Process and Load Impact Evaluation of the Single-Family Affordable Solar Housing Program (SASH)

Final Report

Submitted by Evergreen Economics

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1 Executive Summary

1.1 Introduction

In 2006, in response to Assembly Bill (AB) 2723, the Single-Family Affordable Solar Housing (SASH) program began offering incentives to low-income households (80% of area median income) located within a housing tract defined by the Department of Housing and Urban Development (HUD), designated as affordable housing, or located on tribal lands. The SASH program was intended to decrease electricity usage and reduce energy bills by offering incentives to offset the expense of solar ownership for low-income and single-family homeowners while also referring customers to the investor-owned utilities' (IOUs) Energy Savings Assistance program. Additionally, the program intended to develop the solar workforce while providing hands-on installation experience.

In 2015, California Public Utilities Commission (CPUC) Decision 15-01-027 reauthorized a second iteration of the SASH program (SASH 2.0). The Decision increased the incentive budget to serve more households and decreased the incentive level from the first iteration of SASH (SASH 1.0) in order to maximize the overall benefit to ratepayers.[1] The Decision also required additional energy efficiency education for participants, including Energy Savings Assistance (ESA) program referrals, energy efficiency walkthroughs, and a job training component.

The Program Administrator (PA), GRID Alternatives, administered both programs (SASH 1.0 and SASH 2.0) under the name "Energy for All Program." At the time of this research, March 2022, GRID had completed 9,501 SASH projects for a total of 30,003 kW (CEC-AC[2]), thus making solar accessible to low-income households as intended. An impact analysis of projects resulted in an average realization rate of 105 percent, indicating that the program's expected generation estimates are accurate.

In Decision 15-01-027 that reauthorized the SASH program, the CPUC also required a "close of program" evaluation. This report serves as independent measurement to verify the program's impacts and document the performance of the PA, now that the SASH program is closed.

Program Accomplishments

Through the installation of 9,501 projects from 2009 to March 2022, the program realized the following accomplishments:

[1] SASH 1.0 had an incentive level as high as $7 per Watt and was determined based on the homeowners' federal income tax liability and their CARE eligibility. SASH 2.0 simplified the incentive level and offered a $3 per Watt incentive.

[2] A rating system used to determine the eligibility of a solar system by the California Energy Commission.

- 30,003 kW (CEC-AC[3]) total installed capacity with an average of 3.2 kW per home
- Estimated reduced greenhouse gas (GHG) emissions of 16,601 metric tons of CO_2 equivalent (similar to the average carbon footprint for one year for 738 California households), along with criteria pollutant reductions of 519 kg of methane (CH4) reduction and 64 kg of nitrogen oxides (NOx) reduction[4]
- Participation from customers in all eligible investor-owned utility (IOU) service territories, with 46 percent of projects in PG&E's, 42 percent in SCE's, and 11 percent in SDG&E's service territories
- $133.9 million in incentives paid out for installation projects with an average of $14,089 going to each project[5]
    - $92 million in incentives paid out for SASH 1.0 projects, with an average of $17,489 per project
    - $41.9 million in incentives paid out for SASH 2.0 projects, with an average of $9,876 per project
- $160 million total spent (administration, marketing and outreach [M&O], and incentives) out of a $160.7 million total budget with an average of $16,907 spent per project on administration, M&O costs, and incentives[6]
    - $108.7 million spent on administration, M&O, and incentives for SASH 1.0, with an average of $20,501 per project
    - $51.3 million spent for SASH 2.0, with an average of $12,050 per project
- Solar system performance slightly better than projected (105 percent of projected performance)
- Reports of lower bills (81% of surveyed customers)
- An average of 67 percent decrease in energy consumption (5 MWh per year) for an average total annual bill savings of $904 per year (91% reduction in annual bill costs)
- High customer satisfaction and appreciation for the services provided by the program

Increased solar industry participation from volunteers and trainees after participation in trainings and/or volunteer opportunities created by the program (8 percent worked in the industry before the program and 23 percent reported working in the industry afterwards)

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[3] A rating system used to determine the eligibility of a solar system by the California Energy Commission.

[4] https://rael.berkeley.edu/wp-content/uploads/2018/04/Jones-Wheeler-Kammen-700-California-Cities-Carbon-Footprint-2018.pdf

[5] Analysis of incentives was done on the 9,501 projects that were considered fully complete as of March 2022. There were additional projects that were installed but not yet interconnected, or where incentives had not yet been paid out. Those projects were excluded from this analysis of per-project incentive costs.

[6] Analysis of administration and M&O costs was done on the 9,559 projects that were started as of March 2022. These costs are reported on a semi-annual basis and include administration and M&O time spent before a project is fully completed.

Overall, the programs were responsible for increasing the number of homes with solar rooftops and for providing an opportunity for low-income customers to benefit from solar power. The programs were not cost effective from a total resource or ratepayer perspective. However, this was expected given the cost of providing near-full incentives for photovoltaic (PV) systems to program participants. The programs were cost effective from a societal perspective, where the monetary value of carbon reductions outweighed the program costs.

1.2 Findings and Lessons Learned

While this program has ended, we identified lessons that may be helpful for similar solar programs in the future. This section is organized in the following sections:

1. Lessons learned related to goals of the program
2. Lessons learned related to barriers to solar installation
3. Lessons learned for tracking and collecting valuable data in future programs

1.2.1 Lessons Learned Related to Program Goals

The goals listed in Decision 07-11-045 to authorize the program specified a shared targeted number of kW installed for Multifamily Affordable Solar Homes (MASH) and SASH of 50 megawatts (MW) but did not provide direction on the number of homes served or guidance on the type of customers that should be prioritized through SASH. However, five goals of the SASH program were clear:

1. Decrease electricity use by solar installation and reduce energy bills without increasing monthly expenses.
2. Provide full and partial incentives for solar systems for low-income participants.
3. Offer the power of solar and energy efficiency to homeowners.
4. Decrease the expense of solar ownership with a higher incentive than the General Market California Solar Initiative (CSI) program.
5. Develop energy solutions that are environmentally and economically sustainable.

In this section, we comment on successes by each stated goal and recommend how future related programs can set measurable goals.

Program Goals 1 & 3: Decrease electricity use by solar installation and reduce energy bills without increasing monthly expenses. Offer the power of solar and energy efficiency to homeowners.

Based on analysis of customer energy bills, SASH participants *avoided* the increases in bill costs observed in the matched comparison group, while *saving* money on their energy bill after installing solar. On average, a SASH 1.0 participant experienced a 60 percent decrease in energy consumption (4.4 MW per year) resulting in total bill savings of $1,032 per year, while SASH 2.0 participants were estimated, on average, to have a 67 percent decrease in energy usage (5.0 MW per year), resulting in bill savings of $904 per year. The SASH program successfully reduced energy bills without increasing monthly expenses for most participants.

- Future programs should set measurable goals for bill savings and/or reductions in energy usage to better track successes.

GRID referred customers to the Energy Savings Assistance (ESA) program as part of the SASH participation process to reduce energy usage alongside the installation of solar panels, but we found that only 11 percent of participants had enrolled in the ESA program. GRID also provided energy efficiency education to customers to help them understand how to reduce their usage, and 55 percent of survey respondents that reported lower electricity usage believed their usage decreased due to a better understanding of energy usage in the home or a greater sense of environmental consciousness due to the program.

- Future programs should send an annual follow up letter and email to customers reminding them of related programs (ESA and California Alternate Rates for Energy [CARE], which requires reenrollment every two years).
- Future programs should be sure to offer referrals for parallel programs to eligible customers who are not interested in participating.

Program Goals 2 & 4: Provide full and partial incentives for solar systems for low-income participants. Decrease the expense of solar ownership with a higher incentive than the General Market CSI Program.

As of March 1, 2022, GRID had completed 9,501 SASH projects for a total of 30,003 kW (CEC-AC) for low-income households. GRID offered solar systems to be no-cost to low-income customers by combining the SASH incentive and leveraging other sources of funding external to the program. The SASH program succeeded in its goal to provide full and partial incentives, and to decrease the expense of solar ownership for this population.

- Future programs should research baseline adoption metrics among the eligible population, then set specific, time-constrained goals to measure success.
- Future programs should leverage GRID's model of administering SASH, utilizing local sources of grant funding to help cover full costs of installation so the program is no-cost to low-income households. Continuing to leverage grant funding will ensure that the program funds can be used to serve more households.

Program Goal 5: Develop energy solutions that are environmentally and economically sustainable.

In market rate solar installations, there is a trend of increased energy usage after installation.[7] An analysis of SASH savings over time, however, found that there was not an expected drop off in savings, and the overall trendline suggests there is a 7.3 percent decrease in savings over 12 years (0.61% per year). This decrease is smaller than expected, indicating that SASH was successful in developing solutions that are sustainable.

To evaluate cost effectiveness of the program, we used the Total Resource Cost (TRC) test, Societal Cost Test (SCT), and Ratepayer Impact Measure (RIM) test (Table 1). For the TRC and RIM tests, the cost-benefit ratios are less than one, meaning the costs exceed the benefits from the total resource and ratepayer perspectives. These findings are to be expected given the high costs of providing near-full to full incentives for PV systems to program participants.

For the SCT, which includes the additional benefit of the monetary value of a reduction in carbon, ratios for all IOUs are greater than or equal to one for SASH 2.0, indicating cost effectiveness. On average, ratios increased from SASH 1.0 to SASH 2.0, attributable in part to declining system equipment and installation costs and lower administrative costs.

Table 1: SASH Program Cost-Benefit Ratios

Program	IOU	TRC	SCT	RIM
SASH 1.0	PG&E	0.55	0.88	0.11
	SCE	0.74	1.13	0.08
	SDG&E	0.48	0.78	0.08
	Average	**0.59**	**0.93**	**0.09**
SASH 2.0	PG&E	0.60	1.00	0.10
	SCE	0.68	1.12	0.09
	SDG&E	0.69	1.10	0.09
	Average	**0.66**	**1.07**	**0.10**
Overall	PG&E	0.58	0.94	0.10
	SCE	0.71	1.12	0.08
	SDG&E	0.58	0.94	0.09
	Average	**0.62**	**1.00**	**0.09**

[7] In the CSI impact evaluation, PG&E residential customers increased their consumption by an average of 7.1 percent during the first year after installing solar. Though these systems were incentivized, it is a clear example of the pattern we expected to see, where solar installations often lead to increases in consumption.

1.2.2 Lessons Learned Related to Barriers to Solar Installation

Evergreen identified a set of barriers that have hindered installation progress but found that GRID did a good job of addressing these and became more effective over the years. The biggest barriers were:

1. Trust in a "free program"
2. Customers with homes that were not "solar-ready"
3. Tree location

Trust in a "Free" Program:

- Future programs should follow GRID's model and leverage partnerships with trusted organizations and municipalities, as well as customer referrals, to build up credibility within communities they are aiming to serve.

Customers Not "Solar-Ready":

- Future programs should consider implementing a fund for additional services that may be required to allow customers that are not solar-ready to participate.

Tree Location:

- Future programs should be aware that tree trimming (the need for or the desire not to do so) may create barriers to program participation.

1.2.3 Lessons Learned Regarding Data Tracking

To support future programs and to ensure evaluability of goals, we recommend that future programs track and measure metrics related to specific goals of the program. Lessons learned from SASH include:

- Metrics should be collected on marketing outreach on an annual basis and be divided by total installations, including leads received from the IOUs, purchased from other sources, direct mailers, and referrals.
- Verification that IOU account numbers entered into participant databases are accurate should occur.

2 Introduction

The California Public Utilities Commission (CPUC) established the Single-Family Affordable Solar Housing (SASH) program (as well as a similar program directed at the multifamily sector) in response to Assembly Bill (AB) 2723 that directed at least 10 percent of California Solar Initiative (CSI) funds for assisting low-income households in the electric investor-owned utility IOU service territories. The SASH program began offering incentives to eligible customers in 2009, and while the CSI general market program closed at the end of 2016, the CPUC has continued to provide incentives to low-income customers installing solar PV systems though SASH 2.0 and DAC-SASH (as well as the net energy metering program for all solar and incentives for solar water heaters).

This report contains an evaluation of the SASH program. A separate report covers findings from the DAC-SASH Program Evaluation and Vendor Assessment.

2.1 Program Background

In 2006, in response to Assembly Bill (AB) 2723, the SASH program began offering incentives to install solar to low-income and single-family homeowners residing in the service territories of the electric IOUs: Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E). The goal of SASH was to decrease electricity usage and reduce energy bills.

In 2015, CPUC Decision 15-01-027 reauthorized a second iteration of the SASH program (SASH 2.0). The Decision increased the incentive budget to serve more households and decreased the incentive level from the first iteration of SASH (SASH 1.0) in order to maximize the overall benefit to ratepayers. The incentive level was determined by the capacity installed, and for SASH 1.0, was designated as high as $7 per watt installed ($7/W) for California Alternate Rates for Energy (CARE) eligible households and $5.75/W for non-CARE eligible households. The program offered lower rates dependent on the homeowner's tax liability. For SASH 2.0, the incentive level was lowered to a flat rate of $3/W.[8] The Decision also required additional energy efficiency education for participants, including Energy Savings Assistance (ESA) program referrals, energy efficiency walkthroughs, and a job training component.

To qualify for the program, customers must be homeowners of a single-family home that receives electric service from one of the three electric IOU service providers and is located within a qualified census tract as defined by the Department of Housing and Urban Development (HUD), be considered affordable housing, or reside on tribal lands.[9] They must also be income qualified,

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[8] Accessed via: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M145/K938/145938475.PDF

[9] Affordable housing was defined by California Public Utility Code 2852 and includes HUD Qualified Census Tracts, defined at the tract level from https://www.huduser.gov/portal/sadda/sadda_qct.html. Eligibility requirements were retrieved from https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/california-solar-initiative/csi-single-family-affordable-solar-homes-program

which is defined as having a household income of 80 percent or less of the area median income, as defined at the county level.

The Program Administrator (PA), GRID Alternatives (GRID), administered both iterations of the program (SASH 1.0 and SASH 2.0) across the state through regional affiliate offices. While the SASH program has closed as of 2022, GRID is also the PA for a related program modeled after the SASH program, called Disadvantaged Communities Single-Family Affordable Solar Housing Program, or DAC-SASH. Many lessons learned from the SASH programs can be adopted as recommendations for DAC-SASH.

Customer Journey

GRID administered the SASH program in two main ways: homeowner-owed and third-party owned (TPO). Table 2 below summarizes the differences in the models.

Table 2: Deployment Models

Model	Owner of System	Responsible Party for:				
		Finding & Qualifying Customers	Designing System	Installing System	Servicing Equipment	Monitoring Generation
Homeowner-Owned	Homeowner	GRID Alternatives	GRID Alternatives	GRID Alternatives	GRID Alternatives (10 years)	Homeowner
Third-Party Owned (TPO)	Third-Party Solar Company	GRID Alternatives	GRID Alternatives	GRID Alternatives	GRID Alternatives (10 years) AND Solar Company (25 years)	Solar Company

With homeowner-owned systems, GRID purchases solar equipment in bulk, finds and qualifies customers for SASH, designs and installs the systems, and provides a 10-year warranty for both the service and equipment. With the TPO model, GRID is responsible for all the same tasks but also pre-pays a 25-year power purchase agreement (PPA) from a third-party solar company. In the TPO model, the solar company provides monitoring services and a production guarantee for the entire 25-year lifespan of the PPA. The system itself is owned by the third-party solar company, and at the end of 25 years, the customer has the option to either:

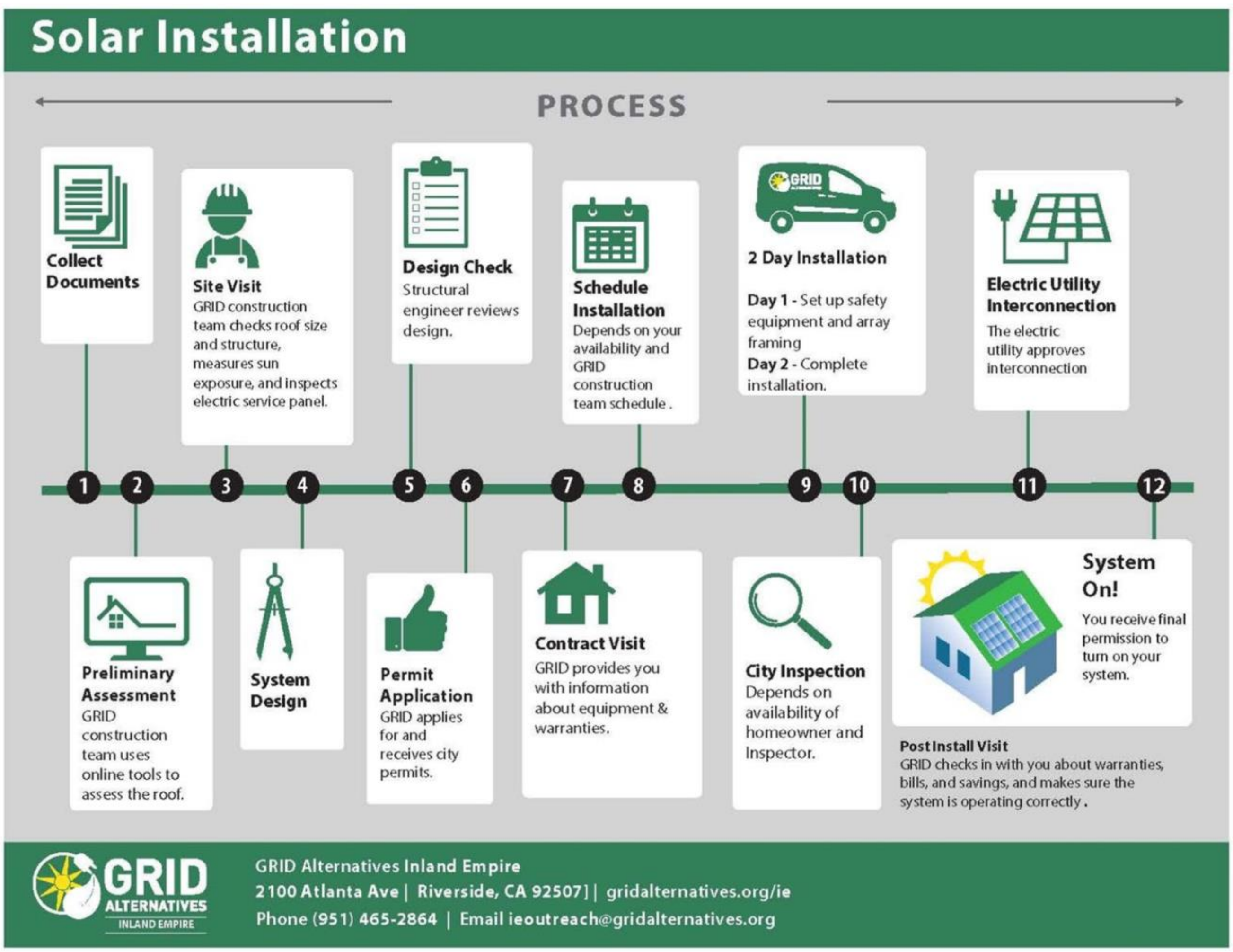
- Purchase the system from the company at the market rate;[10]
- Pay a monthly PPA to continue to receive electric service at a reduced cost; or
- Have the third-party solar company uninstall the solar panel at no cost to them.

Costs and benefits of the TPO system are described in detail in Section 4.2.2

[10] In interviews and an advice letter (AL 18), GRID Alternatives states that the system should be worth $0 after 25 years, but that they cannot guarantee this will be the case, as market conditions and equipment conditions drive the market value of the old equipment.

Figure 1, provided by GRID, illustrates the process a homeowner can expect during their participation in the program. After identifying interested participants, GRID will collect documents to verify eligibility. These typically include proof of homeownership, proof of income, and energy bills. Once the customers are qualified, GRID will perform a preliminary assessment using online tools and conduct a site visit to ensure that the property is fit for solar installation. Many properties are screened out at this stage due to poor quality roofing, older panels, or shading from trees. Once a property is deemed solar-ready, GRID will proceed with the design and permitting steps necessary to schedule the installation. After the installation, the city inspector will inspect the solar system, and the electric utility will facilitate interconnection. The entire process, from outreach to interconnection, can take anywhere from two to six months, with many delays occurring due to scheduling inspections and interconnection with the municipality and the utility.

Figure 1: Participation Process



This process is standard for many of GRIDs regional offices, but details and order may differ by region. We examine the implications of this in Section 4.2.

2.2 Study Objectives

In Decision 15-01-027 that reauthorized the SASH program, the CPUC also required a "close of program" evaluation. Per the study request for proposals (RFP), the study must independently measure and verify the program's impacts and document the performance of the PA and summaries of administrative costs. Evergreen categorized the initial set of program evaluation metrics developed by the CPUC into a set of research questions to organize our evaluation approach. See Appendix B for more detail.

Program administration and marketing: How effective is program administration? What have the programs spent to-date on administration, management, direct implementation, and marketing? Have there been issues related to tracking administrative costs? How effective has program marketing been? Has the Program Administrator (PA) made use of customer data provided by the IOUs, and has that impacted program enrollment?

Customer participation: What are the characteristics of participants versus eligible non-participants? What are the main barriers to participation? Are customers satisfied with the program? How effective are the programs in driving enrollment in other related programs? What is the size of the total eligible customer pool? How many out of program/market adoptions are happening among the eligible population?

PV system performance: Have systems degraded over time since installation? What factors contribute to such degradation? How cost-effective was the SASH program?

Customer bill impacts: What is the average monthly bill reduction outcome for program participants? Are there any measurable changes in energy usage post-participation?

Environmental benefits: What environmental benefits is the program creating as a result of installed projects? Are participating customers aware of the program's environmental benefits?

Workforce development: What job training programs are being leveraged? How many local jobs are being created? What are the longer-term job outcomes for trainees?

3 Methodology

This section describes the overall study approach and details the methodology behind the various analysis tasks.

We linked the metrics for the evaluation to the research activities described to ensure that all metrics were included in the research. Evergreen developed a data collection plan that documented the linkages of the study research components to the metrics, ensuring a systematic approach to assessing the program. This set of metrics and linked data collection plan established data collection protocols and can be found in Appendix B.

We used numerous data and information sources for this study including secondary and primary research:

- Secondary Research:
  - Background document review
  - Program documentation and report review
  - PA program tracking data analysis
  - IOU billing system data analysis
  - Geographic and census data analysis
- Primary Research:
  - Customer surveys with program participants (n = 368) and non-participants (773 completed surveys, with 154 eligible for SASH)
  - Web survey with trainees of the workforce development training (n = 99)
  - Phone interviews with the PA, IOUs, M&O organizations, TPO partner, CPUC Tribal Liaison (n = 17)
  - In-person field research of solar installation sites, marketing and outreach activities, and trainings (Greater Los Angeles area, Inland Empire, and North Valley)
  - On-site solar verification visits (n = 8)

Appendix A provides additional detail on sampling and analysis methodology.

4 Findings

This section presents the study findings. After a summary of data limitations and program progress to date, we provide findings with conclusions following. Additional findings not directly related to metrics are included in Section 6 of this report after the conclusions.

The findings follow the metrics for the evaluation and are categorized by topic:

- Program Administration and Marketing
- Customer Participation
- PV System Impacts
- Customer Bill Impacts
- Cost Effectiveness
- Environmental Benefits
- Workforce Development and Job Training

Appendix B provides more detail on all metrics and maps them to sections in this report.

4.1.1 Data Limitations

The study team identified a number of limitations for completing the evaluation. These limitations are acknowledged in the relevant sections and inform recommendations for future evaluations. Table 3 summarizes the limitations.

