JANUARY 2025

Clean Energy States Alliance

Meaningful Household Savings

Best Practices for Achieving Equitable Solar Development

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About This Report

This report was produced as part of the Equitable Solar Communities of Practice program initiated by the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO). The program investigated five meaningful benefits identified by SETO as fundamental elements of equitable solar solutions: (1) equitable access and consumer protections; (2) meaningful household savings; (3) resilience, storage, and grid benefits; (4) community-led economic development; and (5) solar workforce.

The Clean Energy States Alliance (CESA) led the Community of Practice on Meaningful Household Savings and this report is the result of its investigation. In preparing the report, CESA worked with a core team of six organizations:

- Greenlink Analytics
- Inclusive Prosperity Capital
- Partnership for Southern Equity
- PosiGen
- Stewards of Affordable Housing for the Future
- Sunwealth

CESA and the core team carried out a landscape analysis of the current literature and public understanding of meaningful household savings related to solar projects; hosted two convenings involving 140 stakeholders in the summer of 2024 to gather input; interviewed 29 organizations; and presented draft findings in meetings with SETO, at the 2024 RE+ conference in Anaheim, California, and in a public webinar on October 30, 2024. Please refer to the Appendix on page 69 for a list of organizations interviewed for the production of this report. This report is the final deliverable regarding CESA's work under the Meaningful Household Savings Community of Practice program.

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The authors would also like to thank the many individuals who contributed to this report through interviews, emails and survey responses, or other resource sharing. A list of organizations interviewed in the production of this report is available in the Appendix on page 69. In addition to the authors, Matt Ohloff (formerly of CESA) conducted some of the interviews.

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INTRODUCTION

The U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO) has identified five meaningful benefits that are important for achieving equitable solar solutions. They are the following:

- Equitable access and consumer protections
- Meaningful household savings
- Resilience, storage, and grid benefits
- Community-led economic development
- Solar workforce

In November 2023, SETO launched the Equitable Solar Communities of Practice program to examine the research that has been produced on those benefits in solar photovoltaic (PV) projects, to explore the progress that has been made towards achieving them, to identify best practices, and to determine what would need to be done to scale up widespread achievement through programs aimed at low- and moderate-income households (LMI) and disadvantaged communities.

The nonprofit Clean Energy States Alliance (CESA) was selected to lead the Community of Practice on Meaningful Household Savings and this report is the result of its investigation. In preparing the report, CESA worked with a core team of six organizations:

- Greenlink Analytics
- Inclusive Prosperity Capital
- Partnership for Southern Equity
- PosiGen
- Stewards of Affordable Housing for the Future
- Sunwealth

The Meaningful Household Savings Community of Practice—and this report—focuses on electricity bill savings, other household savings, wealth-building opportunities, and other benefits such as tenant services provided to residents in master-metered buildings. The project team collected information about ways meaningful household savings have been defined; researched best practices to define, achieve, and quantify meaningful household savings; and identified strategies to scale the adoption and implementation of successful methods. We looked at different types of solar projects, including community solar, low-income residential solar, and installations at multifamily affordable housing.

There is a strong consensus among a wide range of stakeholders that it is absolutely essential that LMI households achieve meaningful savings from solar projects. Because these households have few financial resources and limited ability to take on additional financial risks, they need to be assured that they will benefit financially if they are to participate in the solar economy. In addition, as a matter of equity, LMI households' participation in the clean energy transition is essential.

Nevertheless, it was clear early on in the research for the Community of Practice that there is no universally accepted definition for what qualifies as "meaningful" in terms of household savings from solar. Moreover, solar programs administered by states, municipalities, and utilities have difficulty measuring their programs' savings at a household level, and it is also hard to guarantee or verify savings. For many stakeholders, it is not even clear how the mechanisms for achieving savings work for different types of solar projects.

Without widely accepted practices for defining, measuring, and guaranteeing household savings, the project team had to look at a wide range of publications and consult with a large number of stakeholders to piece together a picture of how meaningful savings could best work and be scaled for LMI households. The project team reviewed 93 primary and secondary sources from the years between 2014 and 2024, including research papers, issue briefs, presentation slides, government notices, federal regulations, grant applications, and guides. We conducted interviews with 29 representatives of utilities, solar developers, nonprofits, government agencies, and other organizations. About 140 stakeholders participated in two convenings that gave them the opportunity to provide input. And the staff of 22 LMI-serving solar programs across the US submitted responses to a survey disseminated by CESA.

The research and collective input informed this report, which seeks to identify best practices, that if implemented widely, can ensure that solar projects for the LMI market achieve meaningful household savings. Because there are no universally accepted definitions or easy methods for guaranteeing savings, do not expect to find in this report any simple solutions or a single model program that could be quickly applied everywhere. There are, however, promising initial efforts and reasonable principles that can and should be implemented more widely.

The report starts with a summary of seven best practices recommended by CESA and the core project team. It then turns to examining different savings models to show how household savings are usually achieved in 1) single-family rooftop solar installations, 2) through community solar projects, and 3) in projects for multifamily affordable housing. The report goes on to discuss different definitions of meaningful household savings and their implications; it then further explores approaches for setting and achieving a savings target, how various programs have tried to guarantee savings, and the thorny issue of how to verify savings. Another issue addressed is how to communicate the benefits so that consumers understand not only the amount of savings they will receive but the mechanisms for receiving those savings. The report also provides case studies of six companies and programs that have taken the topic of meaningful household savings seriously and have important lessons for other programs working with the LMI solar market.

Following the main body of the report, an Appendix reviews the literature and other informational resources that the project team consulted and identifies key informational gaps that currently are not well covered in the literature.

A SUMMARY OF BEST PRACTICES

This section of the report describes best practices to advance household savings from solar that are recommended by CESA and the core team. We believe they should be considered for adoption to ensure households receive meaningful savings from solar, especially in the case of programs aimed at LMI participants. Some, but not all, of these practices are already being implemented in the market. These recommendations are discussed more fully later in this report. Table 1 lists the seven proposed best practices and shows the types of installations to which they especially apply.

TABLE 1: **BEST PRACTICES AT A GLANCE**

	Type of Installation			
Best Practice	**Rooftop single-family homes**	**Rooftop multifamily housing**	**Community solar**	**LMI programs, especially Solar for All**
1. Set a savings goal based on the market	X	X	X	X
2. Structure solar contracts to minimize risks for consumers and include strong consumer protections	X	X	X	X
3. Make savings easy to understand	X	X	X	X
4. Adopt consolidated billing		X	X	X
5. Reduce the risk that savings will not occur		X		X
6. Combine solar with energy efficiency	X	X		X
7. Implement a verification strategy	X	X	X	X

1. **Set a savings goal based on the market.** Any savings metric, such as a 20 percent electric bill savings target, has limitations. It should be used with awareness of its implications in different locations and different settings. Shortcomings of the metric should be identified and accounted for.
    a. No matter what savings metric is used as a program's standard, it should be supplemented with intentional solar program design and contractual structuring to ensure a reasonable expectation of savings in the long term.

b. No matter what savings metric is used as a program's standard, it should be supplemented with a dollar savings test that ensures all households will achieve at least some minimum dollar amount threshold deemed to be meaningful and achievable in the market.

2. **Structure solar contracts to minimize risks for consumers and include strong consumer protections to ensure savings.** LMI consumers need to be assured that they will not be at risk of unexpected financial harm.

   a. Program administrators should evaluate contractual models proposed to achieve savings and encourage developers to explain the potential impact of various shifts in market and regulatory structures on consumers.

   b. Program administrators should structure savings models so that LMI customers' net electric payments do not exceed their pre-solar utility bill due to seasonality shifts (all things being equal for demand).

   c. Program administrators should require performance monitoring to ensure that customers are receiving the benefits that they signed up for and are expecting.

   d. LMI consumers should be able to exit a community solar contract at any time for any reason with no cost or penalty.

3. **Make savings easy to understand.** Clear communication and easy-to-understand billing practices should be prioritized to enable participants to understand savings from solar.

   a. Program administrators should require solar companies to present information about solar contracts in standard ways that make it easy for consumers to understand potential savings and compare bids from different companies.

   b. Program administrators should educate consumers to understand the savings they can expect from signing up for solar and help consumers monitor if they are actually receiving those savings.

   c. Due to the complexity of solar savings, solar programs should implement measures to help answer prospective and existing customers' questions about bills, savings, and questions about solar power.

   d. Advocates and state and federal leaders should investigate opportunities to develop and implement standard practices with utilities for bill clarity to best enable solar power.

4. **Adopt consolidated billing.** Consolidated billing—a billing practice combining a customer's utility bill and their solar bill into one bill—is highly desirable for reducing confusion, communicating about savings, and being able to easily understand actual experienced savings.

5. **Reduce the risk that savings will not occur.** States and other entities administering LMI solar programs should take concrete steps to reduce risks and help guarantee savings for program participants.

   a. Solar for All program awardees will develop programs with 20 percent minimum net electricity savings targets. They should also evaluate whether federal funds could be used to reduce risk from regulatory or market changes that would decrease the savings from solar.

b. DOE should further study how programs that purport to guarantee savings perform, and how savings are verified there.

c. In addition, DOE should study how escalator clauses have worked in practice and identify best practices for escalator clauses so that they do not inappropriately reduce future household savings.

6. **Combine solar with energy efficiency to deepen savings.** States, utilities, and solar companies should consider and act on the potential to couple solar with household energy efficiency measures to increase total savings, making financial benefits from solar larger and more meaningful.

   a. Administrators for the Weather Assistance Program (WAP) and the Low Income Home Energy Assistance Program (LIHEAP) should consider how to automatically direct these customers to solar programs that have high savings potential.

   b. DOE and national labs should study structural, data, and market barriers to the energy efficiency-to-solar and the solar-to-energy efficiency project pipelines.

   c. Federal agencies and market stakeholders should develop best practices for WAP and LIHEAP administrators to refer customers to solar programs.

7. **Create and implement a verification strategy to ensure savings are achieved.** The verification of savings has received insufficient attention and needs to have a much greater focus going forward, especially for LMI solar programs.

   a. As a starting point, all state programs should monitor performance of the solar systems installed through their programs as a proxy for savings.

   b. At minimum, solar programs should include regular spot checks that evaluate whether or not savings are achieved in their programs and quantify them. Solar programs should both provide remedies and develop interventions to modify program design parameters where savings are not achieved.

   c. In the medium term, we recommend that DOE work with states, developers, and utilities to evaluate challenges to data sharing, explore verification solutions, and set best practices for savings verifications beyond spot checks.

COMMON SAVING MODELS

Before discussing how programs can define, set requirements for, achieve, and verify solar savings, it is useful to examine different savings models to clarify how household savings are usually achieved.

Each solar sector approaches savings differently. Several segmentation methodologies exist to describe solar sectors (e.g., residential vs. commercial and industrial, rooftop vs. community solar, etc.). In this report, we focus on residential customers and explore savings across 1) roof-top single-family homes and 2) community solar. In addition, we recognize that all savings from roof-top systems will share similarities, but multifamily tenants face unique challenges that merit specific attention, especially with respect to 3) multifamily affordable housing.

Single-Family Rooftop Solar Savings

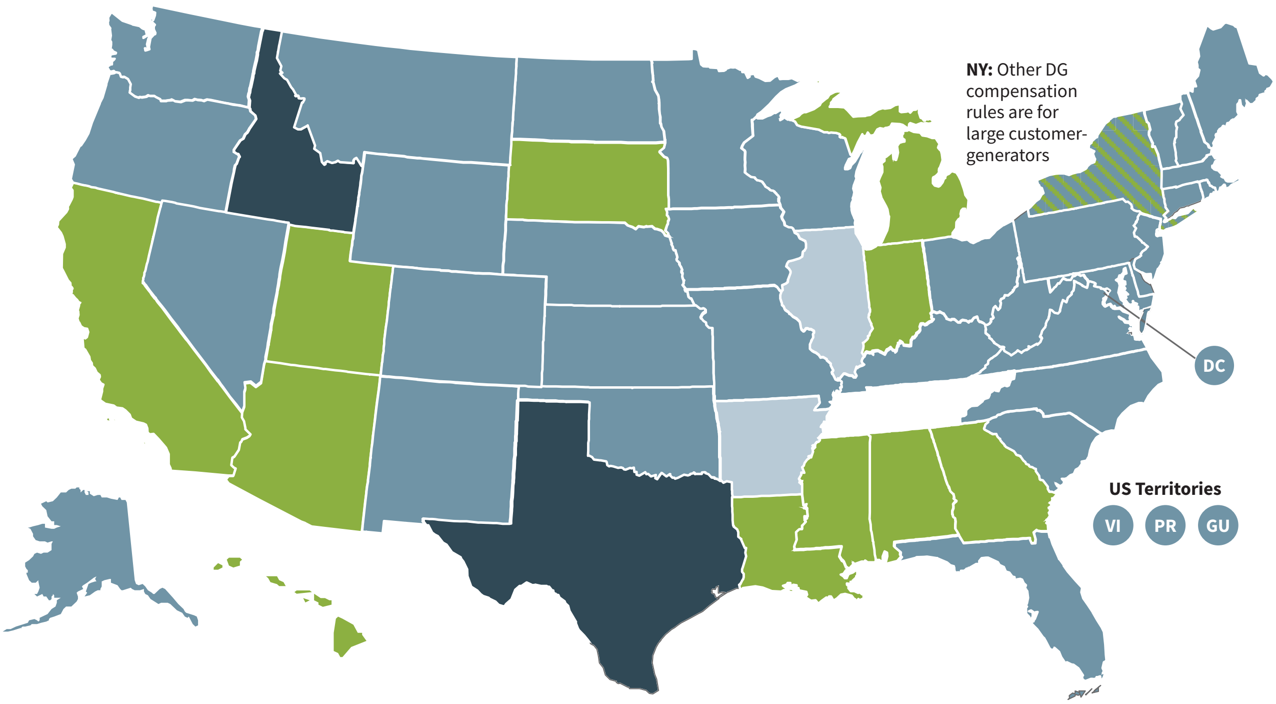
Single-family systems offer the simplest starting point for this analysis. Before we delve further, it is useful to remember the importance of net energy metering (NEM) in enabling the significant growth of the residential rooftop market in the US. NEM is a compensation and billing mechanism by which customers with grid-connected distributed solar can (a) offset immediate onsite consumption, and (b) bank excess generation from the system to offset later use. It is a critical component of solar economics, and the potential size of net savings and speed of payback for rooftop solar will be strongly influenced by the availability and the valuation of NEM credits. This concept is relevant for single-family home solar and for its cousin, virtual net metering (VNEM), which provides similar benefits to many community solar customers. See Figure 1 (p. 13) for an overview of state and territory net metering policies.

Single-family solar systems are deployed either via *direct ownership* by the homeowner or via a *third-party ownership* model.

With **direct ownership**, the residential solar installation is typically either paid for by the homeowner with upfront cash or financed with a loan.

- With a *cash purchase*, a homeowner purchases a solar system outright. The homeowner enjoys all the benefits of the solar ownership and solar production, including (a) federal tax credits—usually the investment tax credit (ITC), (b) NEM payments for solar energy exports to the grid, and (c) renewable energy credit (REC) payments, where available. They are liable for all costs associated with operating and maintaining the system. In addition, as with all residential solar installations, the homeowner pays the regular utility rate for any electricity consumed beyond what the solar system generates. See Figure 2 (p. 14).

FIGURE 1 **NET METERING POLICIES BY STATE AND TERRITORY**



- State-developed mandatory rules for certain utilities (34 states + DC + 3 territories)
- In transition to statewide distributed generation compensation rules other than net metering (2 states)
- Statewide distributed generaiton compensation rules other than net metering (11 states)
- No statewide mandatory rules, but some utilities allow net metering (2 states)

Thirty-four states plus Washington, DC, Guam, Puerto Rico, and the US Virgin Islands currently have mandatory net metering rules. Two of these states are in transition to policies other than net metering.

Source: dsireusa.org

- Under a *solar loan* arrangement, a homeowner enters into a loan agreement with a third-party lender to finance the system. As above, the homeowner enjoys the benefits—and incurs the costs—associated with the ownership of the system. In addition to having a reduced utility bill, the homeowner must make monthly payments to the lending institution, thereby reducing savings. The loan may cover some or all of the cost of the system installation. Solar loans can be offered by many different institutions such as the lending arm of large developers, banks, credit unions, community development financial institutions, green banks, housing finance institutions, investment funds, and even utilities. Solar loans can also be either secured or unsecured, although they come in many flavors, each with its own impact on savings and risks.[1] With a secured solar loan, the homeowner will provide collateral, such as equity in their home, to reduce the risk for the lender. The lower interest

1 For example, Property Assessed Clean Energy loans, which use the local tax collection process to guarantee payments, have come under scrutiny for risks posed to homeowners but can provide lower interest rates. Home equity loans also come with significant risks for homeowners, but lower costs as compared with unsecured loans, whereas loans insured by the Federal Housing Administration may be safer for lenders, leading to lower interest rates and potentially higher savings. For additional information about these lending structures see this explainer from EnergySage.

rate offered in return and the deductibility of interest payments for secured solar loans usually leads to higher savings potential.[2] On the other hand, an unsecured solar loan will typically have higher interest rates, but it will be simpler and safer for the homeowner.

FIGURE 2 **UNDERSTANDING INPUTS TO ROOFTOP SOLAR SAVINGS OVER TIME—DIRECT OWNERSHIP**

$+

- **Decreased utility load (kWh)**
  ONE TIME: Impacted by the size of the solar system
  OVER TIME: Influenced by system performance, utility rates, and rate structure, including fixed charge, consumer consumption (load), and the weather
- **Tax credits**
- **Net energy metering credits**
  OVER TIME: Influenced by regulatory and legislative changes (taking into account grandfathering)
- **Renewable energy certificates**

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- **Purchase cost of system (or down-payment)**
  ONE TIME: Impacted by level of incentives available
- **Debt service payment**
  OVER TIME: Influenced by financial structure and terms, including interest rates, contract term, amortization style, and others
- **Cost of operation and maintenance**
- **Cost of insurance, if insured**

Many inputs factor into savings calculations. Figure 2 generally summarizes inputs relevant to solar loans.
Source: Clean Energy States Alliance

The decision to finance a system and the nature of financing terms have implications for customer savings. For example, interest rates, the amount of principal, the amortization style, the repayment period, and other key financing terms all have consequences on both the timing and the amount of customers' savings.

For a graphical representation of these models, see pages 18–20.

With the average cost for solar installation in the United States at $4.20 per watt in 2023,[3] the national average cost of a residential solar system was about $31,000 in that year.[4] This means that cash-purchased systems always have negative cashflows in the first years. However, in general, that customer will receive more savings over the long term than a customer who financed the system due to the cost of capital. The payback period is also generally significantly

2 A UCC-1 filing, or Uniform Commercial Code Financing Statement, is also common and provides a security interest in the solar asset itself but usually not in the underlying home. To learn more about UCC-1 filings, see this 2023 blog post from law firm Pender and Coward.

3 Galen Barbose, Naïm Darghouth, Eric O'Shaughnessy, and Sydney Forrester, *Tracking the Sun, 2024 Edition* (Lawrence Berkeley National Laboratory, 2024).

4 Id., assuming a 7.4 kW median size.

shorter for a cash purchase, although we caution the reader that payback period is a fundamentally flawed metric as it ignores the time value of money.[5]

Unlike third-party ownership, direct ownership is technically possible everywhere, but it can be practically limited for low-income households. This includes situations where households do not have enough tax liability to take advantage of available tax credits such as the ITC or any local tax incentives, or instances where neither cash purchase nor financing options are financially feasible for households.[6] In addition, public utility commissions (PUCs) and utilities may limit the compensation values available for solar production (e.g., if NEM is not allowed, is limited to a small-size program, or if the NEM rate is set at a very low value).

