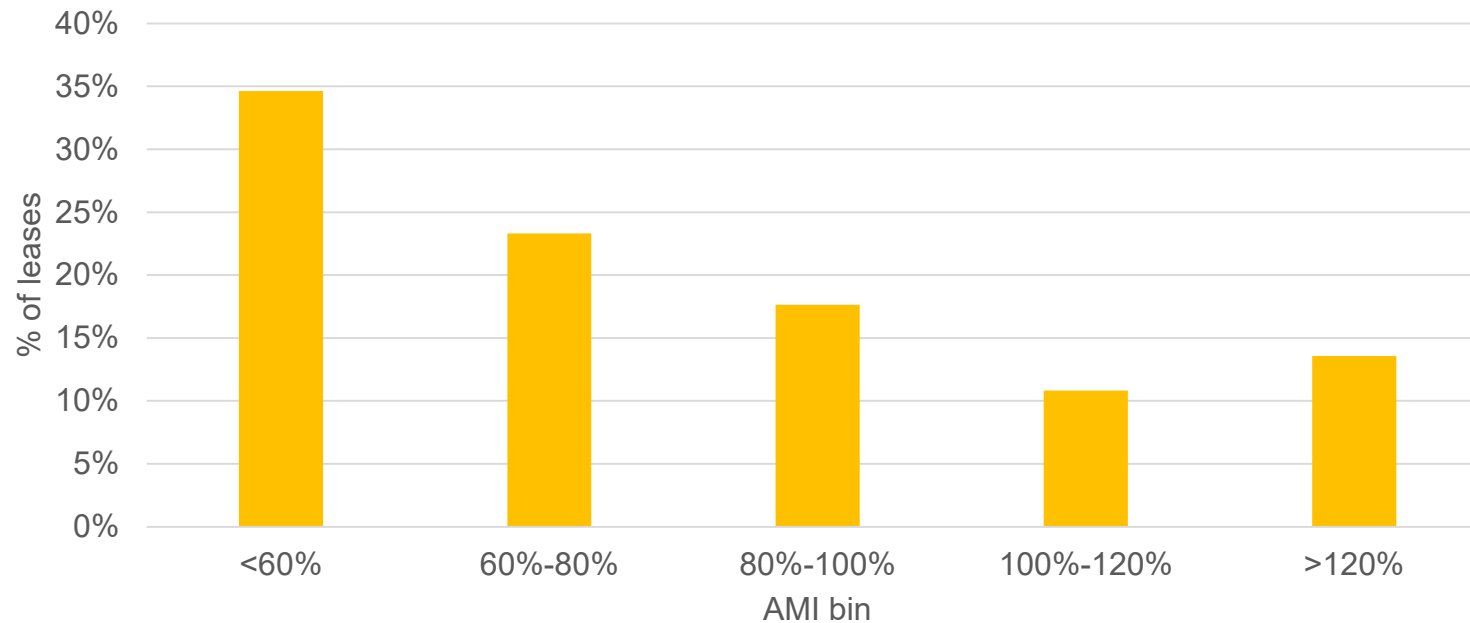
- Analysis based on customer-level data from:
  - ▣ CGB/PosiGen lease portfolio
  - ▣ Three other CGB products that finance residential solar systems but do not specifically target LMI borrowers
  - ▣ All data date from the end of March 2020
- Methodology
  - ▣ Break down PosiGen participants and participants in other CGB programs by credit score, income, etc. to describe population served
  - ▣ Calculate common financial metrics for various programs
  - ▣ Break down financial performance by credit score, income, principal amount, system size, and loan vintage/seasoning
  - ▣ Compare performance of PosiGen portfolio with other CGB portfolios
  - ▣ Compare performance of PosiGen portfolio with external benchmarks:
    - Securitizations of private solar loans and leases
    - Auto loans
    - Consumer loans



## Population served by CGB/PosiGen program



# CGB/PosiGen customer census tract-based incomes

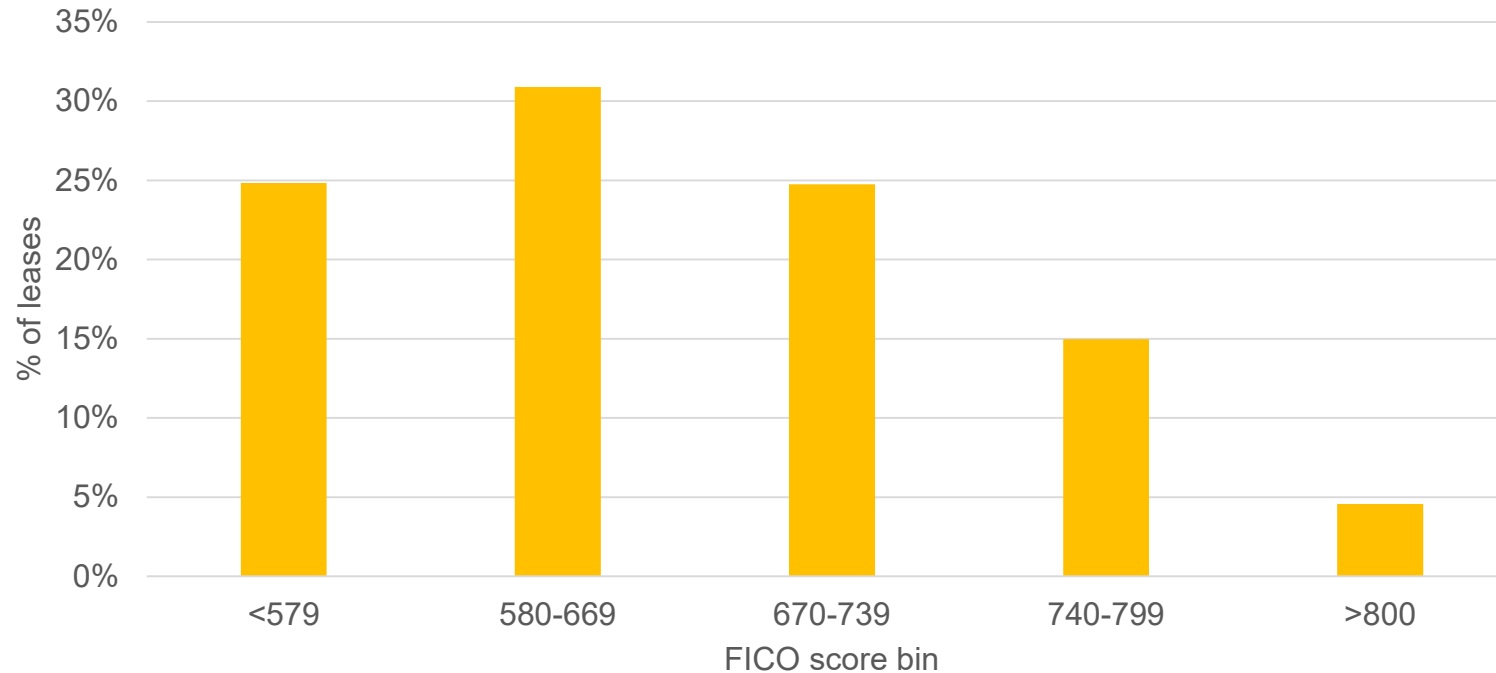


58% of CGB/PosiGen participants live in a census tract whose average income is <80% of area median income (AMI). Another 18% live in a census tract whose average income is between 80% and 100% of AMI. Taking <80% AMI as low-income (LI) and 80%-100% AMI as moderate income (MI), households in LMI census tracts make up 76% of CGB/PosiGen participants.





# CGB/PosiGen customer credit scores



56% of CGB/PosiGen participants have FICO scores under 670, which are generally considered non-prime credit scores. Only 20% have scores of 740 or above.



# PosiGen borrowers, systems, and leases: averages, medians, and ranges

---

- **Credit score:**

- ▣ Mean: 651
- ▣ Median: 655
- ▣ Range: 428-825

- **System size (kW):**

- ▣ Mean: 6.7
- ▣ Median: 6.4
- ▣ Range: 4.5-11.4

- **Lease principal amount:**

- ▣ Mean: \$22,025
- ▣ Median: \$21,598
- ▣ Range: \$9,600-\$55,198

- **Monthly payments** (includes \$10/month for efficiency improvements where applicable):

- ▣ Mean: \$91
- ▣ Median: \$90
- ▣ Range: \$40-\$230



## Other CGB solar financing products used for comparison purposes

---

- *Smart-E loan*: a loan used to finance residential solar PV projects, energy efficiency projects, and combined projects. Program is still active. We only consider Smart-E loans that include solar PV in this report, as all PosiGen leases include solar PV.
- *Solar loan*: a loan program used to finance residential solar PV projects. Program is now closed.
- *Solar lease*: a lease program used to finance residential solar PV projects. Program is now closed.

None of these comparison programs focuses on LMI customers.



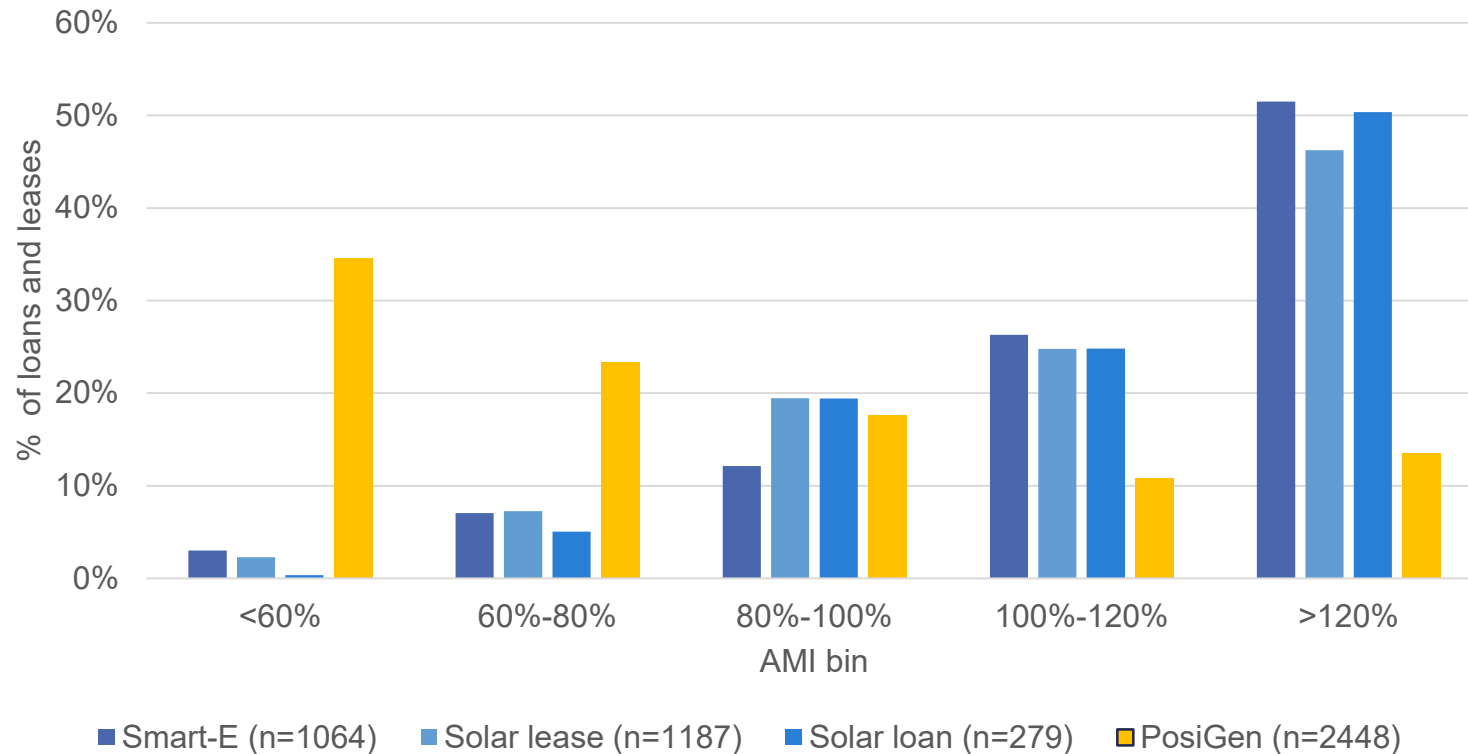
# Customer monthly payment per kW comparison, PosiGen vs. other CGB programs

