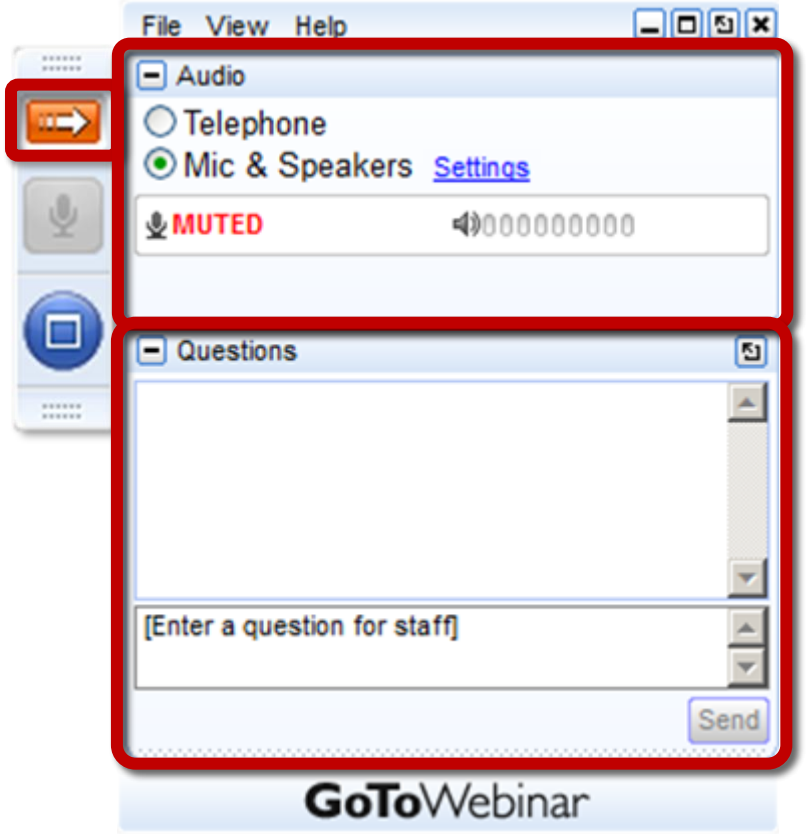
# How Low- and Moderate-Income Solar Programs are Evaluated: Trends and Best Practices

May 20, 2021

# Webinar Logistics




Join audio:

- Choose Mic & Speakers to use VoIP
- Choose Telephone and dial using the information provided

Use the orange arrow to open and close your control panel

Submit questions and comments via the Questions panel

This webinar is being recorded. We will email you a webinar recording within 48 hours. This webinar will be posted on CESA's website at www.cesa.org/webinars

CleanEnergy States Alliance

# Clean Energy States Alliance













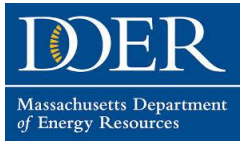





















www.cesa.org

# Scaling Up Solar for Under-Resourced Communities

CESA is leading a wide-ranging initiative to accelerate the development of solar projects that benefit low-and-moderate-income (LMI) households and communities.

The project focuses on three distinct subsets of the LMI solar market:

- Single-family homes
- Manufactured homes
- Multifamily affordable housing

The project is made possible through a funding award from the US Department of Energy Solar Energy Technologies Office.

www.cesa.org/projects/scaling-up-solar-for-under-resourced-communities/

CleanEnergy States Alliance

SOLAR ENERGY TECHNOLOGIES OFFICE
U.S. Department Of Energy

# Webinar Speakers

**Ben Paulos**
Lawrence Berkeley National Laboratory

**Eric O'Shaughnessy**
Lawrence Berkeley National Laboratory

**Sydney Forrester**
Lawrence Berkeley National Laboratory

**Nate Hausman**
Clean Energy States Alliance (moderator)

BERKELEY LAB
Bringing Science Solutions to the World

CleanEnergy States Alliance

# An Assessment of Evaluation Practices of Low- And Moderate-Income Solar Programs

Bentham Paulos, Sydney Forrester, Eric O'Shaughnessy, Christopher Dyson (DNV GL), Galen Barbose, and Ryan Wiser

May 2021

# Goals and Methods of Meta-Evaluation

## Goals

- How are LMI solar programs being evaluated? Are program designs and evaluations aligned with program goals? Are program administrators collecting and analyzing the right data?
- What makes for a "good" evaluation? What are the barriers preventing good evaluation? How can evaluations be improved?

## Methods

- Evaluate evaluations: Collected, read, and synthesized the literature of internal and external evaluation reports, including 32 documents
- Interviewed 10 program administrators and evaluators
- Data-driven strategies: Tested to see if it is possible to use publicly available data as a low-cost way to find program impacts and adoption levels