Third-party ownership of residential solar systems allows homeowners to avoid high, upfront system costs and instead spreads out payments over time. Note that third-party ownership is not an option in some states because of statutory or regulatory barriers or legal uncertainty. Third-party ownership puts the responsibility for system operation and maintenance on the third-party owner. There are two primary third-party ownership models, although there can be many variations.[7]

- Under a *solar lease* arrangement, a homeowner enters into a service contract to pay scheduled, pre-determined monthly payments to a solar leasing company, which installs and owns the solar system on the property. The homeowner consumes whatever electricity the leased solar system produces. If the system provides excess electricity to the grid, the homeowner may get credit for that generation from the electric utility under NEM. As with all residential solar installations, the homeowner pays the regular utility rate for any electricity consumed beyond what the solar system generates. Leases typically include a production guarantee that compensates the customer if the system produces less electricity than expected on an annual basis.[8]

- With a residential solar *power-purchase agreement* (PPA), a homeowner contracts with a project developer that installs, owns, and operates a solar system on the homeowner's site and agrees to provide all the electricity produced by the system to the homeowner at a determined—either predetermined fixed or gradually escalating—per-kilowatt-hour (kWh) rate, at least initially lower than the homeowner's electric utility rate.[9] Because the homeowner only pays for electricity that is actually produced, there is typically no production guarantee, and monthly payments fluctuate based on production.

Due to their structures, both of these models entail performance monitoring.

5 "The time value of money is a financial principle that states the value of a dollar today is worth more than the value of a dollar in the future. This philosophy holds true because money today can be invested and potentially grow into a larger amount in the future." Shauna Croome, *Understanding the Time Value of Money* (Investopedia, 2024).

6 For additional information about barriers to solar access for low-income households, see Warren Leon et al., *Solar with Justice: Strategies for Powering Up Under-Resourced Communities and Growing an Inclusive Solar Market* (CESA, 2019).

7 For more on these models, see Nate Hausman, *A Homeowner's Guide to Solar Financing: Leases, Loans, and PPAs*, (CESA, 2018).

8 For examples, see SEIA's model template contracts available here.

9 Note that prepaid PPAs also exist, in which a customer pays for the total discounted value PPA upfront and does not make payments during the term of the agreement. The financier assumes no credit risk because the customer makes all payments in advance.

Escalators may reduce a homeowner's savings over time in many third-party ownership contracts. With such a clause, the customer's monthly payments increase by a certain percentage or dollar value on an annual basis to account for inflation in operation and maintenance (O&M) costs and projected increases in electricity rates. If the escalator percentage is greater than the actual increase in electricity rates, the household's savings will be reduced or may even turn negative. On the other hand, if electricity rates rise faster than the escalator percentage, the savings will increase over time. Although the customer takes on greater long-term financial risk with an escalator clause, the inclusion of one can make it easier for the third-party owner to offer the customer near-term savings, particularly in markets with low utility rates or non-traditional net metering structures.

In theory, the third-party ownership model that is most adaptable to providing guaranteed savings on a percentage basis is a PPA, although few PPAs do this. In a pilot program launched by the Maryland-based Montgomery County Green Bank in 2022, a third-party owner offered customers 25-year contracts with a discount to the utility price that stayed the same over the whole term of the contract.[10] The fixed percentage discount approach would remove the risk of reduced savings for the customer if electric rates increase less than projected, but would also reduce the potential upside if utility rates increase rapidly.

FIGURE 3 **ROOFTOP SOLAR SAVINGS INPUTS—THIRD-PARTY OWNERSHIP/LEASE**

- **Decreased utility load (kWh)**
  OVER TIME: Influenced by system performance, utility rates and rate structure, including fixed charges, consumer consumption (load), and the weather

- **Lease payment**
  Influenced by escalators

Whether it is a direct-owned system or a third-party owned system, the savings the homeowner receives are usually not guaranteed. Instead, the solar installation company makes a projection of what savings the homeowner will experience in the first year and over the term of the contract. That projection usually starts with collecting the previous 12 months of utility bills from the customer. Then the developer assesses the homeowner's roof to size the system, taking into account constraints from utilities and PUCs. In many jurisdictions, net-metered residential solar systems can only be sized below a set percentage of a customer's historical demand (i.e., consumption). For example, in Rhode Island, systems may not receive NEM credits beyond 125 percent of their own annual energy demand, and the portion between 100-125 percent receives the utility's avoided cost rate only.[11] In Mississippi, the maximum nameplate capacity of net-metered

10 The pilot also included two other options for customers to choose from, including a 0% escalator and set price for the term of the contract. See *Scaling Up Solar – The Montgomery County Green Bank and Sunnova's Low-and Moderate-Income Solar Pilot Program* (CESA, 2022).

11 See Chapter 26.4 Net Metering R.I. Gen. Laws § 39-26.4-2(8).

residential solar systems is the lesser of 110 percent of the customer's annual peak demand, defined as the average kilowatts during 15 minutes of highest use, or 20 kW_{DC}.[12]

Some jurisdictions allow for sizing to consider the addition of battery storage or the anticipated installation of electrification assets (e.g., electric vehicles). Note that common sense dictates that in states with robust net metering rates, the larger the system, the larger the saving, because the fixed costs of installing solar are diluted by the added kilowatt-hours generated. However, oversizing a solar system can lock vulnerable customers into contracts that are too expensive to afford for a specific household.

Developers make a projection of how much electricity the system will produce and then factor in the cost of financing the system, the tax incentives the homeowner or developer may be eligible for, projected maintenance costs, system degradation over time, the household's historical electricity consumption, NEM rates and structure, other available incentives, and current and projected electricity rates. Because most of these numbers are based on projections of future conditions, there is considerable uncertainty about what actual long-term savings will be. State policies are also an important factor in determining how savings are calculated and presented to customers.

Several factors can make savings more or less certain, particularly in the case of direct ownership of solar systems where homeowners are responsible for ongoing costs:

- **Performance guarantees.** Savings will be more assured if there are strong system performance guarantees in the contract from the solar company and if the homeowner does not take on the risk of equipment failure and unplanned system maintenance costs.
- **Careful escalators.** While solar installers do not usually guarantee savings due to the possibility of future utility rate, net metering, or other regulatory changes, a system that has a meaningful year-one estimated savings (whether direct owned or third-party owned) and a carefully crafted or no-escalator clause can have a reasonable expectation of long-term savings. This is generally true because solar savings tend to increase as either (a) utility rates increase (faster than the escalator, if present) and (b) as financing gets repaid in direct ownership models.
- **Regulatory change.** The risks associated with regulatory actions and other policy changes, such as state policy changes to net metering or the imposition of larger monthly fixed charges on utility bills, make savings less certain. However, when significant changes are made to net metering or other solar compensation policies, existing customers may retain legacy rights for the life of their system or for a fixed period of time (typically 20 or 25 years from the date the system was activated), thereby helping to mitigate risk and allowing customers to receive the value they expected.
- **Increased consumption.** Whether a customer sees a *net* saving or achieves a particular net savings rate in the long term also largely depends on the customer's consumption and whether it increases over time.
- **Metrics and communication.** There is also little standardization in how projected savings are presented to customers. A projection may emphasize a payback period, an average annual or monthly dollar savings amount for the first year or multiple years, year-by-year

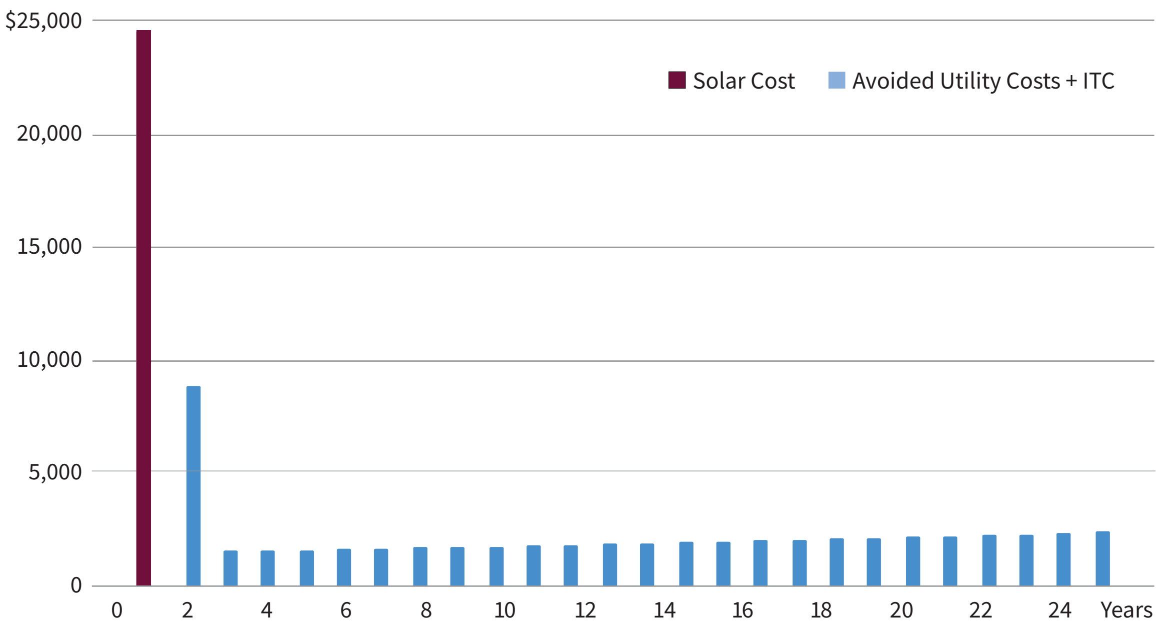
12 Mississippi Power, *Renewable Energy Net Metering Rate Schedule "RENM-2"* (Mississippi Power, 2023).

savings, or total savings over the life of the system. They may be presented as a percentage discount over the utility rate, with or without fixed charges that may impact total savings. Customers may also have different preferences for which of those savings metrics are most important to them or easiest to understand.

Some companies and state programs incorporate savings guarantees into their offerings, at least for the first year or some other limited time. See the PosiGen case study on page 46 for an example.

Figures 4 through 8 below show how savings typically occur over time in the different single-family home financing models: cash purchase, loan purchase with ITC separate, loan purchase, lease or PPA with no escalator, and lease or PPA with an escalator. Note that the numbers on the y axis are different on some of the figures.

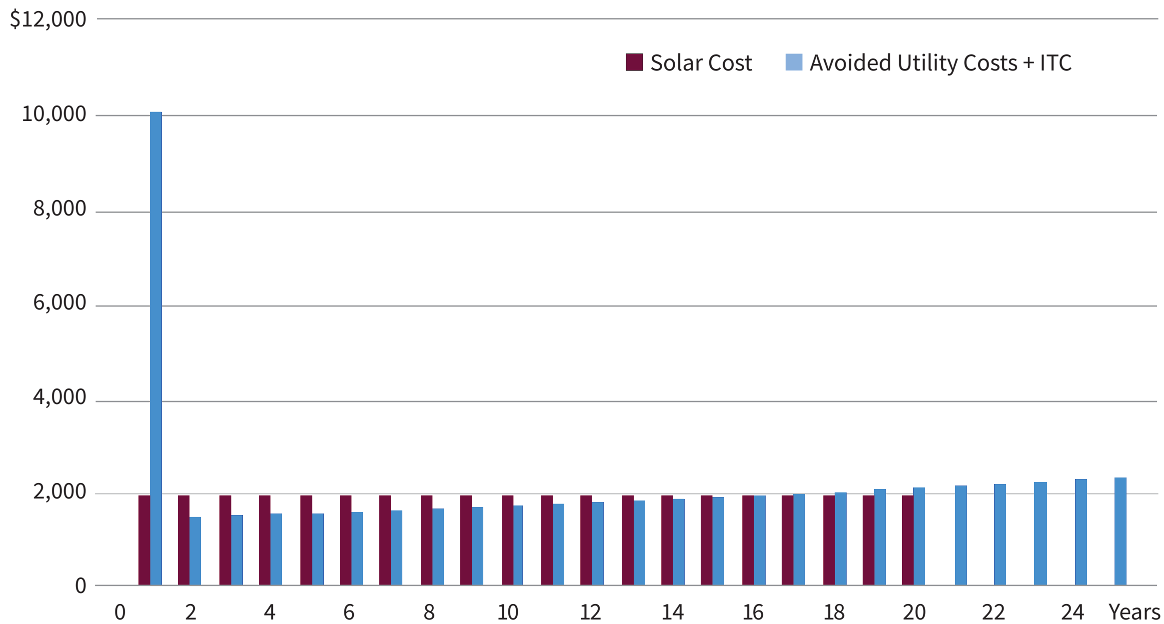
FIGURE 4 **CASH PURCHASE** EXAMPLE



With a cash purchase, the homeowner's costs occur upfront, with savings occurring gradually over the life of the system. If the homeowner is eligible for the investment tax credit, those savings will be received in the first year after the system's installation.

Source: PosiGen

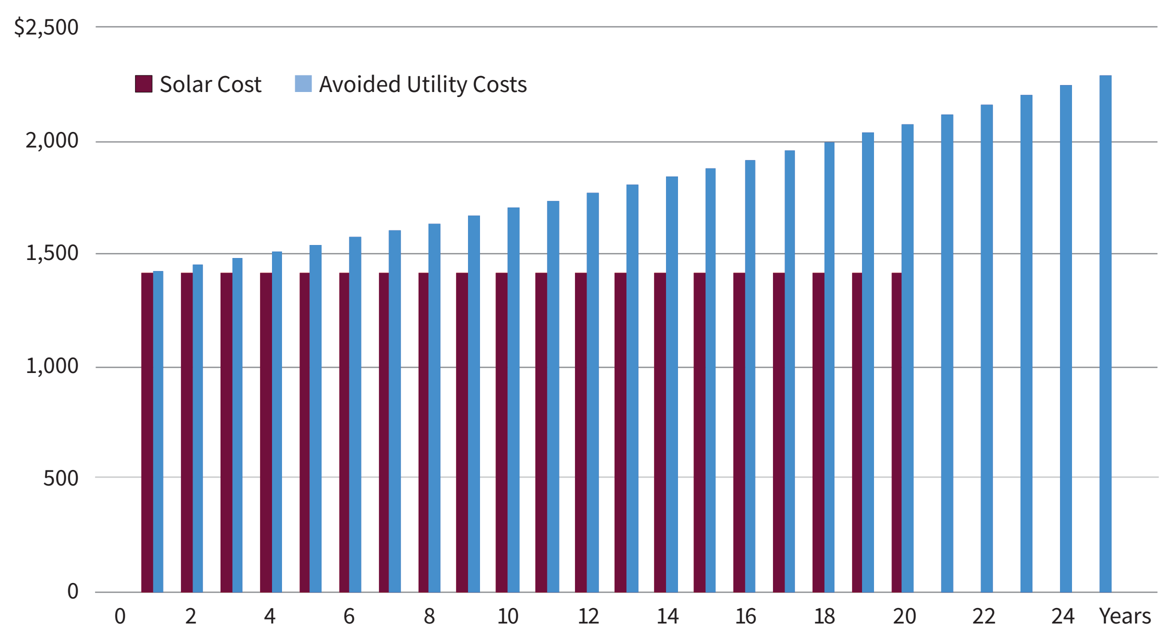
FIGURE 5 **CUSTOMER-OWNED WITH LOAN** (ITC SEPARATE)



In this case, the homeowner borrows enough money to cover the entire cost of the system. The homeowner receives a large short-term financial benefit by receiving the ITC in year one. Here, the solar loan payments were calculated without accounting for the ITC, which the customer simply received and kept. This results in total loan payments higher than in Figure 6.

Source: PosiGen

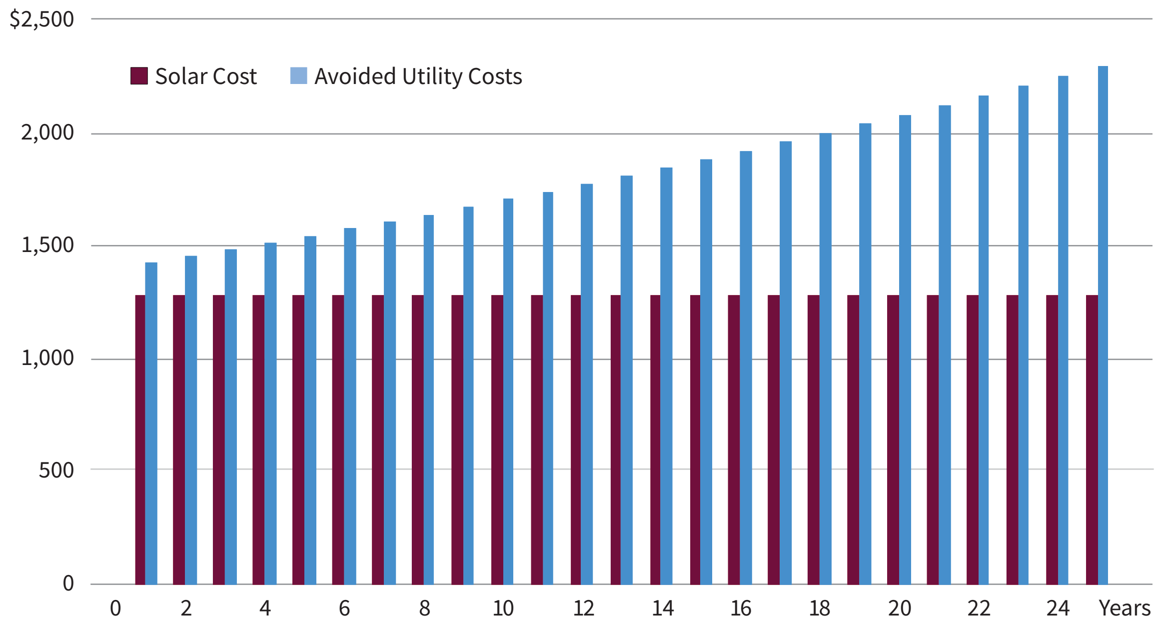
FIGURE 6 **CUSTOMER-OWNED WITH LOAN** (ITC INCLUDED IN AMORTIZATION)



In this case, the solar loan payments are calculated with the assumption that the value of the ITC will be applied to the loan balance when it is received. This results in faster repayment and a lower cost of capital.