Program	Monthly Payment (\$) per Installed kW	
	Mean	Median
Solar Lease	11.9	12.2
PosiGen Lease	12.8	12.8
Loan Programs	24.0	21.0

- This comparison reflects only solar PV costs – we remove the costs of efficiency measures from PosiGen customers and exclude loans for mixed solar/EE projects
- PosiGen customers pay a similar monthly amount – slightly higher – per kW than did Solar Lease customers, and considerably less than loan customers
- We might expect costs to vary across programs due to several factors:
  - Solar loan customers own the system outright at the end of the term, while lease customers have an option to purchase for remaining system value (which may be minimal after a 20-year lease)
  - Solar loan customers receive tax benefits themselves; for lease customers, the system owner (HoldCo) receives the incentives and passes them on to consumers, at least in part, via a lower lease payment. Note that these tax incentives require sufficient tax liability to monetize them, which many LMI households may not possess; this is one reason leases are often more financially attractive to LMI (and some non-LMI) households.
  - Both solar costs and CGB incentives have fallen over time, complicating the payment comparison between the Solar Lease (active 2014-2017) and PosiGen lease (active since mid-2015, most volume is from 2017 forward)
  - Non-payment risks differ across populations served (see the next section of this report)



# Census tract-based AMI: Comparison with other CGB solar financing products

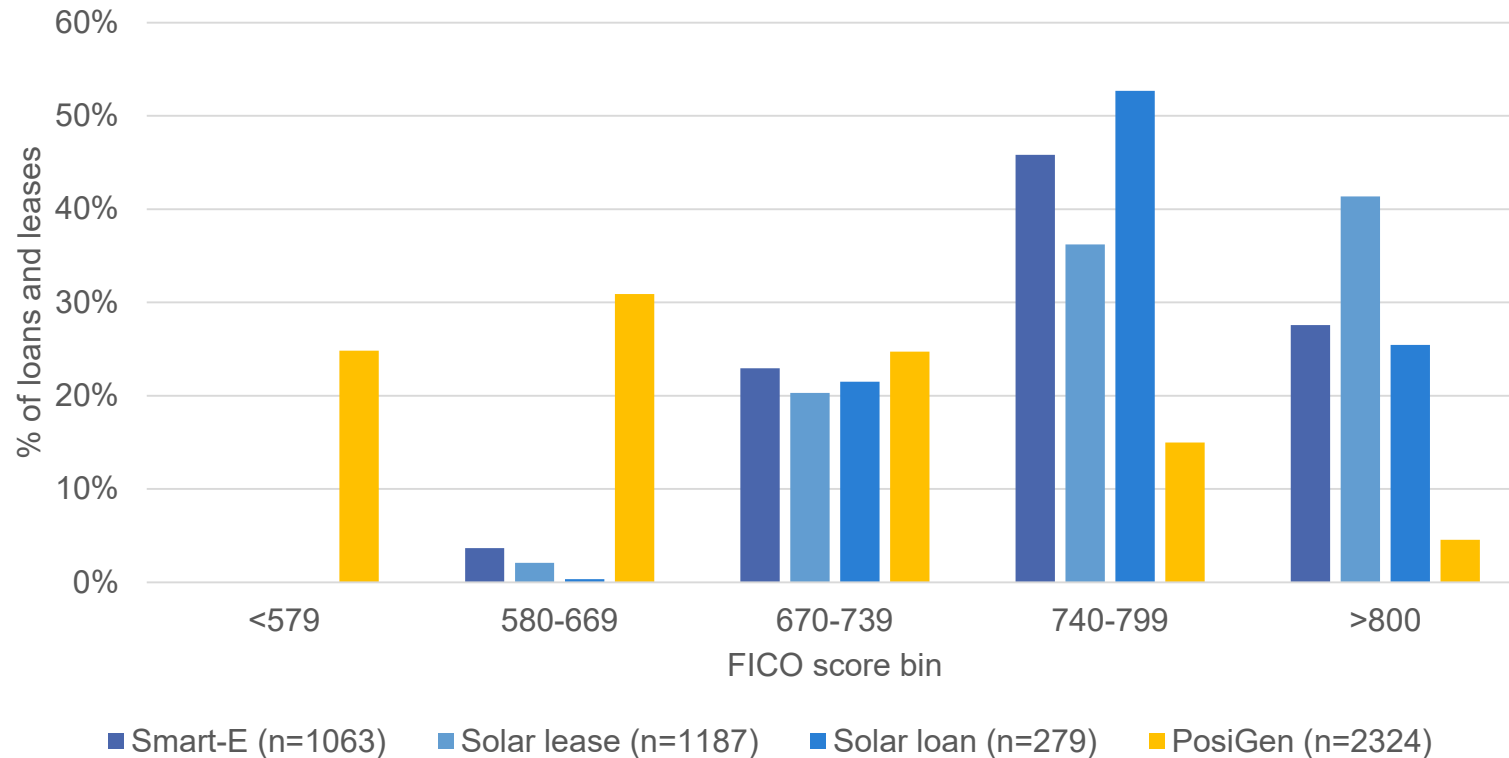


While 74% of participants in other CGB solar programs live in census tracts above 100% of AMI, 76% of PosiGen participants live in census tracts under 100% of AMI. 58% of PosiGen participants live in tracts under 80% of AMI compared to only 9% of participants in other programs.

Note: Customer counts by program vary somewhat on the slides that follow due to missing data and other factors – see Appendix A for more detail.



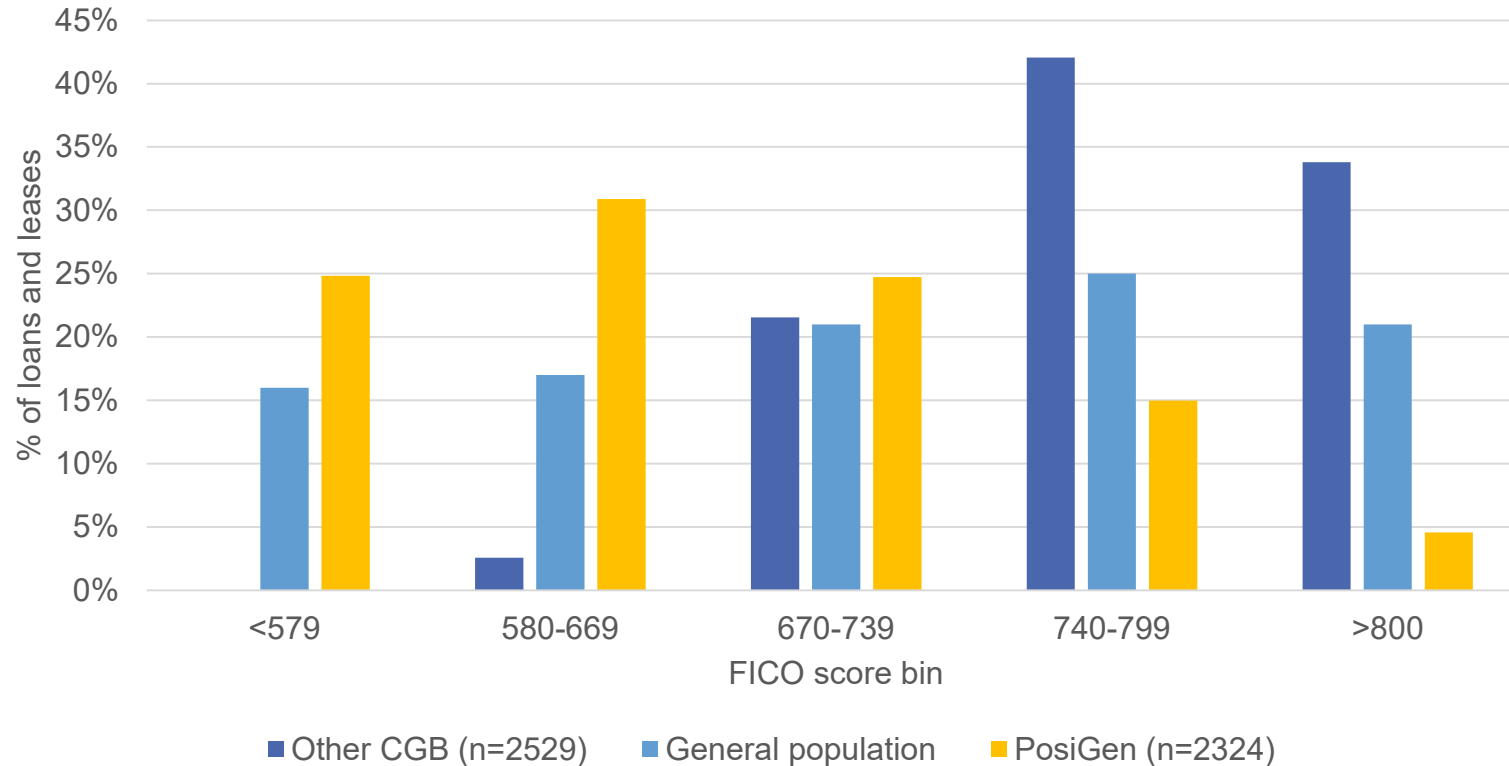
# Credit scores: Comparison with other CGB solar products



76% of customers in other programs have FICO scores over 740, considered “very good” scores by Experian. Conversely, 81% of PosiGen participants have scores under 740. 56% of PosiGen customers have scores below 670; only 2% of participants in other programs do.