**Not:** How are LMI solar programs doing?
It's hard to compare between non-standard evaluations.

# Landscape of LMI Solar Programs

About Evaluations

Evaluation Case Studies

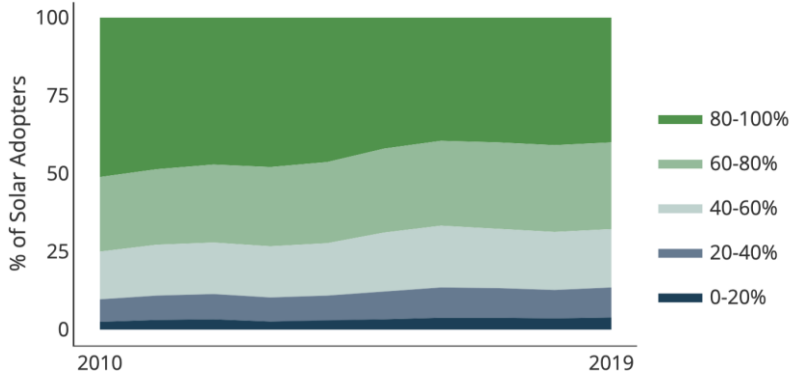
Data-driven Strategies for Evaluation

Findings and Recommendations

# Solar Power and Energy Burdens

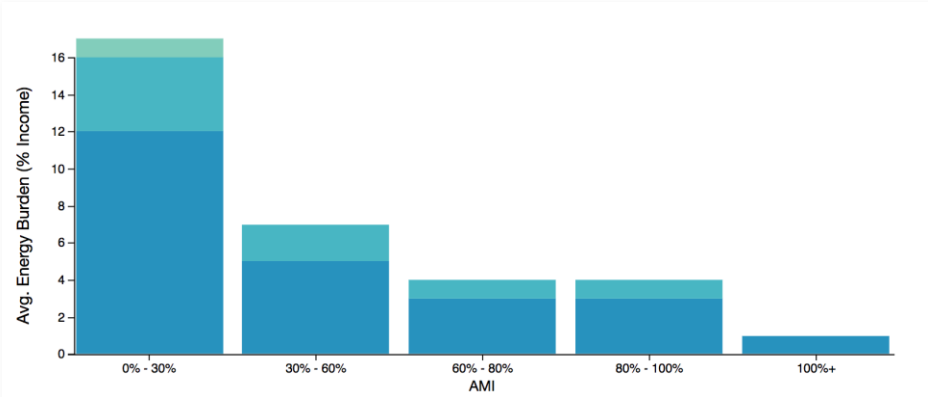
- Lowest income households spend 12% of income just for electricity, 4x the US average. Burdens are highest in the Southeast, in New England, and in rural areas; for elderly households; and for people of color. Energy assistance programs are expensive, with federal programs costing $54 billion over the past decade, plus more spent on state programs.
- Solar is becoming a middle class home improvement, but uptake by LMI customers is modest.