Source: PosiGen

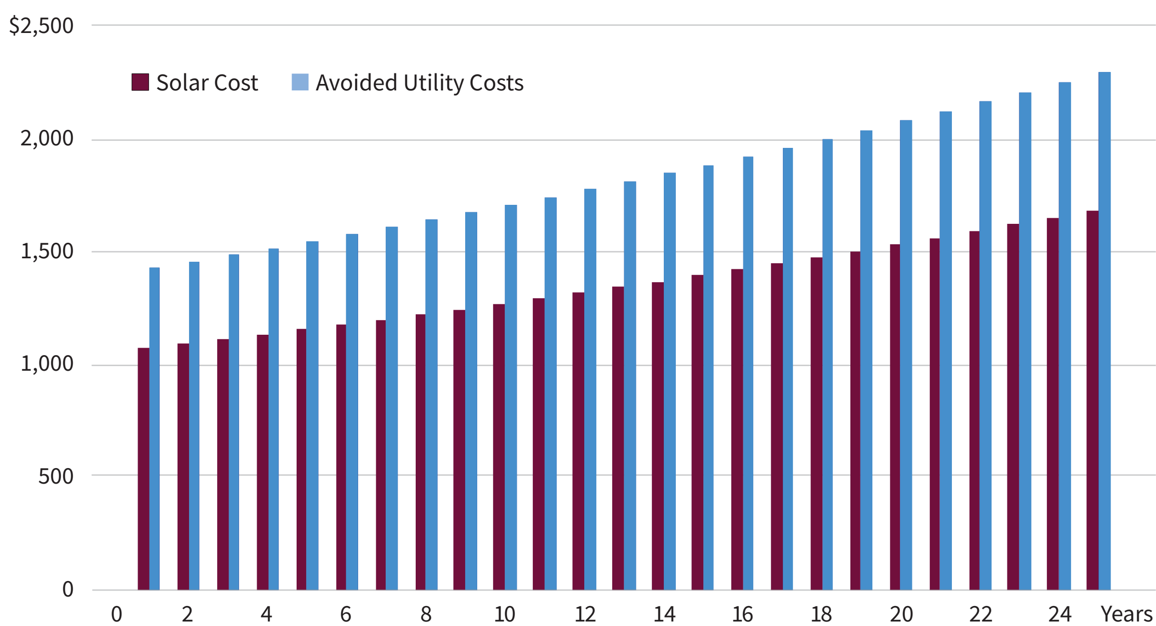
FIGURE 7 **LEASE OR PPA WITH NO ESCALATOR** EXAMPLE



With steady payments to the third-party owner of the system, the homeowner's savings increase over time as avoided utility rates rise but solar costs remain constant.

Source: PosiGen

FIGURE 8 **LEASE OR PPA WITH EXCALATOR** EXAMPLE



The inclusion of a cost escalator in the homeowner's contract with the system's third-party owner means that solar costs rise gradually over the life of the system. Expected avoided utility costs also increase gradually. Savings here increase less over time than in contracts without escalators. However, as escalators reduce risks for developers, solar costs may initially be lower in contracts with escalators than in those without them.

Source: PosiGen

Community Solar Savings

The U.S. Department of Energy defines community solar as "any solar project or purchasing program, within a geographic area, in which the benefits of a solar project flow to multiple customers such as individuals, businesses, nonprofits, and other groups."[13] Some federal funding programs, like the U.S. Environmental Protection Agency (EPA) Solar for All program—a key component of the Greenhouse Gas Reduction Fund (GGRF) initiative that is funded through the Inflation Reduction Act—have adopted slightly different definitions,[14] but generally conform to the idea that community solar customers will pay for some of the production of a solar system shared by multiple customers.

Community solar can be particularly useful to bring solar benefits to low-income households that cannot install solar on their homes' roofs, because they are renters, lack upfront capital, lack appropriate rooftop space, or have roofs that require major repairs.

Several community solar program models exist, and savings are achieved in different ways depending upon which model is used. The subscription model is the most frequently used community solar approach. Other models include direct ownership, where customers buy offsite panels that are part of a solar facility that was built, operated, and maintained by a utility or third-party developer; cooperative models, where member-owners buy shares in a cooperative that holds the community solar asset; and what CESA calls the energy assistance model, where an energy assistance administrator owns and operates a facility for the benefit of its customers. You can read about these models and find examples of programs structured these ways in a July 2023 CESA report, *Community Solar for Low-Income and Disadvantaged Communities Solar for All Greenhouse Gas Reduction Fund Program Design Options for States.*

Here, we will focus on the subscription model and briefly explore a cooperative model. In the subscription model, a utility or a third-party developer owns and operates a solar facility and conveys the value to customers through a monthly subscription that is billed either as a credit on utility bills, or as a credit on a separate bill.[15] Subscribers typically do not incur an upfront cost to enroll and can cancel their subscriptions without fees, with a 30-day notice. Subscription managers manage marketing, enrollment, and customer turnover.[16]

In a subscription program, the customer is not eligible to receive any tax credits associated with the development of the solar facility.

Virtual net metering (VNEM) is a compensation and billing mechanism that is frequently a component of community solar. The details of program rules, including compensation values, have a large impact on solar economics. VNEM credits are generated and applied in proportion to a customer's assigned share of solar production (i.e., their community solar subscription). VNEM credits can be generated both for systems that are located on-site, as is sometimes the case for

13 *National Community Solar Partnership webpage*, DOE, accessed August 29, 2024.

14 In the Solar for All notice of funding opportunity, EPA defines community solar as (a) a solar PV power-producing facility or solar energy purchasing program from a power-producing facility, (b) with up to 5 megawatts (MW) nameplate capacity, (c) that delivers at least 50% of the power generated from the system (d) to multiple residential customers (e) within the same utility territory as the facility.

15 Bentham Paulos and Vero Bourg-Meyer, *Community Solar for Low-Income and Disadvantaged Communities: Solar for All Greenhouse Gas Reduction Fund Program Design Options for States*, (CESA, 2023).

16 Id.

multifamily housing where VNEM credits are shared with the building owner and the participating tenants, and those located off-site. Off-site projects could be owned by communities, developers, or utilities, among others.

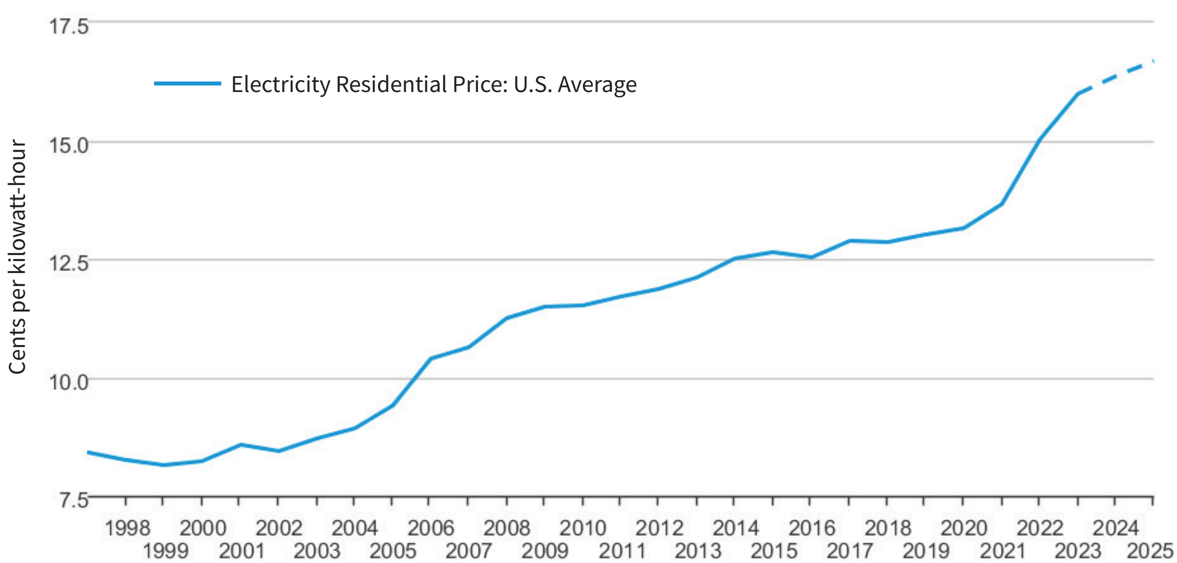
Community solar savings are usually achieved following one of the following approaches.

Fixed Electricity Rate Applied to Solar Production

In this model, a community solar customer receives a fixed solar price, in $/kWh, applied to their share of the solar production in a project. If electric rates go up, both the savings percentages and the savings themselves will increase as the difference between the locked rate and the utility rate increases. Should electric rates go down, then the savings diminish, or vanish if the utility price becomes lower than the locked rate. We note that utility rates have most frequently increased rather than decreased over time, with the average residential rate in the US growing from 8.4 cents/kWh in 1997 to 16 cents/kWh in 2023.[17] (See Figure 9.) This translates to a 2.5 percent annual (compound) growth rate over 26 years.

Here is an example calculation provided by EnergySage[18] and slightly modified to fit the goals of this report: Assume a customer signs up for a community solar program that sells electricity for 11.7 cents per kWh compared to a 13 cents per kWh utility rate, and that the customer's share of community solar generates 769 kWh. The customer would then pay about $90 for credits to the solar company (i.e., power production of 769 kWh x locked price of 11.7 cents/kWh). The

FIGURE 9 **ELECTRICITY RESIDENTIAL PRICE: U.S. AVERAGE**



US Average Electricity Residential Price from 1997 to 2023.

Source: U.S. Energy Information Administration

17 *US Average Electricity Residential Price from 1997 to 2023*, U.S. Energy Information Administration, accessed August 29, 2024.

18 EnergySage is an online marketplace for solar consumers and installers.

customer would save about $100 on their bill from the electric utility (i.e., power production of 769 kWh x utility price of 13 cents/kWh). The net savings would be $10 ($90 in solar cost—$100 utility cost saving). This approach has the advantage of being very simple to explain.

Does this approach guarantee a certain level of savings for customers? No. This approach only guarantees savings as long as the locked rate stays below the utility rate. When a customer signs the contract, they arguably do so to take advantage of the lower solar rate, as compared with the utility rate. Because falling electric utility rates would reduce savings, there are greater risks inherent to this model than to the fixed discount model. However, the savings potential is also higher because the savings percentage is likely to increase over time as the delta between the utility rate and the locked solar rate increases.

In addition, savings on the energy charge portion of the utility bill will not necessarily translate one-for-one into a whole bill saving. In the example above, the final whole bill saving percentage would be less if the offset is applied to the energy portion of the bill only.

Escalating Electricity Rate Applied to Solar Production

In this model, community solar customers receive a solar price, in $/kWh, that varies over time. It is applied to their share of the solar production of the project. This model is a production-based model like the fixed electricity rate model above, but the solar rate is subject to escalators. Escalators included in these contracts have the potential to greatly reduce savings and to add uncertainty for the customer, especially if the escalators increase the solar cost at a rate unrelated to utility rates. In this case, savings may increase, decrease, or even disappear as a function of market or regulatory changes; for example, if an escalator increases to a level higher than the utility rate. Alternatively, the escalator rate could be tied to changes in utility rates, e.g., by providing a locked $/kWh solar price set over time by applying a constant percentage reduction from the adjusted utility rate. In this case, savings would be comparable to the fixed discount model, although we note that a fixed rate model is usually expressed in kWh rather than as a percentage discount of a utility rate.

Does this approach guarantee a certain level of savings for customers? No. Like the structure above, this model does not necessarily translate into savings after year one, with the added risk and complexity brought by the changing rate, unless solar escalators are tied proportionally to utility changes. As above, offsets may apply to only part of the bill, so that a percentage savings on a utility rate does not necessarily relate to whole bill savings one-for-one.

Fixed Discount on Bill Credits

In this model, community solar customers receive bill credits, generally in US dollars, reflecting the generation from their portion of the community solar array, and they pay for the credits at a discount. For example, with a 5 percent discount, the customer will pay for 95 percent of the value of the solar credits they receive. Community solar firms report 5–10 percent discounts being typical, but some customers receive 20 percent discounts or more.[19] Note that discount percentage numbers are also typically different for standard residential customers than for LMI customers, based upon state program requirements.

19 Note that some programs, such as the Illinois Solar for All program include higher goals, but these are calculated slightly differently. See the Illinois Solar for All case study on page 44 for additional information.

This approach seems to be the most commonly used in the community solar industry. It is used by Sunwealth and Arcadia, among other organizations. For an example of how this model is applied in practice, see the Sunwealth case study on page 25.

Under a fixed discount model, the credits' discount percentage does not vary over time. All other things being equal, whether electricity rates go up or down, dollar savings would go up or down but would not disappear, even if utility rates decreased significantly. A percentage discount does not, however, necessarily translate into a one-for-one whole bill saving. Here is an example calculation provided by EnergySage and slightly modified to fit the goals of this report: A community solar project offers a fixed 10 percent discount on a customer's assigned share of solar production. Assuming the solar panels generate 769 kWh that earn a $100 credit toward a utility bill, the customer will pay $90 for that credit after the community solar company applies the 10 percent discount. This would result in a saving of $10 on a monthly electricity bill.[20]

Does this approach guarantee a certain level of savings for customers? This approach guarantees some savings but not necessarily a certain level of savings without some intentional structuring. A percentage discount on the value of a credit does not necessarily translate into the same percentage discount on the value of a whole bill. There are several reasons why this could be the case.

First, it could be that credits are not set at the retail value, so that they are worth less than the value of the bill even before applying a discount. According to the trade association Coalition for Community Solar Access (CCSA), "using a credit rate based upon a subscriber's retail rate has been the simplest and most practical mechanism for establishing successful community solar markets throughout the country. . . . [A]s markets evolve states typically move toward a value-based compensation approach—a more complex rate structure that is designed to value. . . . solar . . . based on location, time of production, societal benefits and other factors. . . ."[21] As per CCSA, examples of the latter include New York's Value of Distributed Energy Resources approach where location and other project characteristics are considered, or Illinois, where credit rates combine "the Supply rate + Upfront Rebate + REC value."[22] In addition, some credits are expressed in US dollars, while others are expressed in kilowatt-hours.[23]

Second, it could be that the credits do not offset the entire value of the bill either because they only offset the energy costs portion of the bill, leaving the transmission and distribution costs portion of the bill untouched, or because other fixed fees or charges exist that reduce the percentage bill savings achieved by the discounted credits. Nevertheless, this model can be adapted to ensure that high savings are attained under this structure (see the Sunwealth case study below).

Developers have different opinions about which of the models above is the easiest to explain to customers. Some find the concept of credit discount more straightforward, while others prefer to compare utility rates to lower solar rates. Without additional information and education about bills and energy consumption, neither of these approaches provides a full picture of savings to customers.

20 *Community Solar Billing: Four Things to Know* (Energy Sage, 2023).

21 *Policy Guidebook, Expanding Solar Access through Informed Policy Decisions*, pg. 12 (Coalition for Community Solar Access, 2024).

22 Id. pg. 13.

23 For example, see Leon et al., *Solar for Manufactured Homes Volume 3*, pg. 23 (CESA, 2023).

CASE STUDY 1

Sunwealth

Sunwealth is a solar investment firm that finances and manages solar projects. They have completed 716 projects across the country, many of them community solar projects.

For the community solar projects in Massachusetts and New York, where they have developed many of their projects, Sunwealth uses a model that aims to be easy for potential subscribers to understand and risk-free for customers. There is no credit check, no enrollment fee, and subscribers can cancel at any time. Sunwealth believes that complicated terms that are difficult to explain can increase a company's acquisition costs and leave customers feeling uncomfortable with a long-term contract.

The Sunwealth team takes an inclusive approach to community outreach and works with trusted community leaders to share educational materials about the program. Through partnerships with municipalities, housing organizations, and nonprofits, Sunwealth communicates to potential subscribers about the benefits of a community solar program through a trusted community partner.

Household savings are provided through discounted credits from the production of the community solar array. Each subscriber is enrolled to receive a certain share of the output from the array based on their estimated electricity usage. The solar output from the array is sent directly to the local grid, and the electric utility distributes credits for the energy generated to the subscribing household's monthly electric bill. Sunwealth then charges the household for those credits at a locked-in discount, typically 20-25 percent.[24] In other words, for every kilowatt-hour of electricity the solar array generates for the subscriber, the subscriber receives 20-25 percent discount off the cost of the credits. If production from the array is less than anticipated, the number of credits each subscriber receives is reduced proportionately.

To address seasonal variations in solar output and electricity use, Sunwealth sizes a household's subscription to roughly 85 percent of its projected electricity consumption. This mitigates instances where subscribers receive and must pay for credits that they cannot immediately use because they exceed the household's electricity consumption in a month. In the rare case that they receive too many credits in a month, the credits roll over and can be used in ensuing months.

Although households receive a 20-25 percent discount on the credits created from the solar array, it does not mean that their total electricity bill is reduced by 20-25 percent. As noted above, the subscription is scaled to approximately 85 percent of household electricity use, so the savings would be scaled accordingly. In other words, subscribers with a 25 percent discount on credits experience 85 percent of a 25 percent reduction in the electricity costs associated with solar production, or a 21.25 percent reduction. The average Sunwealth subscriber saves around $300 a year, which amounts to $6,000 throughout the lifetime of the project. Note that the

CONTINUED

24 Sunwealth's projects through the DC Solar for All program provide greater savings—usually at least 50 percent.

CASE STUDY 1 CONTINUED

credits cover both the energy supply and the transmission/distribution portions of the subscriber's bill, but do not account for any monthly fixed charges.

Sunwealth takes on the risk of price volatility. If the value of the solar output changes or retail electricity prices change, the household continues to receive the same number of credits from the electric utility for the solar output and still pays for the credits at the same discounted rate. Sunwealth can offer this price stability for the customer by building a financial model that accounts for contingencies such as solar credit price changes, maintenance costs, and a certain amount of customer churn. They set their subscription prices based on projections for those factors, and have the ability to adjust allocations at any point if a subscriber should receive more or fewer credits.

The savings that Sunwealth offers community solar subscribers vary from state to state depending upon the maturity of the solar market, the level of state incentives, the range of solar policies in place, and retail electricity prices. In addition, state incentives and program rules can change the extent to which savings are guaranteed and how they are guaranteed. For example, in the Massachusetts SMART program that Sunwealth participates in, the total compensation rate is guaranteed for 20 years.

Sunwealth presents their model and how consumers can participate here: *https://www.sunwealth.com/communitysolar*.

As previously stated, other models exist in addition to the base models described above. One such model is **cooperative ownership**. In this case, members of a community own a cooperative, which in turn owns and operates community solar projects.[25] In addition to subscribing to a community solar project, the member-owners buy shares in the cooperative and can earn a dividend.[26] See Case Study 2 on page 27 for an example of this model.

25 Bentham Paulos and Vero Bourg-Meyer, *Community Solar for Low-Income and Disadvantaged Communities: Solar for All Greenhouse Gas Reduction Fund Program Design Options for States*, (CESA, 2023).

26 Id.

CASE STUDY 2

Cooperative Energy Futures

Cooperatives are organized under state laws and can be for-profit or nonprofit. As cooperatives, they must be democratic (one member, one vote, including annual board elections) and entail profit sharing for members. See Figure 10 (p. 28) for an energy cooperative structure.

Cooperative Energy Futures (CEF) is a Minneapolis-based, for-profit cooperative, or 308(B), under Minnesota state law. It owns and operates multiple community solar projects in Illinois and Minnesota.

Generally, the cooperative includes three categories of customers/owner-members, based on income brackets. CEF charges a subscription fee for the projects as a rate expressed in $/kWh based on a year-one percentage savings target. The middle-income bracket receives a rate that provides customers with a saving equivalent to a 20 percent bill credit discount rate. Customers with lower incomes (<80% area median income) receive a lower rate and thus higher savings, while customers with higher income (>150% area median income) receive a higher rate and thus lower savings from the project.

The rate escalates by 2 percent per year versus a projected average utility rate increase of 3 percent per year. With that in mind, the savings percentage is meant to increase over time. Projects are sized at the maximum capacity allowed by the PUC rules based on consumers' historical consumption. If loads increase, the subscription sizes (in kilowatts) can also increase within these constraints. Once per year, a "true up" occurs where the utility pays the value of extra credits back to the customers if they have not been used.

Each customer also pays a one-time fixed fee ($25 in Minnesota and $5 in Illinois) to become a lifetime cooperative member. As the cooperative starts to profit, members start receiving dividends. Such dividends do not necessarily materialize in year one.