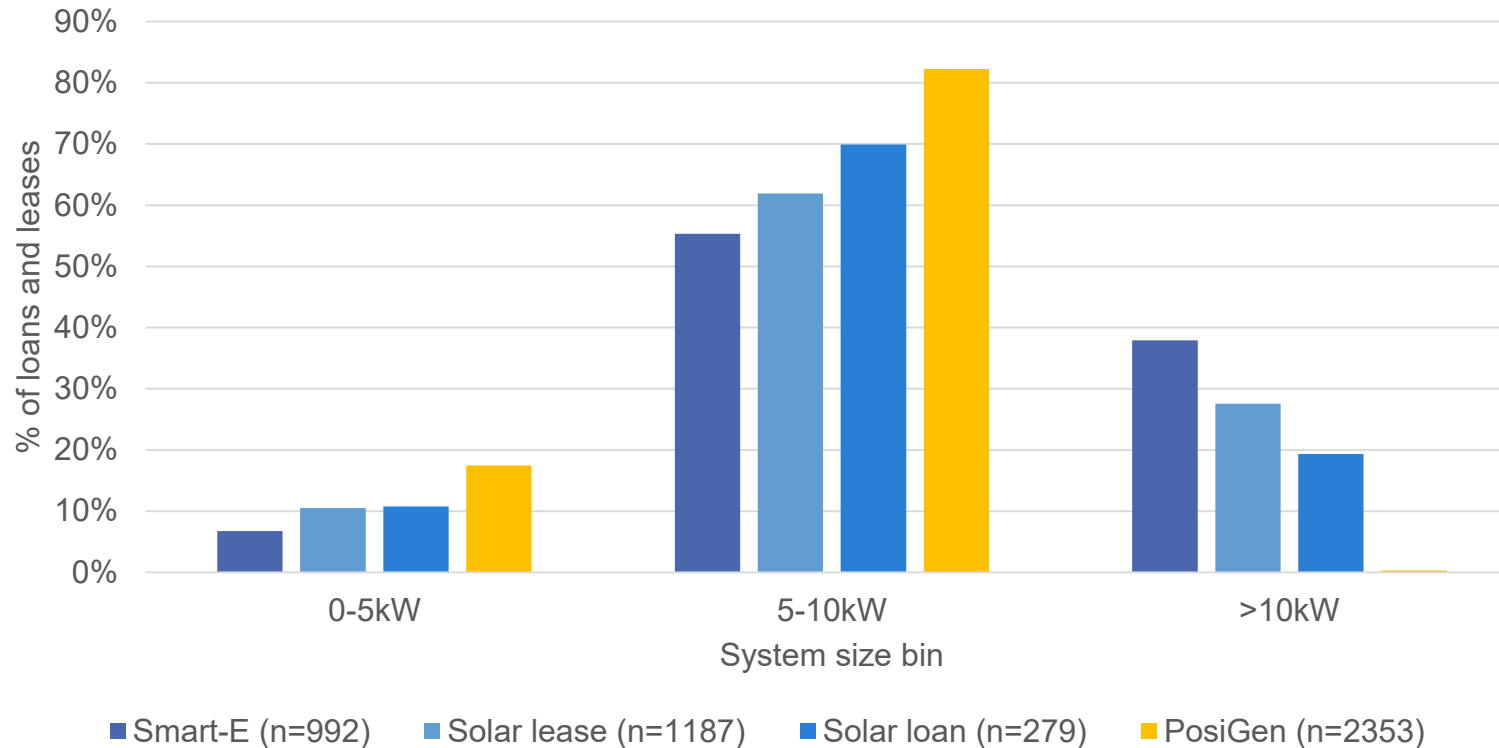
# Credit scores: Comparison to U.S. population



Compared to the general U.S. population (per Experian data), higher credit participants are overrepresented in other programs whereas lower credit score participants are overrepresented in PosiGen's program.



# System size: Comparison with other CGB solar products



82% of PosiGen participants lease PV systems that are between 5-10 kW. This is the most common size for other programs as well, but those other programs also include larger systems. Almost no PosiGen customers lease systems larger than 10 kW.





# Principal amount: Comparison with other CGB solar products



PosiGen principal amounts are concentrated: 72% are between \$15k and \$25k. Other programs have more large-principal systems and slightly more small-principal systems. These data coupled with the system size data demonstrate that PosiGen systems are more standardized than those financed by other programs.



## CGB Program eligibility criteria

Metric	Criteria			
	Smart-E	Solar Loan	Solar Lease	PosiGen
Minimum FICO	Standard term sheet: 640 Credit-challenged term sheet: 580	640	640	Alternative underwriting. No credit check or DTI requirement; must be current on mortgage/property taxes
Maximum debt-to-income	Credit-challenged term sheet 50% Standard term sheet 45%	42%, waived if FICO $\geq$ 720	45%	
Bankruptcy	None in last 4 to 7 years, depending on lender and situation	None in last 7 years	None in last 7 years	None at time of application

Source: CGB: Update on Residential and Commercial Solar & Efficiency Lending



# PosiGen customer eligibility for other programs by credit score

---

A large share of PosiGen customers would not qualify for other CGB programs.

Based on credit score requirements alone:

- Smart-E:
  - 4 lenders use a standard term sheet and 5 use a credit challenged term sheet. Lenders using the credit challenged term sheet have done 93% of program lending.
  - 44% of PosiGen participants would not qualify for standard term sheet
  - 25% of PosiGen participants would not qualify for credit-challenged term sheet
    - Only 4 loans (1% of Smart-E PV loans) have FICO < 640. Since most Smart-E loans use credit challenged term sheets, this suggests most applicants are not credit challenged
- CT Solar Lease/CT Solar Loan : 44% of PosiGen participants would not have qualified.

Some PosiGen customers would also fail to meet other criteria.



# Participant takeaways

---

- The PosiGen program has been successful in reaching a very different, more underserved customer base than the other solar PV financing programs in Connecticut
- Given these data, it is likely that many PosiGen customers would not have been able to access solar PV without this program – strongly implying that PosiGen has supported many installations that would not have been otherwise possible
- The differences in participant characteristics we observe across programs also mean that we should expect differences in repayment rates



## Repayment performance of PosiGen and other CGB solar financing products



## Purpose of this section

---

- Document the financial performance of PosiGen leases in Connecticut
- Compare PosiGen lease performance to the other CGB solar financing products
- Use detailed loan-level data across all CGB solar financing products to explore the determinants of performance for solar leases/loans in Connecticut



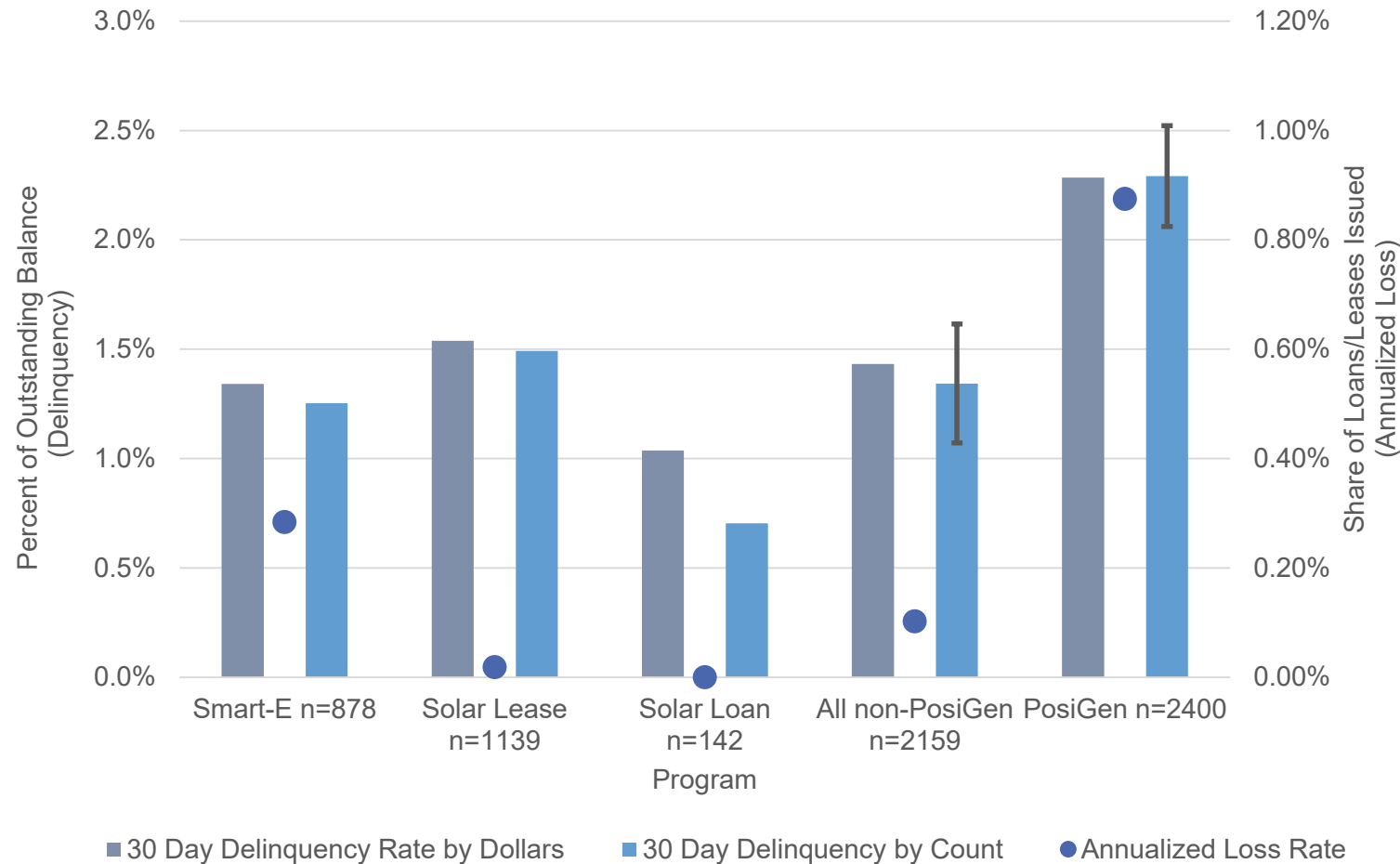
# Definitions of financial performance terms/metrics

---

- ***Delinquent***: leases or loans that are 30 days or more delinquent and are not terminated early or paid off in full
  - We focus on this definition of delinquency because it is the one most often used to define delinquency in our external comparators
  - In one case, on slide 42, we redefine delinquency to mean 30 days or more and less than 120 days delinquent, to match the definition used in an external comparator
- ***Early termination***: leases or loans that have been declared unrecoverable by the lender, according to each lender's practices
  - We use the term "early termination" because PosiGen seeks to redeploy removed systems rather than declaring their value to be lost. Many other settings, including some of our external comparators, use the term "charged off" to denote an unrecoverable balance.
  - Note that lender practices regarding when to terminate/charge-off a delinquent account can vary substantially
- ***Cumulative gross loss***: the share of total portfolio principal that has been terminated early as of March 31, 2020
- ***Annualized gross loss***: cumulative gross loss divided by the average years of seasoning (time since origination) of the portfolio