**National Solar Adopter Income Distributions**
(State Income Percentiles)




Source: LBL, SolarDemographics.lbl.gov

**Avg. Energy Burden (% of income) by Income Level**



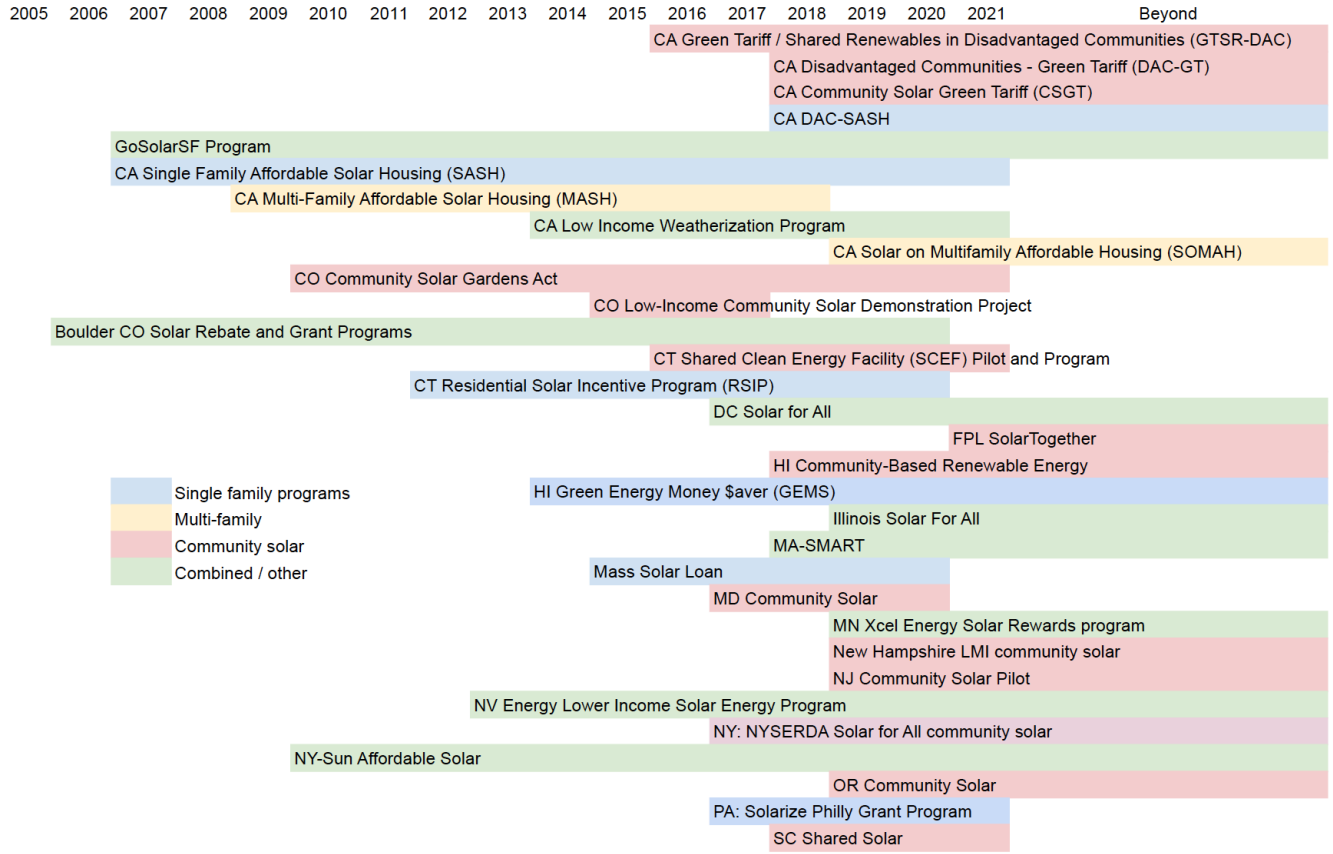

Source: LEAD Tool

# LMI Solar Programs

- Cheap solar can cut energy burdens, reduce pollution, create jobs, and more.
- Many policymakers thinks solar policies were missing LMI households and communities.
- We count over 40 LMI solar programs in the US. The largest have been for on-site solar, but community solar will likely be bigger with big programs in HI and NJ.

| | CA | CO | CT | DC | FL | HI | IL | MA | MD | MN | NH | NJ | NV | NY | OR | PA | RI | SC | VA | WA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TARGET SECTORS** | | | | | | | | | | | | | | | | | | | | |
| Single family | | | | | | | | | | | | | | | | | | | | |
| Multi-family | | | | | | | | | | | | | | | | | | | | |
| Community solar | | | | | | | | | | | | | | | | | | | | |
| NGO/public | | | | | | | | | | | | | | | | | | | | |
| Disadvantaged communities | | | | | | | | | | | | | | | | | | | | |
| **PROGRAM ELEMENTS** | | | | | | | | | | | | | | | | | | | | |
| Finance | | | | | | | | | | | | | | | | | | | | |
| Incentives | | | | | | | | | | | | | | | | | | | | |
| Mandatory set-aside | | | | | | | | | | | | | | | | | | | | |
| **Number of active programs** | 9 | 2 | 3 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 2 | 1 | 1 |

# 15 Years of Programs, But Most Are Recent



# The Size of LMI Solar Programs

- Over $1 billion spent in California to date on on-site programs
- Still only reaching small part of market:
  - California SASH has served 9200 households out of 5.7 million eligible
  - Nationally 200,000 LMI solar homes, out of 1.3 million in LBL sample, and 50 million eligible

| California Customer-Sited LMI Solar Programs | | |
|---|---|---|
| | Cum. Budget $M | MW goals |
| SASH | $162 | 110 |
| MASH | $162 | 130 |
| SOMAH | $600* | 300 |
| DAC-SASH | $120 | 40 |
| **TOTALS** | **$1.044 billion** | **570 MW** |

*The SOMAH annual budget is “up to” $100m, and is currently authorized through 2026, but the program runs through 2030.

# Examples of On-site Solar Programs

**Single family**

## California Single Family Affordable Solar Housing (SASH)

- The largest and longest running program
- Budget of $162m, 9400 installations to date
- Delivered as $ per Watt incentive, and “families first” TPO
- New spinoff program focuses on disadvantaged communities (DAC-SASH) with $120m budget over 10 years

## NY-Sun Affordable Solar On-Site Residential Incentive

- Part of larger NY-Sun program, providing extra incentive to eligible households
- Has spent $15m to install 14.5 MW of solar on 825 households to date

**Multi-family**

## California Solar on Multifamily Affordable Housing (SOMAH)

- Budget potentially over $1 billion over 10 years
- Target to install 300 megawatts by 2030
- Provides technical assistance and a rebate for building owners
- Value delivered to tenants via bill credits

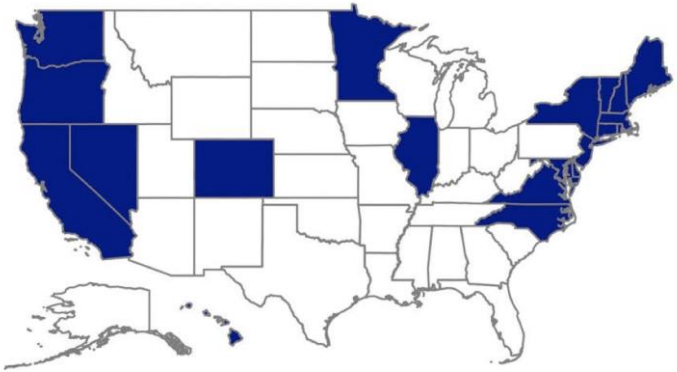
## DC Solar For All

- In “Innovation and Expansion” phase, testing many approaches to solar, such as rooftop community solar with cash benefits delivered to LMI customers

BERKELEY LAB

# Examples of Off-site or “Community” Solar

- Rapidly growing model of development
  - Value delivered to bill via ”virtual net metering”
- Benefits over on-site:
  - Lower cost of energy, easier to scale
  - Can reach tenants in multi-family housing
- Drawbacks:
  - LMI customers usually don’t get value of ownership
- Examples
  - **New Jersey Community Solar Pilot**: 2019 solicitation awarded 45 projects with 75 MW of capacity. All will serve at least 51% LMI subscribers.
  - **Illinois Solar For All**: LMI subscribers have no upfront costs and any subscription costs will be less than 50% of the value of the subscription.