Dividend sharing occurs not at the scale of individual projects in which customers are subscribing, but at the scale of the cooperative in which customers are also member-owners. As a result, financial returns for members-owners increase on the 10-year horizon as financing for the initial projects held by the cooperative gets repaid, and ownership within tax equity structures flips to the cooperative (see the Figure 10, p. 28).

In addition, as projects accumulate within the cooperative, the additional investments can delay dividends distribution but increase the return potential. Understanding the total value received by customers/member-owners requires stacking the projects over their lifetime, an exercise familiar to solar asset managers.

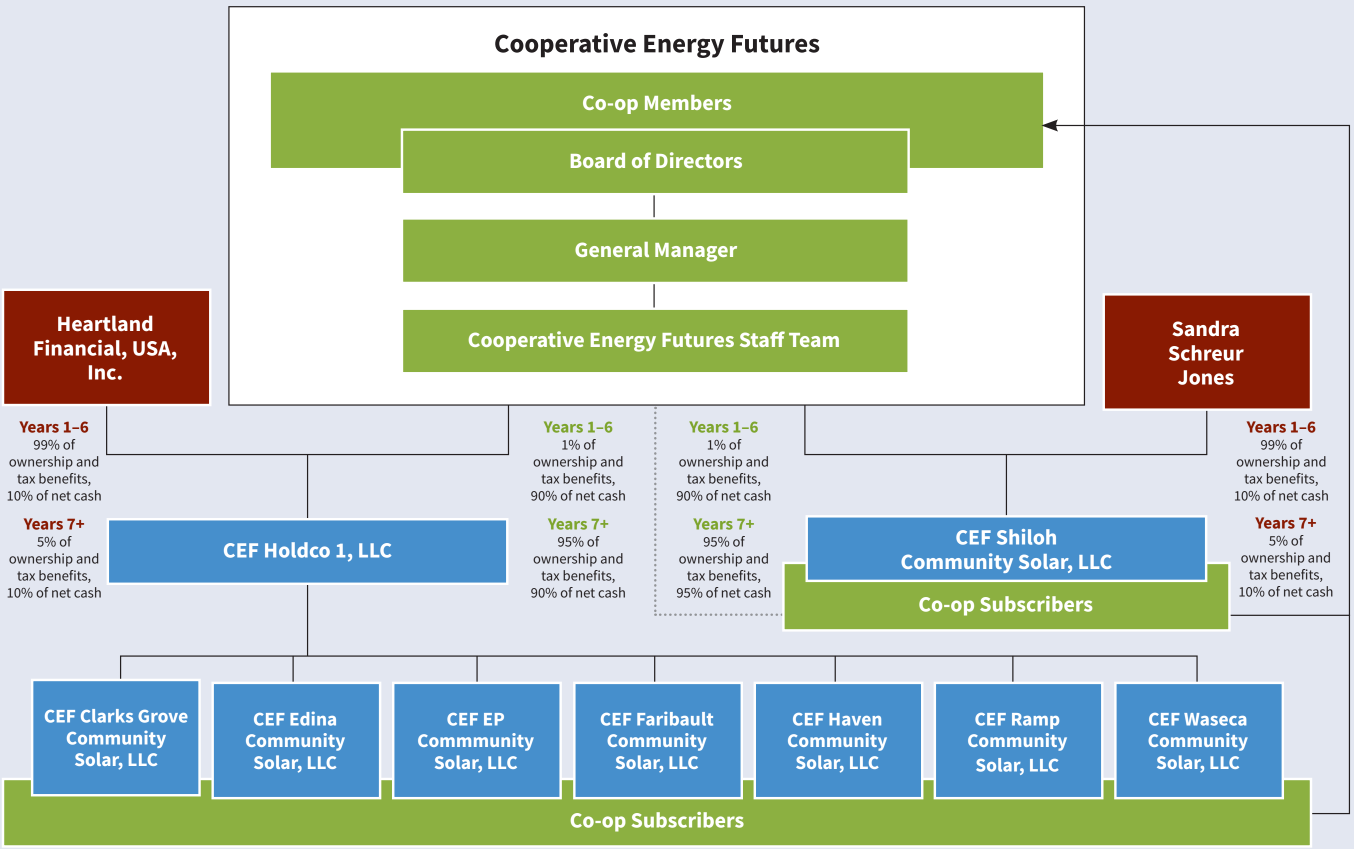
CONTINUED

CASE STUDY 2 CONTINUED

CEF profit sharing is organized "through a combination of cash distributions and equity accounts."[27] Such equity accounts build over time and they, along with a member's initial membership fee, represent the extent of a member-owner's liability in the cooperative.

For additional information, consult CEF's 2024 Membership Annual Report here.

FIGURE 10 **COOPERATIVE AGGREGATING**



Stylized chart of a cooperative aggregating project portfolio with different tax equity investors.

Source: Cooperative Energy Futures

27 *Comment letter from CEF to the Illinois Power Agency*, March 4, 2022.

Multifamily Solar Savings

There are special challenges to achieving savings for renters in multifamily housing and there are a range of approaches for providing those savings. Renters do not control their rooftops and cannot make an independent decision about whether to pursue solar development on them. Moreover, many renters live in master-metered buildings where they do not receive or pay a separate utility bill (see more below). Like all building owners, multifamily building owners can pursue direct ownership or third-party ownership solutions to access solar (if allowed by state law). In practice, solar developers and financiers report third-party ownership being the preferred option for building owners.[28]

Although off-site community solar can be an especially appropriate solution for renters in multifamily housing, it can sometimes make sense to install solar directly on multifamily housing to make that housing more sustainable, to use available roof space, and to provide valuable non-monetary benefits of solar, such as pairing it with energy storage to make the building less vulnerable to power outages.

An especially appealing approach for on-site solar at multifamily housing is the use of virtual net metering. As explained above in the community solar section, VNEM allows property owners to share benefits of off-site or on-site systems with tenants. As detailed by the California Public Utility Commission, in a VNEM arrangement "the generated electricity does not flow directly to a tenant or common area meter but goes through its own meter onto the electric grid. The participating utility applies bill credits for the energy produced by [the system] to the tenants' and common areas' individual monthly electrical bills, based on the pre-arranged allocation agreement."[29]

Solar benefits from such a project can reach tenants efficiently without extensive marketing or a complicated sign-up process. But it can only work in those jurisdictions that permit VNEM. Solar developer Sunrun has developed many such projects in California, generally with about 15 percent of the output going to the building owner and the remaining 85 percent being divided among the tenants at no cost. (See Case Study 3 on California's Solar on Multifamily Affordable Housing Program on page 30.)

However, on-site solar at multifamily housing does not always offer the tenants "meaningful" savings. For one thing, on multi-story buildings, the amount of roof space per household can sharply limit the amount of solar generation per household, thereby restricting each household's potential savings from solar. In addition, the building owner may have greater incentive—and may be required by regulations—to use solar to power the building's common loads rather than transfer savings to the tenants. In fact, outside of projects supported by California state programs for multifamily affordable housing, including the Solar on Multifamily Affordable Housing (SOMAH) Program, most systems for large multifamily buildings have been sized for common space/owner-paid electricity loads.

In addition to the considerations above, there used to be concerns about whether community solar credits could be treated as income for tenants of federal affordable housing, impacting their rent price or eligibility for assistance from the U.S. Department of Housing and Urban

28 Note that this section does not cover multifamily ownership. Owners of multifamily units can either (a) work with the other owners in their buildings to install and share solar on their roof, or (b) use community solar.

29 California Public Utility Commission, *Virtual Net Energy Metering*, accessed November 5, 2024.

30 For a brief summary of the complicated calculations for HUD utility allowances, see "HUD Utility Allowances" in Leon et al, *Solar with Justice*, p. 31 (CESA, 2019).

Development (HUD).[30] In 2019, HUD produced an initial guidance relevant only to the SOMAH program, and clarifying that VNEM credits from community solar that "have no relationship to tenants' electricity consumption" did not meet the definition of tenant income and were to be excluded from utility allowance calculations.[31] In 2022, HUD expanded this guidance to the rest of the country.[32] (See Case Study 3 for a discussion on SOMAH.)

Advocates have further raised concern that if considered additional income, solar savings could put low-income residents at risk of losing other government financial assistance, such as Supplemental Nutrition Assistance Program (SNAP) benefits.

CASE STUDY 3

California's Solar on Multifamily Affordable Housing Program

The SOMAH Program was established in 2017, building on the previous California Multifamily Affordable Solar Housing program (MASH), which helped install over 57 megawatts (MW) of solar PV from 2009 for 2021.[33] SOMAH is jointly administered by the Association for Energy Affordability, Center for Sustainable Energy, and GRID Alternatives in collaboration with California Housing Partnership. It is overseen by the California Public Utilities Commission.

SOMAH does not include a specific savings target or requirement, but the program ensures and enforces tenant economic benefits via a signed affidavit for applicants or host customers as a condition of providing incentive payments. These consumer protection provisions include the following: at least 51 percent of the solar system's electric output must directly offset tenant loads; no portion of the project cost can be passed on to tenants, either directly or indirectly; there can be no rent increases due to the solar installation; and the host customer cannot master meter the property or otherwise remove the tenant's control of the utility bill. Although savings vary by participating utility, PG&E, SCE, and SDG&E all achieved significant savings from 2020 to 2022. For these three utilities, respectively, the SOMAH tenant average monthly year-over-year bill differences between 2020 and 2022 were -39.3 percent, -47.5 percent, and -61.3 percent, adjusted to 2020 base-year values, as verified by a triennial third-party program evaluation.[34]

All solar generation is exported or sold via a SOMAH-specific VNEM tariff. Each utility in the program has its own VNEM allocation forms, which property owners use to distribute bill credits from the system's generation to tenant meters or common area meters. The amount of savings that the tenant receives greatly depends on the program's unique incentive design, which is

CONTINUED

31 HUD, *Memorandum on Treatment of Solar Virtual Net Energy Metering Credits on Tenant Utility Bills* (2019).

32 HUD, *Memorandum on Treatment of Community Solar Credits on Tenant Utility Bills* (2022).

33 On SOMAH's origins, program design, and the partnerships with community-based organizations, see Abbe Ramanan and Ayesha Abbasi, *California's Solar for Multifamily Affordable Housing (SOMAH) Program: Collaboration between Community Organizations and State Energy Agencies*, CESA (2022).

34 SOMAH, *SOMAH Program Handbook*, accessed November 4, 2024.

calculated based on system sizing, installed system capacity, tenant allocation, other funding sources, cost-effective energy efficiency measures, Expected Performance-Based Buydown (EPBB), and tax credits.

An EPBB incentive, like its close cousin the Performance-Based Incentive (PBI), seeks to influence system performance in the long run by incenting good solar design. While a PBI most directly guarantees system performance based on actual production, it is seen as more administratively expensive to manage when compared to an EPBB.[35]

Without the Investment Tax Credit (ITC) and Low-Income Housing Tax Credit (LIHTC), the SOMAH standard tenant rate per AC Watt is $3.50 while the common area rate is $1.19. Accounting for the ITC and LIHTC for LMI customers, the tenant rate decreases by half to $1.75 while the common area rate is $0.65.

Additionally, SOMAH champions a dual-layer protection between host customer and solar providers to ensure savings to households through (1) a 20-year Performance Reporting and Monitoring Service (PRMS) contract on the owner side and (2) fleet monitoring on the SOMAH program administrator side with separate utility generation reports. Monitoring of a building owner's entire building stock utilizes software that brings all inverter data into a single platform and allows comparisons between actual vs. expected performance. This monitoring system allows for tight compliance (in which incentivized systems must consistently generate at least 90 percent of expected electricity) and proactive communication if a system is malfunctioning or under-producing.

HUD has issued a memo about the SOMAH program indicating that tenants' VNEM credits are excluded from annual income and are also excluded when calculating utility allowances.[36]

Master-Metered Buildings and Indirect Benefits

In master-metered buildings, tenants do not have an individual electricity bill, making it impossible to assign VNEM credits from community solar directly to tenants (on-site or off-site).[37]

In instances where tenants do not receive a bill, the building owner or project developer may choose to distribute the financial benefits in some alternative form, such as a direct cash payments

35 Tom Hoff, *Photovoltaic Incentive Design Handbook* (NREL, 2006).

36 HUD, *Memorandum on Treatment of Solar Virtual Net Energy Metering Credits on Tenant Utility Bills* (2019).

37 Note that in some instances, owners of master-metered buildings have used strategies to pass on utility costs to tenants so that they would receive a bill even if in a master-metered building. One of the most common strategies is called the Ratio Utility Billing System (RUBS). Using this method, owners use property-wide usage and divide costs based on a cost allocation strategy (occupancy, square footage, or a fixed fee), rather than individual consumption in each unit. For additional information about meters, see Maryland Office of People's Counsel, *Individual Meters vs Master Meters*, accessed November 5, 2024.

or other amenities, such as a shuttle bus for residents.[38] There are several reasons why multi-family affordable housing owners would be interested in solar. These can include opportunities for operational cost savings for themselves or for tenants, or as a hedge against future utility rate increases.[39] Other reasons include resilience, particularly when paired with energy storage,[40] and the availability of tax credits.[41]

Here again, there are concerns that direct cash payments or other services could be detrimental to affordable housing tenants because the payment could be treated as annual income. In 2023, HUD issued guidance to help administrators navigate what may be considered "annual income" for residents of affordable housing, including a list of nonmonetary benefits that do not conflict with or jeopardize other financial assistance received by master-metered tenants.[42] These benefits include the following:

- Job training and workforce development
- Additional support staff
- Facility upgrades
- Free or reduced cost high-speed internet service
- Financial literacy programs and services
- Wellness programs and services
- Shuttle services
- Community events and/or support for resident associations
- Increased operating or replacement reserves for the property
- Resilience center
- Nonmonetary donations (e.g., food, clothing)
- Gift cards or cash payments[43]

Administrators of LMI solar programs should reference this guidance[44] and the HUD handbook[45] when developing a program that delivers benefits to residents of HUD housing. Table 2 (p. 33) shows examples of benefits that actual solar projects have offered residents of affordable housing.

38 HUD, *Treatment of Solar Benefits for Residents in Master-Metered Buildings* (2023).

39 Jae Berg, *5 Lessons for Successful Solar on Multifamily Affordable Housing* (Center for Sustainable Energy, 2022).

40 For a list of motivating factors specific to solar+storage projects, see Seth Mullendore et al., *Overcoming Barriers to Solar+Storage in Affordable Housing: A Survey of Multifamily Affordable Housing Developers* (Clean Energy Group, 2021).

41 Anne Levin-Nussbaum and Sara Langan, *Maximizing Tax Credits by Installing Solar at LIHTC Projects* (Akerman, 2024).

42 Id.

43 Note that there are limits to gift cards and cash payments. For example, see this blog, Reneé McTyeire, *How to consider cash and other contributions when calculating rent in the Multifamily Housing program* (2020).

44 HUD, *Treatment of Solar Benefits for Residents in Master-Metered Buildings* (2023).

45 HUD, *Handbook 4350.3: Occupancy Requirements of Subsidized Multifamily Housing Programs* (2013).

TABLE 2: **EXAMPLES OF NONMONETARY BENEFITS**

Program	State	Services
Dupont Park Seventh Day Adventist Church	District of Columbia	Grocery deliveries, wheelchair-accessible transportation to events, and educational health seminars[46]
The Housing Authority of the City and County of Denver CommunitySolar Garden	Colorado	"Enhanced services, improved facilities, and sustainable operations aligned"[47] and resident workforce training program through GRID Alternatives' Solar Training Academy[48]
NHT Ingenuity Power	District of Columbia	COVID-19 vaccine drives, transportation assistance, community engagement and community education, workshops, food drives, rental and utility assistance for tenants, on-site security services, and internet access for residents[49]

Solar One, a nonprofit focused on "education, training, and technical assistance that fosters sustainability and resiliency" primarily in New York City, has facilitated 31 MW of solar across 880 buildings, including 510 affordable housing properties.[50] They have found that most building owners have prioritized using the solar output for common spaces to reduce the building's operating costs. Because affordable housing buildings are hard to maintain, anything that reduces operating expenses helps keep housing affordable, especially in the case of low-income co-ops. But some projects have also delivered additional benefits, such as a recent project with the New York City Housing Authority that provided workforce training for 17 trainees as paid apprentices, five of whom went on to get full-time jobs.[51] But future projects under the federal Solar for All program will need to comply with EPA's guidelines on the delivery of benefits to tenants.

In addition to the use of these benefits to provide meaningful benefits to customers, some solar programs, including those in EPA's Solar for All program, are exploring using such indirect benefits outside of multifamily customers in localities where community solar is otherwise challenging to develop due to policy environments.

46 Groundswell, *Dupont Park Seventh Day Adventist Church in Ward 7: Working Together to Power Stronger Communities*, accessed November 4, 2024.

47 DOE, *Issue Brief: Reducing Energy Burden for Low-income Residents in Multifamily Housing with Solar Energy*, pg. 3.

48 Denver Housing Authority, *DHA'S Community Solar Project keeps Housing Affordable*, (2017).

49 DC Department of Energy and Environment, *Fiscal Year 2022 Solar for All Program and Renewable Portfolio Standard Expansion Amendment Act of 2016 Annual Report*, pg. 3 (2024).

50 Solar One, *Solar One website*, accessed November 4, 2024.

51 Interview with Anika Wistar-Jones and Geovani Caldero of Solar One (2024).

DEFINING MEANINGFUL HOUSEHOLD SAVINGS

Background

Although household savings have been identified as an essential benefit of solar development, there is no consensus on how much money customers need to save for it to be "meaningful." Ultimately, what is meaningful is defined at the household level, and program administrators, policymakers, and legislators should engage consumers to understand what would make a meaningful impact for them. Still, having a standard metric is useful from the standpoint of federal agencies and program administrators because it creates some level of uniformity and a benchmark for measuring program impact. Various possible thresholds are offered below.

20 Percent Bill Savings

While there is no single generally accepted metric for what constitutes "meaningful" savings, 20 percent bill savings is the most frequently referenced threshold. Over the past year, an increasing number of federal and state government agencies have focused on 20 percent bill savings as an appropriate goal for low-income solar programs, primarily because that was the required level of savings set out in the EPA's Notice of Funding Opportunity (NOFO) for the Solar for All Program.[52] EPA expects that annual savings will be on average $400 per household.[53]

Much remains to be refined, however, as EPA defined 20 percent household savings as "20 percent of the average household electricity bill in the utility territory"[54] for all households.[55] No further details are publicly available yet regarding critical elements such as the length or frequency of the savings, or whether one should consider the size of the household of the "average utility bill." Throughout the application period, states applying to the Solar for All competition had many discussions about what this could mean for programs, with some highlighting that their states include large numbers of utilities, creating a patchwork of requirements.[56]

DOE also frequently references a 20 percent electricity bill savings goal, which appears to have been initially rooted in a desire to make community solar savings comparable to what was assumed to be typical savings from rooftop solar installations.[57]

52 US EPA, *Solar for All Webpage*, accessed July 3, 2024.

53 US EPA, *Solar for All Fast Facts Webpage*, accessed July 10, 2024.

54 US EPA, *Solar for All Notice of Funding Opportunity*, pg. 12 (2023).

55 To define "average," US EPA advised Solar for All applicants to calculate "20% household savings from the average electricity expenditures of the average household in the utility territory." EPA, *Solar for All NOFO*, pg. 79 (2023).