# Delinquency and annualized gross loss by program



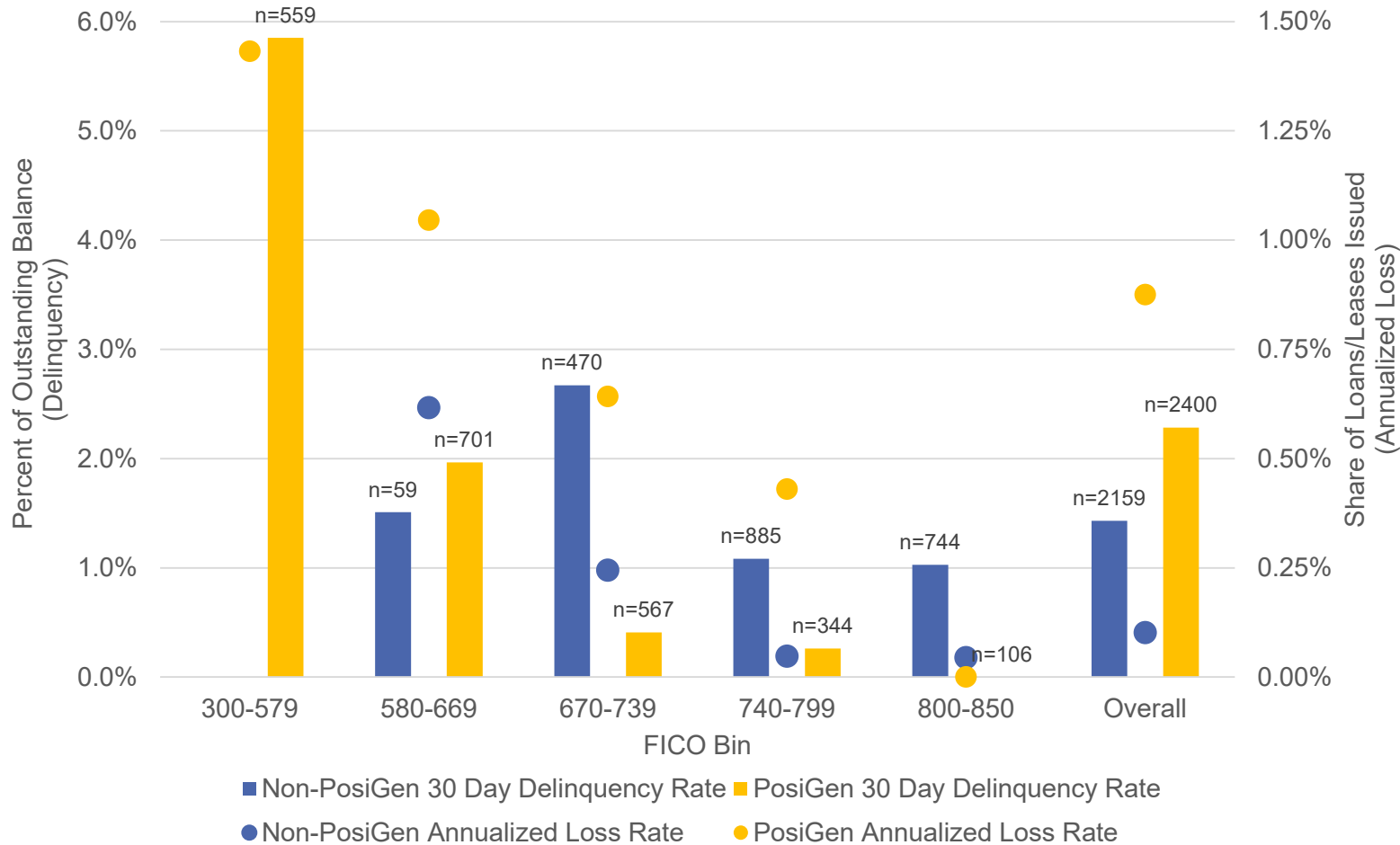
Delinquency and gross loss rates are higher for PosiGen than for the other CGB solar products. Sample sizes are large enough that differences in delinquency rates are likely not due to chance. The slides that follow explore what factors might explain these differences.

Note: We show count-based delinquency rates in addition to dollar-based because count-based rates allow for calculation of confidence intervals. 95% confidence intervals on delinquency are indicated by bracketed black bars. Sample sizes indicate outstanding loans that were part of the delinquency rate calculations, which excludes terminated and fully paid leases/loans. See Appendix A for more details on sample sizes.





# Repayment performance by credit score: PosiGen and other CGB programs



Performance is strongly related to credit score. In all programs, delinquency/default/loss metrics are generally higher in lower credit score bins.

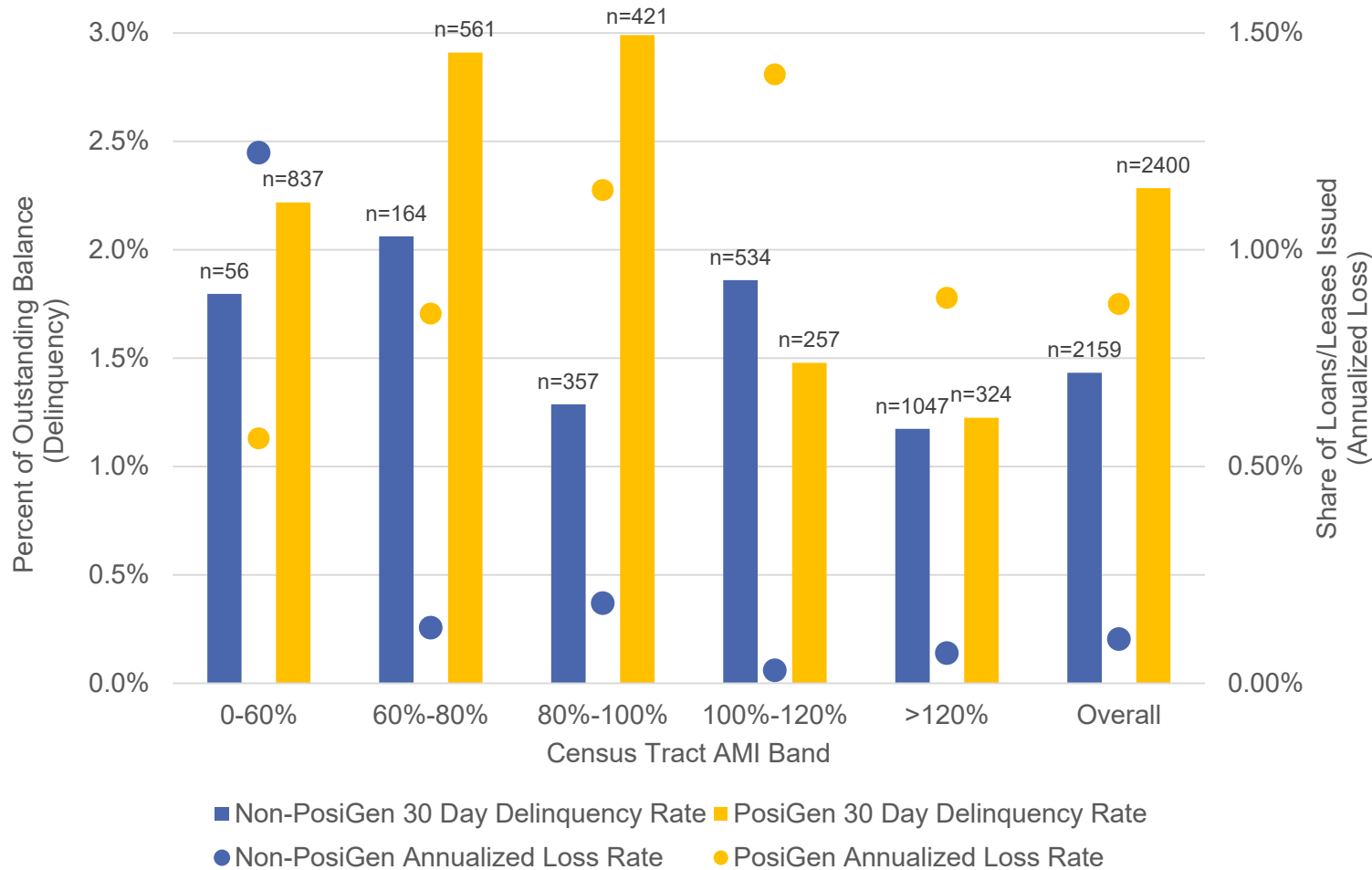
PosiGen delinquency rates in each bin are generally *lower* than the other programs, with the exception of the 580-669 bin where the sample size of non-PosiGen customers is small.

PosiGen annualized gross losses by bin are generally *higher* than the other programs.

We will explore explanations for these divergent findings later (see slides 36 and 37).



# Repayment performance by area median income (AMI): PosiGen and other CGB programs



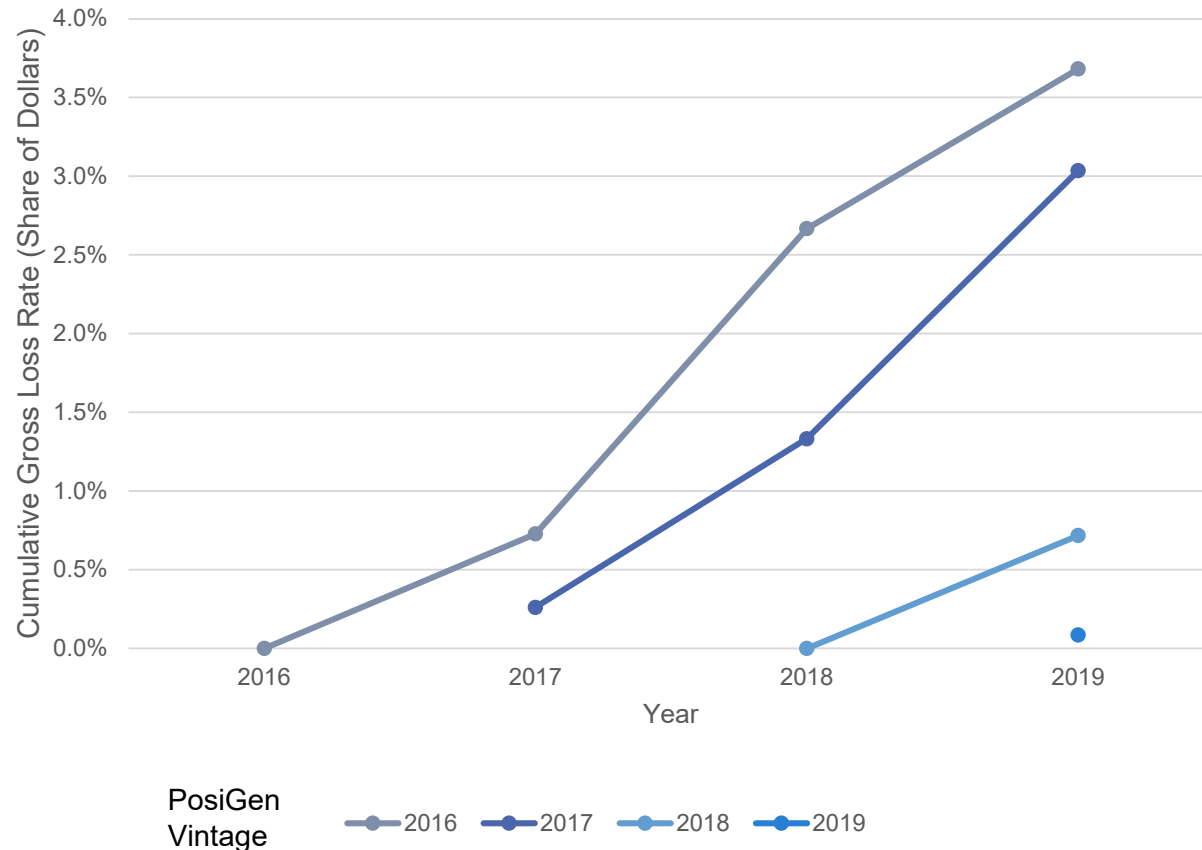
Overall, delinquencies and losses show little relationship with census tract AMI.