States with community solar enabling legislation (NREL)

Landscape of LMI Solar Programs

# About Evaluations

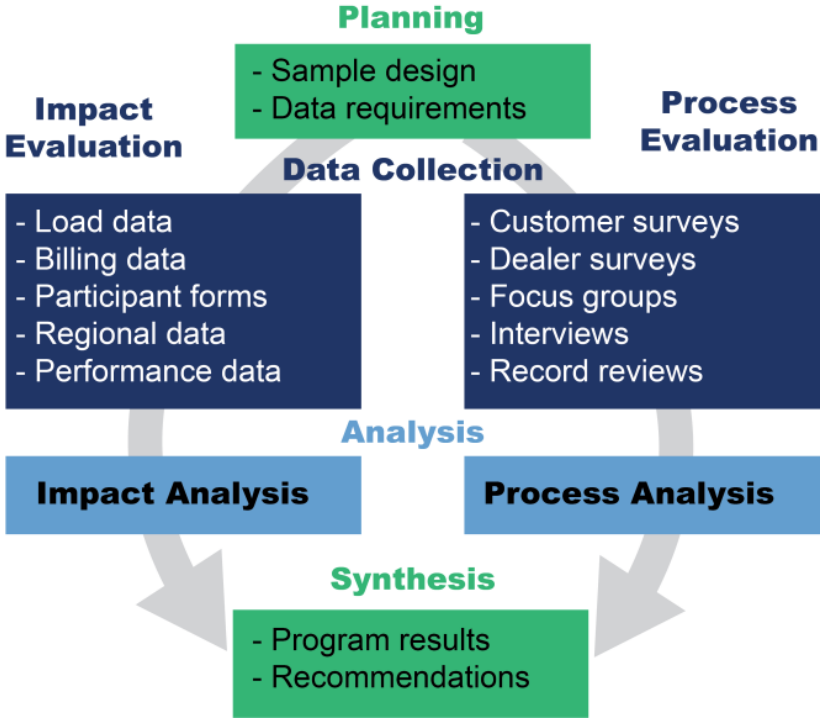
Evaluation Case Studies

Data-driven Strategies for Evaluation

Findings and Recommendations

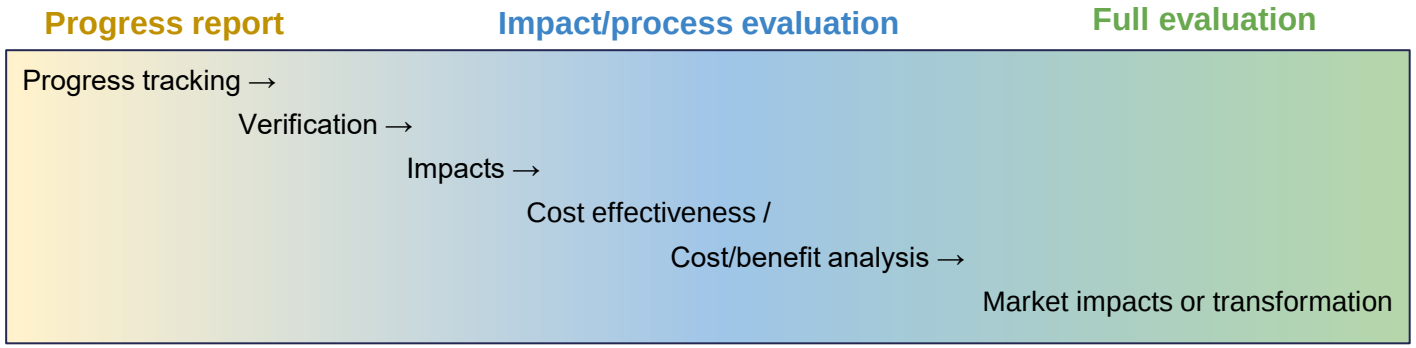
# EM&V Theory

- Evaluation, measurement & verification (EM&V) has been highly refined after decades of use in reviewing energy efficiency programs. It has clear rules, resting on a vast research literature, many practitioners, and a history of best practices.
- Impact and Process evaluations
- It can follow strict standards for planning, data collection, analysis, and synthesis.
- Standardization means uniform results ("cost of saved energy") can be used to make comparisons and "investment grade" analysis is used to validate cost recovery



# EM&V Practice

- But there is a wide range of program evaluation actually practiced, from simple progress tracking to looking at full market impacts
- Evaluations can be done internally by the program, or by external evaluators.
- The level of rigor is often determined by the program and evaluation budget, future program plans, and requirements by regulators or statute.