Table 3: Data Limitations

Data	Limitation	Implication	Recommendations for Future Programs
Enphase-Enlighten Monitoring Data	Most (22 of 30) systems in our sample had reporting errors.	The prevalence of reporting errors limited Evergreen's ability to comment on the long-term performance of SASH 1.0 projects due to the inconsistency of monitoring system tracking of older systems.	Future programs should ensure program participants know how to access their generation data and determine if the PA should be responsible for tracking or fixing monitoring issues.
IOU Billing Data	Lack of pre-2012 data for some IOUs. Some participants lacked enough pre- or post- solar install	Early SASH 1.0 billing analysis findings could be biased because of the different climate zones contained in each IOU.	PAs of future programs should verify IOU account numbers in their program database to help with data matching for evaluations.

Data	Limitation	Implication	Recommendations for Future Programs
	data to be included in the analysis (30%).	Results may be biased in an unknown way due to the availability (or lack) of data.	
Trainee Contact Information	No trainee address; missing trainee type field before 2019	Not able to compare if trainees are from targeted communities themselves or if they are travelling for the work.	PAs of future programs should collect and report on this information.
IOU CIS Data	No standardized information on own/rent, home type, or income eligibility	Sampling was done via census analysis to target high concentrations of eligible households.	No recommendation – Future evaluations should use similar methods for sampling eligible households (i.e., Census).
PA Cost Data	No marketing, outreach, and admin costs split out by region	Not able to compare acquisition costs for program participants across regions	PAs of future programs should collect and report on this information.
PA Tracking Data	Time spent on searching for gap financing not tracked	Not able to quantify staff time spent on gap financing	PAs of future programs should collect and report on this information.

4.1.2 Program Progress

At the time of this research, March 2022, GRID had completed **9,501 SASH projects, for a total of 30,003 kW** installed. Completed projects are defined as those that were installed and interconnected, and for which incentives were paid out. There were an additional 466 projects installed at the time of data collection but not yet fully completed with incentives paid out, so we did not include them in the analysis. SASH projects were distributed across all three IOUs. PG&E had 46 percent of all installations, SCE had 42 percent, and SDG&E had 11 percent (Table 4).

Table 4: SASH Projects Completed by IOU

IOU	Projects Installed	% of Total
Pacific Gas & Electric Company (PG&E)	4,414	46%
Southern California Edison (SCE)	4,031	42%
San Diego Gas & Electric (SDG&E)	1,056	11%
Total	9,501	100%

4.2 Program Administration

This section reports on a summary of costs and an assessment of underutilization of funds. We also review the program administration models used by GRID, such as documenting the differences between regional offices and reviewing the third-party ownership (TPO) model. The metrics addressed in this section are:

- How effective was program administration?
- What have the programs spent-to-date on administration, management, direct implementation, and marketing?
- Have there been issues related to tracking administrative costs?
- How effective has program marketing been?
- Has the PA made use of customer data provided by the IOUs, and has that impacted program enrollment?

4.2.1 Summary of Costs

Program costs approved by the CPUC include administration, marketing and outreach, and incentives for the cost of installation and materials (i.e., solar panels). Between 2006 and 2014, the incentive level provided by SASH ($7/W for CARE-households and $5.75/W for non-CARE households) was sufficient to cover the full costs of solar installation (including labor and materials). As of 2015, the CPUC adopted a non-declining incentive rate of $3/W, which created a difference between the total project costs and the incentive received through the program. GRID referred to the efforts needed to fill this gap as “gap financing.”

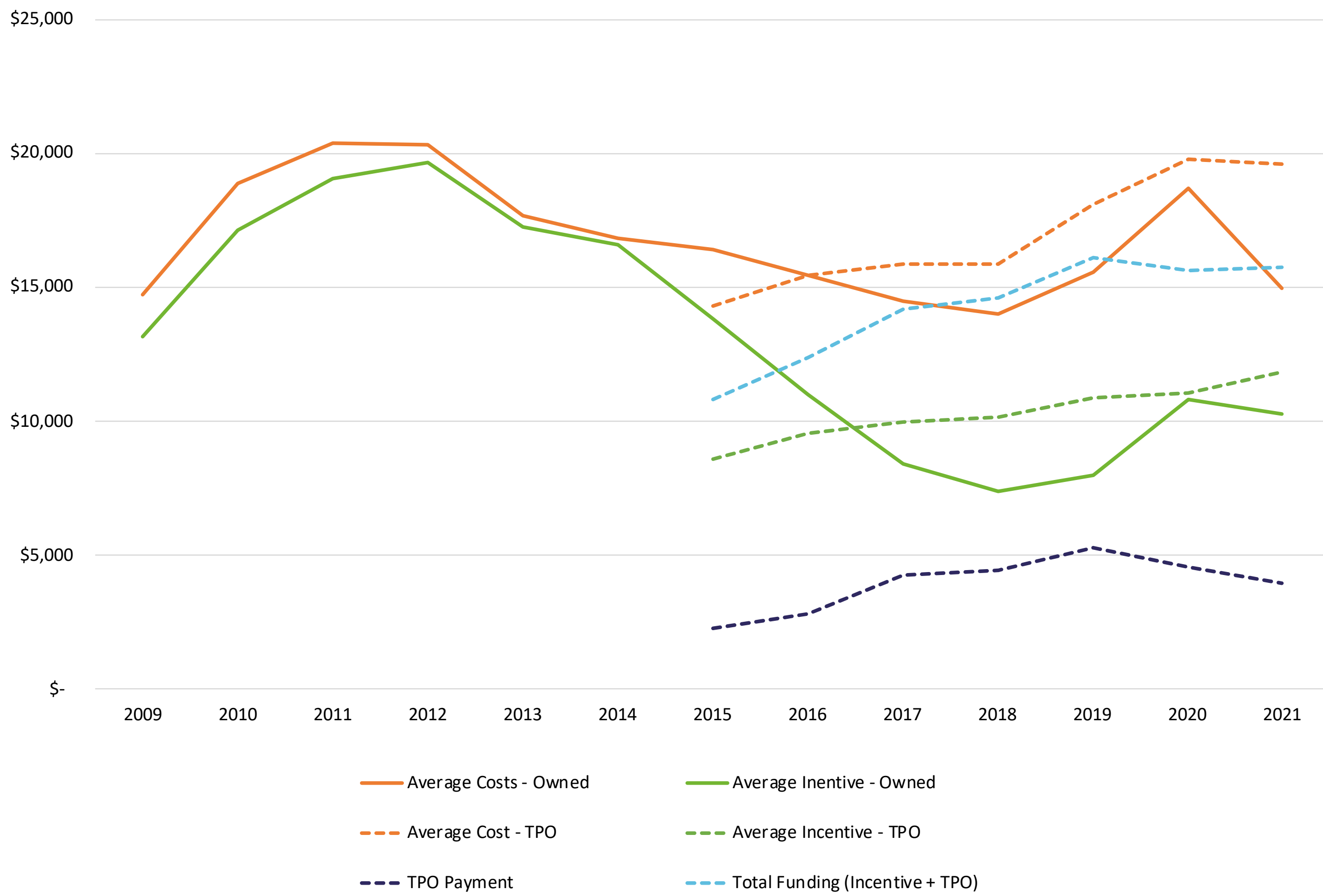
Gap Financing

GRID staff fundraised for other sources of funding to provide professional services needed and to cover the gap between the solar system cost and incentives received. In addition to the money spent on professional services and covering the gap in financing, GRID also reported that a significant amount of SASH staff time went towards identifying sources of gap financing. Time spent on searching for gap financing was not tracked and thus was not quantifiable. GRID staff in different regions employed different tactics due to the unique funding opportunities in their local communities and leveraged local relationships.

Availability of financing differed by region. Some partnered with their local municipalities to provide funding for specific projects, and others leveraged partnerships with other programs to fill the gap. It is worth noting that GRID was originally chosen as the PA for SASH in part because of its ability to leverage community-based organizations (CBOs) for this kind of funding as a non-profit. Though GRID staff could not estimate the cost of fully funding projects, many reported that virtually 100 percent of recent projects required additional funding to ensure the customer has no costs.

To help bridge the gap in financing after the incentive amount changed, the CPUC allowed GRID to utilize a TPO model to leverage the federal tax credit. As part of the TPO model, GRID receives payment from the solar company to install the system, and the TPO company owns the system but passes the bill discounts on to the homeowner. We report on the TPO model in greater detail in Section 4.2.2. Figure 2 shows the average costs and incentives received for owned systems (solid lines) and TPO systems (dashed lines). The TPO funding is the dashed dark purple line indicating the average amount received per TPO project. Finally, the figure depicts the gap between project costs and the incentive plus the TPO funding, as “Total funding” in the light blue dashed line. The gap between the TPO average costs (dashed orange line) and average total funding (dashed light blue line) show that the gap in financing is relieved by TPO payments, but still not enough to cover full costs of each project.

Figure 2: Average Costs and Incentive Amounts for SASH Projects by Year, Owned Systems and TPO Systems



4.2.2 Budget Assessment

Evergreen used GRID-provided data and budget allocations from the SASH Semi-Annual Progress Report to consider allocated budget versus actual spending for SASH 1.0 and SASH 2.0. GRID provided data for all program functions besides evaluation (which makes up 1% of the projected program budget). For the purposes of this analysis, Evergreen assumed that evaluation budget projections were equal to actual evaluation spending. GRID provided administrative and ME&O cost data aggregated across IOUs, so Evergreen calculated actuals by IOU based on budget allocations by IOU listed in Table 5 below.

Table 5: Budget Allocation by IOU

IOU	Budget %
PG&E	43.7%
SCE	46.0%
SDG&E	10.3%
	100%

Table 6 shows allocated budget by program function. The CPUC decision called for most program spending to go toward incentives (85%), and the remaining to be split by administration (10%), M&O (4%), and evaluation (1%). On average, GRID spent $1,661 on administrative costs per project, and $13,563 per project on incentives, roughly meeting the intent of the program distribution to spent 85 percent on incentives and 10 percent on administration.[11]

Table 6: Mandated Budget Allocation Caps by Program Function

Program Function	Budget %
Administration	10%
ME&O	4%
Evaluation	1%
Incentives	85%
	100%

Table 7 shows allocated budget by IOU and program function and compares the values to actual spending. When comparing SASH 1.0 and SASH 2.0 separately for all IOUs combined, we see that SASH 1.0 was $1.4 million over budget while SASH 2.0 was $2.2M under budget. This was largely driven by incentive spending on projects in PG&E's service territory being $898,000 over the allocated amount for SASH 1.0 and $1 million under the allocated amount for SASH 2.0.[12] We

[11] Analysis of administration and M&O costs were done on the 9,559 projects that were started as of March 2022. These costs are reported on a semi-annual basis and include administration and M&O time spent before a project is fully completed.

[12] Spending totals may be slightly misrepresented due to inconsistencies in the data cutoffs used to compartmentalize SASH 1.0 versus 2.0 (e.g., Administrative and M&O costs were pulled starting with Q4 2008, but incentives were pulled starting with a grouping of 'dates earlier than June 25th, 2009).

found that, on average, SASH 1.0 spent $0.55/W installed on administration and $0.23/W on ME&O. SASH 2.0 spend less with $0.37/W on administration and $0.14W on ME&O, indicating that the program became more effective over time.

Table 7: Allocated Budget and Actual Spending for SASH 1.0 & 2.0 (Millions of Dollars)

IOU	Admin		ME&O		Evaluation		Incentives		Total	
	Allocated	Actuals	Allocated	Actuals	Allocated	Actuals	Allocated	Actuals	Allocated	Actuals
SASH 1.0										
PG&E	$4.73	$4.48	$1.89	$1.87	$0.47	$0.47	$40.24	$41.42	$47.34	$48.24
SCE	$4.98	$4.72	$1.99	$1.97	$0.50	$0.50	$42.36	$42.76	$49.84	$49.94
SDG&E	$1.12	$1.06	$0.45	$0.44	$0.11	$0.11	$9.49	$9.99	$11.16	$11.59
All	**$10.83**	**$10.26**	**$4.33**	**$4.28**	**$1.08**	**$1.08**	**$92.09**	**$94.16**	**$108.34**	**$109.78**
SASH 2.0										
PG&E	$2.36	$2.57	$0.94	$0.97	$0.24	$0.24	$20.06	$18.82	$23.60	$22.60
SCE	$2.48	$2.71	$0.99	$1.02	$0.25	$0.25	$21.11	$20.16	$24.84	$24.13
SDG&E	$0.56	$0.61	$0.22	$0.23	$0.56	$0.56	$4.73	$4.22	$5.56	$5.11
All	**$5.40**	**$5.88**	**$2.16**	**$2.22**	**$0.54**	**$0.54**	**$45.90**	**$43.20**	**$54.00**	**$51.84**
Total (SASH 1.0 & 2.0)										
All	**$16.23**	**$16.14**	**$6.49**	**$6.49**	**$1.62**	**$1.62**	**$137.99**	**$137.36**	**$162.34**	**$161.62**

In Table 8, we calculate the difference in allocated funding and actual spending by IOU and program function. Values are presented in millions of dollars, with parentheses indicating overspending compared to the allocated budget. We can clearly see that differences in incentive spending compared to allocated amounts is driving both the overall budget deficit in SASH 1.0 and surplus in SASH 2.0. Overall, there were no major differences between budgeted versus actual spending and no concerning trends.

Table 8: Differences in Allocated Budget and Actual Spending (Millions of Dollars)

IOU	Admin		ME&O		Incentives		Total	
	Difference	% Dif.	Difference	% Dif.	Difference	% Dif.	Difference	% Dif.
SASH 1.0								
PG&E	$0.25	5%	$0.02	1%	($1.18)	-3%	($0.90)	-2%
SCE	$0.26	5%	$0.02	1%	($0.40)	-1%	($0.10)	0%
SDG&E	$0.06	5%	$0.01	2%	($0.50)	-5%	($0.43)	-4%
All	**$0.57**	**5%**	**$0.05**	**1%**	**($2.07)**	**-2%**	**($1.44)**	**-1%**
SASH 2.0								
PG&E	($0.21)	-9%	($0.03)	-3%	$1.24	6%	$1.00	4%
SCE	($0.23)	-9%	($0.03)	-3%	$0.95	5%	$0.71	3%
SDG&E	($0.05)	-9%	($0.01)	-5%	$0.51	11%	$0.45	8%
All	**($0.48)**	**-9%**	**($0.06)**	**-3%**	**$2.70**	**6%**	**$2.16**	**4%**
Total (SASH 1.0 & 2.0)								
All	**$0.09**	**1%**	**$0.00**	**0%**	**$0.63**	**0%**	**$0.72**	**0%**

4.2.1 GRID Regional Affiliates

GRID implemented the SASH program through regional offices throughout the state. GRID chose the locations of these offices due to their proximity to eligible HUD-qualified census tracts and their distribution across the state. The regional offices worked with GRID headquarters to follow up on leads, but often formed their own relationships with community-based organizations (CBOs) or municipalities local to the region. This regional approach allowed GRID to leverage CBOs and municipalities familiar with the eligible population to overcome the barrier of introducing a new organization to the community.

In addition to helping with community trust and marketing, CBOs and local municipalities provided funding specific to regional offices. For example, the North Valley office in Sacramento leveraged city grants from the City of Stockton to help pay for re-roofing projects for SASH customers that may otherwise not be able to participate in SASH.[13] This allowed the program to move more efficiently with projects that may otherwise be delayed or not approved.

The regional office approach also allowed for experimentation between the offices. For example, in the Greater Los Angeles office (GLA), rather than qualifying customers first then conducting the construction site visit second, as is typical in other offices, outreach coordinators first conducted the construction site visit before collecting all eligibility documents. GLA claims that many customers were disqualified from the program after the site visit stage due to poor housing quality in their region; therefore, they save time by disqualifying them early in the process. Other offices noted that they were aware of this approach but preferred to collect income and homeownership eligibility documentation before sending a construction crew out for the site visit.

4.2.2 Third Party Ownership Model

GRID leveraged a TPO model to help close the gap between the incentive and the cost of the solar systems installed. The TPO model was approved by the CPUC in 2015, and GRID moved most projects over to this model throughout the years. Interviews with GRID found that they used the TPO model wherever possible in order to reduce costs, except for in cases of tribal projects or systems under 2 kW.

In this section, we explain the TPO model in terms of costs and benefits to the homeowner, the program, GRID, and the TPO company. During the evaluation, we identified areas of uncertainty where more data collection and documentation would be required to fully characterize these costs and benefits. We expand on these in Section 6.1.

[13] We expand on this further in Section 4.5.2

In the TPO model, GRID pre-paid a 25-year Power Purchase Agreement (PPA) to the TPO company, then purchased, designed, and installed the system on customers' homes.

The TPO company then paid for the installation cost and provided monitoring and service for 25 years. At the end of 25 years, the TPO company planned to uninstall the system at no cost to the homeowner, offer to sell the system to the homeowner at the depreciated value, or offer to sell a new PPA to the homeowner.

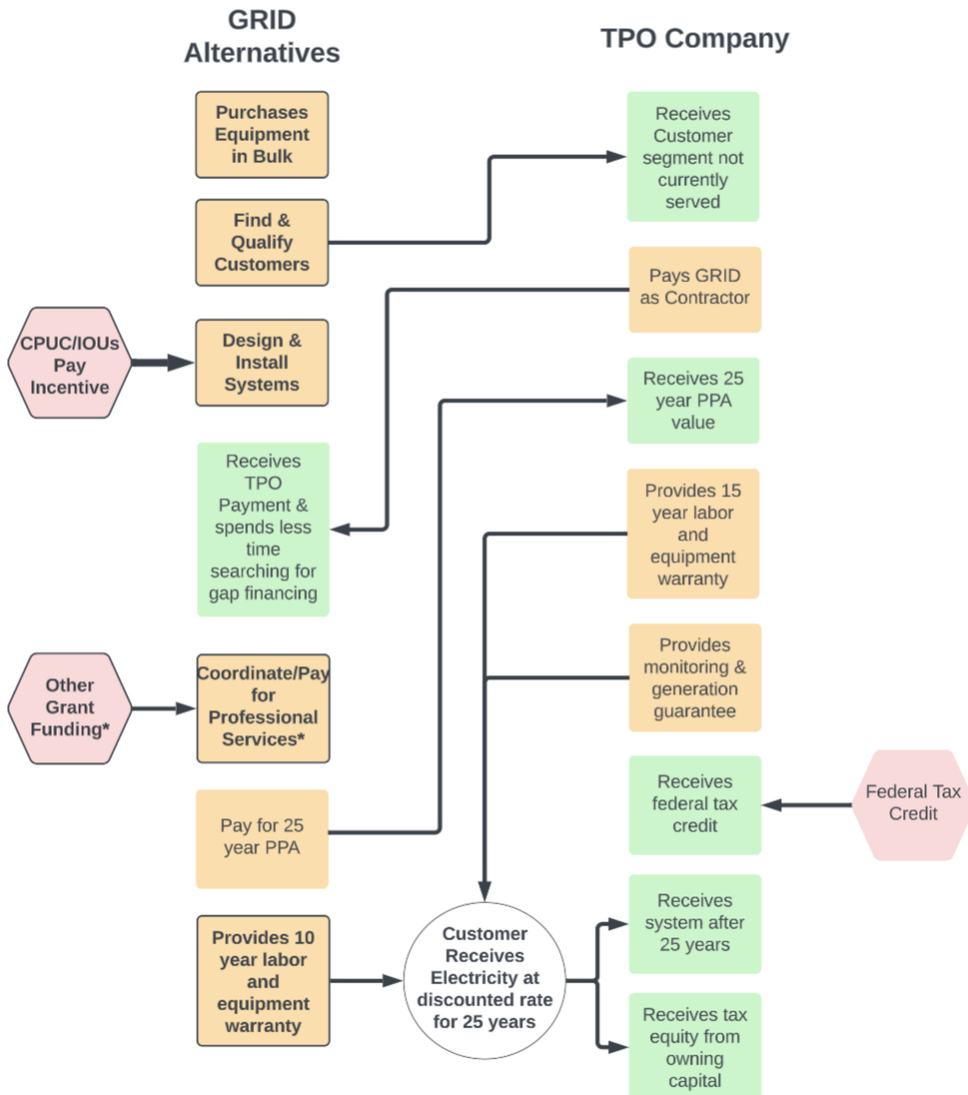
A Power Purchase Agreement (PPA) is a financial arrangement in which a third-party developer owns, operates, and maintains the photovoltaic (PV) system, and a host customer agrees to site the system on its property and purchases the system's electric output from the solar services provider for a predetermined period. In this TPO model, GRID pre-pays the 25-year PPA on behalf of the customer at a pre-arranged assumed rate of generation and energy usage. The customer receives a bill from their utility that is the net of the pre-arranged generation and their specific energy usage. The customer does not receive a bill from the TPO company.

Explaining the TPO Model

Through interviews with GRID staff members and customers, we developed a model to display the various costs and benefits between GRID, the customer, and the TPO company. Notably, the main TPO company involved in these relationships, Sunrun, did not respond to our multiple requests for an interview.

Costs for both GRID and the TPO company are depicted in orange in Figure 3. Benefits or payments to each party are in green. Red items show the benefits that accrue to the CPUC based on the program structures including the use of a non-profit that can leverage grant funding and the use of a TPO that can leverage the federal tax credit. In contrast, for an ownership model, only bolded, outlined cells are active. For example, the federal tax credit is left unclaimed and no activities on the right-hand side of the model occur.

Figure 3: Benefits and Costs of the TPO Model



The costs of participating in the TPO model that are unique when compared to an ownership structure (not inclusive of costs of owned projects) were identified as:

1. The pre-paid 25-year PPA GRID paid to the TPO
2. Staff and administrative time spent coordinating the TPO relationships
3. Staff time coordinating the TPO model with homeowners

Table 9 summarizes the average cost of TPO projects compared to owned projects using costs provided to the evaluation team. This excludes the PPA agreement, staff time coordinating with TPOs, and staff time coordinating with homeowners. These costs include equipment cost, installation cost, and professional services. To normalize across all projects, we report on costs on a per-project and per-kW basis. Additionally, to illustrate how costs have changed over time, the table is segmented by year installed. For SASH projects, we find that **costs per kW** were slightly lower for TPO systems than homeowner-owned systems, but attribute that to the difference in average sizes. On average, TPO systems were larger than owned systems (TPO systems had a minimum system size of 2 kW, compared to owned systems' 1 kW minimum), so there were cost savings in economies of scale.

Table 9: Costs for TPO Systems vs. Owned Systems

Year Installed	Total number of Projects[14]		Average Cost per Project		Average kW per Project		Average Cost per kW	
	Owned	TPO	Owned	TPO	Owned	TPO	Owned	TPO
2009	36		$14,750		2.01		$7,344	
2010	216		$18,896		2.61		$7,245	
2011	767		$20,388		2.95		$6,919	
2012	1364		$20,357		3.19		$6,389	
2013	1050		$17,714		3.00		$5,899	
2014	870		$16,856		3.04		$5,542	
2015[15]	876	123	$16,403	$14,320	3.06	2.87	$5,354	$4,985
2016	305	515	$15,466	$15,485	2.96	3.19	$5,224	$4,849
2017	228	575	$14,515	$15,860	2.79	3.32	$5,201	$4,776
2018	168	907	$14,041	$15,888	2.43	3.39	$5,786	$4,691
2019	163	795	$15,571	$18,113	2.67	3.62	$5,836	$5,004
2020	39	327	$18,738	$19,770	3.61	3.69	$5,189	$5,360
2021	1	135	$14,980	$19,586	3.43	3.94	$4,371	$4,969

The benefits of participating in the TPO model that are unique when compared to an ownership structure (not inclusive of benefits of owned projects) were identified as:

1. The payment from the TPO to GRID as the installation contractor
2. Less staff and administrative time searching for additional funding to cover the gap between the incentive and installation and equipment costs
3. Homeowner receives monitoring and production guarantees

In this report, we have included a range of figures to illustrate the average gap in financing GRID must overcome to keep systems at no-cost for homeowners, however, the contracting cost and PPA pricing agreements between GRID and the third-party solar companies have been requested to be treated as confidential, so we provided a separate memo to the CPUC Energy Division with further detail on these discrepancies. Table 10 illustrates the gap in financing for TPO projects

[14] 41 projects were excluded from this analysis due to insufficient data.