56 CESA discussions with states in June-October 2023.

57 US DOE, *Community Solar Best Practices Guide: Developing Projects with Meaningful Benefits*, accessed August 15, 2024.

The Concept of "Financial Benefits"

Other federal programs with a key role in solar financing and deployment, such as the U.S. Department of the Treasury (Treasury), also provide clues as to what is "meaningful," but focus on elements of the savings rather than the savings themselves. For example, the Low-Income Communities Bonus Credit Program, referred to as the "48(e)" program, provides 10 to 20 additional percentage points to a project's base ITC under Section 48 of the Internal Revenue Code. The 48(e) program focuses on the concept of "financial benefits" rather than savings.[57]

Community solar. Treasury requires community solar projects[58] to provide each qualifying household with at least a 20 percent "bill credit discount rate" per year[59] for the project to be eligible to receive additional investment tax credits.[60] This is calculated as follows:

$$\frac{\textit{Value of financial benefits to households} - \textit{Costs}}{\textit{Value of financial benefits}} \geq 20\%$$

Financial benefits include "utility bill credits, reductions in a Qualifying Household's electricity rate, or other monetary benefits accrued by the Qualifying Household on their utility bill."[61] The costs are the costs of participation in the community solar program, including subscription payments and any other related fee or charge paid to the solar facility owner and any related third parties as a condition of receiving the financial benefits.[62]

In practice, this calculation amounts to the traditional bill credit discount rate discussed in the *Community Solar Savings* section on page 23. As discussed, bill credit discount rates may not amount to a one-for-one whole bill saving percentage.

In the comments section of the final regulations for 48(e), Treasury explained: "The Treasury Department and the IRS considered a variety of bill credit discounts for Category 4 qualified low-income benefit project facilities. The bill credit discounts considered included 10 percent, 15 percent, or 20 percent. Alternatively, Treasury and the IRS considered the option of a range of discounts from 10 percent to 20 percent from which applicants could choose the discount rate to provide low-income customers. However, to ensure that low-income customers are receiving meaningful financial benefits, Treasury and the IRS decided to propose a 20 percent discount."[63] The agency does not, however, explicitly define "meaningful," or explain what data were considered in reaching this conclusion.

In 2024, Treasury released a Notice of Public Rulemaking (NPRM) regarding a follow-up program to 48(e).[64] On January 1, 2025, the ITC will be replaced by its functionally similar but technology-neutral successor, the Clean Electricity Investment Tax Credit (CEITC). Under the successor program,

58 See 26 USC 48(e) and 26 CFR 1.48(e)-1.

59 More precisely, for projects defined as "Category 4" by Treasury.

60 Internal Revenue Service (IRS), Treasury, 88 FR 55506.

61 With a few exceptions that are outside of scope of coverage.

62 See 26 CFR 1.48(e)-1(f)(2)(i).

63 Id.

64 IRS, 88 FR 55506, pg. 120. See also, U.S. Department of the Treasury Issues Proposed Rules to Expand Clean Energy Investments in Underserved Communities.

known as 48E(h), the required bill credit discount rate proposed by the NPRM increases to 30 percent.

Affordable housing. Treasury uses the concept of "equitable distribution of financial benefits" for solar projects serving affordable housing residents.[65] In this case, "at least 50 percent of the financial value of the energy produced by the facility"[66] must be equitably distributed to residents to be eligible to receive additional tax incentives under 48(e).

Here, the focus is on households receiving a percentage of the value of the self-consumed and exported kilowatt-hours and of "the sale of any attributes associated with the facility's production (including, for example, any Federal, State, or Tribal renewable energy tax credits or incentives), if separate from the metered price of electricity or export compensation rate."[67]

This model is very similar to the SOMAH model discussed above.

Bill Parity

The Colorado Energy Office proposes to focus on "bill parity" where low-income households would spend a similar percentage (i.e., 4 percent or less) of their annual income on energy bills as do middle and upper-income households.[69] During CESA's community convening focused on meaningful household savings, some stakeholders recommended a similar approach, emphasizing that reduced "energy burden," i.e., the percentage of gross household income spent on energy costs, can be a useful metric for defining what is meaningful for participating households.

Shortcomings of a Single Universally Applied Metric

Although meaningful household savings can be defined in terms of a dollar threshold or a certain reduction in energy costs, 20 percent bill savings is likely to be the leading threshold over at least the next several years because it is what is outlined in EPA's Solar for All program. Having a single metric can be helpful for program administration and measurement, but without nuance, a standard metric can be insufficient or misleading.

For example, when requiring savings based on the "average electricity expenditures of the average household in the utility territory" (as was included in the Solar for All program NOFO), it might be very difficult to achieve that reduction in spending for a one-person household whose electricity bill may already be substantially below the average for the utility territory. Alternatively, if savings for that household are measured only in terms of its own percentage savings, a 20 percent saving may not be large enough to be considered meaningful.

When it comes to a percentage savings metric, such as 20 percent, there are also questions as to what it applies to. Does it include or exclude fixed costs on the electricity bill? As detailed above, it may be more difficult to achieve the savings goal on the whole bill in areas where fixed rates are high. Solar developers typically think about savings in relation to the components of the

65 *Guidance on Clean Electricity Low-Income Communities Bonus Credit Amount Program* (IRS, 2024).

66 More precisely, for projects defined as "Category 3" by Treasury.

67 26 CFR 1.48(e)-1(e)(2).

68 26 CFR 1.48(e)-1(e).

69 Hillary Dobos et al., *Insights from the Colorado Energy Office Low-Income Community Solar Demonstration Project* (Colorado Energy Office, 2017).

utility bill that can be offset, which excludes fixed charges. This allows for "rate-to-rate" comparisons of volumetric charges.

Program administrators should be aware of the limitations of a standard metric and consider how they can reach the savings threshold while also accounting for market conditions and mitigating possible unintended consequences. For example, in Louisiana, where the market rate for residential electricity is the lowest in the nation,[70] solar developer PosiGen takes additional steps to deliver savings to households, including prioritizing energy efficiency work in conjunction with solar, and redeploying used systems that are in good condition so that the solar lease price can be lower to provide savings.

Consider Additional Principles that Make Savings Meaningful

Because no one standard will be meaningful across the board, program administrators can consider further principles that can assure savings are impactful for households. Such principles, summarized at the start of the report, are further detailed in the sections below.[71]

Beyond a numerical value, we propose that a meaningful solar saving is one that customers can both see and feel. A saving that a consumer can see is one that is communicated clearly. Common challenges to how savings can be clearly communicated include a lack of understanding of utility bills or the existence of multiple bills, and the use of confusing concepts such as percentage discount rates, dollar values, and percent savings over a baseline. Although there are established developer practices to estimate savings, there is no clearly accepted methodology, and as demonstrated above, inputs into solar savings change over time, sometimes making savings all but invisible. Clear communication and billing practices that enable participants to understand savings must be prioritized to achieve meaningful savings.

A solar saving that customers can feel is one that makes a material difference in the customers' lives. It should reduce energy burdens and be set in a way that prioritizes parity between renters and homeowners. Here we note again that while a percentage metric is a helpful goal, it can be in practice very large or very small, so whether it is felt as meaningfully beneficial is a matter best determined at the level of a household. Further, there needs to be engagement of low-income tenants in crafting indirect benefit proposals for savings. For savings to be meaningful, it is also necessary to ensure that billing practices do not impact access to other programs, like LIHEAP, HUD vouchers, and others, and the savings are not treated as income.

Savings versus Value

When setting a savings target for a solar program, it is important to keep in mind that bill savings is not the only way in which customers can get tangible value from a solar system. Sometimes, they may prefer to receive a different benefit, even if it reduces their savings. The two most important alternative benefits to consider are additional energy services and resiliency.

Some customers who install solar or subscribe to a community solar project choose to increase their electricity use. With a lower electricity rate, they can afford energy services that were

70 US Energy Information Administration, Table 5.6.A. Average Price of Electricity to Ultimate Customers by End-Use Sector, accessed August 19, 2024.

71 Note that the content below was generated in part from stakeholder conversations held by CESA during the summer of 2024.

previously unaffordable or did not seem sufficiently cost effective. For example, they may be able to use air conditioning or an electric clothes dryer more frequently. By doing this, they reduce their bill savings but still benefit financially from solar and an improved quality of life. These consumer choices should not cause a program to be penalized for failure to achieve a household bill-savings target, especially if homes were energy insecure and curtailed energy usage before they could access to the benefits of solar.

In terms of resiliency, households are increasingly choosing to pair solar with battery energy storage. Storage can enable the household to retain and use power during storms and other grid outages. Especially for households with electricity-dependent medical equipment needs or limited mobility, energy resiliency is extremely valuable and desirable, even if it reduces the amount of money they save on their electricity bill. Unfortunately, the resiliency value of storage is usually not monetized when the costs and savings from a solar system are calculated.

A solar program should ideally be assessed on how much value it is providing to households, not just how much savings. In fact, there are ways to assess value beyond bill savings that have been used by WAP and other low-income energy efficiency programs to analyze non-energy benefits.

Develop Definitions with Program Beneficiaries

Finally, a standard metric, such as 20 percent bill savings, does not explicitly consider what LMI households would themselves consider to be a meaningful reduction in energy bills. While it may not be feasible to survey all LMI program participants, program administrators should prioritize understanding beneficiaries' perceptions of their household needs and expectations. Working directly with beneficiaries is especially important when offering nonmonetary benefits for residents who cannot receive direct financial benefit (e.g., residents in master-metered housing).[72]

72 See above in the section on *Master-Metered Buildings and Indirect Benefits* on page 31 for more information on this topic.

SETTING AND ACHIEVING A SAVINGS TARGET

Background

When a household installs solar, whether and how much money is saved hinges on many factors, including weather, existing electricity rates, changes in electricity rates, state net metering policies, human behavior, and more.

In setting a target for meaningful savings, program administrators must understand their existing context, as well as savings that have been achieved in other programs. Unfortunately, the data on savings from existing solar installations is incomplete, unsystematic, and not always reliable. While information on the cost of solar installations is readily available, it is much harder to find out how much money the owners and subscribers save from those installations.[73]

Table 3 (p. 40) provides an overview of savings from several existing LMI-serving solar programs.[74] For the sake of clarity, we note that these are not the savings requirements of these programs, some of which are further explored below in Table 4 (p. 41).

Importantly, these programs are all specifically designed to reduce electricity bills for LMI households. Without strategic program design, savings may not occur. For example, if solar is installed on a multifamily housing complex and there are no protections or mechanisms for savings to be distributed to tenants, tenants may not see any change in their bill. In addition, some households have fallen victim to solar scams and have seen their electricity bills go up with solar due to predatory practices. Access to solar does not inherently achieve savings for households: strategic program design, and strong consumer protections are essential elements to achieving savings.

Understand Savings Targets from Other Programs

Only about half of the programs surveyed for this report (9 of 19) require that households achieve monetary or other savings through the solar programs. This does not mean that no solar savings occur in the absence of requirements. For example, California's Disadvantaged Communities—Single-Family Solar Homes program does not require savings but in practice achieves a significant reduction in annual bill costs.

It is unclear from existing data whether participants fare better in programs that have an established savings requirement compared to those without. The authors recommend that this topic be taken up as a research topic for federal agencies as they continue to explore and/or require

73 On solar installed price trends, see Berkeley Lab's annual *Tracking the Sun* report, https://emp.lbl.gov/tracking-the-sun.

74 To better understand various aspects of savings, CESA distributed a survey to many existing LMI-serving solar programs across the US. CESA received 25 responses and analyzed 19 programs, omitting duplicates, programs not focused on solar, and programs that started after 2023.

TABLE 3: **ANNUAL SAVINGS BY LOW-INCOME SOLAR PROGRAM**

Program	Installation Type	Annual Savings (Average)	Annual Savings (Percentage of Bill)
DC Solar for All[75]	Single Family, Multifamily, Community Solar	$520	51%
California (CA) Solar on Multifamily Affordable Housing[76]	Multifamily	$480–$720	60%–80%
CA Disadvantaged Communities–Single-family Solar Homes[77]	Single Family	$990	94%
Oregon Community Solar Program[78]	Community Solar	Unknown	25%
Louisiana Solar Leasing (PosiGen)[79]	Single Family	$744 net savings ($1,404 (gross) minus $660 (lease payments)*	Unknown
Rhode Island Solar Leasing (PosiGen)[80]	Single Family	Solar + efficiency: $987 (projected) Solar alone: $546 (projected)	39% (projected)
Connecticut Solar for All[81]	Single Family	Solar + efficiency: $1290–$1340* Solar alone: $687	Solar + efficiency: unknown Solar alone: 34%

* Programs that include savings from energy efficiency measures.

certain levels of savings for solar programs. Example saving targets from existing programs follow in Table 4 (p. 41).

In some cases, programs do not require monetary savings but have other targets that relate to savings. For example, California's SOMAH program requires that at least 51 percent of the solar capacity must be dedicated to tenants. SOMAH has achieved 60-80 percent annual bill savings for its participants.

Consider Efficiency Gains

While this report focuses on meaningful household savings from solar development, it is important to note the savings potential of coupling solar and efficiency services, especially when installing solar on residences. An analysis of LMI solar programs offered in Connecticut found that savings for customers who received deep energy efficiency services significantly increased the total savings, see Table 5 (p. 41).

75 CESA 2024 Meaningful Household Savings Survey.

76 Id.

77 Id.

78 Id.

79 Wallace, K. (2024) *Meaningful Household Savings* [PowerPoint Presentation], accessed July 24, 2024.

80 Id.

81 VEIC, *Connecticut Green Bank Low- and Moderate-Income Solar Program Savings Analysis*, pg. 1. This program is distinct from the federal Solar for All program. The Connecticut Solar for All program began in 2015.

TABLE 4: **EXAMPLE SAVING TARGETS FROM EXISTING PROGRAMS**

State	Program	Savings Target
DC	DC Solar for All	Targeting 50% reduction to the average electric bill (based on the residential rate class average electricity bill for 2016), i.e., approximately $500 annually
HI	Green Energy Money $aver On-Bill Financing Program	Minimum estimated post-installation bill savings (including loan or lease repayment) is based on the of disconnection notices: 0 = 5% savings; 1 to 4 = 10% savings; 5+ = 15% savings. For third-party owned systems, regardless of disconnection notices, minimum bill savings is 20%.
IL	Illinois Solar for All	The customer must see at least a 50% savings on the value of the credits received from the system.
MA	SMART	Participant must receive a net savings.
MD	Community Solar LMI-PPA Grant Program	Incentivizes savings that exceed 15% below the utility's Standard Offer Service rate. The greater the saving, the greater the incentive.
NH	Low-Moderate Income Solar Grant Program	A minimum of 75% of the project's net revenues from electric generation must directly benefit LMI participants
WA	Community Solar Expansion Program	The project administrator must demonstrate how the project will deliver continuing direct benefits to low-income subscribers (e.g., credit for the power generation for the community solar project or other mechanisms that lower the energy burden of a low-income subscriber)

TABLE 5: **SOLAR V. EFFICIENCY SAVINGS**

Program	Program Type	Annual Solar Savings	Annual Energy Efficiency Savings	Cumulative Savings
Connecticut Solar for All	Solar Lease	$687	$603–653[82]	$1,290–$1,340[83]

Tips for Utilizing Nonmonetary Benefits

Nonmonetary benefits are only meaningful to the extent by which they are needed and used by residents. Program implementers and building owners should prioritize tenant engagement to understand and implement tenants' stated preferences for how to use nonmonetary benefits. Stakeholders have raised a concern with the use of nonmonetary benefits. These benefits should be verified as providing benefits to tenants beyond what might have already been offered by the building owner. Program administrators should have the ability to verify them.

82 VEIC, *Connecticut Green Bank Low- and Moderate-Income Solar Program Savings Analysis*, pg. 1.

83 Id.

CASE STUDY 4

DC Solar For All

DC Solar For All, in partnership with the DC Sustainability Energy Utility, has helped reduce electricity bills by 50 percent or $500 per year (the program's savings target) for over 9,000 income-eligible households. The program provides "meaningful savings" to low-income households, but also to small businesses and nonprofits, through both direct bill credits and indirect (in-kind) benefits. A key feature is that there is no cost to the LMI households that participate.

The community solar farm at Oxon Run, with a total capacity of 2.65 MW is a good example of the direct-credit savings approach used in DC Solar For All. It provides $500 in savings annually for about 750 households in the District. Using NREL's PV Watt Solar Production Tool and the 2016 average DC household residential electricity consumption (about 8,400 kWh annually) as a baseline, the project determined that 3.5 watts per household subscription would optimally reach the program's savings target.

Another noteworthy community-solar project of DC Solar For All lies in Dupont Park. It is a hybrid project that channels savings through both direct credits and indirect benefits. Groundswell, a DC Solar For All grant awardee, worked with churches to use their buildings as community solar host sites. Through a streamlined operational model, solar production first goes to the church's master meter and is then re-valued at the residential retail rate in dollar terms. The program delivers meaningful indirect benefits to 44 eligible senior households. These indirect benefits include transportation assistance (e.g., help with grocery shopping), food subsidies, (e.g., supplements to customers' SNAP benefits or offsets for food costs), and educational services (e.g., free financial management).

Aiming for proactivity in subscription management, DC Solar For All adopts two key practices to ensure the stability and equity of savings for their subscribers: (1) ad hoc resizing of customers' individual subscriptions in response to production issues, and (2) biannual reconciliation by comparing savings across all Community Renewable Energy projects to ensure that every subscriber is on track to meet the $500 per year savings target.

The benefits are managed and verified through a grant that imposes flow-down requirements, necessitating detailed reporting on the benefits provided. The grantees, who are DC Solar For All's authorized vendors,[84] are required to supply a breakdown of production levels, the total dollar value of the energy produced, the amount distributed to eligible households, and the nature of the in-kind benefits provided. Additionally, they must submit a budget breakdown and expenditure documentation to demonstrate that the benefits were delivered as required. DC Solar For All determined that it would be beneficial to have a memorandum of understanding that mandates this reporting. If similar guidelines are established at the federal level, they should be explicitly communicated and enforced.

84 The authorized vendors include ENFLECTION Energy Consulting, GRID Alternatives, Enterprise, Neighborhood Solar Equity OpenMarket ESCO, New Columbia Solar, Solar United Neighbors, New Partners Community Solar, and Urban Ingenuity. DC Department of Energy & Environment, *DC Solar for All*, accessed August 14, 2024.

GUARANTEEING SAVINGS

Background

Guaranteeing savings for solar adopters beyond the first year of the project can be difficult, or even impossible in some circumstances. Many factors impact prices beyond the first year and are outside the control of developers and program administrators, such as electricity rate changes, increased consumption, and fluctuating net metering policies.[85] Table 6 below shows four programs that explicitly guarantee savings beyond the participant's first year. A savings guarantee is distinct from a target in that, with a guarantee, consumers are promised savings and will receive savings regardless of how the system performs or other factors that could impact solar output. In contrast, a target is a goal that does not compensate consumers if the goal is not met.