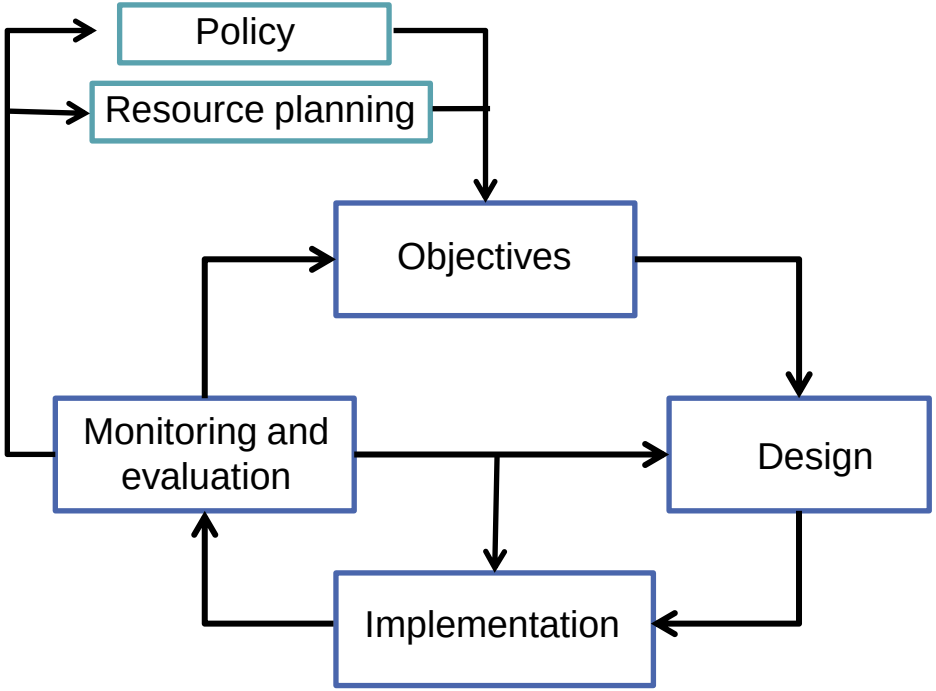


# Goals → Metrics → Evaluations

| Goal | Metrics | Evaluation |
|---|---|---|
| “Solar for all” | ○ Incentives and installations for eligible households ($, #, kW) | ○ Distribution of incentives and installations |
| Cost effectively reduce poverty | ○ Utility bills, household income<br>○ Cost of solar installation, energy production, impact on utility bills<br>○ Impact on home value | ○ Change in energy burden<br>○ Change in customer spending or savings<br>○ Cost of program administration<br>○ Comparison with other strategies |

# Continuous Improvement

- Evaluation is not just a report card at the completion of a task, but continuous improvement as it is implemented.
- Feedback into planning, design, and implementation.
- Build in evaluation from the inception, just as objectives, design, and implementation are.



# Key Evaluation Questions

**Benefits to whom?**

- Cost-benefit measurements can be done from many perspectives: the participant, all utility customers, the program administrator, or society as a whole.

**Cost Effective?**

- Low-income energy programs of any kind are usually not cost effective.

**Non-energy impacts**

- Many LMI solar programs have non-energy goals, like boosting household wealth or cutting energy assistance program cost.

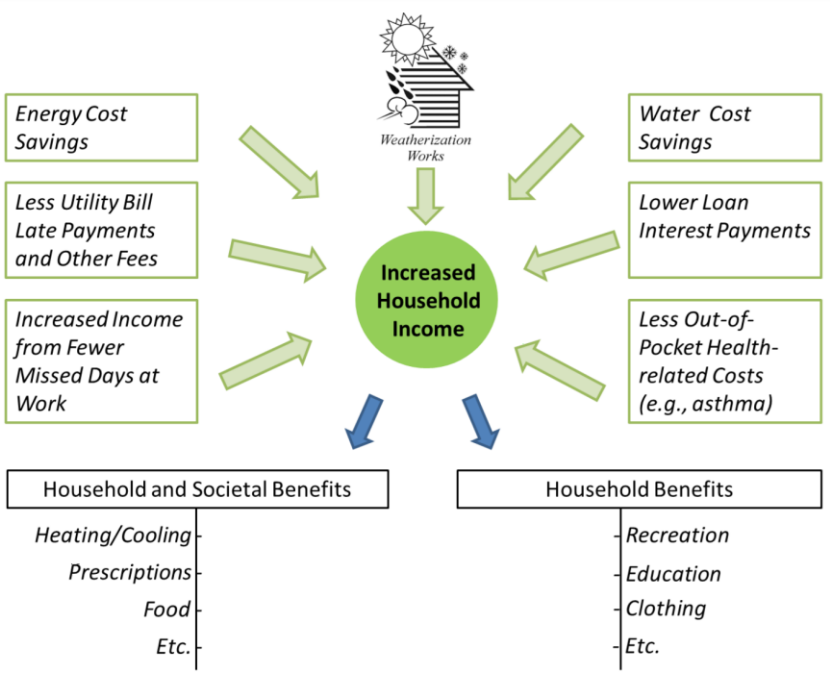



**Figure 2.4. Schematic of Household Non-Energy Income and Expenditure Benefits**

Landscape of LMI Solar Programs

About Evaluations

# Evaluation Case Studies

Data-driven Strategies for Evaluation

Findings and Recommendations

# Highlights

**Full Evaluation**: California SASH and MASH

- Repeated multi-volume evaluations of the longest running (13 years) and biggest budget ($324m) LMI solar programs to-date, these represent the “gold standard” among program evaluations. They include all “best practices” including market impacts, quality assurance, and non-energy benefits.

**Demographic Analysis**: Connecticut Green Bank

- Green Bank offers incentives and leasing products to LMI households. They have developed very low-cost internal evaluation that combines program data with publicly available Census data to shed light on participant demographics and non-energy benefits.

**Data Collection**: Hawaii Green Energy Money $aver (GEM$)

- On-bill financing for LMI household for residential solar. To meet state financing rules, the agency collects extensive data on household income, credit score, and other factors. They then calculate energy savings, fuel savings, job creation, and state tax revenues resulting from solar installations.

# More Highlights

## **Planning for Evaluation**: Illinois Solar For All

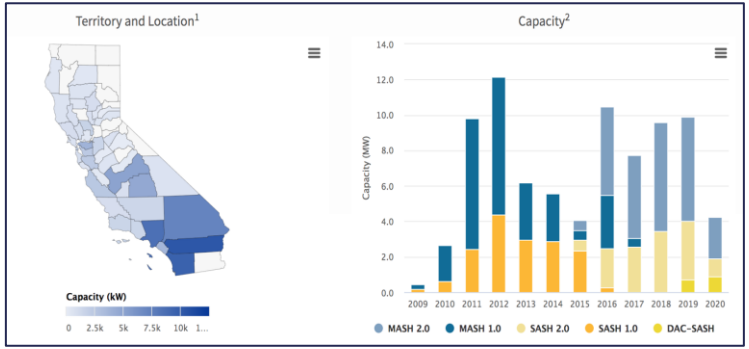
- Evaluations were scheduled and funded by the law, and are used to modify program design. The first evaluation looked at the program startup, while the second was done after only five months of operation, before any projects had been built.