[15] The TPO model was approved in 2015.

compared to owned projects. The gap that GRID must fill with TPO projects is significantly less than the gap it needs to fill for owned projects. This does not account for grant acquisition costs or the PPA and coordination costs mentioned in the previous section.

Table 10: Gap in Financing for TPO Systems vs. Owned Systems

Year Installed	Total number of Projects[16]		Average kW per Project		Average Gap per Project		Average Gap per kW	
	Owned	TPO	Owned	TPO	Owned	TPO	Owned	TPO
2009	36		2.01		$1,598		$796	
2010	216		2.61		$1,740		$667	
2011	767		2.95		$1,341		$455	
2012	1364		3.19		$671		$211	
2013	1050		3.00		$424		$141	
2014	870		3.04		$246		$81	
2015	876	123	3.06	2.87	$2,551	$3,000 - $3,500	$832	$1,000 - $1,500
2016	305	515	2.96	3.19	$4,440	$3,000 - $3,500	$1,500	$800 – $1,200
2017	228	575	2.79	3.32	$6,096	$1,500 - $2,000	$2,184	$400 - $900
2018	168	907	2.43	3.39	$6,646	$1,000 - $1,500	$2,739	$200 - $700
2019	163	795	2.67	3.62	$7,567	$1,000 - $1,500	$2,836	$500 - $1,000
2020	39	327	3.61	3.69	$7,904	$4,000 - $4,500	$2,189	$1,000 - $1,500
2021	1	135	3.43	3.94	$4,699	$3,500 - $4,000	$1,371	$900 - $1,000

We were unable to calculate the full benefits and costs of the TPO model due to the data constraints mentioned previously (i.e., administrative time spent on TPO management and fundraising not collected). However, as we report on in Section 4.8, there did not appear to be evidence that customers who participated using the TPO were seeing less bill savings than homeowner-owned models. Despite the complication of the model, GRID increased its share of TPO projects over the years, indicating that it sees a net value to the relationship.

4.3 Identification of Eligible Customers

This section reports on the characterization of eligible customers. The evaluation focused on understanding the eligible customer market, solar adoptions within that group, and how participation levels varied across the state:

[16] Forty-one projects were excluded from this analysis due to insufficient data.

Evaluation Objective	Summary of Findings
4.3.1 Participation/non-participation by geographic location and other characteristics **4.3.2 Size of the eligible customer market** – We attempted to identify the eligible customer pool for the SASH program to inform assessments of customer participation, program eligibility, and the effectiveness of program outreach and marketing.	Evergreen estimates the total eligible customer pool at 237,000 households. Participation has been well spread out throughout the state; see Table 11. SASH served 4 percent of the 237,000 households; see Table 15.
4.3.3 Market adoptions of rooftop solar among eligible households – We attempted to identify how much natural solar adoption is happening outside of the program among eligible households.	We estimate the upper bound of market adoption among eligible households at 10 percent (11% for PG&E, 6% for SCE, 10% for SDG&E). The number is likely lower due to homes in the eligible population often not being solar-ready.

Additional details on these findings can be found in the remainder of this section.

4.3.1 Participant Distribution Across California

Table 11 characterizes the population served by SASH to date. Participants have been well distributed across the state.

Table 11: Program Participation

Category	Participants	Percent
DAC	3,175	33%
Non-DAC[17]	6,326	67%
Total	**9,501**	**100%**
PG&E	4,415	46%
SCE	4,031	42%
SDG&E	1,055	11%
Total	**9,501**	**100%**
Bay Area/North Coast	1,726	18%

[17] Participants are considered non-DAC if they were not in a DAC at the time of the project. Due to changes in the CalEnviroScreen disadvantaged communities list from V.3 to V.4, some past participants may no longer be in a DAC, but were at the time of eligibility.

Category	Participants	Percent
Central Coast	1,096	12%
Central Valley	2,075	22%
Greater LA	1,257	13%
Inland Empire	1,522	16%
North Valley	770	8%
San Diego	1,055	11%
Total	**9,501**	**100%**

Sections 4.3.2 and 4.5.2 go into detail on barriers to participation beyond eligibility and estimates the number of eligible households in California.

4.3.2 Size of the Eligible Customer Market

For the program, customers must reside in a home defined as affordable housing, as defined by CPUC code 2852, be served by one of the three IOUs, own their home, live in a single-family home, and have an annual household income lower than 80 percent of the area median income.

This Census analysis considers geographic eligibility criteria for the program (i.e., US Department of Housing and Urban Development Qualified Tracts) and other measurable criteria such as income, home type, and homeownership, but does not include the number of homes that are defined under other definitions of affordable housing under CPUC code 2852. This analysis also does not consider whether the eligible households reside in homes are that are "solar-ready." The true number of eligible, solar-ready homes is likely smaller.

To estimate the number of eligible households in California, we used Census data and built a linear regression model on Public Use Microdata Area (PUMA) data. PUMAs provide specific household data such as house type, income, number of occupants, and homeownership. We can determine if a household is eligible for SASH using PUMA data. We then used the regression model and applied it to Census tracts to filter for eligible tracts, which were US HUD Qualified Tracts (HUD QTs). More detail on how we estimated the eligible homes is in Appendix A.

In addition to Census data, we leveraged IOU-provided CIS data, and GRID provided non-participant customer data.

Eligible Customer Maps

Across the state, we estimate there are about 237,000 eligible households, which is about 15 percent of all HUD QT households and almost 2 percent of all households within the state. Of those eligible households, most reside in Pacific Gas and Electric's service territory (48%, or 114,000 households) or Southern California Edison's service territory (44%, or 105,000 households). Very few eligible households reside in San Diego Gas & Electric's service territory, with only 8 percent of the state's eligible households in the region, or about 18,000 households (Table 12).

Table 12: Estimated Number of Eligible Households by IOU

IOU	Estimated Eligible Households	% Of Eligible Population
PG&E	114,000	**48%**
SCE	105,000	**44%**
SDG&E	18,000	**8%**
TOTAL	**237,000**	**100%**

When defining eligibility, GRID first checks a customer's address to see if they reside in a HUD QT or confirms if they are considered affordable housing. Table 13 shows the percent of the population that live in HUD QTs and the percent of those households that are eligible. Once they are confirmed to live in a HUD QT, SCE customers are more likely to be eligible by income, homeownership, and home type, with almost 16 percent of households in those tracts eligible (compared to 14% or 13% in PG&E and SDG&E).

Table 13: Eligibility Estimates by IOU

IOU	IOU Households	HUD QT Households		Estimated Eligible Households		
		N	% Of all IOU HH	N	% Of HUD QT	% Of All IOU HH
PG&E	4,711,933	794,781	16.9%	114,000	14.4%	2.4%
SCE	4,227,833	668,324	15.8%	105,000	15.7%	2.5%
SDG&E	1,050,568	135,132	12.9%	18,000	13.3%	1.7%
Total	**9,990,334**	**1,598,237**	**16.0%**	**237,000**	**14.8%**	**2.4%**

Figure 4 displays the eligibility rate by Census tract, with more detail in the Bay Area and Greater LA Area in Figure 5. Most tracts are grey, as eligibility for this analysis was constrained by HUD QT. The percent eligible is shown by a gradient, and tracts with higher proportions of eligible households are filled in yellow, while homes with lower proportions are filled in purple. On average, 10 percent of households in a HUD QT are eligible for the program.

Figure 4: Eligibility for Program by Tract

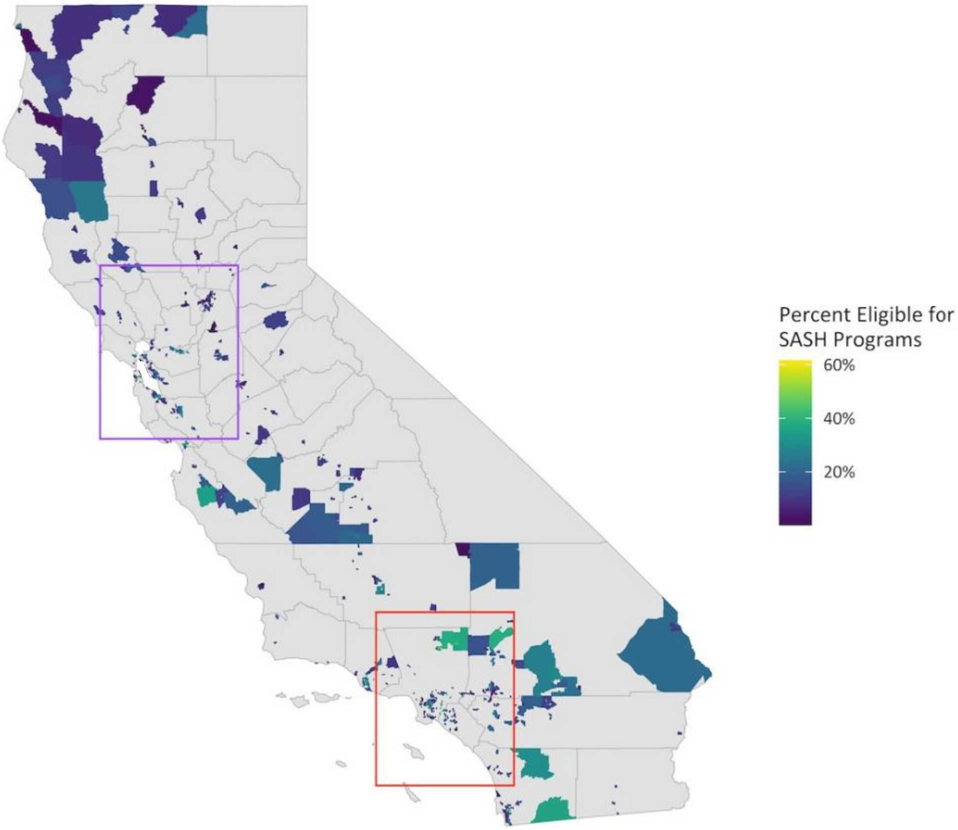
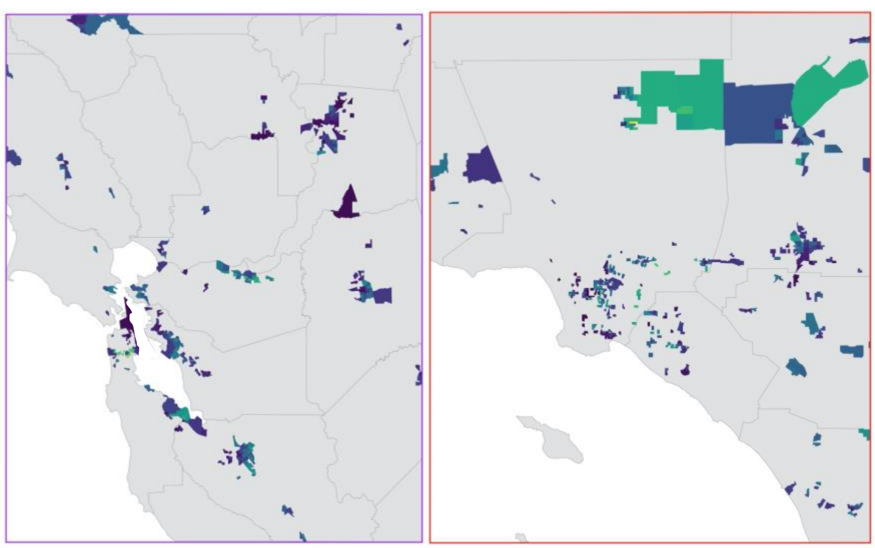


Figure 5: Eligibility for Program by Tract - Bay Area and Greater LA



Interviews with GRID staff found that each office served specific counties near them, but there were exceptions in cases where leads for new customers were managed directly by the regional office and there was flexibility to accommodate capacity constraints. To examine the difficulty in finding eligible customers by GRID regional office, we analyzed the estimated number of eligible households within certain radii of each office location. We pulled the addresses of all completed projects and their associated offices to determine the minimum, average, and maximum distance each office travels. Note that distance had implications for drive time for both outreach staff and installers, who travelled both to the office for equipment, and to homes for installations.

Historically, GRID pursued projects within a certain range of each office, but that range differed based on location. For example, Table 14 shows that projects in the Inland Empire were much farther out than projects in Greater Los Angeles. Central Valley projects had the least number of projects within average distance, with 45 percent. These differences were likely to do with drive times. Driving 20 miles in Greater Los Angeles would take much longer than driving 20 miles in the Inland Empire, for example.

Table 14: Historic Data on Distance Travelled for SASH Projects by Office

GRID Office Assigned	Minimum Distance (Miles)	Average Distance (Miles)	Maximum Distance (Miles)	Number of Projects Served	% of Projects within Average Distance
Bay Area	0	19	106	1364	63%
Bay Area/North Coast	0	53	132	362	66%
Central Valley	1	44	146	2166	45%
Greater Los Angeles	4	22	76	1309	65%
Inland Empire	2	68	467	1672	78%
North Valley	1	32	115	771	51%
San Diego	0	12	56	1063	74%

To assess the coverage based on the office locations, we used these historic distance data to estimate the number of eligible households within a reasonable range from each office. All eligible homes were within the maximum distance that GRID has historically traveled to in the past for an installation, but only 68 percent of all homes are within the average driving distance, suggesting that nearly a third of the eligible households would have required additional travel time compared to the average. These findings are reported on in more detail and visualized in Section 6.2.

Program Penetration

As explained in the previous section, we estimate the number of SASH-eligible households to be around 237,000. With the number of completed installations at 9,501 at the time of this research, program penetration is estimated to be 4 percent across the state. In Table 15, we analyze the program penetration by GRID regional office and find that the Central Valley and North Coast offices had the highest program penetration, while Greater Los Angeles and Inland Empire had the lowest. We estimated program penetration based on the average distance travelled for projects for each regional office. Note that about a third of all eligible households would not be served with this distance assumed, as shown in the last row of the table.

Table 15: Program Penetration by GRID Regional Office, Average Distance

GRID Regional Office	Distance Assumed (mi)	Total Households Served by IOU	Total HUD QT Households Served by IOU	Estimated Eligible	Total Program Participants[18]	Program Penetration
Bay Area	19	1,221,321	266,640	34,000	1,363	4.0%
Bay Area/North Coast	53	59,724	16,986	3,000	362	13.5%
Central Valley	44	393,438	54,953	7,000	2,075	30.3%
Greater Los Angeles	22	1,550,627	222,982	36,000	1,257	3.5%
Inland Empire	68	2,443,730	334,956	54,000	1,522	2.8%
North Valley	32	540,423	92,737	10,000	770	7.5%
San Diego	12	597,084	140,482	19,000	1,057	5.6%
Outside of Office Range		3,183,987	468,502	75,000		
Total		**9,990,334**	**1,598,237**	**237,000**	**9,501**	**4.0%**

Our analysis concludes that travel time to cover the wide spread of eligible homes, especially in rural tracts or tribal lands that are further from regional offices, was a challenge to finding eligible customers, but not necessarily a barrier. Interviews with GRID found that for tribal projects in the Inland Empire, staff members arranged to set up at a community center for a few days. This time would align with multiple scheduled installations in the area. GRID staff then conducted marketing and outreach activities, arranged site visits to assess solar potential, and took applications for the program. This batched process allowed for more one-on-one engagement of the population but also reduced per-unit costs of installation for these further regions.

4.3.3 Market Adoptions of Rooftop Solar

Evergreen heard from both customers and from GRID that targeted customers had been reached by other external solar companies with offers to install rooftop solar. These offers were partly responsible for distrust in the program truly being no-cost to customers and indicated that there may be eligible participants who take a different pathway to solar. Evergreen triangulated an estimate of market adoptions outside of the program using both CIS data and non-participant responses to our survey. Overall, about a fifth of surveyed non-participants who had heard of the program had installed solar without the use of the SASH program (19%, total n = 74).

[18] 1096 program participants were assigned to the Central Coast office, which no longer exists and was not evaluated.

Based on analysis of IOU CIS data of non-participants, the upper bound of market adoption in the eligible population is about 10 percent (11% for PG&E, 6% for SCE, 10% for SDG&E).[19] Surveyed eligible non-participants that had not heard of the program reported a much higher rate of market adoption with about a third (34%, total n = 68) responding that they had installed solar panels without the use of the program. This is likely due to the recruitment method for the survey. The evaluation recruitment postcard mailed to non-participants mentions the CPUC and that we were conducting a survey about solar panels. Customers with solar panels may have been more likely to take the survey, while customers without were more likely to think the survey was not relevant to them.

We examined how this group of low-income homeowners were able to install solar and found that many reported paying for the system on their own, with the help of a tax credit, or another organization (Table 16).

Table 16: Assistance Received (n = 22)

Type of Assistance	N	%
Paid on own	5	23%
Received a tax credit	8	36%
Received help from another program or organization	6	27%
Something else	3	14%

4.4 Marketing to Customers

In this section, we share GRID's marketing strategy, including its use of data from external sources. We then share customer opinions on solar in general, on GRID's marketing strategies, and on the clarity of marketing material from both GRID and the IOUs.

GRID used several marketing and outreach strategies to reach eligible customers. These strategies differed by regional office and IOU service territory to best serve the population reached. Based on the review of background documents, we understand that GRID used a variety of marketing and outreach strategies – it leveraged partnerships with existing organizations; provided consumer education sessions; encouraged adopters to share their participation experience with their friends and neighbors; and used media, marketing collateral (including co-branding with cities, counties, and IOUs), and events to raise awareness. GRID modified its strategies to adapt to COVID-19-related constraints that impacted construction logistics and marketing and outreach approaches.

[19] Additional details on how we estimated the upper bound of 10 percent and the motivations non-participants gave as to why they received solar may be found in Section 6.2.

4.4.1 Program Lead Generation

GRID headquarters purchased lists of potentially eligible customers from sources such as Faraday,[20] an online prediction-based marketing tool, then cleaned the data and forwarded it to the regional offices. Regional offices leveraged existing relationships with local CBOs and hosted their own marketing and outreach events. They also followed up on referrals from participants to generate new leads. This section evaluates the data limitations and successes.

Once customer leads were generated, regional offices took different approaches to qualifying and moving customers through the program. All regional staff interviewed pre-screened customers by phone or in-person (if at an event). In some regions, like the Central Valley and the Bay Area, they first qualified customers by requiring proof of income and home ownership, but others, such as in the Greater Los Angeles area, they began with a site visit to ensure the home is solar ready. Outreach coordinators in Los Angeles mentioned that out of around 550 site visits last year (DAC-SASH and SASH projects), only about 250 homes qualified after the construction site visit. In other regions, outreach coordinators agreed that home quality was a significant barrier to participation, but that they started with the income and ownership verification to save time driving out to sites that were not ultimately eligible. This difference may be attributable to different housing stock and drive time requirements for each regional office. For example, in the Greater Los Angeles area, housing stock issues were a frequent barrier, so the office found it more efficient to conduct the construction site visits before gathering all documentation from the homeowner. On the other hand, in the Inland Empire, projects were more spread out, so gathering all documentation and ensuring homeowners are eligible before conducting the site visit was more appropriate. Allowing GRID to experiment across regional offices is a benefit of the flexibility of the program rules.

Data Sources

GRID received leads from CBOs and municipal partners, online marketing lists, and customer referrals. Table 17 describes different sources and their successes and limitations.

Table 17: Success and Limitations of Different Lead Sources

Data Source	Description	Successes	Limitations
Partner Leads	Local community-based organizations, municipalities, and other low-income programs referred customers to SASH.	Similar eligibility requirements, leads tailored to the needs of the regional office	Eligibility for SASH was harder to meet than other low-income programs.
Faraday	Faraday is an online prediction-based marketing tool that purchases data from various sources, then uses a proprietary predictive model to provide lists of potentially eligible leads	Eligibility information on ownership and income were fairly accurate.	Lists were not geographically strategic and could not identify affordable housing or HUD Qualified Tracts. GRID

[20] Accessed at: https://faraday.ai/

Data Source	Description	Successes	Limitations
			staff had to manually clean these lists.
Referrals	GRID provided a referral bonus for SASH customers to refer friends. Sunrun also provided a bonus that could be stacked.	Communities were likely to share with each other and word-of-mouth was trustworthy.	Not able to break into new markets by word-of-mouth only

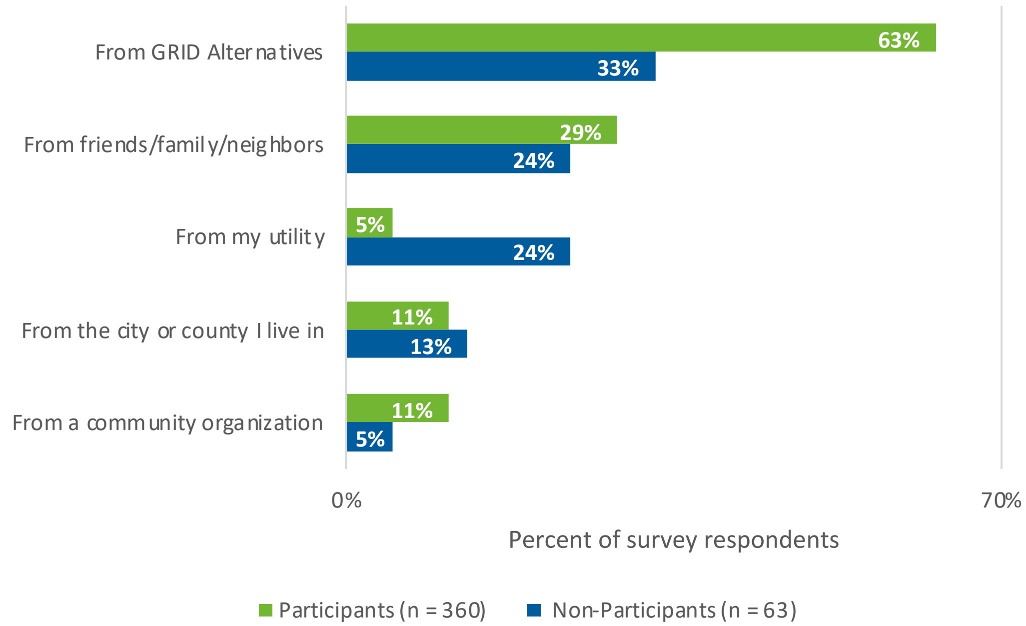
Many GRID staff reported that referrals were the best way to generate new leads for the program. Working with CBOs lent credibility to GRID and allowed staff to reach eligible populations that may not trust IOUs or the CPUC.

GRID's referral program provided a cash referral bonus for participants that referred an eligible neighbor to the program. Participants were also able to stack a referral bonus from Sunrun if they had a TPO system. The monetary incentive, paired with the established credibility of hearing about the program from someone they know, helped increase word-of-mouth about the program and led to increased participation.