By AMI band, PosiGen annualized gross losses are generally somewhat higher than other programs. PosiGen customers are somewhat more likely to be delinquent than non-PosiGen customers in bins below 100% AMI.

Note: The higher loss rate in the <60% AMI bin for non-PosiGen programs is due to a single terminated account; the sample size in this bin is quite small.



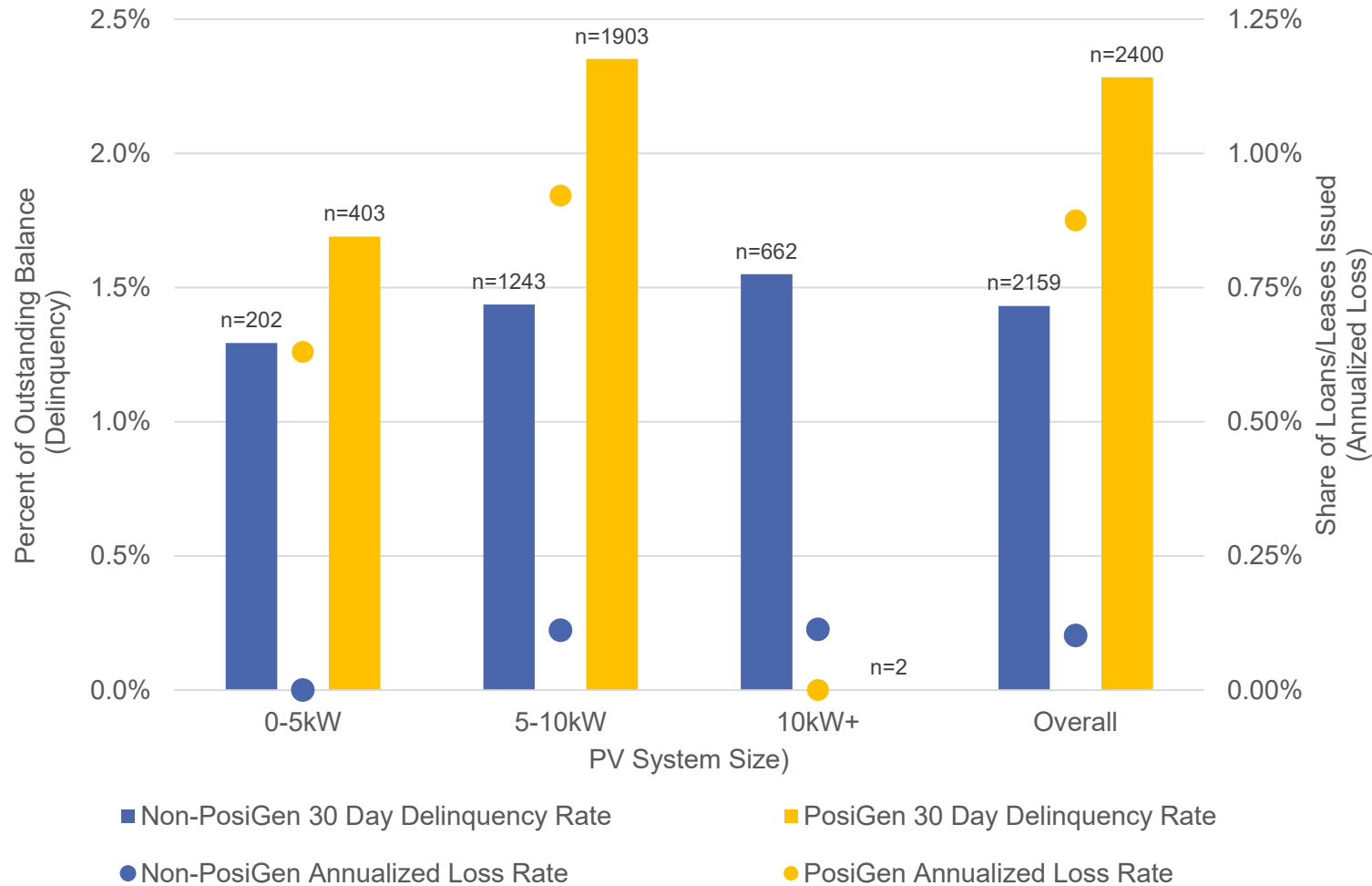
# CGB/PosiGen repayment performance by vintage and seasoning



This graph shows PosiGen loss rates over time by vintage, defined as the calendar year in which the leases were issued. PosiGen leases show a rise in gross loss rate in the second year after issuance. Performance across vintages is similar.



# Repayment performance by system size: PosiGen and other CGB programs



Delinquencies and losses show little relationship with system size. PosiGen delinquency and loss rates are higher than the other programs for small and medium-sized systems. PosiGen finances very few large systems.



# Regression analysis

---

We used logistic regression to assess how differences in program, credit score, lease/loan seasoning, income, and principal amount affect the likelihood of delinquency and early termination for individual loans/leases. Full regression results tables are in Appendix B.

- Principal amounts and income are not statistically significant predictors of delinquency or early termination
- Seasoning is a statistically significant predictor of early termination (more seasoned loans or leases are *more likely* to be terminated early), but not of delinquencies
- Credit score is a statistically significant predictor of both delinquencies and early termination: lower credit score customers are *more likely* to go delinquent and *more likely* to be terminated early. A change in credit score of 117 points – the difference between the average credit score in the PosiGen program and the average in the other CGB programs – would be expected to:
  - raise 30-day delinquency rates by 2.3%, more than explaining the difference in delinquency rates between the programs
  - raise the chances of being terminated early by 0.8%.
- Program results:
  - PosiGen leases are *less likely* than leases/loans in other programs to be 30+ days delinquent (and not terminated). All other customer characteristics equal, a PosiGen customer is 1.7% less likely to be delinquent.
  - Program status (PosiGen/non-PosiGen) is not a statistically significant predictor of more stringent (60+ or 120+) definitions of delinquency
  - PosiGen leases are *more likely* to be terminated early relative to leases/loans in other programs. All other customer characteristics equal, a PosiGen customer is 2.6% more likely to be terminated early.



# Interpreting regression results

---

- Differences in performance between PosiGen leases and other CGB leases/loans are in large measure due to the differences in credit quality among participants in the different programs
  - These results are consistent with the descriptive statistics shown in the previous slides. When broken down by credit score (slide 32), PosiGen performance improves relative to the other portfolios, showing lower delinquencies within a credit score bin and closing the gap in losses somewhat. Breaking the data down by other metrics does not change the relative performance of PosiGen leases meaningfully.
- Seasoning (the amount of time since a loan/lease began) affects early termination rates for individual loans. In prior slides, seasoning is accounted for by annualizing losses (albeit in approximate fashion). Seasoning, therefore, likely does not explain observed differences between the programs
- Relative to other CGB programs, the CGB/PosiGen program has fewer short-term (30-60-day) delinquencies, and no significant difference in longer-term (60+ day) delinquencies, than we would expect given participant characteristics. The CGB/PosiGen program does see more early terminations relative to other CGB programs than we would expect given program characteristics. Not all early terminations are due to payment delinquency, and these results may suggest that factors other than payment performance are more likely to drive terminations among PosiGen customers than other CGB customers.



## Potential system redeployment as loss mitigation for PosiGen

---

- In its Louisiana program, which has operated since 2012, PosiGen has made a practice of redeploying PV systems that are removed from customer roofs due to early termination, thereby recovering some of the value of the system by generating a new stream of lease payments
- According to Citi analysis of PosiGen's Louisiana portfolio, 81.5% of systems have been redeployed. This is a far higher share than in most other solar financing programs.
- No PosiGen systems have been redeployed to date in Connecticut. However, PosiGen is implementing program practices in Connecticut – most particularly, a small number of standard system sizes – that facilitate redeployment.
- If PosiGen can achieve its Louisiana redeployment rates in Connecticut in the future, this would lower the program's loss rates substantially



# Repayment performance takeaways from CGB data

---

- Without controlling for customer characteristics, PosiGen portfolio has higher rates of delinquency and loss than the other CGB products
- Given the stark differences in customer credit profiles, this is not a surprise
- When controlling for credit score, census tract AMI, and other customer characteristics, we see that:
  - PosiGen short-term delinquencies (30 days or more) are lower relative to the other programs than customer characteristics might suggest
  - Longer-term PosiGen delinquency rates (60 days or more) show no clear differences from the other programs when accounting for customer characteristics
  - PosiGen losses (early terminations), on the other hand, are higher relative to the other programs than customer characteristics might suggest
- The AMI of a household's census tract is not a statistically significant predictor of delinquency or early termination
- If implemented at scale in Connecticut, system redeployment could lower PosiGen loss rates significantly in the future
- All of these comparisons are based on relatively small sample sizes. Moreover, all these comparisons are within the CGB's different programs; non-PosiGen CGB programs may be atypical in terms of their performance. The next section of this report compares PosiGen performance to aggregates representing much larger pools of consumer products – both solar PV and other consumer lending – to broaden our perspective.