## **Exit Strategy**: Mass Solar Loan

- As the loan program winds down, they are sharing detailed loan performance data with banks, as a way to entice state banks into the LMI solar marketplace and create a lasting impact.

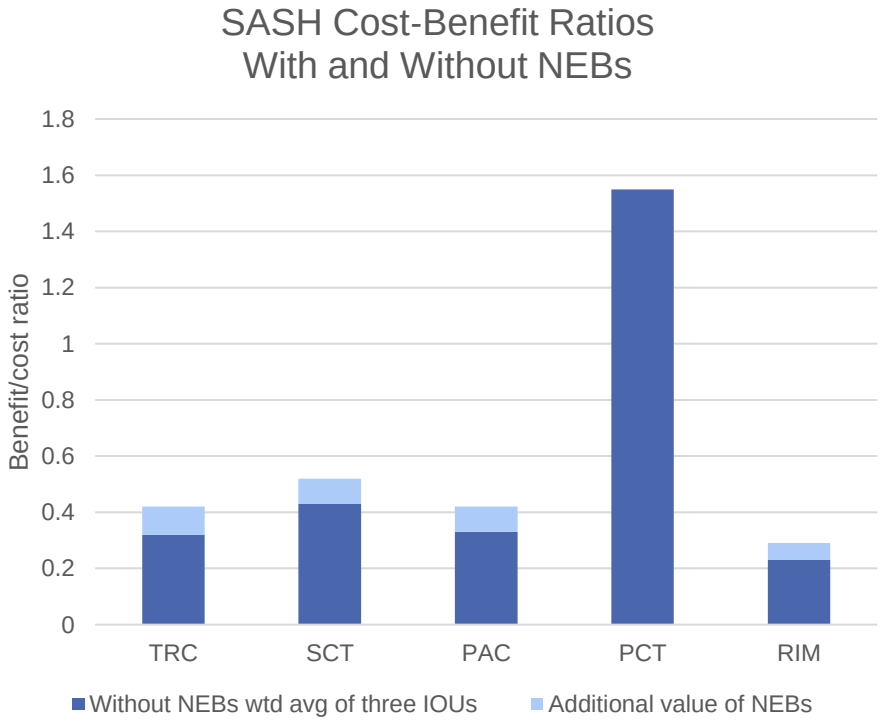
## Transparency in Progress Tracking

- At least three LMI solar programs track and report progress metrics in real time. These provide data for continuous improvement, keep stakeholders informed, and help vendors plan.



# Example of Cost Tests and NEBs

- The 2015 evaluation of the California SASH program looked at benefit/cost ratios from five different perspectives, and included non-energy benefits (NEBs)
- A ratio better than 1.0 means the program has more benefits than costs.
- The evaluation found that benefits to participants were high, while from other perspectives it was not cost effective.
- Including NEBs raised the scores by about 25%. The largest NEB was savings to utilities from avoided bill payment subsidies for low-income households and fewer arrearages.




Source: Navigant, 2015

Landscape of LMI Solar Programs

About Evaluations

Evaluation Case Studies

# Data-Driven Strategies for Evaluation

Findings and Recommendations

# Leveraging Available Data for LMI Solar Program Evaluation

## Household-Level Approach

Household-level data (observed or modeled) allow program evaluators to make precise estimates of program impacts.

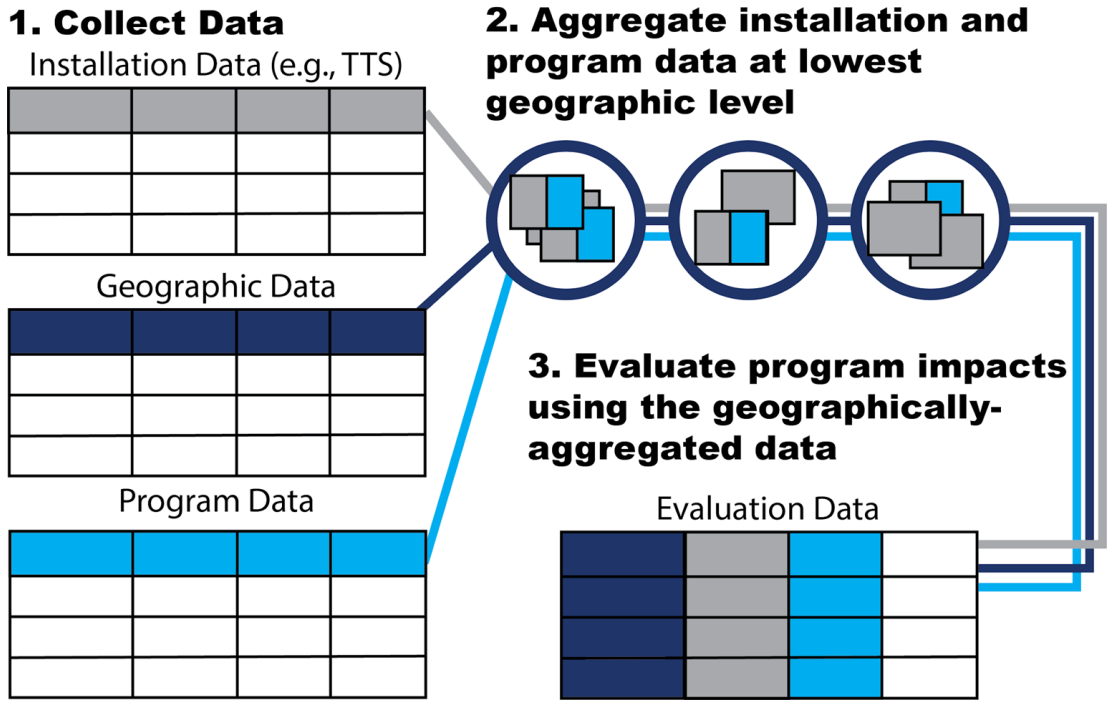
- \+ Larger sample sizes and more granular data increase statistical power and precision.
- \- Household-level data may be difficult or expensive to obtain.