4.4.2 Customer Perspectives on Marketing

GRID reported that most participants heard of the program through referrals, and program participants confirmed that that was the second most likely place they heard about the program after hearing from GRID themselves. In Figure 6, survey results from both program participants and non-participants aware of the program found that both groups reported hearing of the program from GRID (63% and 33%, respectively), or from friends, family, or neighbors as a referral (29% and 24%, respectively). Non-participating customers more often heard of the program from their utility (24% vs. 5% of participants). Neither participants nor non-participants emphasize learning about the program from a community organization.

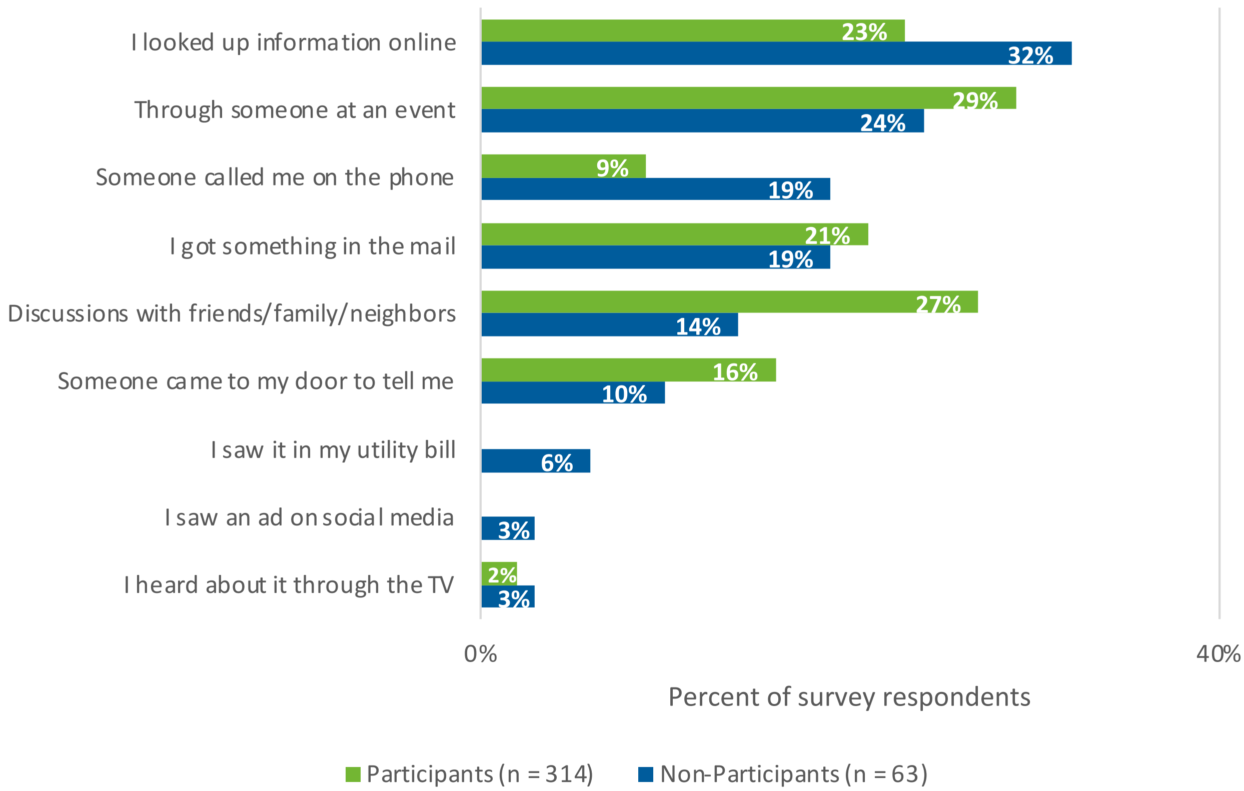
Figure 6: Program Information Source Reported by Survey Respondents (multiple responses allowed)



Both participant and non-participant respondents that heard about the program through their utility were mainly Southern California Edison customers (67% and 60%). This aligns with what we heard in GRID interviews that their co-marketing with Southern California Edison has been successful in generating leads.

Figure 7 reiterates the way in which people learned about the program through word of mouth, with 27 percent of participants receiving information from friends/family/neighbors. Non-participants were less likely to have had discussed the program with friends/family/neighbors, indicating that respondents may be more likely to participate if they already know and trust the opinion of someone else who has participated.

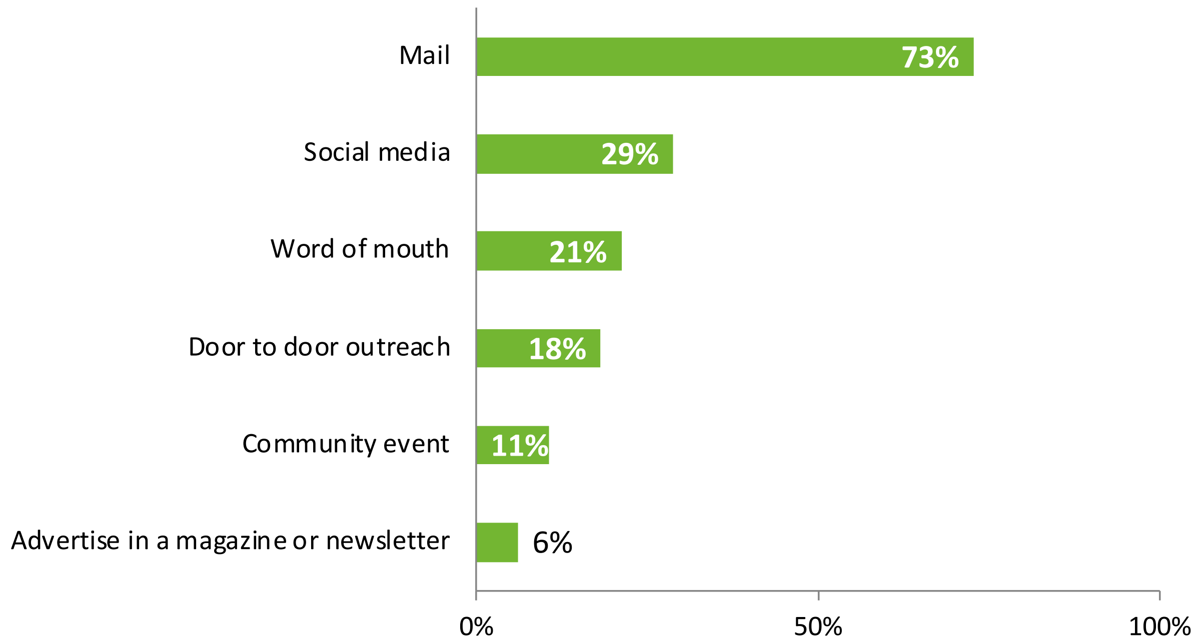
Figure 7: Program Information Mode Reported (multiple responses allowed)



Both participants and non-participants were asked to suggest outreach strategies that may work within their communities to get information out about SASH. Participants and non-participants suggested expanding outreach about the program to social media (56%, n = 343 for participants and 52%, n = 63 for non-participants), which was not a common source of information from current participants. Some respondents also cited specific magazines and events to commit better community outreach (24% of participants and 10% of non-participants): a booth at a local farmers market, community council meetings, church events, health fairs, local schools or law enforcement, resource fairs, and community centers. Of those who recommended advertising in a magazine or newsletter (6%), the *Hi-Desert Star* and the *North Coast Journal* were specifically noted.

We also asked non-participants unfamiliar with the program about their preferred sources of information about energy programs. Mail and social media were both popular responses (73% and 29%, Figure 8).

Figure 8: Preferred Marketing Methods by Unaware Non-Participants (n = 66)



Of respondents that selected community events (11%), a few offered examples including "senior center," "town fair," and "weekly farmers market". A handful of respondents (6%) recommended advertisements in a magazine or newsletter, specifically "local paper" or "Revista de la Ciudad". Of respondents that selected "other" (5%), a couple provided examples: "email" and "online". Most non-participants expected to hear about energy programs from their utility. The majority (80%) of non-participant respondents stated that they receive information about energy programs from their utility.

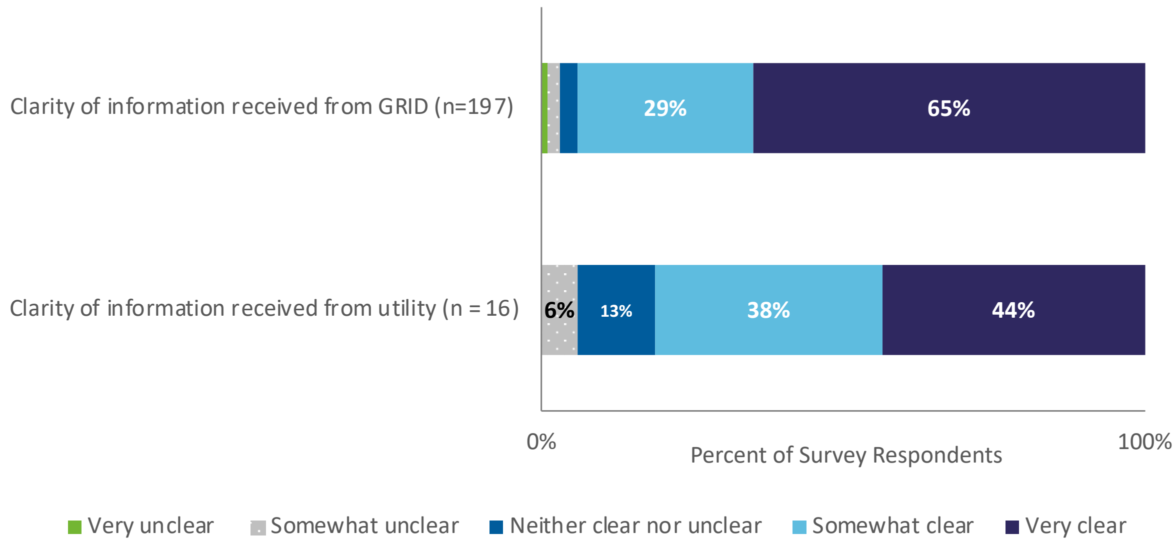
4.4.3 Clarity of Marketing Materials

Over the course of the program, GRID had tested different marketing materials and messaging to recruit eligible participants. Field visits to regional offices allowed us to confirm that marketing materials are translated into the regions' most common languages: English, Spanish, Mandarin, and Cantonese. GRID's ME&O plan also lists Korean, Vietnamese, and Tagalog.

As part of their customer journey, GRID first presented all customers with a homeowner orientation. These orientations varied by region and were presented by GRID outreach coordinators. Some homeowner orientations were one-on-one, and others were in a small group setting. During a field visit, we attended an orientation and found that the outreach coordinator was diligent about answering questions. The questions the homeowner had mirrored what we found in the survey: not understanding the ownership model, how solar panels work, and how their bill would change.

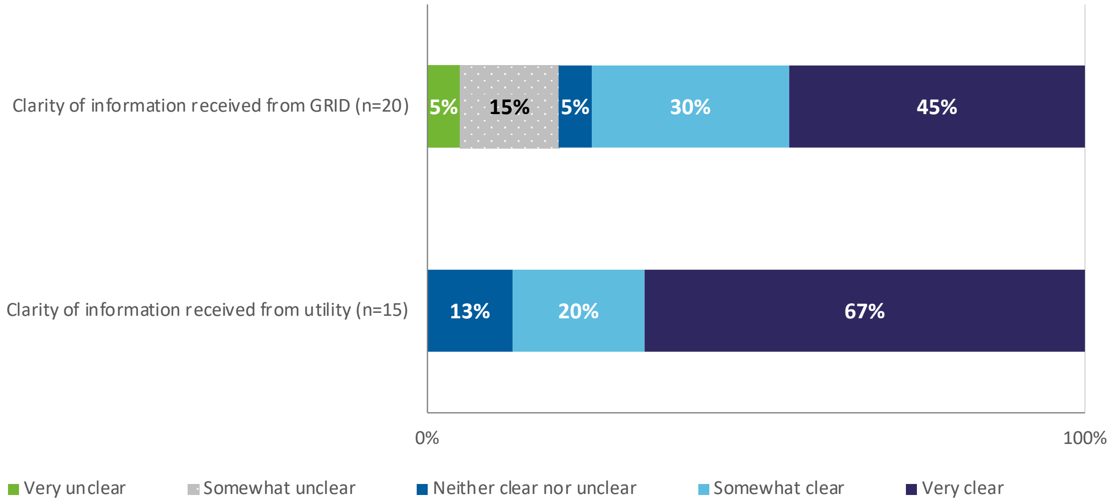
A significant percentage of respondents reported that the marketing materials received from both GRID and their utility were 'very' or 'somewhat clear', with only a very small minority saying otherwise (Figure 9). However, respondents were more likely to report that the information was somewhat unclear when they received it from their utility.

Figure 9: Clarity of Information Reported by Participants



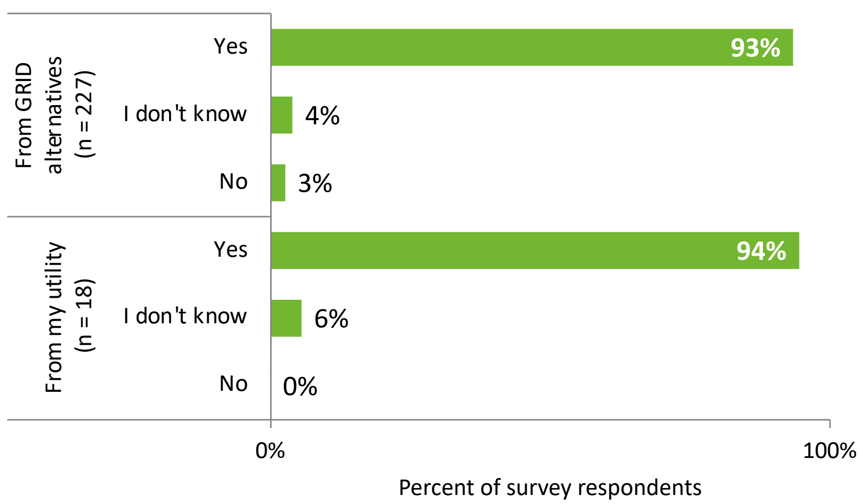
Non-participants who were aware of the program were more likely to say the information received from GRID was very or somewhat unclear when compared to information received from their utility (Figure 10). Interviews with GRID indicated that educating customers on the program and gaining their trust was a barrier. Surveyed non-participants may have had some confusion regarding the program if they were not able to move forward with the program.

Figure 10: Clarity of Information Received Reported by Non-Participants



Ultimately, most surveyed participants reported that they had access to enough information needed to participate in the program (93%), regardless of how they first heard about the program. As shown in Figure 11, respondents that learned about the program through GRID were more likely to report that they had enough information compared to those that heard about the program through their utility (93% and 94%).

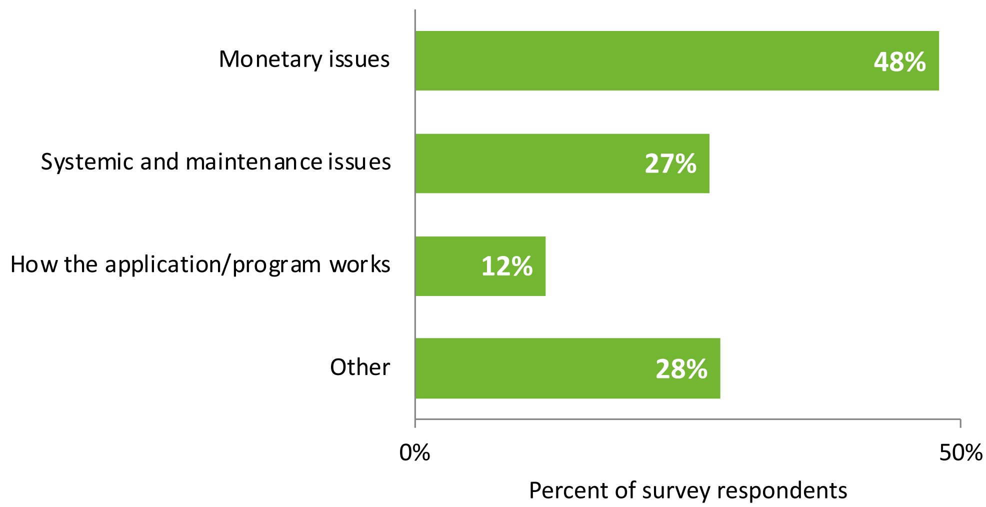
Figure 11: Access to Enough Information Needed for Program Participation



Surveyed participants who did not feel they had enough information to participate provided free-text responses to explain why (n = 100). We categorized those responses by topic. Figure 12 shows that many did not understand issues related to the system itself (including maintenance) (27%), monetary issues (48%), and how the program or application process works (12%). Other responses included:

- Not understanding how ownership works (n = 14)
- How the program works in relation to their utility (n = 5)
- How to receive a battery system (n = 5)

Figure 12: Topics that GRID Alternatives Discussed that Have Not Been Understood Properly (n = 100, multiple responses allowed)



A few (n = 4) non-participants that were aware of the program also shared what was unclear about information they received. The responses included confusion around the following topics:

- Process: did not understand length of process (1); did not understand "downsides" of program (1)
- Financial implications: financial commitment (1), income guidelines (1)
- Communication: was not provided adequate information (1)

4.5 Customer Participation

The evaluation focused on the following metrics associated with customer participation. Findings are expanded upon in the sections below.

Evaluation Objective	Summary of Findings
4.5.1 Customer satisfaction with the programs – A study component was used to solicit input from customers on their experience enrolling in the programs, experience, and satisfaction with the PA, and identify ways to improve their satisfaction going forward.	Customer satisfaction was high amongst participants. Non-participant satisfaction levels reflect frustration with realizing they were ineligible for reasons such as solar-readiness or changing program guidelines.
4.5.2 Effectiveness of the programs in addressing barriers to participation – The CPUC identified several barriers to clean energy adoption among residential customers, and these programs were designed to address those barriers.	Barriers identified include: • Trust in the program offering • Solar-readiness • Unpermitted work • Low energy usage

Part of the study's charge was to identify awareness among target customers of the various programs designed to serve them and whether the programs helped increase enrollment in the other programs. The evaluation also asked customers and reviewed program data to see if customers were being enrolled in other related programs.

Evaluation Objective	Summary of Findings
4.5.3 Enrollment in related programs such as CARE/FERA and ESAP for income-eligible customers.	Interviews with GRID staff found that there was not a formal process to actively refer program participants to CARE or other programs, and this was reflected in our findings of lower participation numbers in programs like CARE (39%). While there was a formal referral for ESA, enrollment was low (11%).

4.5.1 Customer Satisfaction

This section details the participant experience and includes findings from the customer surveys on satisfaction with the program. Overall, customers reported high satisfaction.

Interviewees staff from GRID and IOUs reported that they perceived customer satisfaction to be high; this was confirmed via customer surveys. From the perspective of program implementation staff, complaints from program participants were related to timing, and most complaints came from non-participants who were frustrated to find that they were ineligible.

Nearly half of all program participants (42%) provided feedback about the program via free-text response. Of the respondents that provided feedback, over half (55%) expressed general gratitude, such as “very satisfied”, or “we are very grateful for the solar panels....” Table 18 displays the other topics mentioned in the free-text responses, including program communication, general feedback, and requests for additional support, with some respondents mentioning more than one thing.[21]

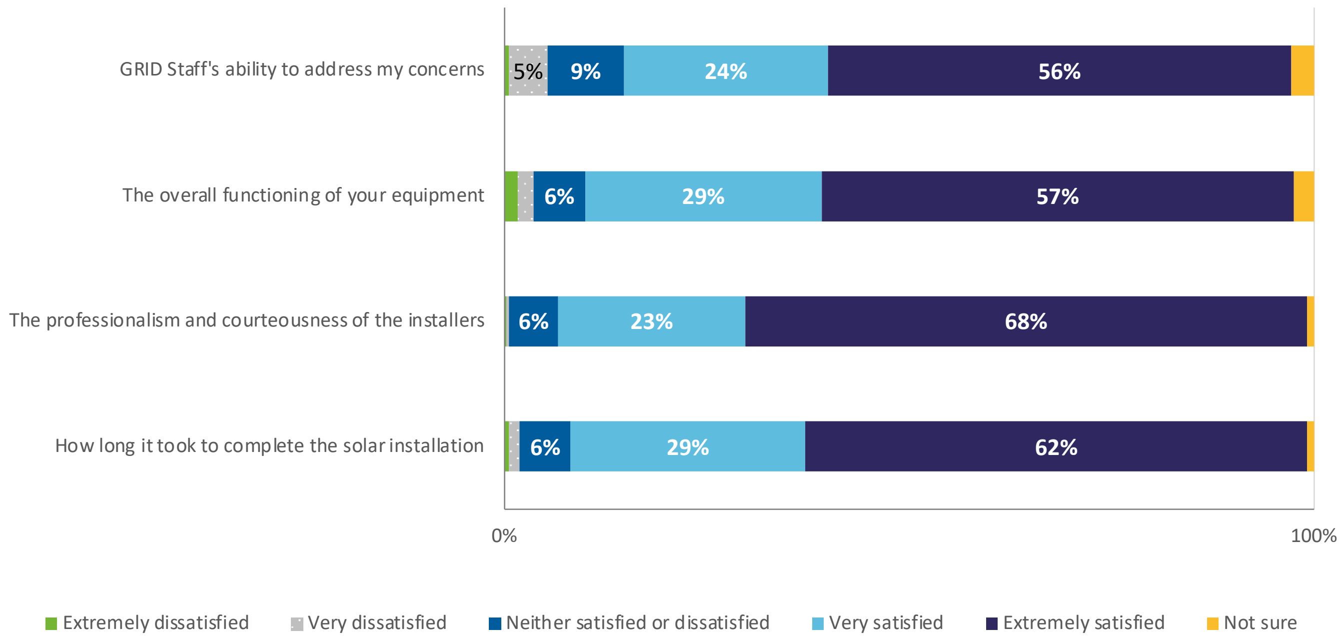
Table 18: Participant Program Feedback from Subset of Respondents (n = 156, multiple responses allowed)

Feedback Theme	Types of Responses	% of Respondents
General gratitude	Includes expressions of gratitude such as “thank you to everyone involved” and “I’m just so grateful…”	55%
Program communication	Includes requests to increase bill transparency, bill amount concerns, recommendation for more accessible outreach/marketing/educational resources, and notes on customer service	38%
General feedback	Includes specific notes on savings from program, demand for program or eligibility criteria expansion, criticism on overall process and providers, complaints on installation, notes on ethical impact of program or opinion on program	23%
Request for additional support	Includes requests for upgraded or additional technology, batter, or machinery installation, additional support: demand for more maintenance, need for general repair or installation, need for greater assistance or referral to other assistance	31%

To assess satisfaction across program elements, surveyed customers were offered a scale from extremely dissatisfied to extremely satisfied to measure four components of their experience with the program: GRID’s ability to address concerns, overall functioning of equipment, professionalism and courteousness of installers, and length of solar installation time. All four components reflected a “satisfied” (extremely satisfied or very satisfied majority) customer experience (Figure 13).