TABLE 6: **EXAMPLE PROGRAM GUARANTEES**

Program or Project	Guarantee
NY-SUN	Projects are "required to dedicate at least 20% of capacity to guaranteed-savings subscriptions for individual LMI households, with a minimum 10% bill savings in order to receive the Inclusive Community Solar Adder. This 10% bill savings assumption was utilized as part of New York State Energy Research and Development Authority's modeling of the costs and benefits associated with the expanded NY-Sun program, as compared to an assumed 5% bill savings for non-LMI mass-market customers."[86]
Community Power Project, New York City	"Guaranteed electricity bill savings of 20% to 500 low- to moderate-income households."[876]
JOE-4-SUN (Citizens Energy Corporation), Massachusetts	"Guaranteed 50% savings on bill credits to participating LMI households."[88] Savings are fully guaranteed for the first year and, so far, have been offered in subsequent years.
Oregon Community Solar Program	"The bill fees for the community solar program must be 40% less than the bill credits for qualifying low-income households. Households are guaranteed savings and may not be charged additional fees."[89]

85 For additional information about why that is the case, see the *Common Saving Models* Section above.

86 State of New York Public Service Commission, *Order Expanding NY-SUN Program, CASE 19-E-0735*, pg. 42.

87 DOE, *Community Power Project: Sunny Awards Winner,* accessed November 8, 2024.

88 DOE, *JOE-4-SUN Ashland Project: Sunny Awards Winner,* accessed November 8, 2024.

89 CESA 2024 Meaningful Household Savings Survey.

CASE STUDY 5

Illinois Solar for All

The Illinois Solar for All (ILSFA) is a noteworthy example of a major state LMI solar program that guarantees savings to participants. It was created by the state's Future Energy Jobs Act (FEJA) in 2016, to "expand the reach of solar energy" as part of FEJA's broader goal to require 100 percent renewable electricity in Illinois by 2050. The 2021 Climate and Equitable Jobs Act expanded ILSFA by increasing funding for it and encouraging the development of projects promoting energy sovereignty.[90] The program is administered by the Illinois Power Agency, an independent state agency.

To participate in the program, solar companies must be approved by the State of Illinois and must agree to a strict set of vendor requirements.[91] Compared to most other state LMI solar programs, ILSFA has more detailed and rigorous vendor rules and consumer protection measures. In terms of household savings, ILSFA requires that participating households who receive rooftop solar installations cannot have any upfront costs and ongoing costs and fees cannot exceed 50 percent of the value of the energy generated.[92] For example, if a solar system that is installed on a home generates enough energy to yield $1,000 worth of net metering credits on the home's electricity bill in the first year, the household's total costs and fees must not exceed $500 for that year. Similarly, over a 15-year contract, if the system's energy value is $15,000, the participant's savings must be at least $7,500 over that period. Similarly, community solar customers cannot have any upfront costs and the "ongoing costs and fees cannot exceed 50 percent of the value of the bill credits applied to the customer's electric bill."[93]

For customers who reside in a multifamily affordable building who do not pay for their own utility bill, they must receive through indirect benefits the savings from no less than 50 percent of the net metering credits that their property owner receives. For community solar customers, their savings value is determined by anticipated bill credits from their energy supplier. This savings requirement is assessed in the first year and throughout the contract term for customers on an annual basis by utilizing an ILSFA-standardized methodology, as detailed in the program manual.

The program's consumer protection provisions[94] include a tier-based Program Violation Response Matrix that outlines disciplinary consequences following consumer complaints for vendors' non-compliance actions. If a project fails to deliver the required savings, non-disciplinary measures such as enhanced monitoring by ILSFA are first enforced to correct the issue. With repeated violations, the severity of the consequences escalates, culminating with the vendor's permanent expulsion from ILSFA.

90 Illinois Solar for All, *"About Us," Illinois Solar for All website*, accessed October 22, 2024.

91 Illinois Solar for All, *Approved Vendor Manual*, (Illinois Solar for All, 2024)

92 Illinois Power Agency, "*Protecting Participants," Illinois Solar for All website,* accessed November 8, 2024.

93 Id.

94 Illinois Power Agency, *Consumer Protection Handbook*, (Illinois Power Agency, 2024).

Guarantee Savings for the First Year of the Program (and Beyond, if Possible)

For developers, guaranteeing savings in year one can build prospective participants' trust in the program and serve as a valuable tool for bringing in new customers. Solar developer PosiGen guarantees first-year savings for its projects and underwrites its systems based on savings.[95] PosiGen targets a minimum of 15 percent solar-only savings, but the percentage can vary depending on the market served. (See Case Study 6, p. 46.)

Use Federal Funds to Reduce Risks for LMI Consumers

An appropriate focus for states using federal funding, such as Solar for All awards, may be to use a portion of funds to reduce the risk of market or regulatory policy changes and subsequent impacts on LMI consumers. These federal funds could be used to provide program stability to further enable guaranteed savings that would be difficult for an individual solar developer to achieve. However, program funds should only be used in the case of external market changes, such as a sudden change in net metering rates, or an unexpected change in utility rates. Federal funds should not be used as a blanket guarantee, as this could create misaligned incentives for industry.

In addition, program designers must account for the limited funding deployment time provided by the EPA program, as all funds must be fully deployed within five years from an awardee's budget period start date.[96]

When Savings Can't Be Guaranteed, Identify Other Meaningful Mechanisms for Consumer Protection

While savings are, in most cases, not guaranteed beyond the first year (or at all), many programs have protective mechanisms to support long-term savings and protect consumers. Examples follow:

- Using conservative modeling, which increases the likelihood of underestimating rather than overestimating savings
- Monitoring system performance, which allows the program administrator to proactively address any issues that could reduce generation and savings
- Offering a performance guarantee. The vast majority of lease programs offer performance guarantees. For example, one program administrator compensates customers for any under-generation below 80 percent of expected performance. Programs supporting direct-owned systems could also consider such a guarantee. As detailed above, SOMAH requires at least 51 percent of system's electric output to directly offset tenant loads. If requirements are not met, the program host can face program removal and repossession of dispersed incentive funds.[97]
- Allowing LMI customers to withdraw from a community solar project at no cost at any time for any reason

95 Kyle Wallace, *Meaningful Household Savings PowerPoint Presentation*, accessed July 24, 2024.

96 Note that awardees may receive up to two years of no-cost extension in certain circumstances.

97 Solar on Multifamily Affordable Housing, *Affidavit Ensuring 100% Tenant Economic Benefit.*

- Using state-of-the-art installation standards and conducting on-site verifications to ensure that the installation is consistent with the system design
- Requiring that no portion of the project cost can be passed to tenants, directly or indirectly, through changes to utility allowance calculations
- Requiring no rent increases due to solar installation
- Allowing the program administrator to request documentation of participant savings
- Modelling and underwriting savings for each household

Many interviewees noted the importance of having some form of recourse if savings or production goals are not met, such as program expulsion or full or partial incentive claw back.

CASE STUDY 6

PosiGen

PosiGen is a solar energy and energy efficiency developer that finances and manages solar and energy efficiency for single-family homes. PosiGen currently has customers in 14 states.

PosiGen's lease model is distinctive in that it underwrites customers based on expected savings; has no income, FICO score, or debt-to-income requirements; includes a first-year savings guarantee; and provides energy efficiency services. It also includes elements of a traditional lease such as no upfront costs; a production guarantee; handling of monitoring, operations, maintenance, and system insurance; and providing predictable payments over the term of the lease. PosiGen offers an app for customers to track their solar installation, pay their bill, and provide referrals.

PosiGen's model aims to provide affordable rooftop solar leases to LMI households with at least 15 percent to 20 percent bill savings in the first year. Many customers achieve bill savings of at least $50 per month, though that is dependent on system size and shading, utility rates, and solar compensation policies. PosiGen also seeks to provide long-term savings by ensuring that any increase in the lease payment over time is smaller than historical or expected utility rate increases. Instead of a percentage-based escalator, PosiGen utilizes a fixed dollar value payment increase, which means that it does not compound.

PosiGen develops its lease pricing and associated production minimums to ensure a minimum level of savings. The proposal document provided to prospective customers includes detailed inputs and assumptions and estimated savings over time under multiple scenarios. Prior to approving and countersigning a solar lease agreement, PosiGen runs an additional savings calculation that accounts for the prospective customer's electricity consumption and recent utility bills; their solar system design and production; and the applicable utility rate and net metering structure. To ensure the utility rates used are accurate, PosiGen utilizes the utility rate service Genability. PosiGen utilizes Aurora solar design software to generate the solar design.

CONTINUED

CASE STUDY 6 CONTINUED

If a system fails to meet the required savings minimum during the savings check, then alternative options are explored, such as changing the system design, including reducing the system size to avoid a portion of the roof that has less solar resource. Additionally, in certain markets re-deployed solar systems may be available, which can be provided at a lower cost than a new solar system.

PosiGen also provides energy efficiency upgrades to help achieve additional savings. The savings calculation for the solar lease is separate from the energy efficiency upgrades, so those upgrades create savings on both electric and heating bills.

To minimize the lease price to the customer, PosiGen leverages all available incentives, including federal tax credits and state or municipal incentive programs. Where possible, PosiGen leverages energy efficiency program incentives to maximize the energy efficiency work that can be done.

After the system has been activated and is producing electricity, PosiGen monitors the solar production to ensure ongoing savings. Should customers have questions or concerns regarding their actual savings, PosiGen's Customer Care team reviews the system production, the customer's utility bills, and applicable utility rates in order to determine the level of savings the customer is receiving.

Under PosiGen's model, the customer receives both a bill from their utility and a solar lease bill from PosiGen. Both bills are included in calculating the total net savings for a customer. Currently, there are no consolidated billing options for residential rooftop solar.

VERIFYING SAVINGS

Background

Once a system is in place with saving targets set and households benefiting, it is important to have a mechanism for verifying that households are receiving expected savings. Fifteen of 19 programs surveyed by CESA in 2024 do not verify that consumers receive savings after installation.[98] Those that do verify savings employ a range of strategies, further detailed below, such as utility bill scraping (e.g., DC Solar for All and NY-SUN) and audits (e.g., Mass SMART) or third-party program evaluations (e.g., Energy Trust of Oregon and DC Solar for All), at least on a spot check basis.

In addition, some programs, which we excluded from the count of programs that verify savings, use verification strategies that are "savings-adjacent" such as fleet monitoring services. This allows programs to assess production, which together with other program features ensures savings, without necessarily verifying them (e.g., SOMAH). The exact reasons why program administrators do not verify savings are not known, but this finding could be related to the many notable difficulties related to verifying savings, such as not having access to the necessary data, or not having the staff capacity to complete verification.

One common refrain from stakeholders and administrators was the lack of access to utility data that would allow for ongoing savings verification.

Determine What Is Feasible and Develop a Mechanism for Verifying Savings

Verifying savings is important to ensure consumers receive expected savings and that programs are, on the whole, meeting their stated goals. The authors recommend that this topic be taken up as a research topic for federal agencies as they continue to explore how to verify savings for solar programs. Note that EPA's Solar for All program requires verification of savings for purposes of program evaluation, so the implementation of that program will be an opportunity to make progress on creating and implementing methodologies and best practices for savings verification. Current practice aims to verify annual rather than monthly savings.

While there is no unified approach to verifying savings, several possible verification methods are outlined in Table 7 (p. 49).

98 Note that some Solar for All programs that are currently in their design phase are planning to include savings verifications. We have excluded these from the count.

TABLE 7: **EXAMPLE VERIFICATION METHODS**

Verification Mechanism	Description
Utility Bill Scraping	Program administrator reviews reports distributed by the utility to confirm expected solar credits were applied to bills.
Program Administrator or Third-Party Reports on Savings	Program administrator performs in-depth savings evaluation as part of a program evaluation effort. This can include "gross savings verification" and comparison to expected values. Some programs use desk reviews (invoices, project plan drawings, equipment spec sheets, and post-installation inspection forms), expected savings evaluation tools such as NREL's PV Watts, participant surveys, on-site inspections (to counter poor documentation about a project), and bill analysis.[99]
Fleet Monitoring	Program administrator requires continuous oversight through fleet monitoring services to quickly identify and address discrepancies in solar credits applications to utility bills.
Spot Checks and Audits	Program administrator regularly collects detailed bill information from developer and consumer (or utility) and conducts evaluation of savings achieved over a pre-solar consumption baseline. Note that we have found no established practice for determining the appropriate baseline.

The authors did not analyze sampling methods, although the level at which verification is done (i.e., on average over an entire program or portfolio of projects, or over a small-sized sample), will matter greatly in the level of confidence that can be attached to the results of any savings analysis.

Consider Accountability Processes

Although savings verification is primarily used around the country as a tool for program evaluation, a few programs do provide accountability mechanisms via long-term agreements setting up incentive/grants claw backs to protect consumers. In addition, some program administrators (primarily for community solar) initiate processes to adjust subscription sizes based on continuous monitoring of project generation and solar credit delivery.

Better Understand Data Challenges Working with Utilities

CESA's survey of existing LMI-serving solar programs across the US included questions related to challenges in obtaining data that would make savings verification possible or easier. Challenges in data access include the lack of access to individual customer bill data, staffing limitations, no uniform access to community solar programs, issues relating to interconnection data, technology and interface challenges, the lack of consolidated billing, and time lags between data reporting and data requests.

Existing arrangements with utilities that some programs have with accessing consumers' bills are summarized in Table 8 (p. 50).

99 For more detailed methodology and an example, see DC Sustainable Energy Utility, *FY2021 Program Evaluation Report* (2022).

TABLE 8: **TYPES OF EXISTING ARRANGEMENTS WITH UTILITIES TO ACCESS DATA**

Key Insights	Description
Significant Data Gap	About half of the surveyed programs explicitly indicated arrangements with utilities to access consumers' bills. Responses indicate that access to consumer data from utilities is one of the most significant challenges.
Emphasis on Customer Consent & Privacy	Most surveyed programs with arrangements with utilities to access consumers' bills require explicit customer consent.
Monthly Reporting and Transparency	Some utilities provide detailed monthly reports summarizing bill credits and energy generation, as seen in DC Solar For All.
Formal Data-Sharing Agreements	Some upcoming Solar for All programs are establishing formal data-sharing agreements with utilities to streamline data access and sharing.
Use of Third-Party Tools and APIs	Some programs (e.g., DAC SASH) use third-party tools, such as UtilityAPI, to facilitate accurate and efficient data retrieval.

COMMUNICATIONS AND MARKETING

Background

Having clear and consistent communication with consumers and meeting expectations is essential to building trust, particularly among communities who have been targeted for solar scams. This a central theme that emerged throughout the Community of Practice. Clear communication should come from a trusted messenger and includes ensuring customers understand what to expect from the program, knowing whom to contact if the program isn't meeting their expectations, and being able to interpret and understand their bill and savings.

Be Clear about Expectations and Build Trust through Clear Communication

Customers should know what to expect from participating in a solar program and what is required of them. For example, one interviewee suggested that program administrators should work to stabilize savings for LMI consumers so that bills do not fluctuate substantially month-to-month. While this may be ideal, it is generally not possible for savings to be the same each month because seasonal consumption and production vary. Many other interviewees and stakeholders suggested that it is not necessary for the bill to be the same each month, but consumers should know what to expect so that they can plan for months when savings may be smaller.

It can be helpful to think about customer needs in multiple stages: general solar 101 education, assistance with reviewing the customer's contract, system design and quotes, and then ongoing resources about savings and long-term system needs.

Promote Trustworthy Resources

Many resources are available to help consumers learn about solar, including how they can benefit and protect themselves from scams. Program administrators should promote trustworthy resources and ensure consumers know where to go for help. For example, SOMAH hosts a tenant hotline to assist residents with any issues. Further, Solar United Neighbors runs a "help desk" where anyone can reach out for feedback on a solar proposal or to ask questions of a solar expert. Finally, the U.S. Department of Treasury recently released a series of consumer advisories and educational resources, which may also be a helpful starting point.

Consolidate Billing

Consolidated billing is a pragmatic tool to reduce the administrative burden for the program administrator, but it can also be a powerful tool for communicating about savings to the solar customer. Throughout the Community of Practice, many stakeholders referenced confusion that is caused by having two separate bills, which can lead to consumers feeling like they are not actually saving money (even when they are) and being dissatisfied with the program. When consumers receive one bill, they can more clearly see how much money they are saving, which can reduce confusion and build confidence in the program. Receiving one bill can also help alleviate barriers faced by low-income residents, who may pay their bill in cash or struggle to cash a separate check.

A 2023 report from the National Association of State Energy Officials (NASEO), which analyzed and promoted consolidated billing, identified four states as having implemented consolidated billing policies: Illinois, New York, Oregon, and Virginia.[100] Since then, Colorado and Minnesota have adopted it.[101]

100 National Association of State Energy Officials, *Community Solar Consolidated Billing: Review of State Requirements, Policy, and Key Considerations*, NASEO, 2023, pp. 13-14.

101 State of Colorado General Assembly, Senate Bill 24-207, 2024; Minnesota Legislature, HF2310, 2024.

CONCLUSION

This report illustrates the range of approaches taken to achieve savings for households from solar. It attempts to demonstrate ways that developers, program administrators, as well as federal and state agencies, have tried to guarantee meaningful solar savings, and it also details the practical challenges in doing so.

Savings guarantees are uncommon for several reasons, including the many variables and inputs that go into solar savings calculations. These include changes to solar customers' electric consumption patterns that developers and program administrators cannot control, as well as changes to utility rates or rate structures that greatly impact solar economics. In addition, the categories of inputs to consider when painting a complete picture of solar savings vary across solar deployment models (e.g., rooftop vs. community solar, single family vs. multifamily, third-party ownership vs. direct ownership). They also vary qualitatively and quantitatively across geographies at the scale of a state or even a utility (e.g., the basis upon which the size of a NEM system can be calculated, or the type of credits allowed by community solar legislation).

This explains, in part, why there is no one common goal for savings across the country. In this report, we propose that any numerical savings goal metric, such as a minimum percentage electric bill saving, should be complemented with a set of best practices that a wide range of stakeholders in the solar ecosystem can implement.

These best practices include (1) setting a savings goal based on the market; (2) structuring solar contracts to minimize risks for consumers and including strong consumer protections to ensure savings; (3) making savings easy to understand through clear communication and simple billing practices; (4) adopting consolidated billing where possible; (5) taking steps to reduce risks that savings will not occur; (6) combining solar with energy efficiency to increase savings; and (7) creating and implementing a verification strategy to ensure savings.

These best practices, together with a commitment that solar will result in savings that solar adopters can both "see and feel," should ensure that household savings are achieved and verified, despite challenges in offering guarantees due to the inherent complexity of solar savings models.

These metrics and practices will be particularly important as federal programs, such as tax credits or other funding programs that include solar savings requirements, roll out over the next year. We especially note that programs have to contend with ever-changing local markets and regulatory environments that make achieving solar savings more or less challenging, requiring both a flexible approach and a systematic review of risks for LMI consumers.

Lastly, our research highlights the need to conduct more empirical studies of solar savings and to collect much more information about the actual savings achieved at the household level by different solar programs and different types of solar projects over time. Further research is needed to identify (a) why different programs do or do not collect data on savings, and (b) a range of solutions to explore. A better understanding of the types of data that would be desirable to collect from utilities to accurately measure savings for different types of programs is a necessary step. Additional research needs to consider are highlighted in CESA's October 30, 2024 presentation, *Meaningful Household Savings from Solar*.