## Repayment performance: Comparison to external benchmarks



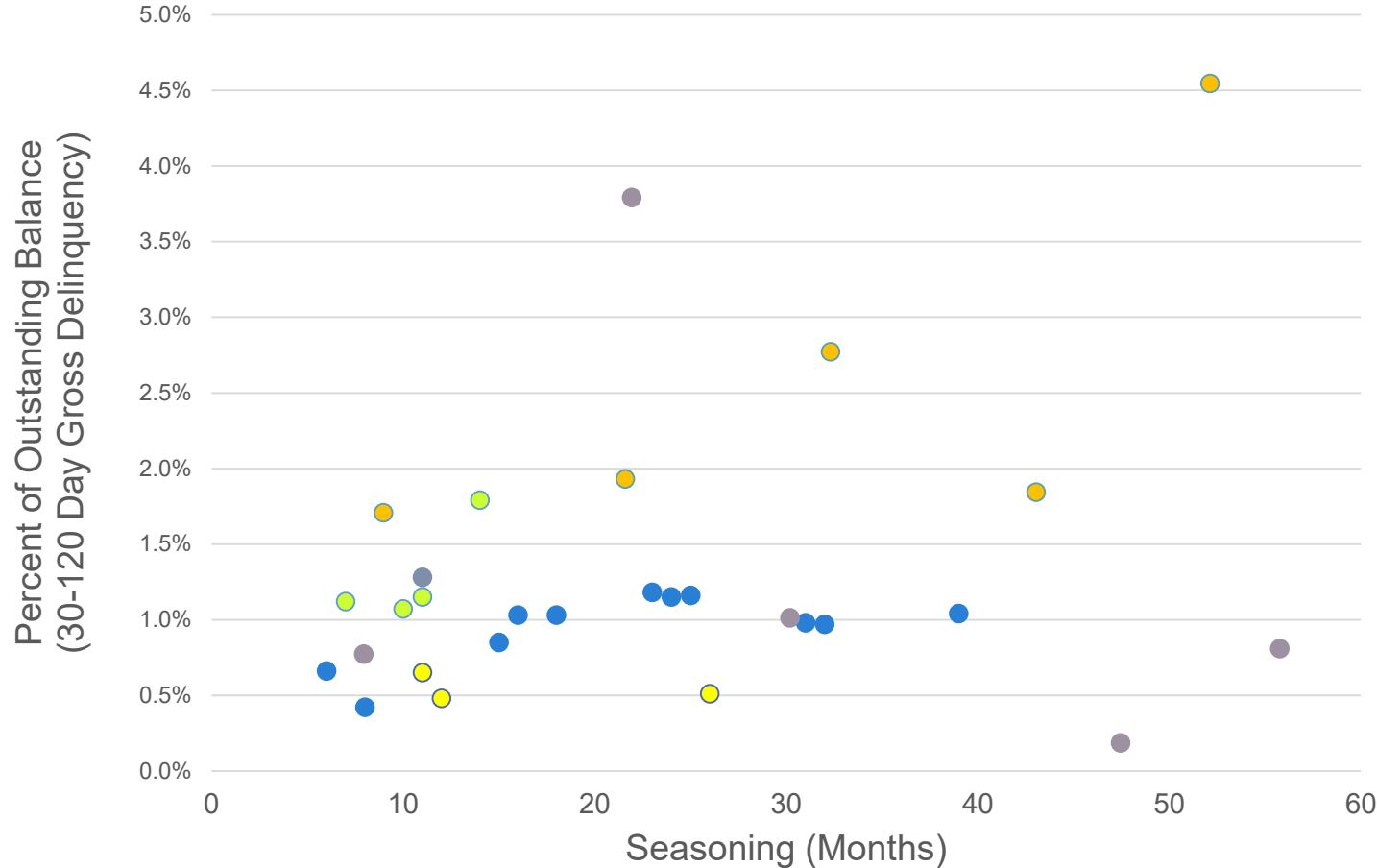
## Purpose of this section

---

- Assess the performance of the CGB/PosiGen lease portfolio relative to:
  - ▣ Larger pools of market-rate solar PV financing products that extend beyond Connecticut
  - ▣ Non-solar benchmarks for consumer-related financing products in large and sustained markets
- In so doing, assess whether performance of the CGB/PosiGen portfolio is within the range of “normal” consumer lending performance



# PosiGen delinquencies relative to market-rate solar delinquencies



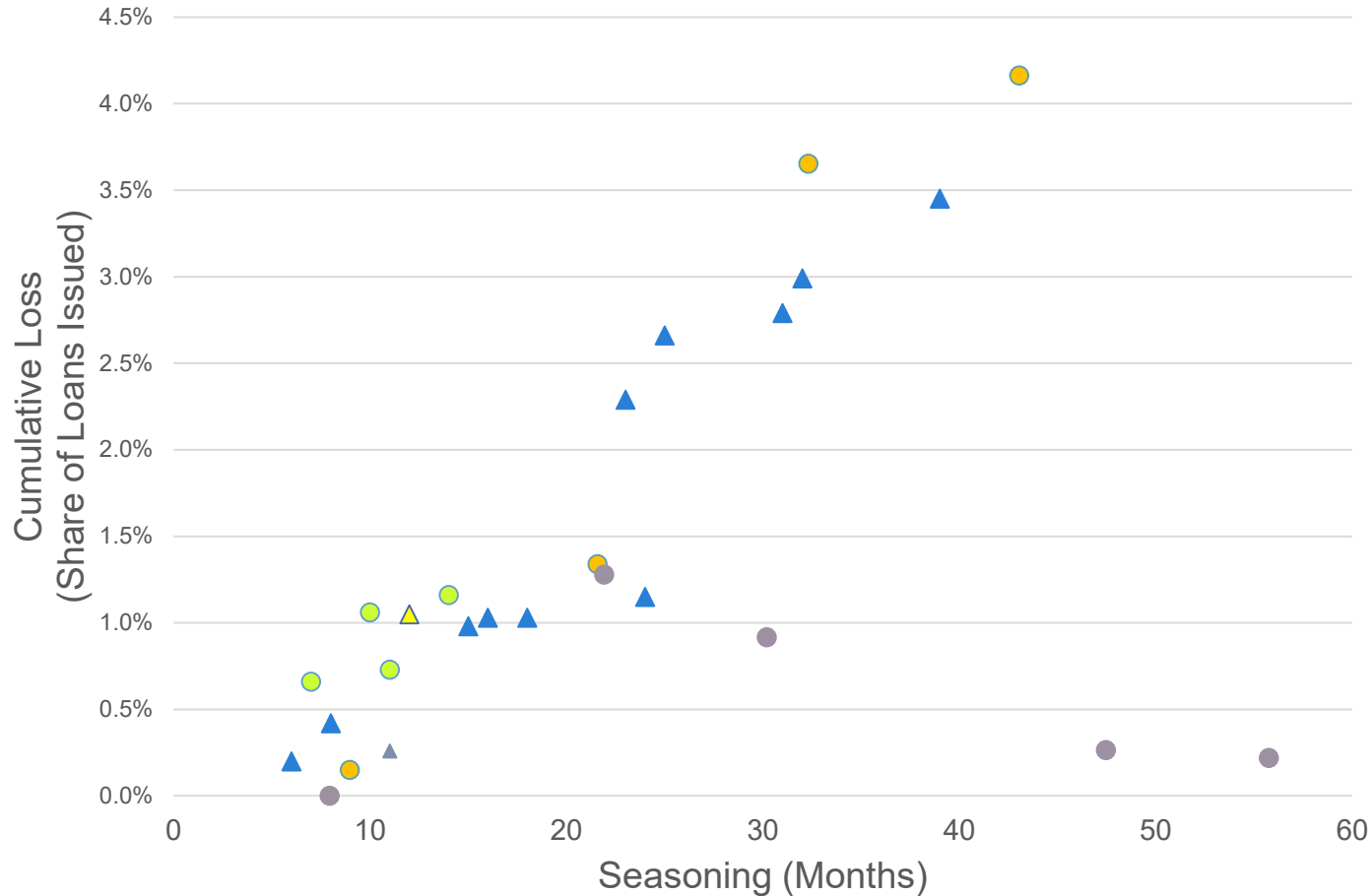
We collected delinquency rates (this slide) and loss rates (next slide) for Kroll Bond Rating Agency (KBRA)-rated securities backed by solar PV loans and leases. Issuers include Dividend Financial, Mill City, Mosaic, and Sunnova.

As shown, PosiGen delinquency rates are generally at the high end of the range of market-rate solar delinquencies. Again, this is not surprising given differences in credit quality: all the securities for which credit scores were reported by KBRA had average credit scores well over 700, in the range of the other Connecticut portfolios.

● Dividend Financial 
 ● Mill City 
 ● Mosaic 
 ● Sunnova 
 ● PosiGen 
 ● Non-Posigen



# PosiGen losses relative to market-rate solar losses



▲ Dividend Financial ● Mill City ▲ Mosaic ▲ Sunnova ● PosiGen ● Non-Posigen

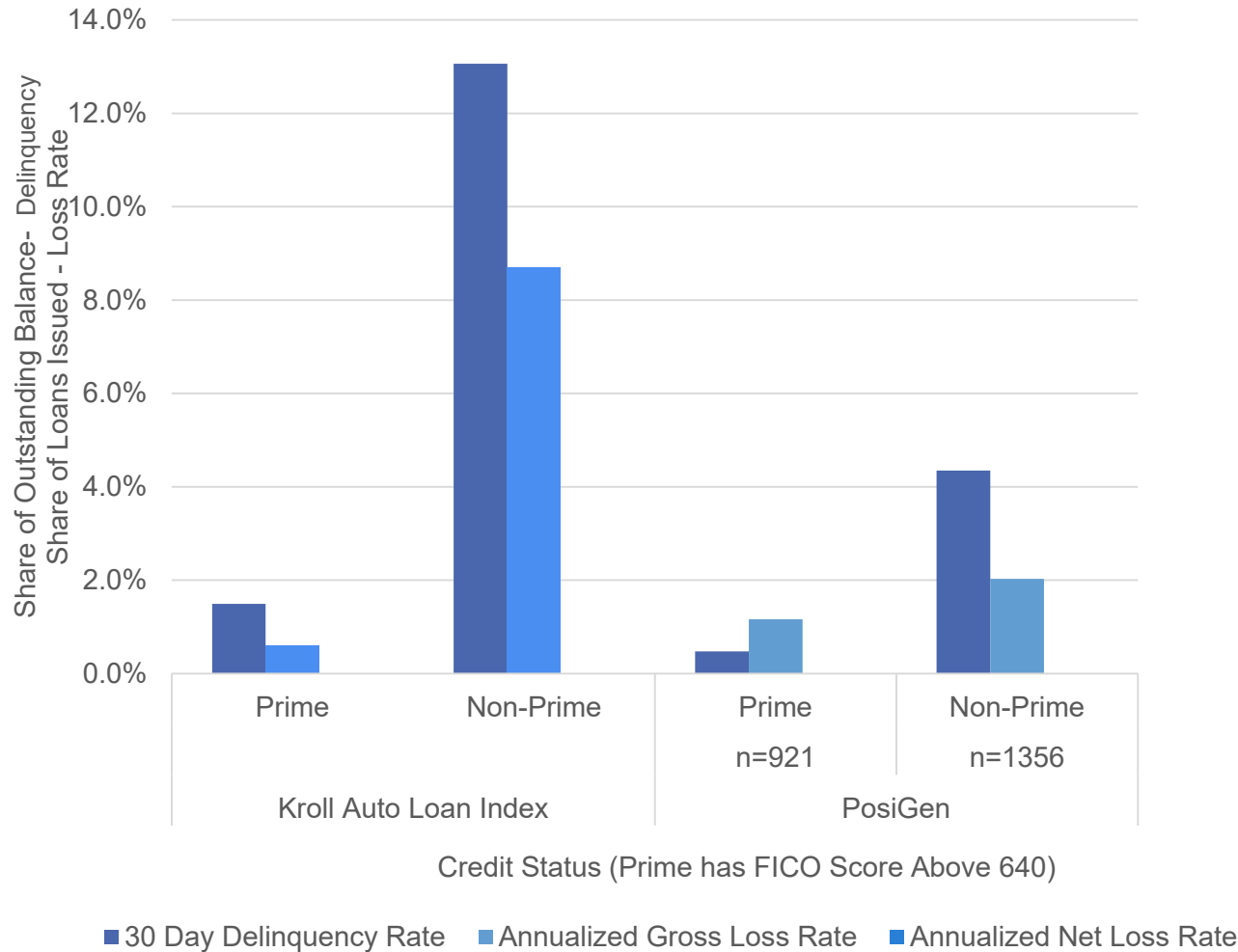
Overall PosiGen loss rates are in the range of these securities backed by market-rate solar loans and leases, which also show rising loss rates after about two years of seasoning (consistent with slide 34).