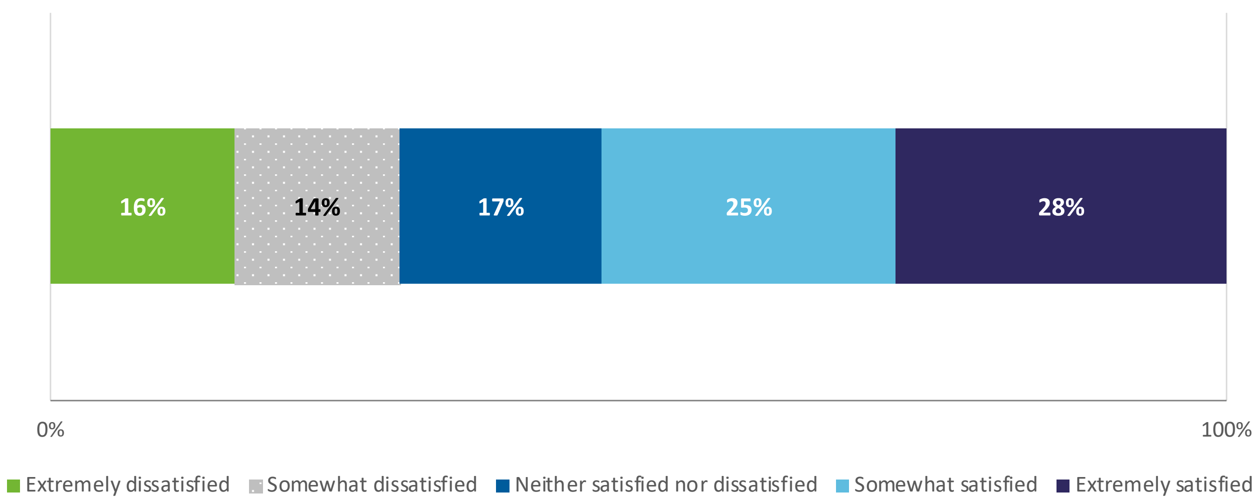
[21] A response could be included in one or more categories. For example, some respondents expressed general gratitude but also requested additional support.

Figure 13: Satisfaction with Installation (n = 368)



We also asked non-participants that had interactions with GRID to share their level of satisfaction with GRID. Figure 14 shows that while respondents were more satisfied than not, there were more dissatisfied responses than among participants.

Figure 14: Non-participant Satisfaction with GRID Alternatives (n = 64)



Many respondents expanded on their response in a free text section. Most dissatisfied respondents cited eligibility or solar readiness for their complaints against GRID, although some did report a lack of communication or poor customer service. We expand upon these barriers in

Section 4.5.2. Among satisfied respondents, however, most reported that GRID's explanations were clear and that staff members were friendly. Table 19 categorizes these findings and provides quotes to illustrate the groups' responses.

Table 19: Satisfaction Among Non-Participants (n = 54)

Interest	Topics	Quotes
Dissatisfied (30%)	Poor communication (12) Home not solar-ready (8) Not enough information (5) Not eligible (3)	"I was to have the system installed and at the last minute they said they couldn't install on my roof. I waited one year for this answer" "They did not give an opportunity to fix the lack of sun they just shut it down" "I had to discover the real facts about the system offered through my own research" "They did not provide a clear enough answer as to when the zip code eligibility rule changed,"
Neither Satisfied nor Dissatisfied (17%)	Home not solar-ready (8) Not eligible (3) Poor communication (3) Not enough information (2)	"I wish they told me that you needed a new home and electrical boxes to add solar…" "I'm still waiting so I have hope that I will be contacted and move forward with this project." "For over three years, I've been reaching out for panels, but there's not (any) project in my area."
Satisfied (53%)	Poor communication (15) Good customer service (17) Not enough information (6) Home not solar-ready (7) Not eligible (4)	"They never called me… I was the one who called them to find out about my status on the application" "Very pleased with their work, communication was great" "Was told out of funding and they would be in touch but never heard again" "The application process was a little difficult… then felt so disappointed when I received the letter telling me I wasn't getting solar" "when my roof needed upgrading in order to move forward, I felt I no longer mattered"

Application Process

Interviews with GRID found that most customers understood the application process. The process was to have an outreach coordinator walk through the documents with the customer or to send them documents and be available for questions via phone or email. Most respondents found the application submission very easy or somewhat easy, regardless of how they completed the applications (Figure 15).

Figure 15: Difficulty Completing Application (n = 142)

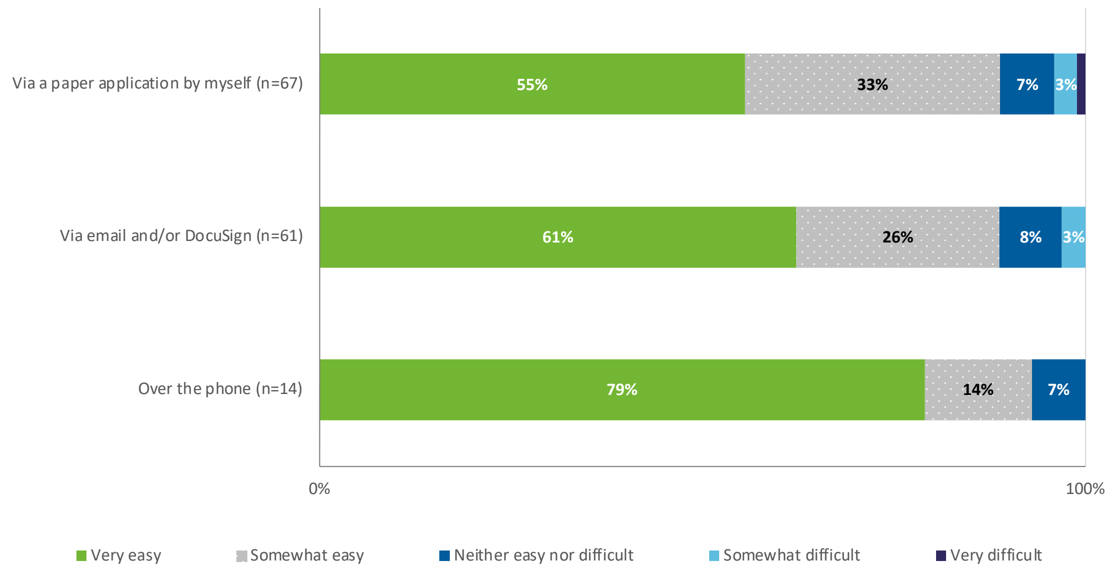
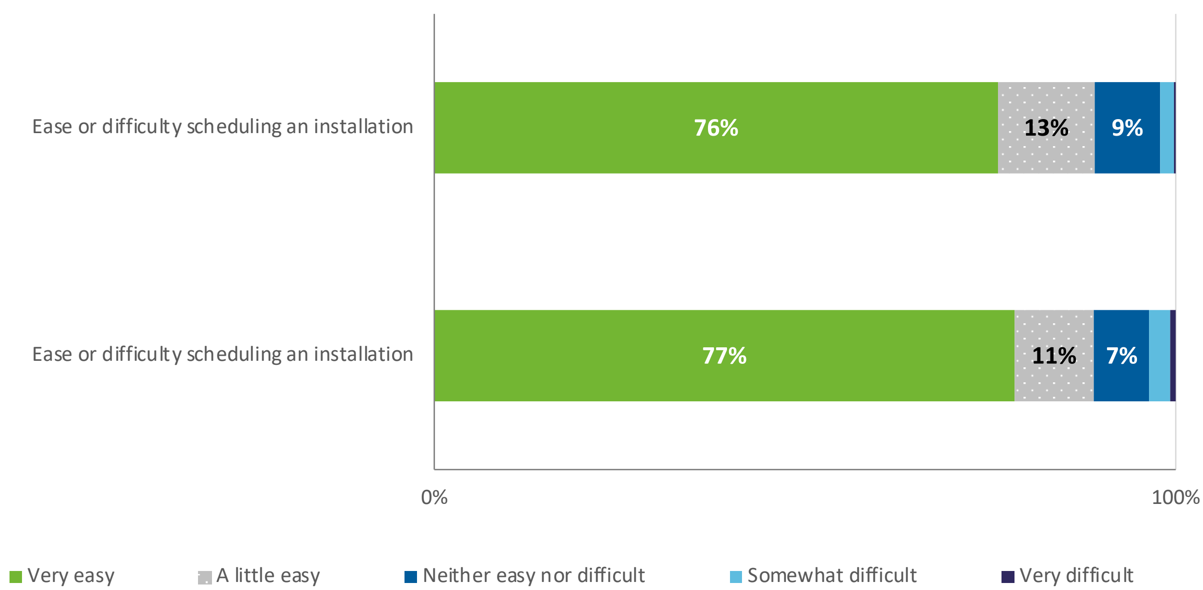


Figure 16 displays levels of ease or difficulty participants experienced when scheduling an installation and the installation overall. Most participants responded that their experiences with installation and its scheduling were “very easy” (76%, 77% respectively).

Figure 16: Ease of Difficulty with Program Elements (n = 368)



4.5.2 Barriers to Participation

GRID staff interviews found barriers that eligible participants may face. Common factors where eligible customers did not move forward with the program, as reported by GRID staff, were:

- Distrust in the program
- Ensuring the home is solar ready
- Energy usage too low to qualify
- Unpermitted work on property

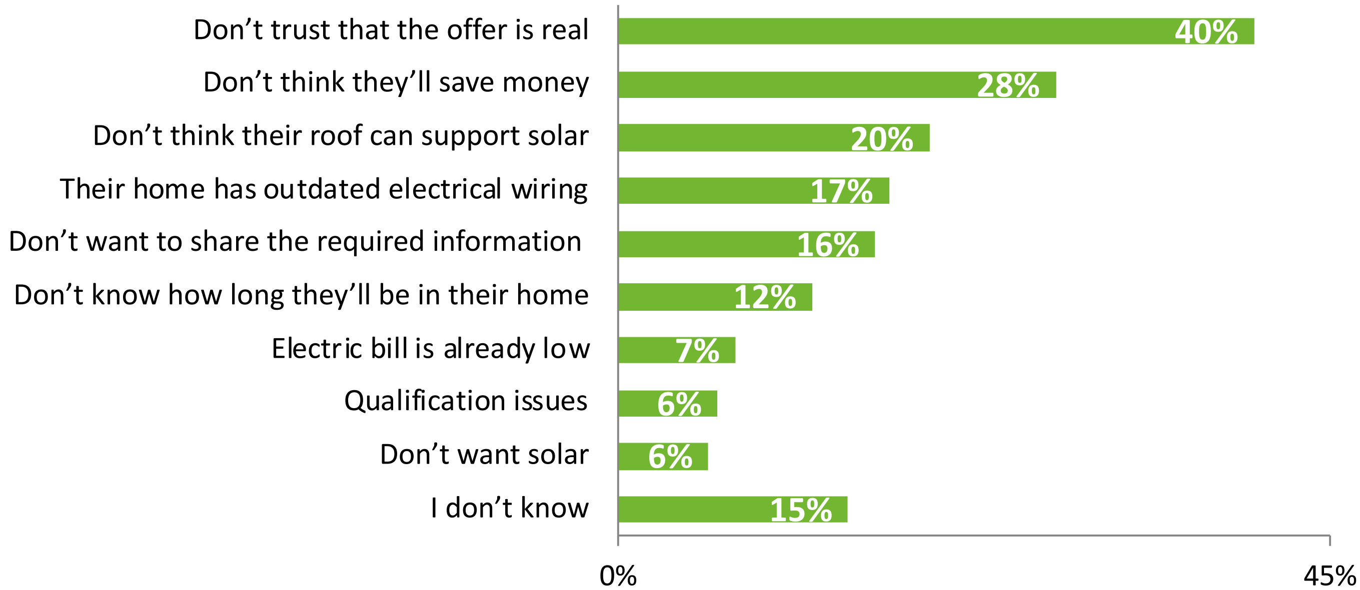
GRID tracked barriers to participation in its program data by indicating whether a customer is inactive or active. Inactive customers included an inactive reason and may include one or more reasons. An analysis of these inactive customers confirmed that many customers did not move forward due to solar-readiness issues such as problems with the roof (44%), code enforcement issues (13%), solar shading, orientation, or pitch issues (12%), or other services needed (6%). Less than a fourth of inactive customers (23%) were inactive due to lack of interest or lost contact, and only 17 percent of customers were deemed ineligible after initial screening of homeownership and income. Table 20 displays all reasons documented by GRID. Note that a customer could be marked inactive for more than one reason, so the percentages shown are of all inactive customers but do not add up to 100 percent.

Table 20: Recorded Reasons for Inactivity (n = 1,728)

Inactive Reason	Detailed Reason	Percent of all Inactive Customers
Home not solar-ready	Roof Issues (unsafe, repairs needed, or too small)	44%
	Code barriers	13%
	Solar shading, orientation, pitch issues	12%
	Other professional services needed	6%
Not interested	Not interested in program	18%
	GRID lost contact with customer	5%
Eligibility	Not eligible	9%
	Energy usage too low	4%
	Other ineligible	4%

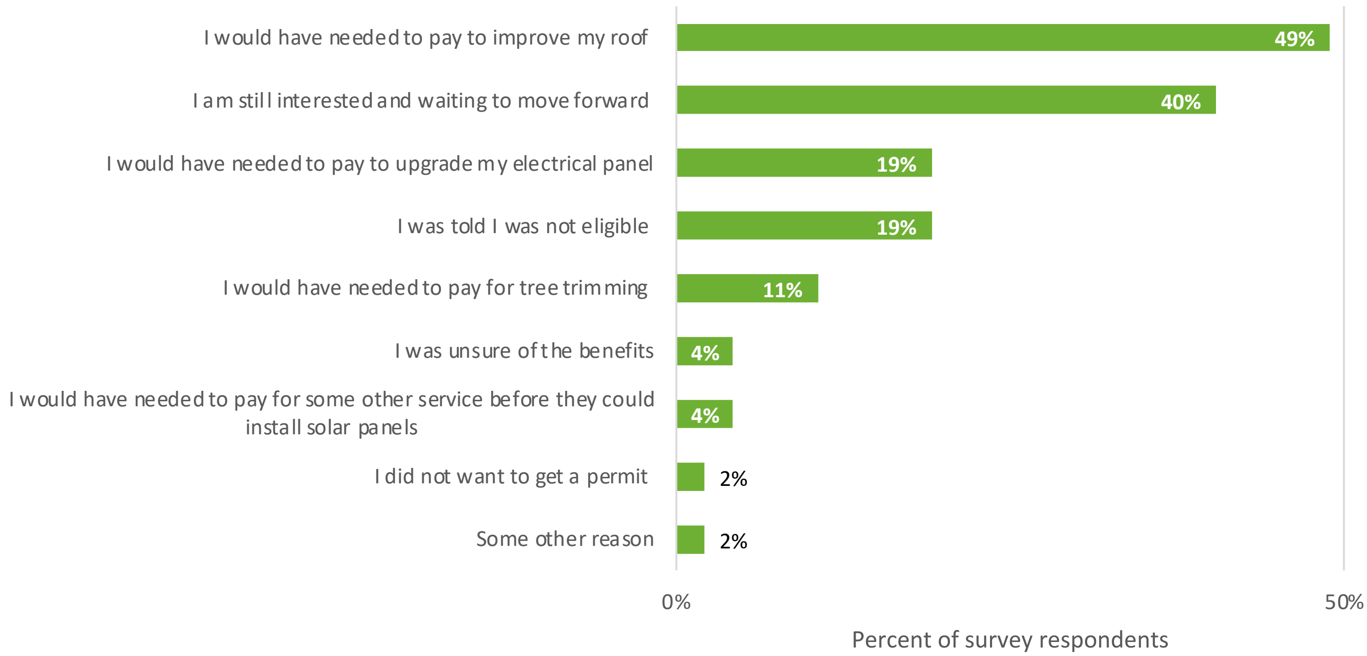
Figure 17 shows that participant-reported barriers align with those reported by GRID, and these are further confirmed in our non-participant survey results shown in Figure 18. Amongst participants, distrust regarding the authenticity of the offer (55%) was most common. Doubts about their ability to save money through the program (32%) and their unwillingness to share required information (22%) were also common responses.

Figure 17: Reported Obstacles to Participation (n = 130, multiple responses allowed)



Notably, interest in solar in general was not a large barrier reported in the survey (see Section 6.4). To further understand why customers who had heard about the program had not yet participated, we asked non-participants to expand on their reasons for not yet participating. Figure 18 shows that about 40 percent of non-participants reported that they are still interested in participating, and the rest of the respondents would have needed to repair their roof before participating (49%), upgrade their electrical panel (19%), or undertake some other service (4%). Only a few respondents reported that they were unsure of the benefits (4%).

Figure 18: Reported Reasons for Not Participating (n = 47, multiple responses allowed)[22]



In the remainder of this section, we expand on the barriers to program participation as identified by GRID, participants, and non-participants.

Trust in Program Offering

Many participants (36%) shared that they felt that the offer seemed too good to be true while deciding to participate in the program (Figure 19). Seventeen percent shared a free-response answer, including:

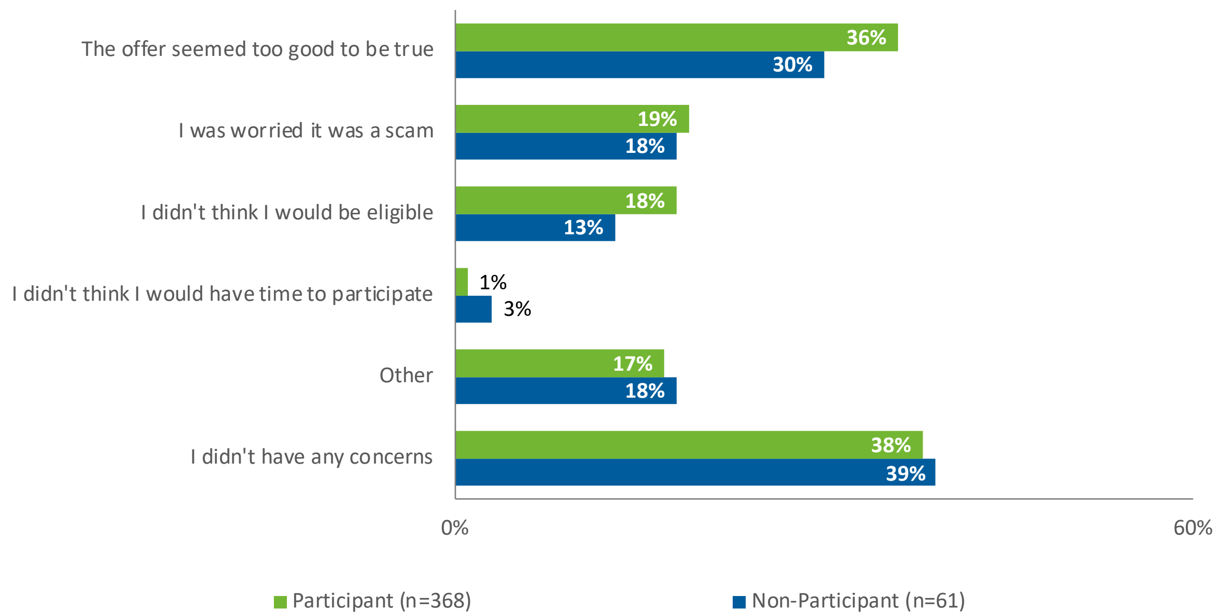
- Concerns surrounding future responsibility for maintenance, repairs, costs/taxes (10)
- General concerns with installation (7)
- Concerns about calculating solar panel and energy needs (5)
- Length or difficulty of process (paperwork or bureaucracy) (5)
- Potential effects (4)

Notably, non-participants were more likely to say they did not have any concerns (39%), but also wrote in that they had other concerns more often than participants. Eighteen percent of the

[22] Out of the 19 SASH respondents who stated that they were waiting to move forward with installing solar, 18 reported an answer about what they were waiting for to move forward. Reported answers included the process being stalled due to time and implementation lags as well as bureaucratic stalls (9), eligibility issues that prohibit them from moving forward (4), needing more information to move forward (2), and a lack of resources and assistance that they need to move forward with installing solar. (2).

respondents stated that they had other concerns and when asked to elaborate, reported concerns such as outreach and availability issues (3), personal reasons (3), worries about panel effectiveness (2), and eligibility issues (2).

Figure 19: Concerns When Deciding Whether to Participate (multiple responses allowed)



Solar-Readiness

Interviews and site visits with GRID found that one of the largest barriers to enrollment of eligible customers was the gap between the cost to install projects and the incentive received through the SASH program. Eligible customers' homes were often not solar-ready and required costly upgrades before solar panels could be installed. To keep the program at no-cost to the customer, GRID often tried to bridge this gap with external funding and TPO agreements, as discussed in Section 4.2.2.

This section reports on costs that were not inherent to the installation or materials reported, but were additional professional services costs that were required to make the homes solar-ready. The costs recorded from program data were often covered by grant funding, either through large partnerships with municipalities, or smaller, one-off grants from CBOs. In a few cases, participants would pay on their own, but these data were limited as the participant may initiate this service on their own. For example, a customer could be deemed eligible then at the site visit be told that their roof is of poor quality and would need to be repaired before solar panels could be installed. GRID will make a good faith effort to find external funding to pay for the roof repair, but if they are not able to, will tell the customer that they cannot move forward with SASH. At that point, the customer may initiate a roof repair on their own, then re-apply to SASH.

Our analysis of program data found that of all projects completed under SASH, 13 percent recorded some professional service that GRID helped pay for. Electrical service upgrades were the most common, with 595 projects, but roof-related expenses were the most expensive on average (Table 21).

Table 21: Professional Services Costs Recorded by GRID

Service Recorded	N	Minimum cost	Average Cost	Maximum Cost
Electrical service upgrade	595	$500	$2,394	$26,865
Professional engineer letter/stamp	321	$80	$161	$500
Electrical services other	208	$50	$664	$4,275
Re-roofing	88	$18	$9,029	$21,000
Other	24	$275	$1,021	$2,595
Roof repair	11	$1,200	$3,946	$7,167
Re-roof & Re-Install PV system	9	$500	$1,457	$3,564
Code Compliance	7	$125	$152	$170
Tree trimming / removal	6	$600	$1,250	$2,000
Equipment Rental	3	$250	$617	$1,000
Fencing	2	$200	$250	$300
Ground mount sub-structure	2	$750	$800	$850
Assessment	1	$150		
General Contracting	1	$500		
Permit Expediting	1	$175		
Service upgrade	1	$2,649		

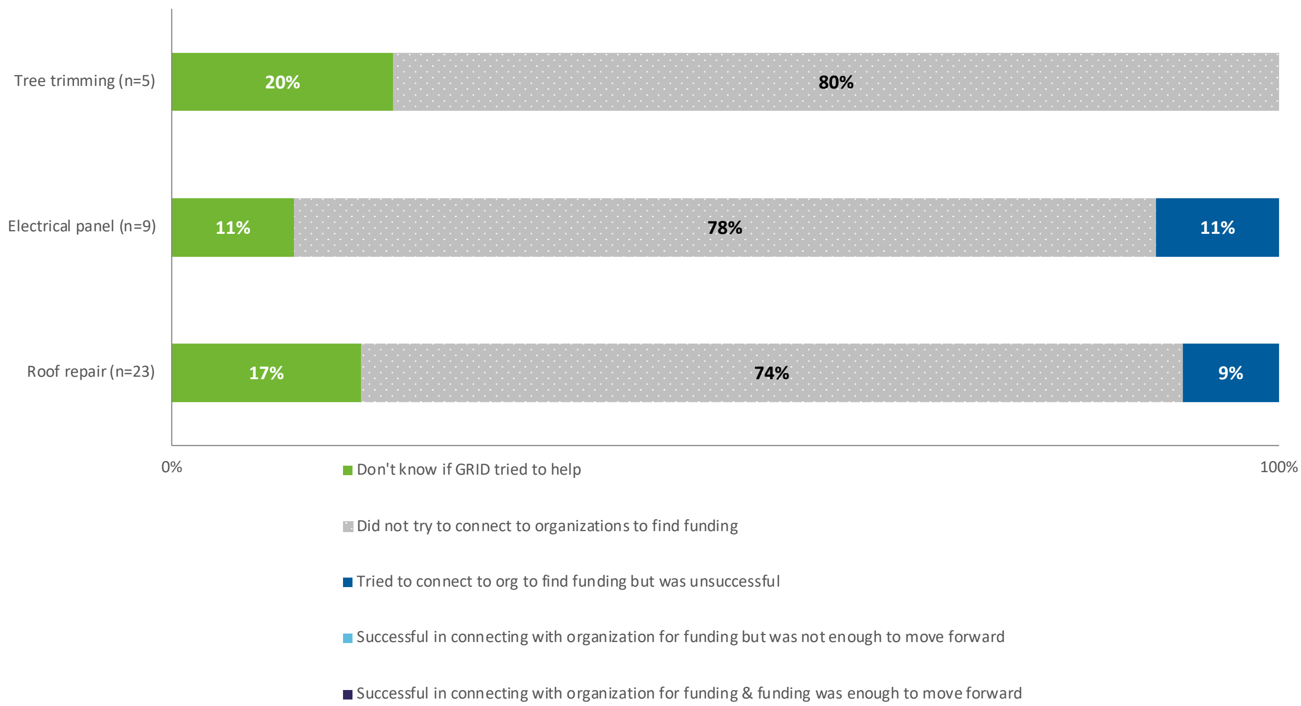
Interviews with GRID found that when they were not able to secure funding for the additional costs required, customers either cannot move forward with the program or must pay out of pocket before participating. The survey of program participants found that most customers that needed additional funding to complete their installation did not receive help from GRID (53%, Table 22).