APPENDIX

SOLAR MEANINGFUL HOUSEHOLD SAVINGS

A LITERATURE REVIEW AND GAP ANALYSIS

Introduction

In this appendix, the Clean Energy States Alliance provides a descriptive review and gap analysis of the current literature and public understanding of meaningful household savings related to solar projects for single-family homes, multifamily affordable housing, and community solar. The appendix is based on four types of inputs:

- **Literature:** CESA staff reviewed 93 primary and secondary informational sources from 2014–2024, although the publication of relevant resources increased significantly following the enactment of the Inflation Reduction Act in 2022. The examined materials included research papers, issue briefs, presentation slides, government notices, federal regulations, grant applications, and guides. These published resources collectively analyze the structure, supporting policies, and implementation of local and state low-and-moderate-income (LMI) solar programs. They also offer guidance to solar providers, utilities, government officials, and LMI community groups that are interested in addressing the financial and social barriers to solar participation by LMI communities.
- **Interviews:** The staff conducted 29 interviews with representatives of utilities, solar developers, non-profits, and other stakeholder organizations. The interviews explored the diverse approaches to defining, calculating, requiring, achieving, measuring, verifying, and expanding meaningful savings in LMI communities.
- **Survey:** This report reflects insights from 22 LMI-serving solar programs across the country. We eliminated three programs from the results because of repetitions or scope. The survey, administered in the summer of 2024, covered savings information, savings requirements, savings calculation methods, data collection, past results, savings verification, utility data, accountability, and challenges.
- **Stakeholder convenings:** CESA conducted two convenings to gather insights from more stakeholders. A virtual public listening session was attended by approximately 90 individuals, while a second, more focused virtual convening attracted 50 implementers of the federal Solar for All program.

The literature and gap analysis first highlights themes in the literature, including discussions of the definition of meaningful savings, overviews of LMI solar policy, discussions of program structures, and lists of tools for modeling solar savings. The analysis then switches to identifying and discussing major gaps in the existing literature.

Despite the recent surge in the volume of literature, the scope of the literature remains constrained and heavily skewed toward community solar. Of the 93 sources, only 21 explicitly discuss “meaningful savings,” and few of these define and quantify meaningful savings with a clear methodology. Even though the compiled list of sources and contributors is not exhaustive, it sufficiently represents the current literature on meaningful household savings from solar. The interviews conducted for this project further explore the empirical challenges and successes in the methodology of measuring savings, billing practices, project risk assessments, and customer outreach.

Themes in the Literature and Interviews

1. Efforts to Define Meaningful Savings

The U.S. Department of Energy (DOE) through the National Community Solar Partnership has defined five meaningful benefits from solar: (1) equitable access and consumer protection, (2) meaningful household savings, (3) resilience, storage, and grid benefits, (4) community-led economic development, (5) and solar workforce development.[102] Although household savings have been identified as an essential benefit of solar development, there is no consensus on how much money customers need to save for it to be "meaningful."[103]

Over the past year, an increasing number of organizations have focused on 20 percent bill savings as an appropriate goal, primarily because that was the required level of savings set out in the Environmental Protection Agency (EPA)'s Notice of Funding Opportunity (NOFO) for the Solar for All Program.[104] See, for example, CESA guidance on *Community Solar for Low-Income and Disadvantaged Communities*. EPA expects that annual savings will be on average $400 per household.[105] Much remains to be refined, however, as EPA defined 20 percent household savings as "20 percent of the average household electricity bill in the utility territory"[106] for all households. While further clarification from EPA is anticipated, no further details exist currently regarding critical elements such as the length or frequency of savings, or whether one should consider the size of the household when determining the "average utility bill." During the convening of Solar for All program administrators, attendees continued discussions about what this could mean for programs, with some highlighting that their states include large numbers of utilities, creating a patchwork of requirements.[107]

Other definitions of meaningful household savings have been offered. "Insights from the Colorado Energy Office Low-Income Community Solar Demonstration Project"[108] proposes to have low-income households reach "bill parity" where they spend a similar percentage (4 percent or less) of their annual income on energy bills as middle and upper-income households.

Other federal programs with a key role in solar financing and deployment, such as the U.S. Treasury (Treasury) focus on elements of the savings rather than the savings themselves. For example, the Low-Income Communities Bonus Credit Program, referred to as the "48(e)" program focuses on the concept of "financial benefits" rather than savings.[109] Treasury requires community

102 DOE, *Education and Outreach Webpage*, accessed July 10, 2024. The U.S. Department of Energy National Community Solar Partnership (NCSP) first issued a document, outlining five meaningful benefits. See *Building with Benefits: Meaningful Benefits as a Foundation for Equitable Community Solar Webinar Series Webpage*, accessed July 3, 2024.

103 Id.

104 EPA, *Solar for All Webpage*, accessed July 3, 2024.

105 EPA, *Solar for All Fast Facts Webpage*, accessed July 10, 2024.

106 EPA, *NOFO*, pg. 12, August 31, 2023.

107 CESA discussions with states in June-October 2023.

108 Hillary Dobos et al., *Insights from the Colorado Energy Office Low-Income Community Solar Demonstration Project* (Colorado Energy Office, 2017).

109 See 26 USC 48(e) and 26 CFR 1.48(e)-1.

solar projects[110] to provide each qualifying household with at least a 20 percent "bill credit discount" per year[111] for the project to be eligible to receive additional investment tax credits.[112]

In the comments section of the final regulations, Treasury explained: "The Treasury Department and the IRS considered a variety of bill credit discounts for Category 4 qualified low-income benefit project facilities. The bill credit discounts considered included 10 percent, 15 percent, or 20 percent. Alternatively, the Treasury Department and the IRS considered the option of a range of discounts from 10 percent to 20 percent from which applicants could choose the discount rate to provide low-income customers. However, to ensure that low-income customers are receiving meaningful financial benefits, Treasury and the IRS decided to propose a 20 percent discount."[113] The agency does not explain what data were considered in reaching this conclusion. Note that utility savings and bill credit discounts are related but distinct concepts.

Similarly, for solar projects serving affordable housing residents,[114] Treasury uses the concept of "equitable distribution of financial benefits," where "at least 50 percent of the financial value of the energy produced by the facility"[115] must be equitably distributed to be eligible to receive additional tax incentives. Here, the focus is on households receiving a percentage of the value of the self-consumed and exported kilowatt-hours and of "the sale of any attributes associated with the facility's production (including, for example, any Federal, State, or Tribal renewable energy tax credits or incentives), if separate from the metered price of electricity or export compensation rate."[116]

While federal and state agencies may provide some definitions, the perspective of communities is also important. At the U.S. DOE Solar Energy Technologies Office Solar Peer Review in March 2024, Anya Schoolman of the nonprofit organization Solar United Neighbors suggested that meaningful tangible benefits should be defined by the people in the LMI community. She noted that community residents might have different ways of thinking about what would make household savings from solar meaningful. Schoolman observed that for many low-income residents, guaranteed savings per month are more important than achieving a certain annual percentage bill savings rate.[117]

Some pilot programs have explored structures that focus on "flattening" savings over time so that households receive consistent savings—and bills—throughout the year.[118] The 2017 Colorado Energy Office demonstration projects with Fort Collins utility included "carry-forward credit" options "that were designed to mitigate the likely higher net power bills for customers in the winter when heating demand is high and solar production is lower."[119] In Minnesota, a 2023 pilot project tested "banking" credits for customers on energy assistance and enrolled in the state's

110 More precisely, for projects defined as "Category 4" by Treasury.

111 Internal Revenue Service (IRS), Treasury, 88 FR 55506.

112 With a few exceptions that are outside of scope of coverage.

113 IRS, 88 FR 55506, pg. 120.

114 More precisely, for projects defined as "Category 3" by Treasury.

115 26 CFR 1.48(e)-1(e)(2).

116 26 CFR 1.48(e)-1(e)

117 Anya Schoolman, *Presentation at DOE Solar Peer Review*, March 26, 2024. See DOE's *2024 SETO Peer Review* webpage for additional information.

118 Warren Leon et al., *Solar for Manufactured Homes: Volume 3*, (CESA, 2023).

119 See Id. pg. 20.

Low Income Home Energy Assistance Program (LIHEAP) so that the pilot "generate[d] a monthly 'deposit' of kilowatt-hour credits in a 'bank' at a Community Action Partnership (CAP)" for future use when production was lower.[120]

Many interviewees and attendees at the Community of Practice convening suggested that consumers can mitigate the impact of inconsistent monthly savings through increased bill literacy and clear communication on expected savings.

Despite these efforts to define what is meaningful, ***there is no one standard***. One interviewee stated, "It would be really helpful for the industry if there could be a uniform savings definition and common methodologies. That would provide economies of scale for developers. On the other hand, you can't create a one-size-fits-all approach, because there are different rates, different markets, etc." They continued that "the way that we regulate electricity in this country makes it challenging to create uniform requirements that apply across all jurisdictions."

2. Overviews of LMI Residential Solar Financing Policies and Programs

Many sources produced by non-profits and the federal government provide holistic policy landscape overviews for LMI solar programs.[121] The financing and implementation strategies these sources for boosting LMI customer enrollment in community solar center around the following categories: compensation mechanisms (e.g., net metering), direct incentives (e.g., rebates, tax credits, and Renewable Energy Certificates), and financing policies (e.g., on-bill repayment, lower interest rate loans, Property-Assessed Clean Energy (PACE), Pay As You Save, third-party ownership models, Solarize group purchase programs, and crowdfunding). Additionally, these sources highlight a wide array of federal economic development programs for reducing the cost of solar, such as LIHEAP, the Weatherization Assistance Program, Community Development Block Grants, and Federal Emergency Management Agency funds.

Both the literature and interviews discuss the impact of different billing practices on savings, including whether consolidated billing offers a clearer presentation of net utility savings and thereby decreases the risk of non-repayment compared to non-consolidated billing practices. On-bill financing allows LMI community solar customers to pay subscription fees through ongoing payments on utility bills in which they would have both their payments, credits, and net savings reflected on their utility bill. For example, the Grand Valley Power Solar Garden, which is a utility-owned community solar project in Colorado, adopts consolidated billing where subscribers receive monthly net metering credits at about $50/month and pay a management fee of about $0.02/kWh, or about $9/month.[122] On the other hand, non-consolidated billing entails LMI customers paying developers directly for their share of a community solar project through a separate bill, with the bill credit applied through the utility. In a program model in Connecticut, "customers make monthly payments of $8 directly to the developer and receive monthly bill credits of $10 on their utility bill."[123]

120 See Id, pg. 23, which details an effort by Minnesota Clean Energy Resources Team, Detroit Lakes Public Utilities, and theMinnesota Department of Commerce to benefit income-eligible manufactured homes residents who heat with electric heat.

121 Jenny Heeter et al., *Design and Implementation of Community Solar Programs for Low-and Moderate Income Customers* (NREL, 2018); Bentham Paulos, *Bringing the Benefits of Solar Energy to Low-Income Consumers* (CESA, 2017); Gabriel Chan et al., *Design choices and equity implications of community shared solar* (The Electricity Journal, 2017); Jeffery J. Cook and Lori Bird, *Unlocking Solar for Low- and Moderate-Income Residents: A matrix of Financing Options by Resident, Provider, and Housing type* (NREL, 2018).

122 Jenny Heeter, *Design and Implementation of Community Solar Programs*.

123 Id.

Many of this project's interviewees advocated for consolidated billing. They argued that a single bill would allow transparency between solar subscriptions and bill savings. A state program administrator in an interview pointed out that "when customers are paying two bills, it can feel like they are actually paying more. If they're not doing the math or the math doesn't line up because the billing cycles aren't aligning, or the timing of information provided by the companies isn't consistent, it may feel like they're paying more out of pocket when in fact they are saving money."

3. Solar Portfolio Modeling Tools and the Methodology for Analyzing Savings

In addition to comprehensive syntheses of the LMI solar financing policy landscape on community solar, the current literature includes a diverse selection of solar portfolio modeling tools.[124] NREL developed the REopt techno-economic decision support platform,[125] the System Advisor Model,[126] the Distributed Generation Market Demand (dGen), and the NCSP Multifamily Affordable Housing Portfolio Modeling Tool,[127] and those tools allow comparisons of the value of self-generated solar energy versus electricity purchased from the utility; estimated income from solar renewable energy certificates, total benefits, upfront versus ongoing costs, total net benefit, return on investment, and payback period between different solar ownership models (direct, joint ventures, and third-party ownership).

Using dGen to forecast savings under different financial incentive scenarios, NREL attempted to compare the impact of financial incentives on low-income households in both single-family owner-occupied and multifamily renter-occupied buildings in "Affordable and Accessible Solar for All: Barriers, Solutions, and On-Site Adoption Potential."[128] NREL found that first-year utility bill savings are notably higher for single-family homeowners, regardless of income class or incentive structure, compared to multifamily owners or renters. Single-family homeowners enjoy savings ranging from $525 to $870, attributed to their larger suitable roof spaces. Conversely, renters, both single-family and multifamily, see the lowest savings, ranging from $40 to $50 on average, except when incentives that cover the entire capital cost of solar installation are provided.

Incentives significantly boost savings for low-income households, with full incentives increasing the lower range of savings by $135 for low-income single-family owners, $460 for renters, and $315 for multifamily renters. Low-income multifamily renters experience savings from $45 (no incentive) to $360 (full incentive), while more significantly, low-income single-family owners see their savings range increase from $525–$725 (no incentive) to $660–$805 (full incentive).

Most of these tools are designed to provide *estimates* of solar energy systems' annual and monthly electricity production. They do not address actual savings on a household level or differentiate between short-term and long-term savings. Specifically, their primary goals are to assist developers, local government, and utilities in gauging and optimizing the size of solar energy systems, the capacity of storage, and the impact of financing models (i.e. rate switching, net metering, meter aggregation, etc.) to meet cost savings, resilience, and energy performance goals.

124 Emily Fekete et al., *Solar Power in Your Community* (DOE, 2023).

125 Amanda Farthing and Emma Elgqvist, *Techno-Economic Analysis Using REopt for Community Solar on Multifamily Affordable housing Properties* (NREL, 2022).

126 Id.

127 NREL, *National Community Solar Partnership Multifamily Affordable Housing Portfolio Screening Approach* (NREL, 2022).

128 Jenny Heeter et al., *Affordable and Accessible Solar for All: Barriers, Solutions, and On-Site Adoption Potential* (NREL, 2021).

4. Measuring the Savings from Solar Projects

A handful of published sources and interviews offer a quantitative measurement of savings for community and rooftop solar programs that have been implemented.

Community Solar and Multifamily Affordable Housing

Among the sources that offer a breakdown of savings for community solar programs, "Insights from the Colorado Energy Office (CEO) Low-Income Community Solar Demonstration Project"[129] and "Analysis of Solar Project Finance Research"[130] by the LIFT Solar Everywhere Research Program[131] provide the most direct insights on meaningful savings.

In partnership with non-profit GRID Alternatives, CEO[132] worked with eight utility partners[133] in Colorado to serve 19 of the 64 counties in the state with community solar. CEO identified several key factors that influenced subscriber savings: the utilities' bill credit structure, rate escalation, fixed charges, annual usage, and credit carryover. While each assessed community solar project is designed differently to optimize for the unique characteristics of its location, CEO observed a consistent positive outcome in savings: the projects collectively resulted in 380 low-income households receiving benefits that equate to, on average, a 15–50 percent reduction in their total utility bill cost, or $130 to $590 per year in savings.

Following a similar methodology framework, LIFT[134] modeled annual savings for 16 LMI households participating in community solar projects that delivered financial benefits through on-bill monetary credits. The observed savings ranged from $134 to $700 (with an average of $403) per household per year, which is about 8–9 percent of the bill credit value. LIFT concludes that the highest savings amounts are associated with (1) "good" value of state-level Renewable Energy Certificates and subsidies available, as well as (2) the availability of capital via low-cost federal loan financing.

Although discussions in the literature about savings from community solar are optimistic, an interviewee expresses equity concerns regarding the complexities of restricted rents in multi-family affordable housing and their impact on customers' meaningful savings from community solar subscriptions. While the financial benefits from net metering are reflected in the utility bills of LMI subscribers, she is particularly concerned about "making sure that we are not just giving people dollars, but then potentially putting them in a different income bracket or impacting their utility allowances or other benefits they might receive."

129 Hillary Dobos et al., *Insights from the Colorado Energy Office Low-Income Community Solar Demonstration Project* (Colorado Energy Office, 2017).

130 Elvis Moleka and Clarke Bacharach, *LIFT Solar Everywhere Research Report: Analysis of Solar Project Finance Research* (LIFT, 2022).

131 Southface, *LIFT Solar Webpage*, accessed July 2, 2024. LIFT Solar Everywhere Research Program is a three-year research project funded through the U.S. Department of Energy Solar Energy Technologies Office (SETO). Led by a partnership between Groundswell, Southface Institute, Elevate Energy, and Clean Energy Works, LIFT Solar is conducting research and developing program designs to accelerate solar deployment for low-income households and communities across the country.

132 Id.

133 The eight utility partners include Empire Electric Association, Delta-Montrose Electric Association, Fort Collins Utilities, Grand Valley Power, Holy Cross Energy, Poudre Valley Rural Electric Association, San Miguel Power Association, and Yampa Valley Electric Association.

134 Elvis Moleka and Clarke Bacharach, *LIFT Solar Everywhere Research Report: Analysis of Solar Project Finance Research* (LIFT, 2022).

Single-Family Homes Rooftop Solar

For solar projects on single-family homes, the following publications offer the most robust insights related to household savings: "Connecticut Green Bank (CGB) Low- and Moderate-Income Solar Program Saving Analysis,"[135] "Performance of solar leasing for low-and middle-income customers in Connecticut"[136] by LBNL, and "Modeling the Potential Effects of Rooftop Solar on Household Energy Burden in the United States"[137] by LBNL.

Connecticut Green Bank[138] assessed 252 residential rooftop projects that were part of a program developed by CGB and implemented in partnership with PosiGen. The program offered single-family homeowners a package that included a leased solar PV system and selected energy-efficient improvements. The study sought to determine the financial impact of LMI solar performance-based incentives (PBI) on households' savings. To calculate customer savings, "pre-solar annual electric load was compared to their system's solar production from January 1, 2019 – December 31, 2019, to determine how much of their electric load was offset by their solar production, and the total value of net metering credits the customer received in 2019," before subtracting the customer's solar lease or PPA cost.[139]

> *(Pre-solar annual electric load × Applicable utility rate) – [(Pre-Solar annual electric load – Measured solar PV production) × Applicable utility rate) + (Monthly lease price × 12)]*

LMI customers who only received the performance-based incentive realized an average savings of $349 for only customers in 2019 (18 percent of their annual utility bill on average), while LMI customers who participated in the lease and performance-based incentive program (Connecticut's Solar for All) saw average savings of $679 (34 percent of their annual utility bill).[140] Customers that combined solar and efficiency measures were estimated to have received average annual savings of $1290-$1340 per customer in 2019.[141] The same study highlighted the great variation in savings for customers, ranging from $46 to $1,585. The variation in savings depended largely on the utility rates applied in different parts of the program and the size of the displaced consumption.

The report "*Modeling the Potential Effects of Rooftop Solar on Household Energy Burden in the United States*"[142] explores household energy burden (total household energy costs/total household gross income) reduction when using an SFH ownership model while accounting for incentives, upfront costs, and financing options in the form of loans or leases. While the research paper is centered around energy burden rather than meaningful savings, it discusses meaningful benefits of single-family home solar beyond savings and offers a comparison of results across geographic regions. It finds that the average adopter of single-family home solar saw $691 in annual savings, after accounting for the costs of financing. Moreover, while the paper concludes

135 Connecticut Green Bank, *Low and Moderate Income Solar Program Savings Analysis* (CGB, 2020).

136 Jeff Deason et al., *Performance of solar leasing for low-and middle-income customers in Connecticut* (LBNL, 2021).

137 Sydney Forrester et al., *Modeling the potential effects of rooftop solar on household energy burden in the United States* (LBNL, 2024).