## Location-Based Approach

Geographically-aggregated data (e.g., Census tracts, zip codes) can still be effective for program evaluation given that household demographic characteristics tend to spatially correlate.

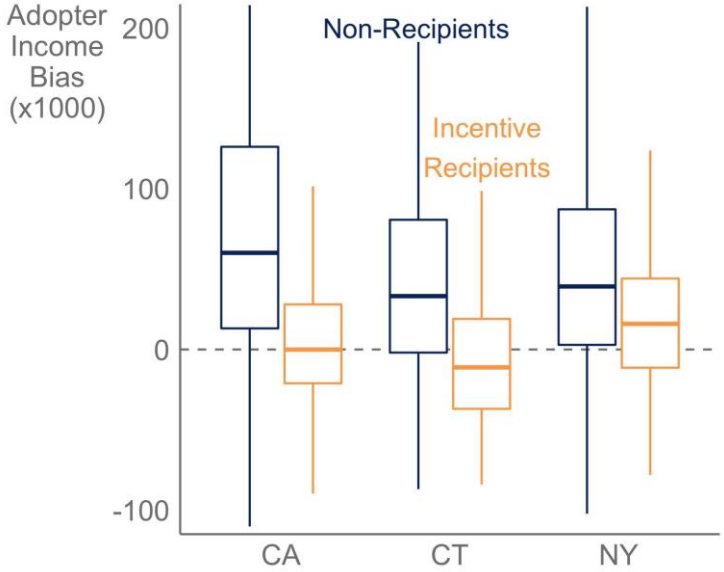
- \+ Location-based approaches may be implemented with easily accessible data.
- \- Less statistical power and precision.

# Leveraging Available Data



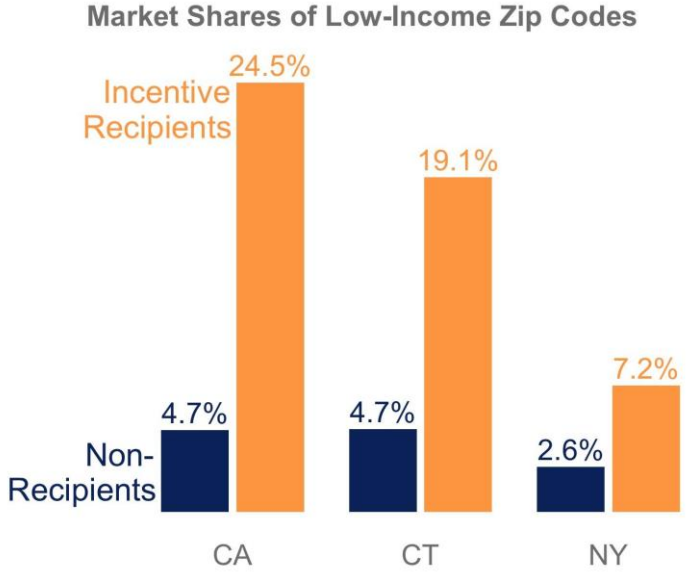
# Examples: Descriptive Analyses

## Household-Level Approach




Adopter income bias (income – county median income) distributions for incentive recipients and non-recipients

## Location-Based Approach




Market shares (% of installed systems) of zip codes in bottom quartiles of zip code median incomes for LMI incentive recipients and non-recipients.

# Identification Strategies

- Descriptive analyses can provide valuable insights into program effects.
- However, descriptive results can be biased by confounding factors, such as free riding and spillovers.
- Several econometric methods allow evaluators to “identify” program impacts while accounting for these confounding factors.
- The most common identification strategies are differences-in-differences, regression discontinuity design, and instrumental variables.*
- See O’Shaughnessy et al. (2020) for an example application of a differences-in-differences strategy to evaluate LMI incentive program impacts on LMI adoption rates.**

• For a recent review of program evaluation identification methods, see Abadie and Cattaneo. 2018. “Econometric Methods for Program Evaluation.” *Annual Review of Economics* 10:465-503.

** O’Shaughnessy et al. 2020. “The impact of policies and business models on income equity in rooftop solar adoption.” *Nature Energy*.

# Discussion: Comparing Approaches

## Household Level

+ Offers precise estimates of program impacts on PV adoption behavior.
+ Through larger sample sizes, facilitates statistically robust methods and estimates.
- The primary limitation is cost: observed data would be costly to collect, while modeled data may be costly to purchase.
- All modeled data introduce additional uncertainty to the results.

## Location Based

+ Yields useful results based entirely on readily accessible data.
+ Particularly useful for programs with limited evaluation budgets or limited access to more granular data.
- By assessing program impacts on adoption rates across geographies (rather than households), the approach can only yield a first-order approximation of a program's impact.