Table 22: Self-Reported Services Needed in Order to Complete Installation (n = 82)

Service	Number of Respondents that Required a Service	Help from GRID	Paid on Own	Number of Responents that Provided Cost information	Average Total Cost
Electrical or panel upgrades	17	71%	29%	5	$1,860
New roof/Roof repair	23	17%	83%	19	$8,067
Tree trimming	7	29%	71%	4	$662
Did not specify	17	71%	29%	3	$11,500
TOTAL	**64**	**47%**	**53%**	**31**	**$6,718**

We also asked non-participants if there were services that prevented them from moving forward with the program. Out of all the respondents across all needed services, 77 percent reported that GRID did not try to connect them with any organizations to help with funding. No respondents reported GRID successfully connecting them with an organization for funding and funding being enough to move forward. Figure 20 displays attempts at finding funding and the extent of support, if provided, by service needed.

Figure 20: GRID Assistance for Other Funding



For the non-participants that needed additional repairs for their home to be ready for solar, the overall average estimated cost reported was $5,045. Table 23 shows the minimum, average, and maximum costs reported.

Table 23: Non-Participants' Cost Estimates to Upgrade Home for Solar (n = 31)

Service needed	Minimum	Average	Maximum
Roof repair (n = 17)	$1,000	$10,970	$27,500
Electrical panel (n = 9)	$1,000	$2,566	$10,000
Tree trimming (n = 5)	$1,000	$1,600	$3,000

Though the survey did not ask directly about respondents' feelings towards making the home solar-ready, there were non-participants that reported they did not want to make the required updates or repairs to their home, even if they had the means to. Seven respondents wrote in that they did not want to cut down shade trees, or that their neighbor's trees precluded them from participating.

Unpermitted Work on the Property

Another barrier reported by GRID staff was the existence of unpermitted work on the property. In our analysis, we found that only seven (of 368 total) surveyed participants reported needing to upgrade their home to bring it up to code. However, of all inactive customers that did not participate in the program, 13 percent listed code issues as one of the reasons (n = 1,728).

Unpermitted work can either impede an installation directly or serve as a deterrent to having an inspector in the customer's home. During the SASH solar installation process, an official from the municipality must inspect the solar project after completion before interconnection can occur. At this stage, if there is unpermitted work on the property (i.e., a deck or patio), the inspector has the right to enforce compliance – either by issuing a fine or having the homeowner remove the unpermitted structure. GRID staff are not involved in this process but allow customers to choose when participating in SASH if they would like to risk the inspector's enforcement, get the work permitted, or not move forward with the project.

Energy Usage

The evaluation also found two groups of non-participants for whom low energy usage is a barrier. One group of non-participants perceive their energy bills as too low for them to benefit from solar panels. This group self-selects out of the program because they do not think they will qualify or benefit.

The other group is comprised of non-participants who applied and were interested in the program but were disqualified due to their low energy usage. The minimum system size eligible for SASH incentives was 1 kW. Some low-income, eligible households already adhere to cost-saving energy-efficiency practices, and therefore their energy usage was too low to qualify for solar. These instances were not as common as eligibility or cost barriers but did occur; 4 percent of all inactive projects were disqualified due to low energy usage (n = 1,728). One outreach coordinator sympathized with these cases and said it was difficult to explain to someone who could really benefit from the program that they are being penalized for saving energy and money.

4.5.3 Enrollment in Related Programs

Part of the study's charge was to identify awareness among target customers of the various programs designed to serve them and whether the program helped increase enrollment in the other programs such as California Alternative Rates for Energy (CARE), Energy Savings Assistance (ESA), or the Self-Generation Incentive Program (SGIP).

The SASH program handbook required that GRID provide education sessions for all program applications and assist in referring them to providers of additional energy efficiency services. Interviews with GRID staff found that some regional offices had direct relationships with ESA program administrators and shared leads between the two programs, but this was not formally documented in the program handbook.

We looked at two additional data sources – IOU Customer Information System (CIS) data and self-reported enrollment from surveyed program participants – to understand if enrollment in other programs was happening alongside enrollment in SASH.[23]

IOU Data Findings: There was very little income data available from IOU data, so we were unable to estimate the number of CARE-eligible SASH participants. The data we analyzed from the IOUs capture CARE enrollment as of the date the data were retrieved. Other studies, such as the 2022 Low Income Needs Assessment, have found that many CARE participants enroll, but do not recertify their income and can fluctuate on and off the CARE rate. Pulling these data at different days of the year could produce different enrollment figures. In Table 24, we present the total number of CARE-enrolled participants and calculated the percentage of the total population. Enrollment in CARE among SASH participants varies by IOU, with higher rates of enrollment for SCE and SDG&E customers than for PG&E customers (56%, 43%, and 22%, respectively).

Table 24: CARE Eligibility and Enrollment Among SASH Participants

Utility	# Participants	# Enrolled	% Enrolled
PG&E	4,336	969	22%
SCE	4,017	2,246	56%
SDG&E	1,055	453	43%
Total	**9,408**	**3,668**	**39%**

SASH participants are also income eligible for ESA, a program that offers free energy-saving improvements. If the customer has previously participated in ESA, they may only be able to participate if previously installed measures have expired or if new measures are offered. Therefore, the number of total eligible households is likely smaller than the number of participants in SASH. In our analysis, we did not request premise-level participation data, so we could not calculate the total number of eligible SASH customers.

Overall, only 11 percent of SASH participants have also participated in ESA (Table 25). Notably, GRID's semi-annual reports include numbers of referrals and enrollments in ESA but include both participants and non-participants they have enrolled, while the evaluation only analyzed participants.

[23] Note that while the full number of completed SASH projects at the time of this evaluation (March 2022) was 9,501, we were only able to match 9,408 program participants to the IOU CIS data used for the analyses in this section

Table 25: ESA Eligibility and Enrollment Among SASH Participants

Utility	# Participants	# Eligible	# Enrolled	% Enrolled
PG&E	4,336	4,336	572	13%
SCE	4,017	4,017	3	1%
SDG&E	1,055	1,055	426	40%
Total	**9,408**	**9,408**	**1,001**	**11%**

The San Joaquin Valley DAC (SJV DAC) pilot offered electric appliances to customers who had to rely on propane and wood for heating and cooking. Eligibility requirements for the project varied over the course of the pilot, and for this analysis whether the consumer resides in an eligible community is the only requirement used to determine eligibility. The SJV DAC pilot was only approved in 2018, so we did not expect many SASH participants. We found that only 1 percent of SASH participants also participated in the SJV DAC pilot (Table 26). GRID staff noted that they had a close partnership with SJV pilot to share leads between the two groups, but IOU CIS data did not find many enrolled.

Table 26: SJV DAC Eligibility and Enrollment Among Participants

Utility	# Participants	# Eligible	# Enrolled	% Enrolled
PG&E	4,336	86	-	0%
SCE	4,017	354	2	1%
SDGE	1,055	-	-	NA
Total	**9,408**	**440**	**2**	**0%**

A small portion of SASH participants were enrolled in SGIP, a program that provides incentives to support installation of energy storage systems even though all SASH customers are eligible for the program by participating in SASH (Table 27). A rebate from the SGIP program could cover approximately 85 percent of the cost of an average storage system. The low enrollments may be due in part to the contractor-driven nature of that program.

Table 27: SGIP Eligibility and Enrollment Among Participants

Utility	# Participants	# Eligible	# Enrolled	% Enrolled
PG&E	4,336	4,336	7	0%
SCE	4,017	4,017	2	0%
SDGE	1,055	1,055	-	NA
Total	**9,408**	**9,408**	**9**	**0%**

Participants that meet additional qualifications, such as residing in a Tier 2 or 3 High Fire Threat District (HFTD) or have experienced two or more utility Public Safety Power Shutoffs (PSPSs), are eligible for rebates that cover close to 100 percent of the cost of an average energy storage system. No participants were enrolled in the SGIP Equity Resiliency Program, but Table 28 shows that 7 percent of all program participants were eligible for this higher rebate.

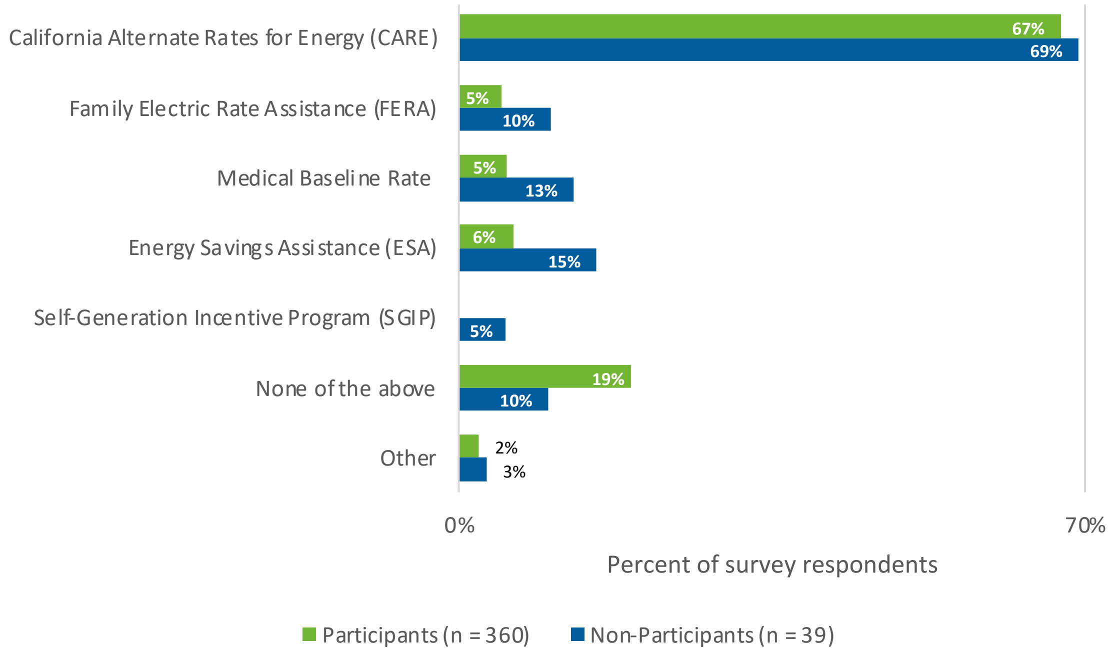
Table 28: SGIP Equity Resiliency Eligibility Among Participants

Utility	# of Participants	# Eligible for Equity Resiliency	% Eligible for Equity Resiliency
PG&E	4,336	288	7%
SCE	4017	159	4%
SDGE	1,055	194	18%
Total	**9,408**	**641**	**7%**

Interviews with GRID staff found that they were ramping up storage work but that funding ran out quickly. Staff members stated that the auto-qualification for SGIP is helpful but that their participants do not often overlap with the HFTD map, so they do not focus on it as much.

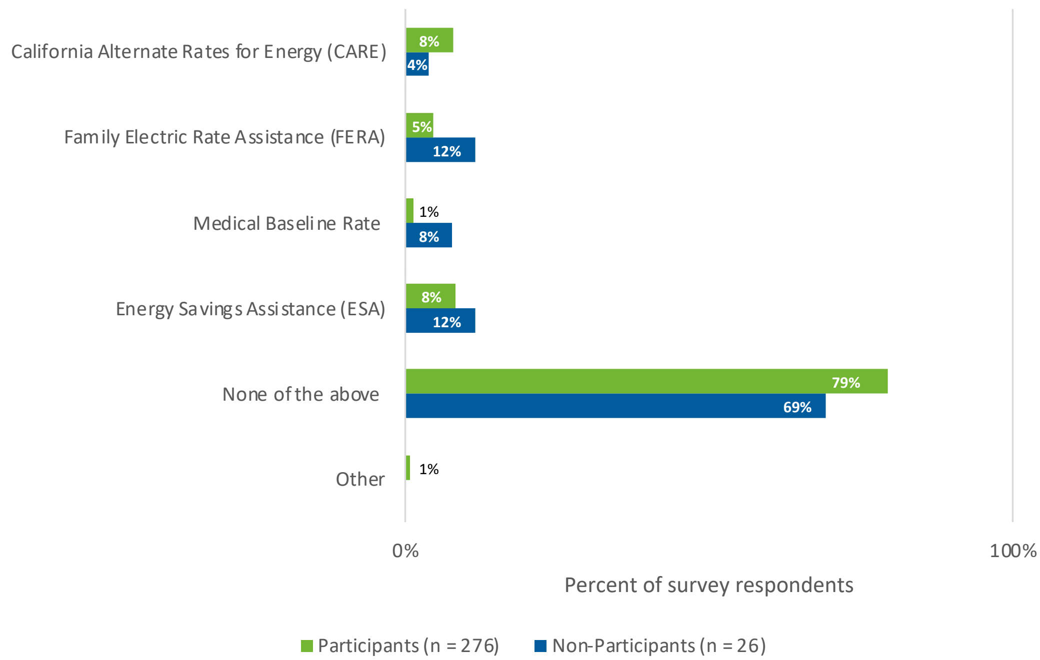
Self-Reported Enrollment in Other Programs: In addition to IOU CIS data, we also asked survey respondents about their enrollment in other energy programs. Figure 21 shows that many surveyed participants and non-participants (67% and 69% respectively) believed they were already enrolled in CARE before applying for the SASH program. The overall CARE enrollment percentage based on IOU CIS data (39%) is lower than what was reported in the survey. This could be due to the most involved participants responding to the survey. Interviews with GRID staff members also found that some customers believe they are enrolled in CARE but are not aware that they need to re-certify their eligibility every two years. Therefore, some survey respondents could be incorrectly reporting their current CARE enrollment status.

Figure 21: Enrollment in Other Energy Program Before Applying to SASH (multiple responses allowed)



Most respondents did not report enrolling in any other energy programs around the same time as applying for SASH, but of the few that did, most frequently reported that they enrolled in ESA (8% and 12%, Figure 22).

Figure 22: Enrollment in Other Energy Program Around the Same Time as Applying for SASH (multiple responses allowed)



4.6 Post-Installation Customer Experience

GRID offered a 10-year equipment and service warranty after solar installations through the SASH program, which is standard in the industry. For TPO systems, the customer received a 25-year warranty for which GRID services the system for the first 10 years, then the TPO company services the system for the remaining 15 years.

Some survey respondents (19%) reported having some issue with the system since installation. Of these, 54 expanded on the issues. The most common issues reported were:

- A need for panel replacement, addition, or maintenance (23%, 16);
- System needing updates and or an unspecified system malfunction (17%, 12);
- Specific component (e.g., inverter or monitor box) (14%, 10);
- Billing or customer service (7%, 5); and
- Roof issues – leaks, birds, cleaning (3%, 2).

Only three respondents reported costs of the post installation isues, which were an average of $417.

The survey also asked about any maintenance required for the panels. A few respondents (14%) reported that their panels required maintenance such as cleaning or washing the panels. Of those that shared costs (n = 10), the reported average cost for maintenance was $102.

In addition to survey responses, our evaluation captured a few anecdotal reports of service requests to GRID and Sunrun. One story is shared below to illustrate some challenges participants have had communicating with Sunrun.

> One participant reported that they were unable to get help for their breaker that keeps tripping since Sunrun installed a new inverter in 2020. The participant called GRID Alternatives for help, which referred her to Sunrun because it was a TPO system. The resident contacted Sunrun but did not understand how to move forward. Our evaluation team stepped in to try to understand the process, and found that the only way for the participant to get her breaker fixed and covered by Sunrun was to:
>
> 1. Take a photo of the issue and email it to Sunrun to start a ticket. Sunrun would decide whether to send a technician.
> 2. Schedule a "healthy system inspection." This would send a technician out to the site to diagnose whether it is solar related. If it is related, they will fix it without cost. If they deem it is not related, they will charge $190 for the visit and will not fix it.
> 3. Hire an independent electrician to determine if it is solar related. If the electrician deems it is and fixes it, Sunrun will reimburse the homeowner for the cost after the electrician submits an office report.
>
> In this case, the participant did not have an email address to start a ticket. Sunrun informed the evaluation team that there was no other way to submit a ticket. Additionally, the participant did not understand the process of reimbursement or feel comfortable paying out of pocket of repairs that may not be reimbursed.

We heard similar stories during our evaluation. After discussing the issue with GRID, they committed to reaching out to the participant to help explain the options for solar ownership better.

4.7 PV System Impacts

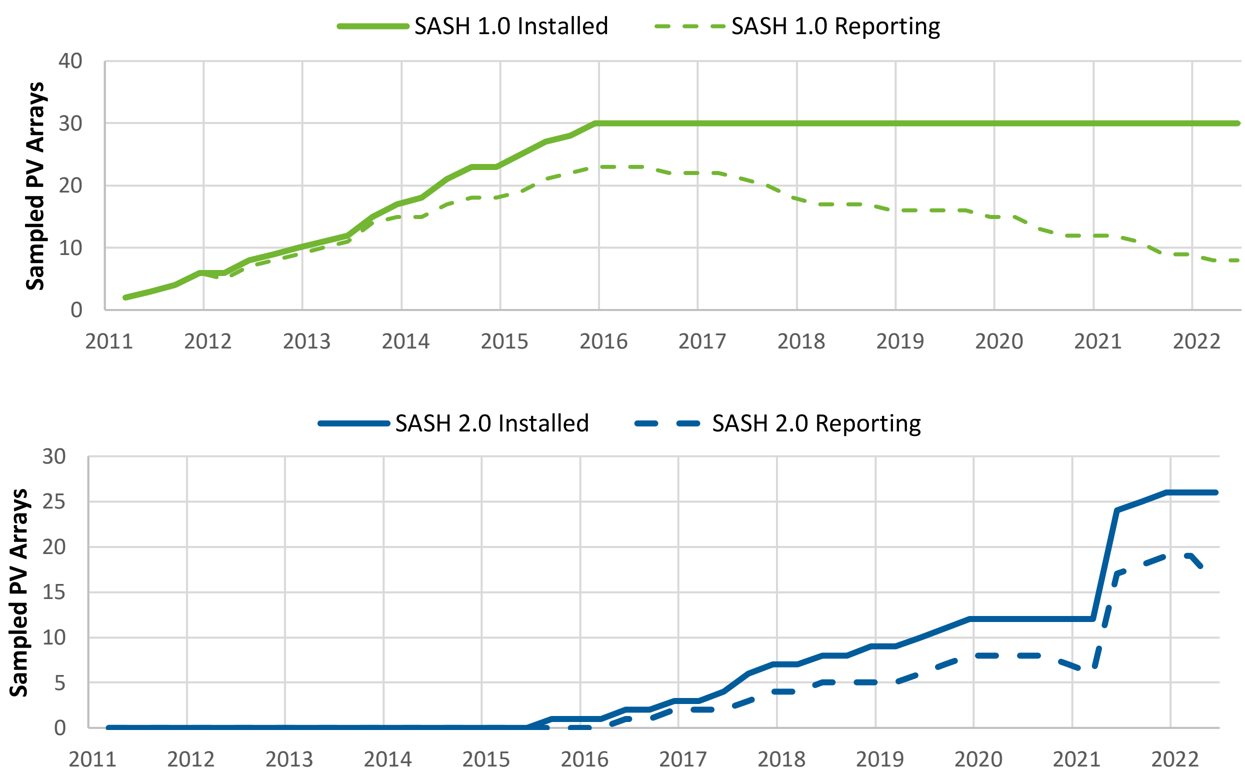
To assess PV impacts, the evaluation had a two-part goal: 1) verify total PV installed capacity achieved through the program, and 2) understand how this installed capacity performed compared to expectations and what factors may be most impactful on system performance. This section summarizes the data limitations, common reporting errors, and overall realization findings and impacts.

4.7.1 Data Limitations

In evaluating the impacts, we discovered several data limitations. We summarize the limitations here to provide context for the findings and go into more detail in Section 6.5.

The Evergreen team reviewed generation data from two different monitoring systems – Enphase-Enlighten and SolarEdge. Monitoring through private systems is the only way we can gain insight into the solar production for solar systems that share an import/export meter with a house. Figure 23 illustrates generation data availability across the sample of projects. Data reporting issues accumulated over time, so of a total of 30 SASH 1.0 projects in the sample, only eight were continuing to report generation data at the time of this evaluation.

Figure 23: Average Hourly Demand Impacts by IOU – July



Reporting errors do not necessarily indicate that the solar system is malfunctioning. One customer indicated during the on-site assessment that despite data missing from their Enphase-Enlighten portal, their utility bills continue to reflect that their PV system is generating. However, the prevalence of reporting errors limited Evergreen's ability to comment on the long-term performance of SASH 1.0 projects due to the inconsistency of monitoring system tracking of older systems. Table 29 outlines the daily data availability for the sampled projects that were monitored with Enphase-Enlighten and SolarEdge.

Table 29: Enphase-Enlighten Sample Daily Availability

Monitoring System	Projects Affected	Projects in Sample	Instances of Error	Total Days	Days with Error	Percent of Days Missing
Enphase-Enlighten	25	48	34	96,776	19,355	20%
SolarEdge	3	13	3	151	6	4%

Through the evaluation, we found that Enphase-Enlighten did not automatically identify outage events to GRID or the customer. It was the responsibility of the system owner to identify monitoring system errors and report to their respective monitoring system company. For homeowner-owned systems, that required the homeowner to monitor their production. For TPO systems, the contract with the TPO states that it was the solar company's responsibility to monitor, communicate, and fix any system outages. As discussed above, however, there were limitations to communication between Sunrun and the participants.

4.7.2 Program Data Errors

The Evergreen team found one data error in the program tracking database provided by GRID:

- **Hardware Replacement:** There was one instance out of eight field visits where a program participant replaced hardware provided through the SASH program with custom equipment. The model for this project would not calibrate to zero, indicating a misalignment between estimated reported energy generation and metered energy generation. This customer-owned project was selected for on-site assessment during which the customer indicated they replaced the original 230W solar panels with new higher-rated 300W panels.

The Evergreen team also found two instances of data errors in the Expected Performance-Based Buydown (EPBB) files that were received from GRID, as bulleted below.