138 Connecticut Green Bank, *Low and Moderate Income Solar Program Savings Analysis* (VEIC, 2020).

139 Id.

140 Id.

141 Id.

142 Sydney Forrester et al., *Modeling the potential effects of rooftop solar on household energy burden in the United States* (LBNL, 2024).

that the reduction in energy burden was more significant for LMI adopters, it also highlights that high energy burdens persisted for about half of the low-income adopters, underscoring the need to pair solar with other supportive measures like weatherization and bill assistance when necessary.

Multifamily Affordable Housing's Rooftop and Ground-Mounted Community Solar

Even though many low-income residents live in either private unsubsidized market-rate or deed-restricted multifamily housing, there is little literature addressing empirical solar savings for multifamily affordable housing. Only a few examined documents[143] convey case studies and considerations for how differences in multifamily housing financing structure and type can i nfluence resident eligibility as well as resulting impacts on savings in both off-site (community solar) and on-site (rooftop) solar installation.

A case study[144] of the Housing Authority of the City and County of Denver's (DHA) deployment of two megawatts of ground-mounted community solar for their multifamily affordable housing residents presents meaningful discussion about measuring and delivering savings to multifamily affordable housing residents. For its multifamily affordable housing community solar project in Watkins, Colorado, DHA pooled funding from multiple partnerships and loans to satisfy the total capital investment of $3.8 million.

The Housing Authority of the City and County of Denver pays 90 percent of all residents' utility bills in their properties and signed power purchase agreements for individual properties. Because all the electricity consumed among housing units is aggregated and presented as a single total quantity on electricity meters, making it hard to pass direct savings to individual residents, a savings of approximately 15–20 percent on monthly electric utility bills is passed to the public housing agency.[145] Although this approach does not reduce residents' energy costs directly, the utility savings are re-invested and flowed to 700 households through indirect benefits, like enhanced services and improved facilities.

According to the case study, the success of DHA multifamily affordable housing community solar project can be attributed to (1) the nature of DHA's Low-Income Housing Tax Credit (LIHTC) properties that benefit from utility allowance structures that are favorable for passing solar benefits to building owners, (2) DHA's secured 20-year solar renewable energy credit agreement with partner and service provider Xcel Energy, which requires deployment of LMI community solar projects in its service territory, and thereby creates many potential revenue streams that support resident electric bill savings, and (3) DHA's dedicated energy management and finance staff who effectively facilitate the project from development through operation.

Another noteworthy case study spotlights the Ecumenical Association for Housing's (EAH) deployment of rooftop solar to its low-income residents of Elena Gardens Apartments[146] by leveraging

143 Better Buildings, *Issue Brief: Reducing Energy Burden for Low-Income Residents in Multifamily Housing with Solar Energy*, accessed July 18, 2024; EAH Housing, *Expanding Solar Benefits for Affordable Multifamily Housing*, accessed July 18, 2024.

144 Id.

145 Andrew Burger, *Denver Housing Authority Achieves Landmark Gains in Making Solar Power Affordable and Accessible* (Solar Magazine, 2018). Even though DHA has made distributing at least some of their utility savings as direct savings to public housing residents a strategic goal, its ability to implement this effectively is constrained.

146 EAH Housing, *Expanding Solar Benefits for Affordable Multifamily Housing*. Elena Gardens Apartments is a 168-unit affordable housing community of 2-story garden-style apartments in San Jose, California.

California's landmark Solar on Multifamily Affordable Housing (SOMAH) incentives. SOMAH ensures direct flow of financial benefits to low-income residents and provides fixed, up-front, and capacity-based incentives for qualifying solar energy systems. At least 51 percent of the energy produced must be allocated to residents, and residents must receive all of the economic benefit of the credits. SOMAH successfully petitioned HUD to allow residents to benefit from the SOMAH credits by determining that on-bill utility solar credits allocated to the residents through Virtual Net Metering (VNEM) are "an incidental benefit that can accrue directly to the resident, i.e. are not required to be reported as additional income. Thus, utility allowances would not be adjusted down in response to the additional solar credits."

In 2019, EAH partnered with Sunrun, a national solar project developer, to assess the feasibility, design, and permitting for the multifamily affordable housing rooftop solar project in Elena Gardens Apartments. The resulting solar panels yielded a cost savings per household per year of $464 in 2021, accounting for the total subsidy from SOMAH and the California discount on electricity rates for qualified low-income residents. The annual household savings value is expected to rise in future years as electricity prices increase faster than the rate of PV panel depreciation. Thus, the case study concludes that assuming a historical average 6 percent increase in electricity expenses, resident savings are estimated to be more than $2.8 million over the next 20 years.

An interviewee from Stewards of Affordable Housing for the Future (SAHF) highlighted significant variations in the level of multifamily affordable housing solar savings across states: "There is a SAHF member who's working in Virginia, piloting some community solar with a developer. Based on the system that's allowed to be installed and the costs associated with it, they're probably only going to be able to give about a 10 percent discount on someone's bill. That's different in California. SAHF is seeing this big variance around the country based on a lot of localized issues."

5. Educational and Marketing Best Practices

Some of the sources examined describe and champion educational and marketing practices that communicate meaningful savings and solar financing programs to LMI communities. The literature reports that effective LMI customer outreach requires engagement[147] with multiple partners to access customer information, estimate customer energy burdens, overcome LMI customer skepticism, execute audience-specific and localized messaging, seek collaboration with other LMI programs, and expand outreach. According to NREL,[148] the most trusted stakeholders include community groups in LMI communities, utilities, low-income weatherization or efficiency programs, housing authorities, and solar developers. "*Innovative Partnerships Bring Community Solar to Low-income Households in the US*"[149] by the World Resources Institute further highlights the power of partnerships in a case study from Kentucky, where strategic collaboration between utility "LG&E and KU" and nonprofit Kentucky Habitat for Humanity successfully gifted[150] 10 shares of community solar to LMI households. The benefited LMI households saw an average savings of $27.94 per month.

147 Jenny Heeter et al., *Design and Implementation of Community Solar Programs for Low- and Moderate-Income Customers* (NREL, 2018).

148 Id., pg. 30.

149 Joseph Womble, *Innovative Partnerships Bring Community Solar to Low-income Households in the US* (World Resources Institute, 2022).

150 The households received the benefits from the solar panels' production without taking on the monthly subscription cost.

The literature also reflects on customer messaging strategies about meaningful savings and determines that not only should outreach emphasize customer savings from the outset, but the utilized materials need to be culturally and linguistically appropriate and easily accessible. Notably, the Interstate Renewable Energy Council report *"Shared Renewable Energy for Low-to-Moderate-Income Consumers"*[151] underscores the importance of having full disclosure of consumer protection provisions, such as LMI subscription price and future recurring and non-recurring costs and benefits of the subscription (i.e., terms and conditions for early termination, cost escalations during the service, and how much advance notice is provided to the LMI customer).

Notable Gaps in the Current Literature

1. The Asymmetric Discussion of Risk Mitigation for Developers and Consumers

The literature gives considerable attention to LMI customer acquisition and retention as significant challenges for community solar project developers. It argues for the importance of efforts to reduce the costs of customer turnover and ongoing subscription management. Strategies for addressing customer turnover and non-repayment include prepaid subscriptions that require external funding to cover LMI subscribers' upfront payments to eliminate the possibility of customer default, multifamily affordable housing authorities' management of subscriptions to minimize the risk of customer turnover, shorter contracts to encourage LMI participation, and having a large anchor tenant to cover customer defaults.[152]

The literature gives less attention to how to protect and guarantee households' savings. The only examined publication that advocates for guaranteed savings is the report "*Community Solar: Expanding Access and Safeguarding Low-Income Families,"*[153] spearheaded by the National Consumer Law Center. It introduces a list of concrete requests to state administrators in terms of LMI consumer protections in the financial, marketing, compliance, eligibility and enrollment, and program coordination categories. The report targets reducing (or eliminating) barriers to entry and exit for LMI customers. The report also recommends prohibiting marketers from requiring down-payments for subscriptions and from charging termination or other fees/penalties to customers. Moreover, the report calls for state program administrators to establish regular accountability protocols to track and report data, such as the number and type of subscribers, estimated savings, waitlists, and complaints, and other metrics—to state program administrators.

None of the published resources presents a methodology for measuring or evaluating the level of risk acceptable to LMI households or the impacts of annual cost escalation clauses in contracts. The project's interviews reinforce the concern for customers' failure to experience expected savings due to rate escalators. "In the worst case, we will see people get pitiful net savings, like a couple of dollars a year, and then the rate escalators kick in and then they're paying more than what they would have paid without solar," a state program administrator in an interview said. "This is especially possible for non-LMI programs."

151 Erica Schroeder McConnell et al., *Shared Renewable Energy for Low-to Moderate-Income Consumers: Policy Guidelines And Model Provisions* (IREC, 2016).

152 Heeter, *Design and Implementation of Community Solar Programs for Low- and Moderate-Income Customers*.

153 Berneta Haynes, *Community Solar: Expanding Access and Safeguarding Low-Income Families* (National Consumer Law Center, 2024).

2. Lack of Discussion of Verification of Meaningful Savings

Little in the literature addresses the verification and accountability processes to ensure that meaningful savings are achieved by solar programs. While the National Consumer Law Center proposes the establishment of regular accountability protocols to track and report savings-related data,[154] no thorough discussion is dedicated to the logistics of such a monitoring system.

An interview with a state program administrator helps explain the lack of discussion of verification of meaningful savings: "We do an annual audit, but it is retroactive. That means that if someone is not getting savings, we're not finding that out until after the fact. I think to the extent that you can do real-time monitoring of this stuff, that's really important but also incredibly difficult to do and takes a lot of effort."

None of the literature or interviews discuss best practices regarding the sharing of benefits to determine what share of tax credits, government incentives, and utility incentives are flowing through to consumers rather than remaining with the solar company or financing institution.

3. Aspects of Savings from Single-Family Homes Need More Attention

Although the literature discusses various single-family home rooftop solar programs and how households can save money from them, there are other topics that deserve more attention. In addition to the areas mentioned above related to risk mitigation and verification, single-family home rooftop solar discussions should be strengthened on consumer protection, the sharing of benefits, and targeted single-family home marketing strategies.

For example, it is important to consider how early termination for consumers would affect savings from rooftop solar, what processes exist to measure savings from single-family home systems and how they differ from community solar, and how savings can be affected by system underperformance and maintenance.

4. Lack of Consistency in Defining Guarantees

Even though guaranteed savings has been identified in the literature[155] as highly desirable for incentivizing LMI communities to subscribe to solar programs and for protecting LMI consumers, the underlying implementation and enforcement strategies usually remain opaque. Few programs directly adopt the term "guaranteed savings" or "contracted savings" in their program designs, but many communicate the concept by having a required minimum threshold of net savings.

As discussed above in the section on "Guaranteeing Savings," there are some programs and projects that have target savings requirements, but it is usually difficult to find explicit information in the literature on how those savings requirements are ensured and enforced.

154 Id.

155 DOE, *Community Solar Best Practices Guide: Developing Projects with Meaningful Benefits*, accessed August 14, 2024.

List of Reviewed Sources

The following is a list of hyperlinked resources that were reviewed under this project.

1 2023 Connecticut Green Bank Annual Report: Case 12—Low Income Solar Lease and Energy Efficiency Energy Savings

2 A Financial Benefit-Cost Analysis of Different Community Solar Approaches in the Northeastern US

3 Affordable and Accessible Solar for All: Barriers, Solutions, and On-Site Adoption Potential

4 All in the Community: Using Community Solar Gardens to Bring the Benefits of Renewable Energy to Low-Income Communities

5 All Utility Allowance Innovations Are Local: A Look at Tulare County's Solar UA

6 An Assessment of Evaluation Practices of Low-and Moderate-Income Solar Programs

7 Analysis of Solar Project Finance Research

8 Bringing the Benefits of Solar Energy to Low-Income Consumers: A Guide for States & Municipalities

9 Community Benefit Playbook: A Guide to Capturing Federal Infrastructure Investments 2022

10 Community Power Project: Sunny Awards Winner

11 Community Solar and HUD Subsidized Housing: An Overview of Current Policies, Programs and Practices and the Impact to Tenant Utility Allowances and Income

12 Community Solar and LIHEAP Considerations

13 Community Solar Barriers, Project Models, and Considerations for Multifamily Affordable Housing

14 Community Solar Best Practices Guide: Developing Projects with Meaningful Benefits

15 Community Solar for Low- and Moderate-Income Communities

16 Community Solar in Illinois

17 Community Solar Opportunities for Low to Moderate Income Households in the Southeast

18 Community Solar Policy Decision Matrix

19 Community Solar Tracker - Institute for Local Self-Reliance

20 Community Solar: Expanding Access and Safeguarding Low-Income Families

21 Community-Owned Community Solar: Opportunities and Challenges

22 Connect the Dots on Community Solar

23 Connecticut Green Bank Low and Moderate Income Solar Program Savings Analysis

24 Customer Experience for Low- and Moderate-Income Community Solar Subscribers

25 DC Solar For All Implementation Plan

26 Design and Implementation of Community Solar Programs for Low and Moderate Income Customers

27 Design Choices and Equity Implications of Community Shared Solar

28 EAH Housing: Expanding Solar Benefits For Affordable Multifamily Housing

29 Energy Democracy Scorecard

30 Equitable Access to Community Solar: Program Design and Subscription Considerations

31 Equitable Community Solar: Policy and Program Guidance for Community Solar Programs that Promote Racial and Economic Equity

32 Expanding Solar Access: Pathways for Multifamily Housing

33 Federal Partnerships/Best Practices Sharing

34 Fiscal Year 2022 Solar for All Program and Renewable Portfolio

35 Guideline on SMART Consumer Protection

36 Guideline Regarding Low Income Generation Units

37 Hawaii: Green Energy Money $aver (GEM$) On-Bill Program

38 How Community Solar Can Benefit Low- and Moderate-Income Customers

39 How Local Governments Can Advance Community Solar for Low- and Moderate-Income Households

40 How much money do solar panels save in 2024?

41 Illinois Solar For All Approved Vendor Manual

42 vIllinois Solar For All Deep Dive for Community Solar Disclosure Form

43 Illinois Solar For All Deep Dive for Residential Solar Disclosure Form

44 Innovative Partnerships Bring Community Solar to Low-income Households in the US

45 Insights from the Colorado Energy Office Low-Income Community Solar Demonstration Project

46 Issue Brief: Reducing Energy Burden for Low-income

47 Issue Brief: Reducing Energy Burden for Low-income Residents in Multifamily Housing with Solar Energy

48 JOE-4-SUN Ashland Project: Sunny Awards Winner

49 Lift Solar Everywhere: Project Finance for Accelerating LMI Solar Access

50 Illinois Solar For All Protecting Participants

51 Locally Charged: Energy Justice Outcomes of a Low-income Community Solar Project in Michigan

52 Low- and Moderate-Income Solar Policy Basics

53 Low-Income Community Solar Policy Guidelines and Sample Bill Language

54 Low-Income Community Solar: Utility Return Considerations for Electric Cooperatives

55 Low-Income Solar Policy Guide

56 Maryland Energy Administration Funding Opportunity Announcement: FY24 Community Solar LMI-PPA Grant Program

57 Minnesota's Solar Gardens: The Status and Benefits of Community Solar

58 Modeling the Cost of LMI Community Solar Participation: Preliminary Results

59 Modeling the Cost of LMI Community Solar Participation: Preliminary Results

60 Modeling the Potential Effects of Rooftop Solar on Household Energy Burden in the United States

61 National Community Solar Partnership Multifamily Affordable Housing Portfolio Screening Approach

62 National Housing Trust Stabilizes Utility Costs by Installing Solar Systems

63 NY-Sun Upstate + Long Island Program Manual

64 Optimizing Equity in Energy Policy Interventions: A Quantitative Decision-Support Framework for Energy Justice

65 Performance of Solar Leasing for Low-and Moderate-Income Customers in Connecticut

66 Philadelphia Energy Authority Board Update Q3 FY24

67 PosiGen's Convening 2 Presentation (no link)

68 Residents in Multifamily Housing with Solar Energy

69 Rooftop Solar Technical Potential for Low-to-Moderate Income Households in the United States

70 SEIA Consumer Guide to Solar

71 SEIA Smart Solar Guide

72 Shared Renewable Energy for Low- to Moderate-Income Consumers: Policy Guidelines and Model Provisions

73 Sharing the Sun Market Report Details Expansive Growth, Recent Trends in Community Solar

74 Solar Benefits for Owners and Tenants of Affordable Housing

75 Solar for All Program Community Solar Subscription Agreement Terms and Conditions

76 Solar for Manufactured Homes: Volume 3

77 Solar Pathways in Federal Energy Assistance Programs: Expanding the Low-Income Home Energy Assistance Program (LIHEAP) and the Weatherization Assistance Program (WAP)

78 Solar Power in Your Community Guidebook

79 Solar Powering Your Community: A Guide for Local Governments

80 SOMAH Handbook Update Summary of February 2024

81 Standard Expansion Amendment Act of 2016 Annual Report

82 State of New York Public Service Commission: Order Expanding NY-SUN Program

83 State Policies to Increase Low-Income Communities' Access to Solar Power

84 Summary of State Approaches to Low-income Community Solar, by Program, Carveout, Incentive

85 Techno-Economic Analysis Using REopt for Community Solar on Multifamily Affordable Housing Properties

86 The Growth of U.S. Community Solar Serving Low- and Moderate-Income Households

87 The Municipal Utility Community Solar Workbook

88 The People's Justice40+ Community Benefit Playbook

89 Treatment of Community Solar Credits on Tenant Utility Bills

90 Treatment of Financial Benefits to HUD-Assisted Tenants Resulting from Participation in Solar Programs

91 Twelve Community-Solar Pricing Strategies from Utilities in the U.S.

92 U.S. Department of the Treasury, IRS Release Final Rules and Guidance on Investing in America Program to Spur Clean Energy Investments in Underserved Communities

93 Unlocking Solar for Low- and Moderate-Income Residents: A Matrix of Financing Options by Resident, Provider, and Housing Type

List of Organizations Interviewed in Alphabetical Order

CESA would like to thank the following organizations for their participation in the individual interviews or group discussions that informed the production of this report:

- Allume Energy
- Arcadia
- California Public Utility Commission
- Center for Sustainable Energy
- CollectiveSun
- Con Edison
- Cooperative Energy Futures
- Drifpoint Renewables
- EnerWealth Solutions
- GoodLeap
- Greenlink Analytics
- GRID Alternatives
- Groundswell
- Hawaii Green Infrastructure Authority
- Inclusive Prosperity Capital
- Massachusetts Executive Office of Energy and Environmental Affairs
- National Renewable Energy Laboratory
- Nevada Clean Energy Fund
- New Jersey Board of Public Utilities
- North Carolina Clean Energy Technologies Center
- Partnership for Southern Equity
- PosiGen
- SolarOne
- Stewards of Affordable Housing for the Future
- Sunrun
- Sunwealth
- U.S. Department of Energy Solar Energy Technologies Office
- University of Minnesota Chan Lab
- Vote Solar

The Clean Energy States Alliance (CESA) is a national, nonprofit coalition of public agencies and organizations working together to advance clean energy. CESA members—mostly state agencies—include many of the most innovative, successful, and influential public funders of clean energy initiatives in the country.

CESA works with state leaders, federal agencies, and other stakeholders to develop and promote clean energy programs and markets, with an emphasis on renewable energy, energy equity, financing strategies, and economic development. CESA facilitates information sharing, provides technical assistance, coordinates multi-state collaborative projects, and communicates the views and achievements of its members.

Ørsted US Offshore Wind/Block Island Wind Farm

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