These results are notable because CGB/PosiGen's losses were high relative to other CGB products (see the previous section). Comparison with the loss rates in this slide suggests that the other CGB programs have unusually low loss rates, rather than CGB/PosiGen's losses being unusually high.

Triangles in this figure indicate net losses (i.e., gross losses less recoveries; if there are no recoveries, net and gross losses are the same). PosiGen loss data is gross.



# Performance of prime and non-prime customers: PosiGen and auto loans

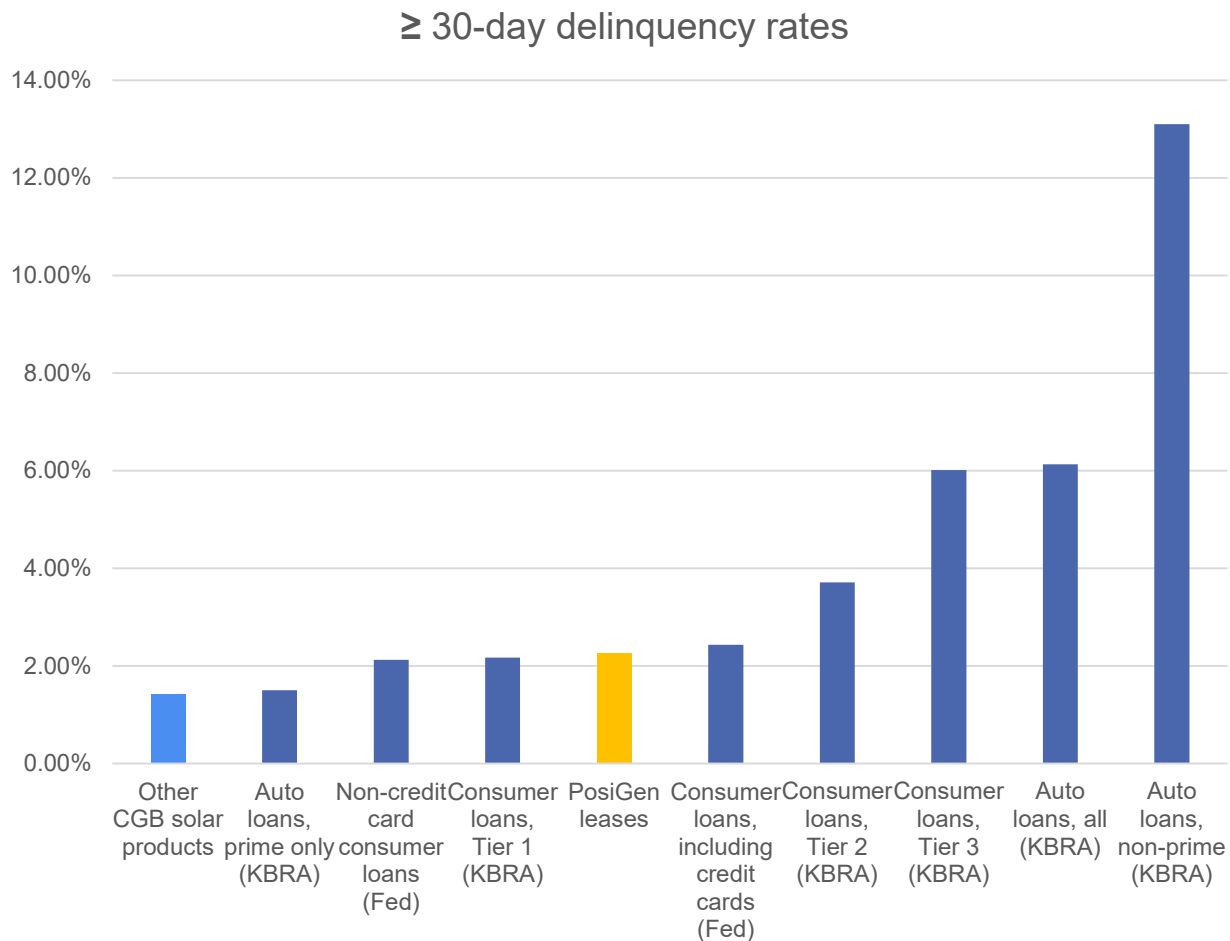


Here we use Kroll Bond Ratings Agency (KBRA)'s auto loan indices as a benchmark to compare the performance of PosiGen's prime and non-prime leases. In general, PosiGen leases outperform auto loans, which have some comparable characteristics (principal amounts are similar; loans/leases are secured by the asset itself in each case). More importantly, the relative performance of PosiGen's prime vs. non-prime leases is similar to or better than the relative performance of prime vs. non-prime auto loans. The ratio of non-prime to prime delinquencies in the auto loan data is 8.7; for PosiGen that ratio is 9.2. For losses the auto loan ratio is 14.5; the PosiGen ratio is much lower (1.7), though this ratio may increase as the PosiGen portfolio becomes more seasoned. These comparisons suggest that the PosiGen program is delivering performance from its non-prime customers that is in line with, or better than, what we might expect.

Note: Credit score cutoffs between prime and non-prime vary. To be consistent with Kroll's approximation of the most common cutoff points in the auto loan data, we here use 640 as the dividing line between prime and non-prime.



# External comparators: $\geq 30$ -day delinquency, PosiGen and other CGB products vs. auto loans and consumer loans



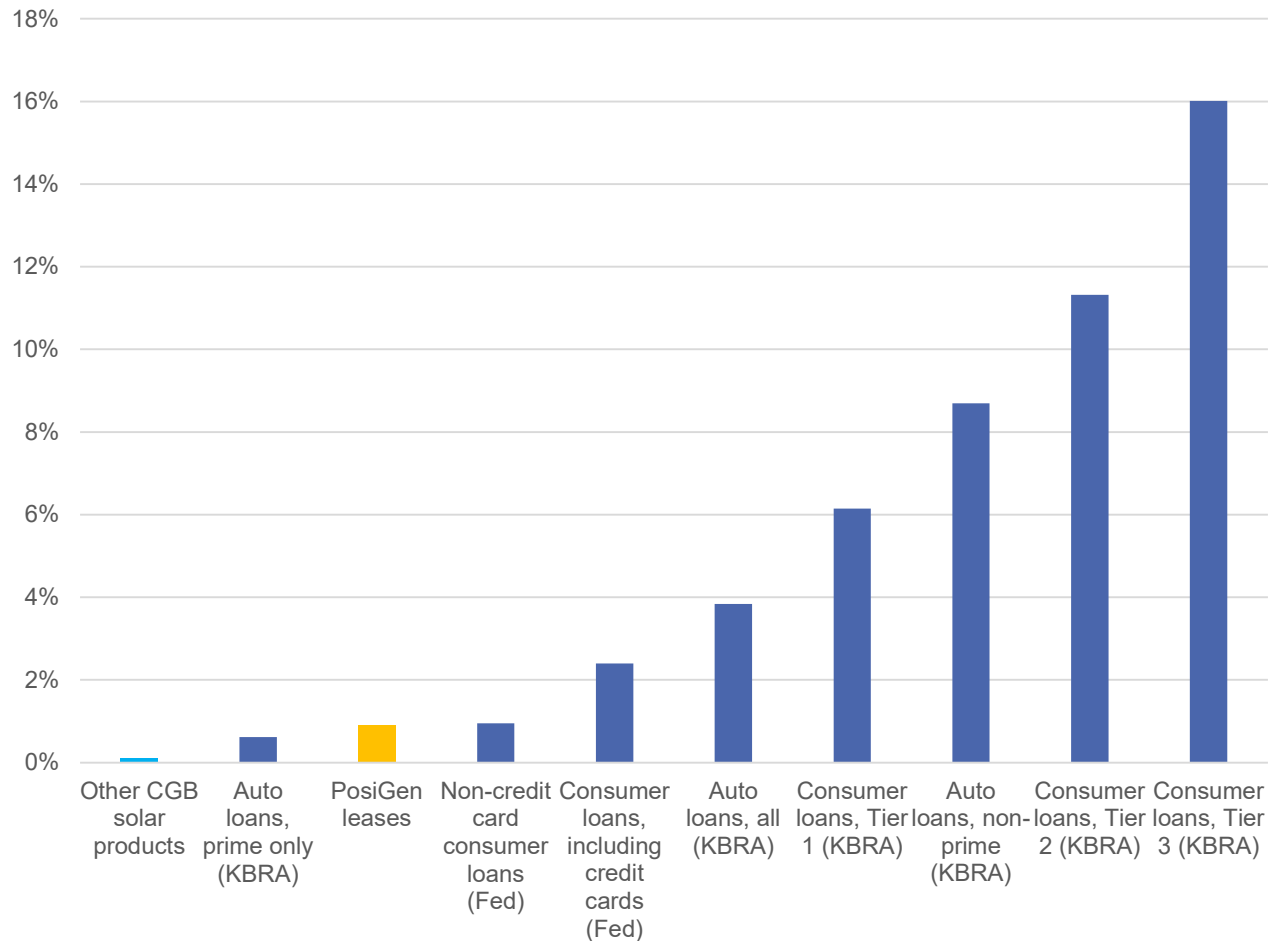
Here we compare delinquency rates of PosiGen and the other CGB products to several non-solar benchmarks: the auto loan indices used in the prior slide; consumer loan indices in three tiers (from KBRA); and another dataset of consumer loan performance (from the Federal Reserve).

PosiGen leases are comparable in performance to the Fed's consumer loan aggregates and to KBRA's Tier 1 consumer loans. KBRA Tier 1 loans have average credit scores in the 710-740 range, while PosiGen's average credit score is 651. This is in the range of KBRA's Tier 3 consumer loans (630-660), which PosiGen outperforms handily.