- **Zero Degree Azimuth and Tilt Angles:** There were three instances out of 48 in the sample where documentation indicates energy generation with a 0-degree tilt angle and 0-degree azimuth angle. Google Earth observations clearly show solar panels are mounted on sloped rooftops. There are instances where an EPBB file and field report are delivered but the values therein do not match, indicating that EPBB files may not have been updated after field verifications were conducted. For the purposes of this analysis, non-zero angles were used for the evaluation.
- **Antiquated Solar Panel and Power Inverter Models:** EPBB output files result in an error when older hardware models or database entry mistakes are used in the EPBB tool. The online EPBB tool is periodically updated by adding and removing hardware options from the drop menus. There are seven instances out of 48 where sample projects have solar

panel modules installed that are no longer listed in the EPBB drop menu, incorrect equipment entry is suspected for one project's inverter model, and database typos occur in one project solar panel and four project inverters. EPBB files with any of these issues do not include the monthly estimated energy generation bar plot, and monthly energy generation for these projects is estimated using annual energy generation from the EPBB file and substitute hardware in the online EPBB tool.

4.7.3 Discrepancies Between EPBB and Tracking

The program tracking database and the EPBB files provided by GRID were generally aligned on estimated annual energy generation and Design Factor (DF). Nuances in program implementation may explain the minor discrepancies that the Evergreen team found. The following sections explain these instances in more detail.

Estimated Annual Energy Generation

The EPBB files and program tracking data aligned for 28 of the sampled projects, and all 48 samples were within 100 kWh of the annual estimate (Table 30). Projects with a higher energy generation difference were frequently included in the field verification activities conducted by GRID. This likely indicates that the EPBB database or the program tracking data are being updated post-verification, while the other is not. Out of the 48 projects in the sample, field verification reports were provided for seven projects. These field verification reports were developed by GRID and described adjustments to originally submitted project parameters for five projects. Revisions were suggested for azimuth angles, module quantity, shading factors, and mounting method. However, field verification findings are not always translated to the EPBB database. It is unclear why revisions are not always made in the EPBB database.

The two outlying samples where generation estimates are greater than 650 kWh have a system size larger than the maximum program allowance of 5.0 kW-DC.[24] When a system is installed that is greater than this threshold, additional energy generation is not recorded in program tracking. In other words, the tracking database will record energy generation for a PV system larger than 5.0 kW-DC as if it were a 5.0 kW-DC system. Energy generation for additional system capacity is not recorded.

[24] Note that the maximum allowable size for the SASH program was a 5.0 kW system. These systems may have been the result of additional panels purchased and installed by the homeowners after participation, but we could not confirm.

Table 30: EPBB and Program Tracking Data Discrepancies

	SASH 1.0		SASH 2.0		TOTAL	
EPBB-Tracking Energy Generation Diff. (kWh)	Project Quantity	GRID Field Verification Quantity	Project Quantity	GRID Field Verification Quantity	Project Quantity	GRID Field Verification Quantity
0	11	1	17	0	28	1
25	1	0	3	0	4	0
50	5	2	1	0	6	2
100	2	0	0	0	2	0
650	5	3	1	1	6	4
2,000	0	0	1	0	1	0
5,000	1	0	0	0	1	0
TOTAL	**25**	**6**	**23**	**1**	**48**	**7**

Table 31 describes the total difference in annual energy generation values for the sampled projects as recorded in the tracking database and the EPBB files. The total difference between the two sources is 2.1 percent.

Table 31: File and Program Tracking Estimated Total Annual Generation Difference

Program	Tracking (MWh)	EPBB (MWh)	Difference (MWh)	Differenc
SASH 1.0	113.5	109.4	4.1	3.6%
SASH 2.0	148.7	147.2	1.5	1.0%
TOTAL	**262.1**	**256.5**	**5.6**	**2.1%**

Design Factor

The CPUC uses the design factor (DF) to determine if a system meets the minimum requirements for eligibility. There are two methods used to calculate a project's DF:

- The method used during SASH 1.0 is the product of a design correction factor, geographic correction factor, and installation correction factor.
- The method used during SASH 2.0 does not consider the geographic correction factor.

The method used to calculate the DF is inconsistent between the EPBB file and the tracking database for 30 projects out of 48 sampled. All EPBB file DFs align with either the SASH 1.0 or SASH 2.0 calculation. A subset of 11 projects within the tracking database, however, reports a DF that does not correspond to known methods in the tracking database. It is unlikely a coincidence that four of the seven projects verified by GRID also have a tracking DF that does not identify with either calculation method. This suggests that EPBB files may have been updated to reflect the field verification while the tracking database remained unchanged.

The tracking database has one DF recorded for any given project. However, there is a calculation required to determine this value when a project has multiple orientations. An EPBB file is provided for each orientation subarray, which makes comparison of them challenging due to an opaque method of combining the subarray DFs into a single factor.

4.7.4 Overall Realization Rates

The Evergreen team calculated a realization rate for each project in the evaluated sample. The realization rate was calculated as the ratio between the verified normalized energy production and the program-reported energy production. Realization rates were calculated using the most recent 12 months of generation data available for each system, ending no later than June 30, 2022. A realization rate greater than 100 percent indicates that the solar array is producing more energy than originally estimated by the program via the EPBB tool.

The average annual sample realization rate is 105 percent across participating IOUs (Table 32). In other words, the solar arrays in the evaluation sample are generating 105 percent of the program's original estimate.

Table 32: Sample Realization Rates by IOU

IOU	Sample Quantity	Reported Energy Production (MWh)	Verified Energy Production (MWh)	Realization Rate
PG&E	14	56	57	103%
SCE	25	161	167	103%
SDG&E	9	40	44	111%
TOTAL	**48**	**257**	**268**	**105%**

Table 33 outlines the realization rate results by program, and Table 34 presents the realization rate by monitoring system type (Enphase-Enlighten and SolarEdge).

Table 33: Sample Realization Rates by Program

Program	Sample Quantity	Reported Energy Production (MWh)	Verified Energy Production (MWh)	Realization Rate
SASH 1.0	25	109	115	105%
SASH 2.0	23	147	153	104%
TOTAL	**48**	**257**	**268**	**105%**

Table 34: Sample Realization Rates by Monitoring System

Monitoring System	Sample Quantity	Reported Energy Production (MWh)	Verified Energy Production (MWh)	Realization Rate
Enphase-Enlighten	35	164	173	105%
SolarEdge	13	93	95	103%
TOTAL	**48**	**257**	**268**	**105%**

Realization rates for projects that were installed earlier were found to be lower than more recently installed systems. The realization rate of systems five to ten years old was 98 percent, as compared to 106 percent for systems zero to four years old (Table 35). This observation is likely due to a combination of two factors:

1. Solar PV system generation degrades over time due to normal wear and tear and exposure to outdoor elements.
2. New PV systems are more efficient with lower inherent loss factors as component designs have been improved.

Many systems had recent and ongoing data reporting issues that could mask greater rates of degradation (Appendix A: Methodology discusses how we determined analysis periods for individual projects). We used the most recent data available for a given project resulting in many project analyses occurring within two years of installation. We were unable to evaluate the current condition of many older systems (over two to four years old) because the data were simply not available. The timespan reflected in the data was too short for system degradation to show in energy generation data, but older projects are expected to show lower realization rates.

Table 35: Sample Realization Rates by System Age

Difference in Analysis Year and Installation	Sample Quantity	Reported Energy Production (MWh)	Verified Energy Production (MWh)	Realization Rate
0 – 4	36	213	225	106%
5 – 10	12	44	43	98%

TPO system and residence-owned system realization rates were found to be similar, within 2 percent of each other (Table 36).

Table 36: Sample Realization Rates by Ownership

System Ownership	Sample Quantity	Reported Energy Production (MWh)	Verified Energy Production (MWh)	Realization Rate
TPO	8	47	49	105%
Non-TPO	40	210	219	104%

4.7.5 Program Energy Impacts

We extrapolated the results of the sample analysis to the total program population to quantify the annual impact of the full SASH program, estimated to be 48,438 MWh per year. Table 37 and Table 38 present energy impacts by IOU and program respectively.

Table 37: Energy Impacts by IOU

IOU	Total Installed kW-Rating (kW-DC)	Energy Generation (MWh)	Percent of Energy Generation (%)
PG&E	15,449	20,275	42%
SCE	15,176	22,538	47%
SDG&E	3,582	5,625	12%
TOTAL	**34,207**	**48,438**	**100%**

Table 38: Energy Impacts by Program

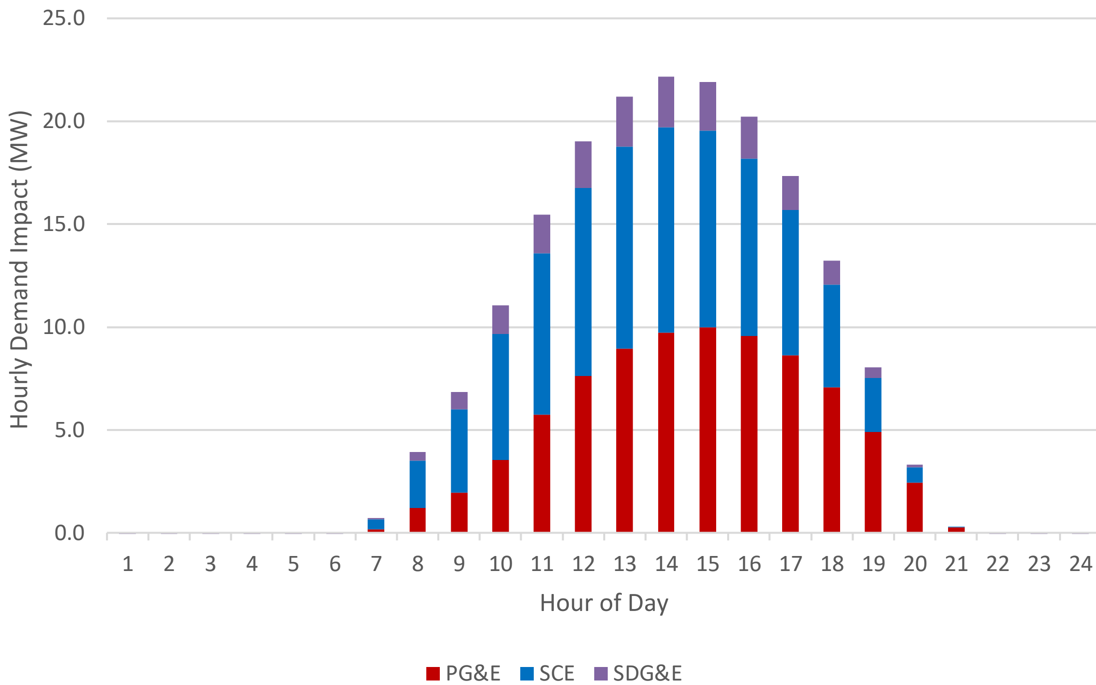
Program	Total Installed kW-Rating (kW-DC])	Energy Generation (MWh)	Percent of Energy Generation (%)
SASH 1.0	18,517	26,134	54%
SASH 2.0	15,690	22,304	46%
TOTAL	**34,207**	**48,438**	**100%**

4.7.6 Demand Impacts

The load shape of energy generated by PV shifts with the angle of the sun hourly and daily throughout each year. The load shape of SASH PV installations for an average July day is shown in Figure 24.[25] The maximum hourly demand impact in July is estimated to be about 22 MW, occurring in the 14th hour of the day, which is 1pm to 2pm.

[25] We checked other summer months to isolate the peak demand. The final peak demand analysis was evaluated on typical year data.

Figure 24: Average Hourly Demand Impacts by IOU – July



4.8 Customer Bill Impacts

This section provides an assessment of the impacts related to installing a solar system through the SASH program using billing and usage data. The objectives of this analysis were to:

- Estimate the
  - Gross annual savings in kWh and bills;[26]
  - Net annual savings in kWh and bills that are attributable to the program;[27]
  - Cumulative program impacts;
  - Persistence of energy savings; and
- Assess the relationship between energy generation and energy consumption by hour for a sample of participants with metered generation data available.

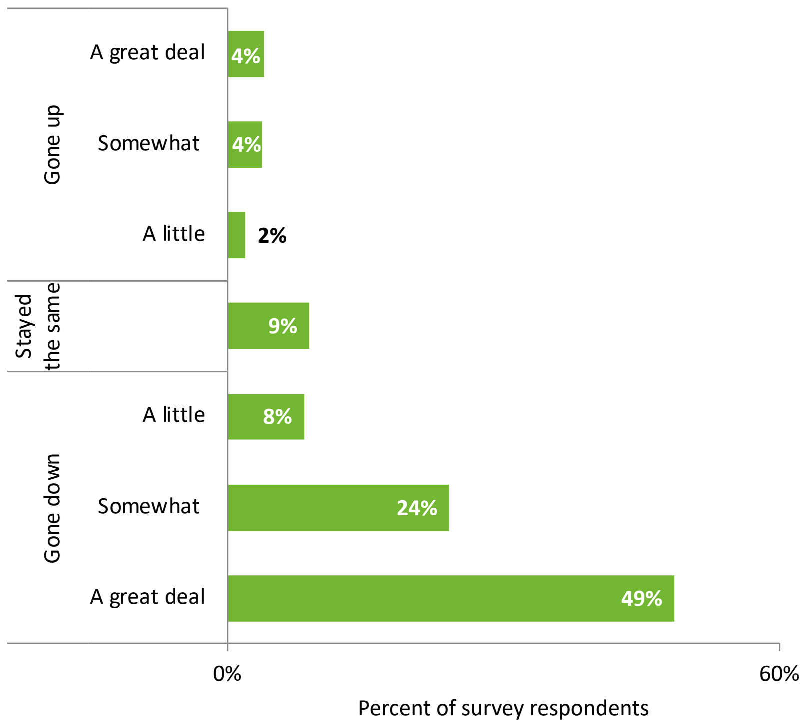
Findings from our billing analysis found that on average, participants saw bill reductions after participation. Figure 25 shows that most of the respondents (81%) reported that their bills have gone down. Only a few respondents shared that they believe their bills increased after installation

[26] Throughout this section, we will refer to "gross energy savings" as the savings found when comparing participants pre- and post-solar install kWh usage.

[27] Throughout this section, we will refer to "net energy savings" as the savings found when comparing participants pre- and post-solar install kWh usage relative to a matched comparison group of future participants over the same time period.

(10%).[28] While most participants exhibited substantial reductions in their electricity bills during the year after the solar installation, we confirmed that a small group of participants exhibited increases in their annual electricity bills after the solar installation.

Figure 25: Self-Reported Bill Impacts After Installation (n = 347)



4.8.1 Annualized Savings

In the rest of this section, we report findings from billing and usage analysis. We used the most granular energy consumption data available (monthly billing kWh and costs, daily and hourly interval kWh from advanced metering infrastructure [AMI] data) in a series of regression models to estimate the energy and bill savings attributable to the solar panels (in kWh and $). See Appendix A for details on the impact analysis methods, sample size, and regression model fit.

Savings by Program

The energy savings estimates from the installation of the solar systems for the post-period were calculated by combining the estimated gross regression coefficients with the weather conditions from the post-period and the Net-to-Gross (NTG) ratio.

[28] Energy usage increases may be due to a variety of factors including a change in the number of people in the home, or a change in equipment.

The gross energy savings estimates were calculated using participants' pre- and post-solar install kWh usage and contain both the decrease in kWh usage due to the energy being generated by the solar panels as well as any change in kWh energy consumption that happened after the panels were installed. When the solar generation credits start being issued, customer energy bills will drop, which often motivates them to use slightly more energy (e.g., increase cooling for comfort). However, in the survey, the participants said they received education on energy efficiency and started to see ways to save around their home around this time.

In general, we would expect to see an increase in energy consumption over the years, as the climate in California has become more extreme (e.g., hotter summers require more cooling) and new electronics or other electrical end-uses are added to the home. An increase in consumption from these types of external pressures will be exhibited by the comparison group. We calculated an NTG adjustment for each program by measuring the savings estimates of the solar installation relative to a matched comparison group of future participants. We estimated this NTG adjustment using gross and net savings for the 2013 program participants for the SASH 1.0 program and 2018 program participants for the SASH 2.0 program.[29] The net savings estimate tells us how much the participants saved *above and beyond* any change exhibited by the comparison group.

Table 39 and Table 40 in this section show the estimated gross savings, NTG adjustment, estimated net savings (in kWh or $ and as a percentage of baseline energy use), and the number of observations that went into the model by program and year of participation. The energy usage NTG adjustment ranged from 1.02 to 1.24, suggesting that without the program, we would have seen a small *increase* in energy usage and bills among participants over the study period (2010-2021) if they had not installed solar. The middle column in Table 39 and Table 40 provides the adjusted net savings estimate (for energy and electricity bill, respectively) with 90 percent confidence intervals. Across the programs, the annual net energy savings have gradually increased, both in kWh and as a percentage of baseline energy consumption. The gross energy savings were relatively stable across these programs, indicating that the increase in savings over time is mostly coming from an increase in *avoided* energy usage. Gross bill savings increased, likely due to changes in rates, as the value of each kWh saved has increased over time.

On average, SASH 1.0 participants are estimated to have a 60 percent decrease in energy usage (4.4 MWh annually) and a 127 percent decrease in their electric bills ($1,032 annually), while SASH 2.0 participants are estimated to have a 67 percent decrease in energy usage (5.0 MWh annually) and a 91 percent decrease in their electric bills ($904 annually). The dollar value of the bill savings will be impacted by the rate schedule. Customers on CARE have a 30 percent discount on each kWh, so their bill savings will show only 70 percent of the cost that they would have had to pay if CARE was not discounting their bill.

[29] For more detail on why we selected these program-years for the NTG adjustment, see Appendix A: Methodology.

Table 39: Estimated Annual Energy and Bill Savings Per Home

Program	Gross Estimated Annual Energy Savings (kWh)	NTG Adjustment (net / gross)	Net Estimated Annual Energy Savings (kWh, after NTG adjustment)	Percent of Energy Savings	N Observations
SASH 1.0	4,274	1.021	4,362 ± 13	60%	11,262,182
SASH 2.0	4,018	1.244	4,997 ± 12	67%	8,717,860

Source: Evergreen analysis of energy consumption of program participants and matched comparison group for program years 2010-2021. The NTG adjustment is based on analysis of the 2013 program participants for the SASH 1.0 program and 2018 for the SASH 2.0 program.

Table 40: Estimated Annual Bill Savings Per Home

Program	Gross Estimated Annual Electricity Bill Savings ($)	NTG Adjustment (net / gross)	Net Estimated Annual Electricity Bill Savings ($, after NTG adjustment)	Percent of Electricity Bill Savings	N Observations
SASH 1.0	$679	1.519	$1,032 ± 1	127%	11,242,660
SASH 2.0	$807	1.121	$904 ± 2	91%	9,951,743

Source: Evergreen analysis of electricity costs of program participants and matched comparison group for program years 2010-2021.

The solar system was intentionally undersized to motivate customers to consider efficiency. The program rules include a provision that "the maximum system size that can receive incentives would be based on an estimate of the household's annual load, assuming all weatherization and energy efficiency measures with a two-year payback or less are undertaken."[30] Notably, the rules do not include a specific benchmark, such as 80 percent of the baseline, to aim for. One downside to this rule is that there is no allowance for future loads from electrification, such as heat pumps and electric vehicles. In the survey, some participants expressed a desire for more panels (n=17 SASH). Specifically, one said that they "wish it [would] produce 100% of my electricity needs and not have a true up bill." Another mentioned electrification, as "We would like to move away from gas appliances. It would be nice if more panels could be added to keep up with these changes."

When shifting to net metering, many participants go from monthly to annual true up bills (19% of SASH participants mentioned this). As one participant put it, "The true up bill at the end of the year is really high and nowadays people are literally trying to make ends meet. Having a huge bill to contend with at the end of a year cycle is scary stuff especially when everything else is so expensive." **Even though solar has decreased their annual electricity bill, it also caused some**

[30] Decision 07-11-045 that established SASH. Retrieved from: https://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/75400-05.htm#P233_54557

customers to incur a single large bill that is difficult to predict. Some participants may be pursuing energy efficiency in the hopes of making their true-up bill more affordable.

Among survey respondents, of the 42 respondents who stated that their bills and usage decreased, the top two reasons included more efficient usage (38%) and maintenance of their panels and more mindful use of energy (29%). Other notable reasons include a decrease in the number of the people in the home (19%) as well as a greater sense of environmental consciousness (17%).

The net bill savings for SASH 1.0 exceed the baseline bill. This is possible because of the NTG adjustment. **In absence of the program, we would expect participants' energy bills to have increased by around 52 percent (or to 1.519 times the size). Instead of participant bills increasing, as the comparison group experienced, participants' bill *decreased* by $679 per year, as we expected.** The overall benefit of the program includes the gross bill savings as well as the avoided bill increases, which increases our savings estimate from $715 to $1,032 per year for SASH 1.0 and $807 to $904 for SASH 2.0.

Savings by Program Year

Figure 26 and Figure 27 show the net annual energy savings per home for each year of the SASH programs, the average size of the solar system installed during each year, and the variability across the years of installation. The left-hand column shows the overall program-level estimate, followed by individual estimates for each program year on the right.[31] The SASH 2.0 savings estimates are between four and five MW per home annually, except for in 2020 (which had a small sample size and therefore was more prone to error). The SASH 1.0 estimates are more variable across the years (between two and five MW per home annually).

[31] The program level results are not the average of the yearly results; the program level estimate is based on a pooled model, including participants from all program years to estimate savings at the program level.