Landscape of LMI Solar Programs

About Evaluations

Evaluation Case Studies

Data-driven Strategies for Evaluation

# Findings and Recommendations

# Five Key Findings

## 1. Most LMI solar programs do not have publicly-available evaluations

Of the 46 LMI solar programs identified, only about one-third have created publicly-available evaluation documents. This could be due to the nascent stage or small size of some programs, budget constraints, or program administrators not separating out LMI-specific from larger solar programs.

## 2. Many progress reports, but few true program evaluations

Most programs conduct periodic progress reports summarizing basic metrics, but only 4 have done in-depth program evaluations. The scarcity of in-depth program evaluations likely reflects program design and budget constraints.

## 3. Evaluations use a variety of metrics

Of the 16 programs with published evaluations, number of installations was the most common metric (16/16). Other common metrics were expenditures (13/16), bill reduction (9/16), energy output (9/16), and jobs created (8/16).

# Key Findings…

## 4. Few build data collection and evaluation into program design

Most LMI solar programs were designed without specific up-front plans for data collection or in-depth program evaluations. In contrast, a few programs were designed with very specific goals, and had specific up-front plans for periodic program evaluations, data collection, and data publication.

## 5. Programs can extend evaluation capabilities by using publicly-available data

Budget-constrained programs can extend their evaluation capabilities by coupling program data with publicly-available demographic and solar market data, such as Census Bureau and *Tracking the Sun*.

# Six Recommended Best Practices

1) **Continuous evaluation**

Using ongoing evaluation to guide improvement during operations. This requires planning ahead to collect and analyze data continuously. Especially important for new programs.

2) **Apply best practices from other fields**

Energy efficiency programs are good models for program evaluation. (They can also be used for operations, like targeting and income verification.)

3) **Match multi-dimensional data with outside sources**

Collecting a broad set of program and participant data creates opportunities to look for correlations, which can provide greater insight into why a program is succeeding or failing. Mix it with publicly available data.

# Six Recommended Best Practices…

## 4) **Standardize LMI solar program evaluation**

Standard evaluation practices can be designed to work with smaller LMI solar programs, lowering evaluation costs and enabling comparisons.

## 5) **Integrate non-energy benefits**

LMI solar programs can generate non-energy benefits such as improved wealth, health, and safety. Including these in evaluations is important to getting a full view of impacts and accurately tracking costs and benefits.

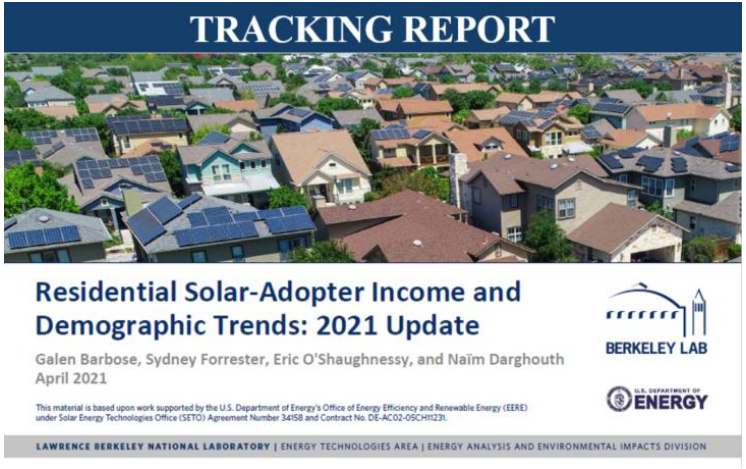
## 6) **Do process evaluations**

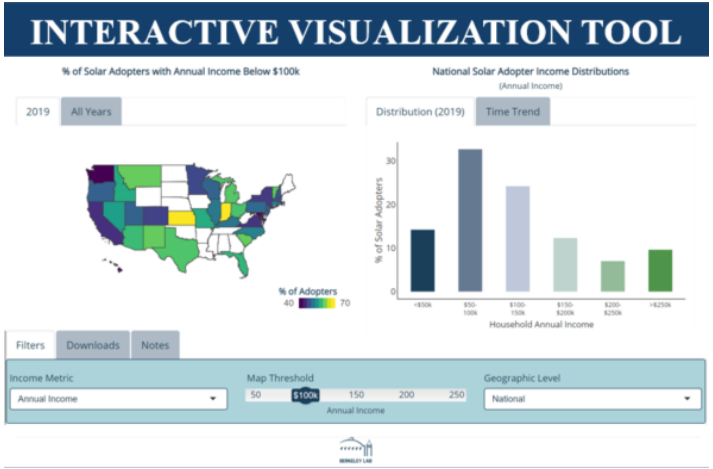
**Impact** evaluations are often viewed as the bottom-line metric, but given the many variables of solar adoption, **process** evaluations can be better at explaining why customers respond or don't respond to programs, and **why** a program succeeds or fails.

# SolarDemographics.LBL.gov

Research on Solar Demographics Trends and Analysis

- Reports
- Webinars
- Data visualization tools



# Thank you for attending our webinar

**Nate Hausman**
Project Director, CESA
nate@cleanegroup.org

Learn more about the Clean Energy States Alliance at www.cesa.org

Connect with us on Facebook: www.facebook.com/cleanenergystates

Follow us on Twitter: @CESA_News

# Upcoming Webinar

**Evaluating the Financial Performance of Connecticut's Low- and Moderate-Income Solar Lease Program**

*Wednesday, May 26, 1-2pm ET*

Read more and register at: www.cesa.org/webinars