Note that the other CGB solar products, which were the comparator in the previous section of this report, also outperform consumer loans of comparable credit quality (Tier 1 being the appropriate comparison). As solar leases or loans are secured by the system itself, it is not surprising that they perform better than unsecured consumer debt (note that auto loans are secured by the vehicle itself). Still, PosiGen's performance is solidly within the range of common forms of consumer debt.



# External comparators: annualized loss rates, PosiGen and other CGB products vs. auto loans and consumer loans



Here we compare loss rates of PosiGen and the other CGB products to the same non-solar benchmarks.

PosiGen leases are again comparable in performance to the Fed's consumer loan aggregates, and outperform all tiers of KBRA's Tier 1 consumer loans (which are comprised of loans made online that generally exhibit higher loss rates). The other CGB solar products exhibit extremely low loss rates, much lower than those of any of the comparators.

Note: Loss rates of comparators are annualized losses for the month of March 2020, while loss rates for the CGB programs reflect losses over the full life of the programs. That said, loss rates for the comparator over the last several years have not varied very much, giving us confidence that the comparison is valid.



## External comparator takeaways

---

- There is no perfect external comparator to PosiGen; all comparisons have their challenges
- Relative to other market-rate solar products outside Connecticut, PosiGen delinquencies are somewhat higher, and losses are essentially comparable. Given that these comparators are all market-rate products, we feel PosiGen's relative performance is strong.
- Comparison with differential performance for prime and non-prime auto loans suggests that performance of lower-credit PosiGen customers relative to higher-credit customers is in line with, or better than, expectations.
- PosiGen lease performance is competitive with broad aggregates of consumer and auto financing products, which cover very large and self-sustaining financial product markets





## Overall perspective on CGB/PosiGen program



# Alternatives to the CGB/PosiGen approach

---

- *A market-rate product* (one without any programmatic support) targeting LMI customers would need to charge more (e.g., higher monthly payments) to serve less credit-worthy customers. As a result:
  - ▣ Demand for the product from less credit-worthy customers would surely be lower (no one *needs* solar, and the value proposition would be positive for fewer households)
  - ▣ Repayment performance might be worse, if higher costs lead more households to miss payments
  - ▣ Overall, a market-rate product would support fewer systems at a higher cost for customers, though costs for the public partner would be lower as it would not need to extend below-market-rate debt and would pay less in incentives
- *A grant-based approach or a public or utility customer-funded loan program* could simply pay the full cost (or a large share of the cost) of solar PV systems for LMI households rather than offering financing via the PosiGen model. Assuming a similar financial outlay, this would result in:
  - ▣ Fewer systems, likely far fewer. Without leveraging an external capital provider, the program budget would not go as far, and returning lease payments could not be re-used to support future systems in the case of a grant.
  - ▣ Lower costs to customers in the case of a grant
  - ▣ Much higher cost per system to the public partner



# Key conclusions

---

- PosiGen has been uniquely successful among CGB's programs at deploying solar PV in LMI and credit-challenged households in Connecticut
- CGB/PosiGen customers are repaying their leases at reasonable rates given their credit characteristics
- Compared to similar asset classes, they are also paying back at reasonable rates
- As noted earlier, the details of program structure may affect both (1) terms extended to LMI customers and (2) costs and risks to program participants



# References

---

- Experian data on credit scores in the U.S. population: <https://www.experian.com/blogs/ask-experian/credit-education/score-basics/what-is-a-good-credit-score/>
- Connecticut Green Bank residential loan products solar & energy efficiency program eligibility requirements: Connecticut Green Bank.(December 12, 2018). “Connecticut Green Bank: Update on Residential and Commercial Solar & Efficiency Lending.” NREL-SEIA Workshop: Solar Finance by Regional and Community Lenders.
- Citi’s analysis of PosiGen portfolio: PosiGen (no date). “Lease Portfolio Performance.”
- Kroll Bond Rating Agency solar PV securitizations are available at <https://www.krollbondratings.com/sectors/abs/publications>
- Federal Reserve delinquency and charge-off data from commercial banks: <https://www.federalreserve.gov/releases/chargeoff/default.htm>
- Kroll Bond Rating Agency auto loan indices: <https://www.krollbondratings.com/documents/report/34153/abs-auto-loan-indices-spreadsheet>
- Kroll Bond Rating Agency consumer loan indices: <https://www.krollbondratings.com/documents/report/32528/abs-marketplace-consumer-loan-indices-spreadsheet>



## Contacts

**Jeff Deason:** [jadeason@lbl.gov](mailto:jadeason@lbl.gov), 510-486-6891

**Greg Leventis:** [glevantis@lbl.gov](mailto:glevantis@lbl.gov), 510-486-5965

**Sean Murphy:** [smurphy@lbl.gov](mailto:smurphy@lbl.gov), 510-486-5923

## For more information

**Download** publications from Electricity Markets & Policy: <https://emp.lbl.gov/publications>

**Sign up** for our email list: <https://emp.lbl.gov/mailling-list>

**Follow** Electricity Markets & Policy on Twitter: @BerkeleyLabEMP

## Acknowledgements

This work was funded by the U.S. Department of Energy Solar Energy Technologies Office, under Contract No. DE-AC02-05CH11231. This report is part of "Bringing Low-and-Moderate-Income Households (LMI) Solar Financing Models to Scale," a project led by the Clean Energy States Alliance. We would like to especially thank Ammar Qusaibaty of DOE for support of this work. For comments and input on this analysis, and assistance with data provision, we also thank Warren Leon and Nate Hausman (Clean Energy States Alliance); Emily Basham, Isabelle Hazlewood, Joe Buonannata, and Selya Price (Connecticut Green Bank), Kerry O'Neill and Madeline Priest (Inclusive Prosperity Capital), and Beth Galante, Ben Healey, Ben Amoss, Pierre Conrad, and Dale Sexton (PosiGen).

The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof, or The Regents of the University of California.

## Appendix A: Sample sizes

---

As noted on slide 20, sample sizes vary – sometimes significantly – across the slides that present our participant statistics and loan performance breakdowns. These variations are due to the following factors:

- Missing data. In some cases, data (for example, credit scores or system sizes) are missing for a small fraction of participants.
- Customers that have paid off their loans in full. We do not consider paid off loans (or loans terminated early) when calculating delinquency rates, in keeping with standard practice. A fairly large fraction of customers in the solar loan program have paid off their loans in full, which explains the considerably smaller sample size for that program in the delinquency results. We do consider paid off loans when calculating loss rates – see our definitions in slide 30.



## Appendix B: Regression results

---

- Final logit specification assessed the impact of the following variables on the likelihood of leases/loans becoming delinquent or terminated early:
  - ▣ Credit score
  - ▣ Program
  - ▣ Principal Amount
  - ▣ Seasoning (days)
  - ▣ Census Tract AMI
- We additionally reviewed PV system size and the loan start year but found that they were not predictive.
- The following tables provide summary statistics on the regression results and average marginal effects of the dependent variables



## Appendix B: Regression results for delinquency $\geq 30$ days

		Logit Regression Results			Average Marginal Effects		
Dependent Variable		Coefficient	Standard Error	P Value	Average Marginal Effects	Standard Error	P Value
Delinquency	Principal Amount	-7.69E-06	1.73E-05	0.657	-1.22E-07	2.76E-07	0.657
	Seasoning (days)	2.00E-04	0.000	0.553	2.44E-06	4.12E-06	0.553
	Credit Score	-0.011	0.002	0.000	-2.00E-04	3.07E-05	0.000
	PosiGen	-1.047	0.443	0.018	-0.017	0.007	0.021
	60%-80% AMI	0.191	0.343	0.579	0.003	0.005	0.579
	80%-100% AMI	0.132	0.366	0.719	0.002	0.006	0.719
	100%-120% AMI	0.068	0.400	0.865	0.001	0.006	0.865
	>120% AMI	-0.457	0.412	0.267	-0.007	0.007	0.270
	Intercept	3.931	1.370	0.004	N/A	N/A	N/A





## Appendix B: Regression results for delinquency $\geq 60$ days

		Logit Regression Results			Average Marginal Effects		
Dependent Variable		Coefficient	Standard Error	P Value	Average Marginal Effects	Standard Error	P Value
Delinquency	Principal Amount	-2.02E-05	2.45E-05	0.410	-1.71E-07	2.10E-07	0.414
	Seasoning (days)	0.001	0.000	0.101	5.14E-06	3.22E-06	0.111
	Credit Score	-0.010	0.002	0.000	-8.59E-05	2.20E-05	0.000
	PosiGen	-0.302	0.616	0.624	-0.003	0.005	0.625
	60%-80% AMI	-0.012	0.511	0.981	-1.00E-04	0.004	0.981
	80%-100% AMI	0.327	0.494	0.509	0.003	0.004	0.510
	100%-120% AMI	0.339	0.535	0.526	0.003	0.005	0.527
	>120% AMI	-0.027	0.538	0.960	-2.00E-04	0.005	0.960
	Intercept	1.964	1.884	0.297	N/A	N/A	N/A



## Appendix B: Regression results for delinquency $\geq 120$ days

		Logit Regression Results			Average Marginal Effects		
Dependent Variable		Coefficient	Standard Error	P Value	Average Marginal Effects	Standard Error	P Value
Delinquency	Principal Amount	3.08E-06	3.46E-05	0.929	9.48E-09	1.06E-07	0.929
	Seasoning (days)	0.001	0.001	0.412	1.46E-06	1.82E-06	0.422
	Credit Score	-0.008	0.004	0.030	-2.57E-05	1.35E-05	0.057
	PosiGen	-0.986	1.022	0.335	-0.003	0.003	0.349
	60%-80% AMI	-0.582	1.233	0.637	-0.002	0.004	0.639
	80%-100% AMI	0.653	0.920	0.478	0.002	0.003	0.485
	100%-120% AMI	0.576	0.969	0.552	0.002	0.003	0.557
	>120% AMI	0.002	0.992	0.999	5.36E-06	0.003	0.999
	Intercept	-0.329	3.299	0.921	N/A	N/A	N/A



# Appendix B: Regression results for early termination

		Logit Regression Results			Average Marginal Effects		
Dependent Variable		Coefficient	Standard Error	P Value	Average Marginal Effects	Standard Error	P Value
Early termination	Principal Amount	2.172E-05	2.450E-05	0.375	2.29E-07	2.60E-07	0.378
	Seasoning (days)	0.002	0.000	0.000	1.80E-05	4.47E-06	0.000
	Credit Score	-0.006	0.002	0.000	-6.49E-05	1.91E-05	0.001
	PosiGen	2.493	0.586	0.000	0.026	0.007	0.000
	60%-80% AMI	0.364	0.434	0.401	0.004	0.005	0.404
	80%-100% AMI	0.684	0.423	0.106	0.007	0.005	0.113
	100%-120% AMI	0.636	0.475	0.181	0.007	0.005	0.187
	>120% AMI	0.243	0.487	0.618	0.003	0.005	0.619
	Intercept	-4.690	1.665	0.005	N/A	N/A	N/A