Figure 26: Estimated Net Annual Energy Savings Per Home – SASH 1.0

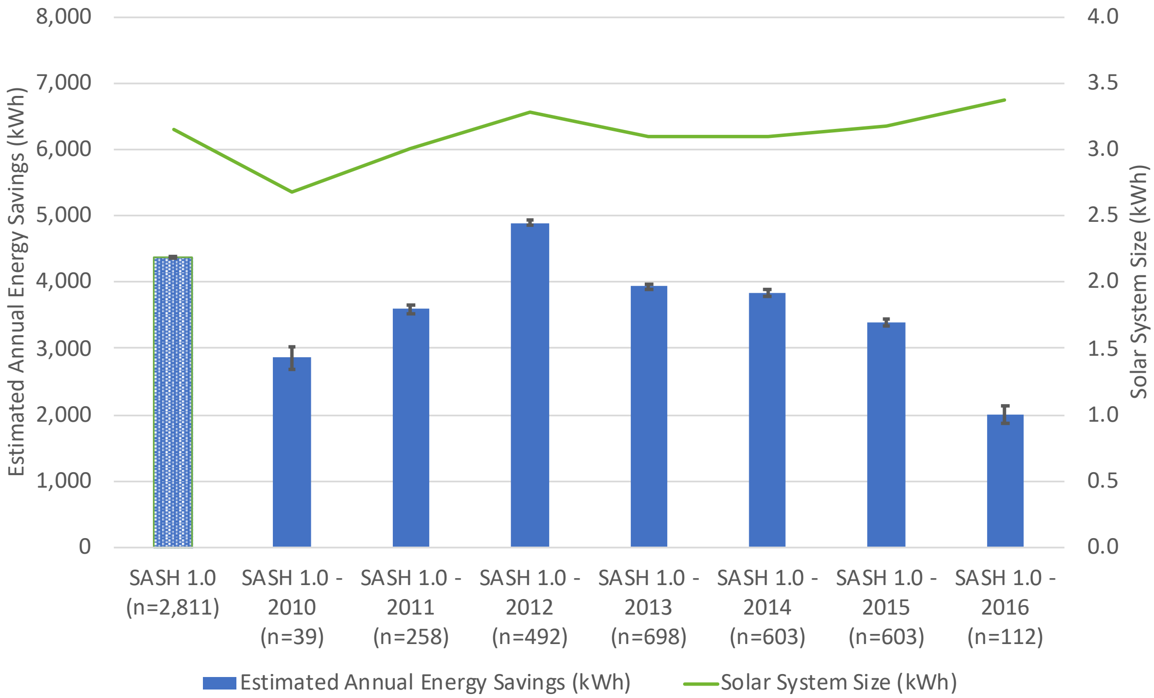


Figure 27: Estimated Net Annual Per Home Energy Savings – SASH 2.0

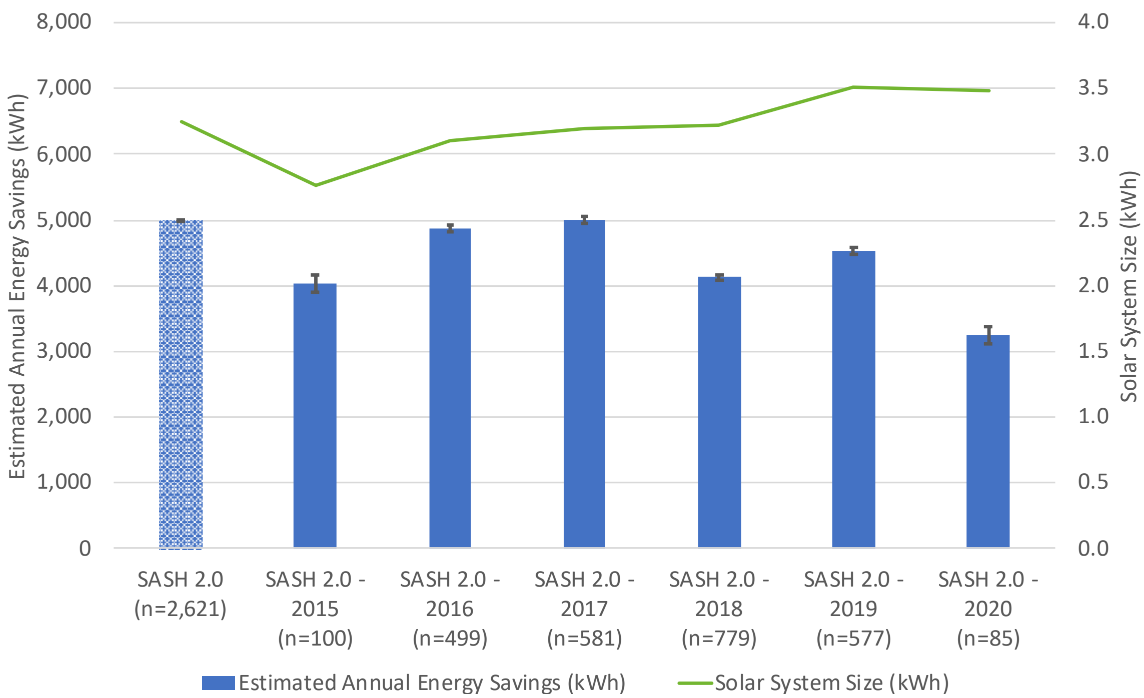


Table 41 shows the estimated annual gross energy savings per home, the NTG adjustment, the estimated annual net energy savings per home, the percent of energy savings, and the number of observations in the model, by program and year that the solar was installed. The estimated annual net energy savings per home fluctuates around three to five MWh per year, which is 45 to 71 percent of a participant's annual energy usage. The two program years that fall outside this range (2010 and 2016) both have small sample sizes, which are less reliable as they are more prone to error. Again, these systems were intentionally undersized to motivate participants to pursue energy efficiency to further reduce their bill.

Table 41: Estimated Annual Energy Savings Per Home

Program – Year	Gross Estimated Annual Energy Savings (kWh)	NTG Adjustment (net / gross)	Net Estimated Annual Energy Savings (kWh, after NTG adjustment)	Percent of Energy Savings	N Observations
SASH 1.0 – Overall	**4,274**	**1.021**	**4,362 ± 13**	**60%**	**11,262,182**
SASH 1.0 – 2010	2,798	1.021	2,856 ± 166	45%	206,705
SASH 1.0 – 2011	3,515	1.021	3,587 ± 62	54%	1,321,731
SASH 1.0 – 2012	4,791	1.021	4,890 ± 45	71%	2,302,679
SASH 1.0 – 2013	3,848	1.021	3,928 ± 39	54%	2,687,525
SASH 1.0 – 2014	3,765	1.021	3,843 ± 48	50%	2,202,920
SASH 1.0 – 2015	3,325	1.021	3,394 ± 50	46%	2,121,474
SASH 1.0 – 2016	1,960	1.021	2,001 ± 138	26%	396,612
SASH 2.0 – Overall	**4,018**	**1.244**	**4,997 ± 12**	**67%**	**8,717,860**
SASH 2.0 – 2015	3,236	1.244	4,024 ± 127	66%	343,844
SASH 2.0 – 2016	3,921	1.244	4,877 ± 52	67%	1,706,073
SASH 2.0 – 2017	4,022	1.244	5,002 ± 48	67%	1,969,646
SASH 2.0 – 2018	3,319	1.244	4,127 ± 40	56%	2,545,064
SASH 2.0 – 2019	3,640	1.244	4,527 ± 50	57%	1,882,463
SASH 2.0 – 2020	2,612	1.244	3,249 ± 123	44%	270,770

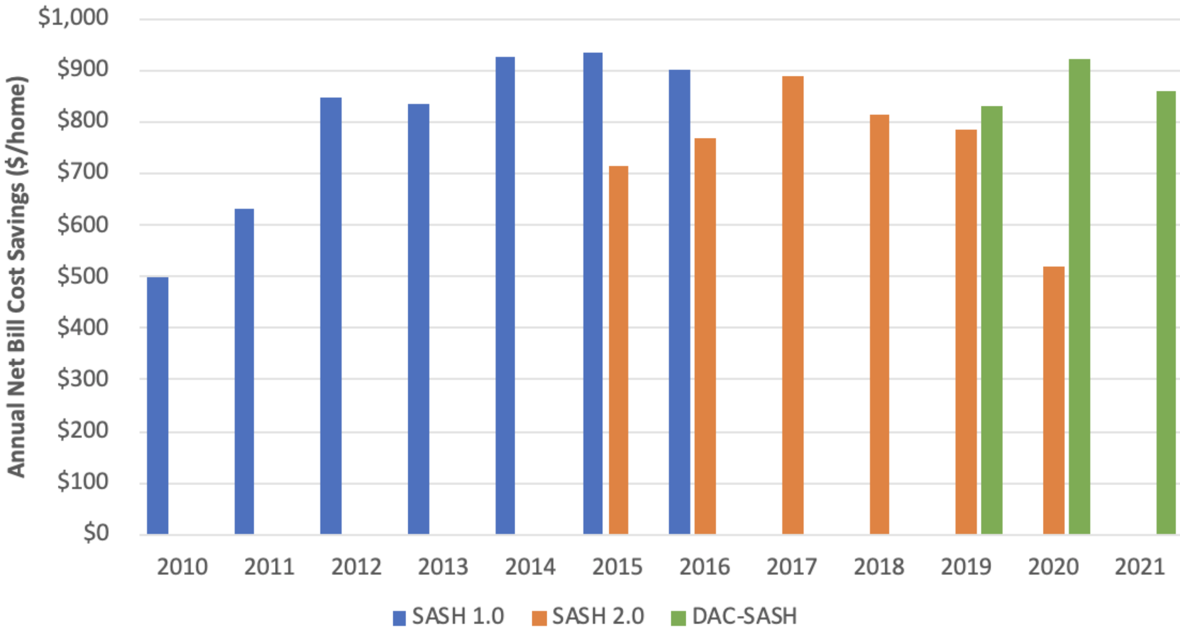
Table 42 shows the estimated annual gross electricity bill savings per home, the NTG adjustment, the estimated annual net electricity bill savings per home, the percent of cost savings, and the number of observations in the model, by program and year. The estimated annual net electricity bill savings per home fluctuates around $600 to $1,000 per year for the SASH programs. Two of the program years that fall outside this range (2010 and 2020) both have small samples, which are less reliable as they are more prone to error. There were a few changes in the solar industry over this time period. The gross bill savings likely fluctuate due to changes in annual generation, consumption, the Net Energy Metering (NEM) rate (as NEM 1.0 offered higher compensation for generation) and increases in rates.

Table 42: Estimated Annual Bill Savings Per Home

Program – Year	Gross Estimated Annual Electricity Cost Savings ($)	NTG Adjustment (net / gross)	Net Estimated Annual Electricity Cost Savings ($, after NTG adjustment)	Percent of Electricity Cost Savings	N Observations
SASH 1.0	**$679**	**1.519**	**$1,032 ± 1**	**127%**	**11,242,660**
SASH 1.0 – 2010	$328	1.519	$498 ± 17	69%	87,006
SASH 1.0 – 2011	$416	1.519	$632 ± 6	94%	1,220,255
SASH 1.0 – 2012	$558	1.519	$848 ± 5	122%	2,251,182
SASH 1.0 – 2013	$550	1.519	$835 ± 4	108%	2,601,807
SASH 1.0 – 2014	$609	1.519	$925 ± 5	107%	2,324,864
SASH 1.0 – 2015	$616	1.519	$936 ± 6	103%	2,244,770
SASH 1.0 – 2016	$594	1.519	$902 ± 17	89%	391,222
SASH 2.0	**$807**	**1.121**	**$904 ± 2**	**91%**	**9,951,743**
SASH 2.0 – 2015	$639	1.121	$715 ± 17	92%	436,399
SASH 2.0 – 2016	$686	1.121	$769 ± 8	89%	1,944,543
SASH 2.0 – 2017	$794	1.121	$890 ± 8	92%	2,209,077
SASH 2.0 – 2018	$726	1.121	$814 ± 7	82%	2,998,706
SASH 2.0 – 2019	$700	1.121	$785 ± 9	70%	2,093,526
SASH 2.0 – 2020	$464	1.121	$520 ± 23	45%	69,492

Figure 28 shows the estimated annual net electricity cost savings, after the NTG adjustment, by program and installation year. The bill savings attributed to solar installations gradually increased from approximately $498 per year in 2010 to a peak of $936 per year in 2015, consistent with the increase in annual energy savings. While gross bill savings gradually increased until 2019, the comparison group exhibited more substantial increases in electricity bills between 2010 and 2016. Therefore, the SASH 1.0 customers have larger net bill savings, as they *avoided* these increases in bills while *saving* money on their bill after installing solar. In addition, NEM 1.0 ended in 2017, which changed the payment structure for behind-the-meter-generation. Solar installed before the end of NEM 1.0 would have received more substantial bill credits for generation, leading to greater bill savings per kWh generated.

Figure 28: Estimated Annual Net Bill Savings per Home



Cumulative First-Year Savings by Program Year

Table 43 presents the number of homes that participated in the program during each year, the estimated annual first-year kWh savings per home for each year (from the impact analysis), and the overall projected first-year kWh savings by program year. This extrapolates from the impact analysis sample to the full population of program participants to provide an estimate of the cumulative program impact. To date, the SASH 1.0 program is estimated to have a first-year savings total of 22,665 MWh, and the SASH 2.0 program a total of 21,047 MWh. Solar panels have an expected useful life of 25 years, so these savings will continue beyond one year, as the panels will continue generating electricity. Please note that the energy savings depends on many factors (e.g., panel degradation, weather, and energy consumption).

Table 43: Estimated Cumulative Energy Savings

Program – Year	Number of Participating Homes	Estimated First Year Annual Energy Savings Per Home (kWh)	Annual First Year Energy Savings for All Homes (MWh)
SASH 1.0**	**5,196**	**4,362**	**22,665**
SASH 1.0 – 2009*	29	2,628	76
SASH 1.0 – 2010	199	2,856	568
SASH 1.0 – 2011	759	3,587	2,723
SASH 1.0 – 2012	1,341	4,890	6,557
SASH 1.0 – 2013	1,045	3,928	4,105
SASH 1.0 – 2014	868	3,843	3,336
SASH 1.0 – 2015	799	3,394	2,712
SASH 1.0 – 2016	151	2,001	302
SASH 1.0 – 2017*	2	4,855	10
SASH 1.0 – 2018*	3	4,182	14
SASH 2.0**	**4,212**	**4,997**	**21,047**
SASH 2.0 – 2015	193	4,024	777
SASH 2.0 – 2016	668	4,877	3,258
SASH 2.0 – 2017	797	5,002	3,987
SASH 2.0 – 2018	1,090	4,127	4,498
SASH 2.0 – 2019	957	4,527	4,332
SASH 2.0 – 2020	367	3,249	1,192
SASH 2.0 – 2021*	134	5,008	671
SASH 2.0 – 2022*	6	4,687	28

Source: Evergreen analysis of energy consumption of program participants and matched comparison group for program years 2010-2021.

* Regression models were not run for program years with fewer than 30 participants or less than a year of post-install data. The estimated annual savings for these program years are based on the overall average for the corresponding program, adjusted to reflect the average size of the solar system installed in the given year.

** The program level results do not add up to the sum of the yearly results because this is based on a pooled model, including participants from all program years to estimate savings at the program level.

Table 44 presents the number of homes that participated in the program during each year, the estimated annual first-year electricity bill savings per home for each year, and the overall projected first-year electricity bill savings by program year. The SASH 1.0 program is estimated to have a first-year electricity bill savings total of $5.4 million, and the SASH 2.0 program a total of $3.8 million. Similar to energy savings, these bill savings will continue beyond one year, as the panels will continue generating electricity. Please note that the dollar value of savings depends on many factors (e.g., panel degradation, weather, energy consumption, and utility NEM rates).

Table 44: Estimated Cumulative Bill Savings

Program – Year	Number of Participating Homes	Estimated First Year Annual Electricity Cost Savings Per Home ($)	Annual First Year Electricity Cost Savings for All Homes ($1,000)
SASH 1.0**	**5,196**	**$1,032**	**$5,361**
SASH 1.0 – 2009*	29	$559	$16
SASH 1.0 – 2010	199	$498	$99
SASH 1.0 – 2011	759	$632	$480
SASH 1.0 – 2012	1,341	$848	$1,137
SASH 1.0 – 2013	1,045	$835	$873
SASH 1.0 – 2014	868	$925	$803
SASH 1.0 – 2015	799	$936	$748
SASH 1.0 – 2016	151	$902	$136
SASH 1.0 – 2017*	2	$1,033	$2
SASH 1.0 – 2018*	3	$889	$3
SASH 2.0**	**4,212**	**$904**	**$3,807**
SASH 2.0 – 2015	193	$715	$138
SASH 2.0 – 2016	668	$769	$514
SASH 2.0 – 2017	797	$890	$709
SASH 2.0 – 2018	1,090	$814	$887
SASH 2.0 – 2019	957	$785	$751
SASH 2.0 – 2020	367	$520	$191
SASH 2.0 – 2021*	134	$987	$132
SASH 2.0 – 2022*	6	$924	$6

Savings by Customer Segment

Next, Table 45 provides the estimated energy savings by program and selected customer segment. The segmentation analysis revealed some important differences across segments:

- Each utility had similar estimated annual kWh savings; however, the average SCE participant's pre-install kWh usage was larger, resulting in a slightly lower percent of energy savings.
- The size of the solar system installed was related to kWh usage, as demonstrated by the percent of energy savings for the one-to-four kWh size bins being roughly 65 to 70 percent. An increase in solar size over time does not necessarily mean an increase in the percent of kWh savings over time.
- Homes that own their solar panels had slightly lower average pre-install kWh usage, resulting in a lower percent of energy savings when compared to TPO panels.

Table 45: Estimated Annual Energy Savings by Subgroup

Category	Sub-group	Est Annual Net kWh Energy Savings (After NTG adj)	Percent of Energy Savings	n
Overall		4,842	67%	5,432
Utility	PG&E	4,898	72%	2,762
	SCE	4,823	61%	2,125
	SDG&E	4,815	71%	545
Size	1 kWh system	2,330	65%	738
	2 kWh system	3,773	70%	1,768
	3 kWh system	4,245	69%	1,693
	4 kWh system	6,996	66%	1,106
	5+ kWh system	10,077	84%	127
Owner	TPO	4,835	64%	3,298
	Homeowner owned	4,752	70%	2,134

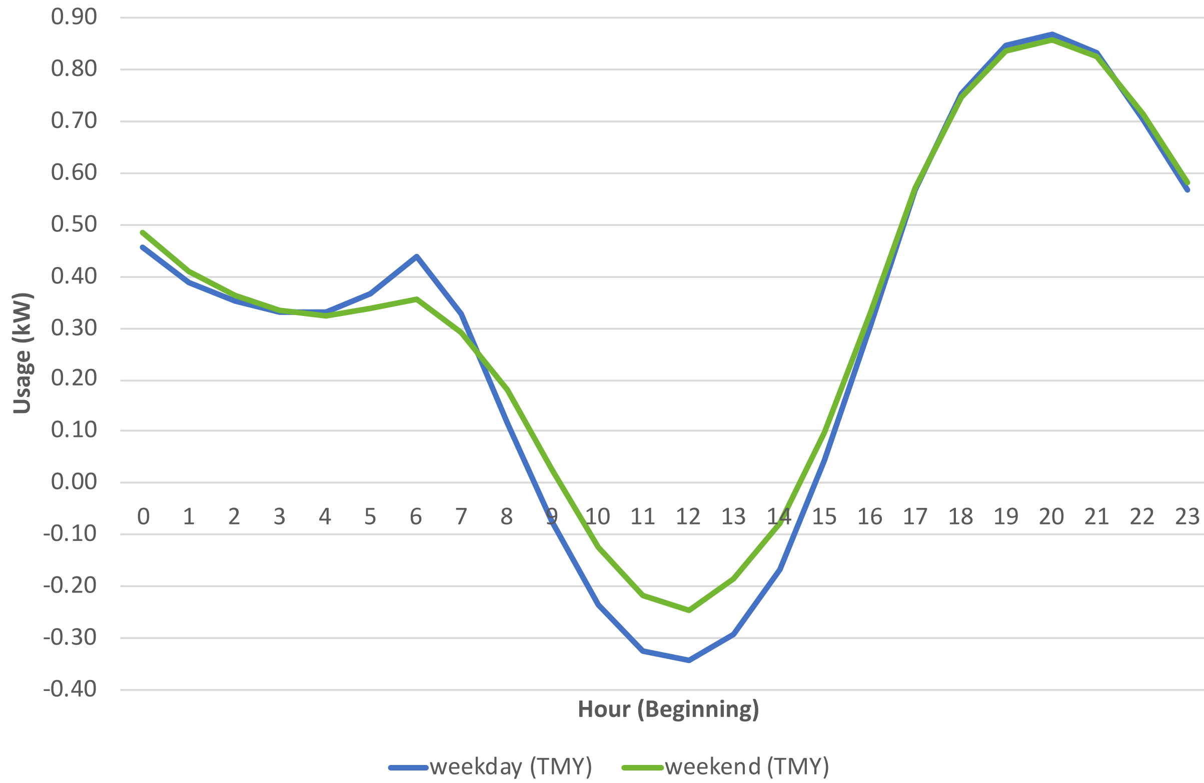
4.8.2 Timing of Savings by Hour and Day

This section provides estimates for the average energy usage following the installation of the solar panels by time-of-day and day-type.

Estimated Hourly Energy Usage

Figure 29 shows the estimated load shape for a normalized weather-year. After solar panels have been installed, the average customer in a weather normalized year has peak energy usage in hour 20 (0.87 kW on a weekday and 0.86 kW on a weekend), the lowest usage at noon (below zero kW when the panels are generating), and a smaller morning peak at 6 a.m. (0.44 kW on a weekday and 0.36 kW on a weekend).

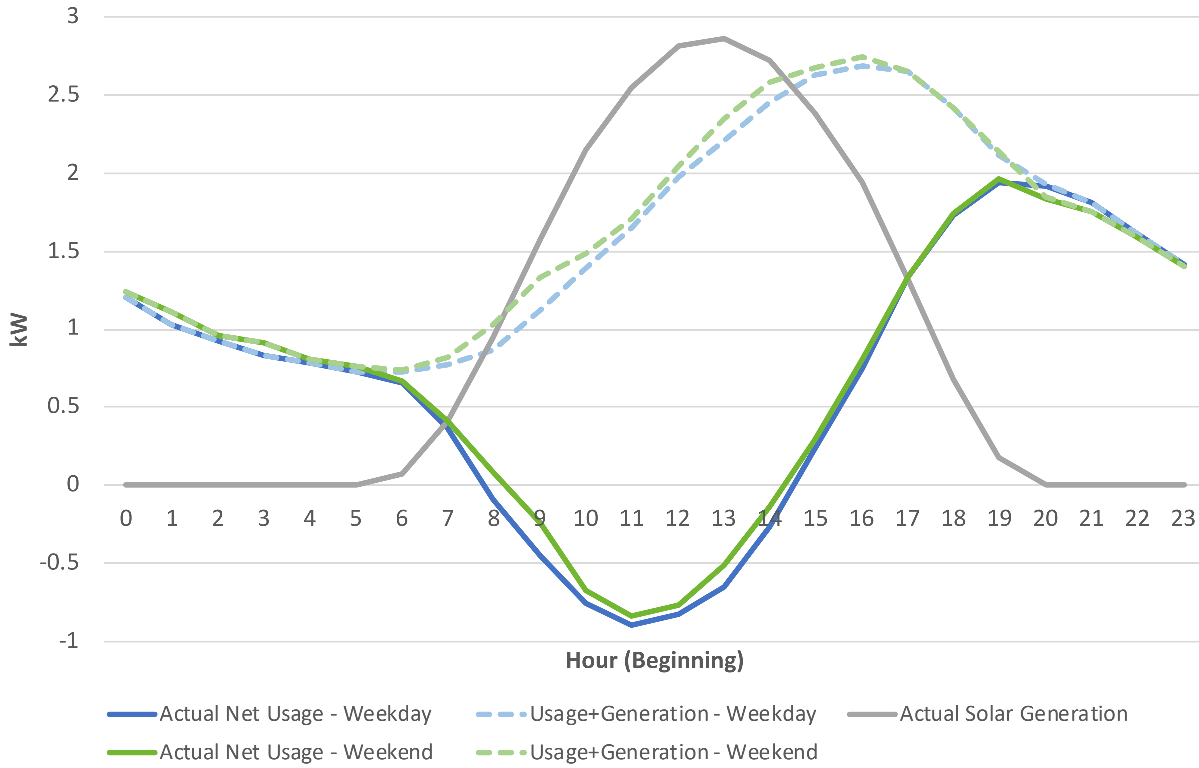
Figure 29: Estimated Average Post-Install Hourly Load Shape for a Normalized Year



Source: Evergreen analysis of energy consumption of a sample of 100 program participants for program years 2010-2021.

Figure 30 shows average net energy usage (solid green and blue lines), average generation (grey line), and average consumption (i.e., net usage + generation; dotted lines) plus generation load shapes for two weeks in July 2022 (July 12 – July 25, 2022). The average sampled participant in July 2022 has peak energy consumption in hour 16 (2.69 kW on a weekday and 2.75 kW on a weekend). The average solar panel is at its peak generation during hour 13 (2.86 kW). What the utility will experience is a peak in net usage (i.e., consumption from the grid beyond self-generation) during hour 19 (1.94 kW on a weekday and 1.96 kW on a weekend) and the lowest net usage at noon (-0.90 kW on an average weekday and -0.84 kW on an average weekend, when the panels are generating).

Figure 30: Average Post-Install Hourly Load Shape for July 2022



Source: Evergreen analysis of energy consumption of a sample of 100 program participants for program years 2010-2021.

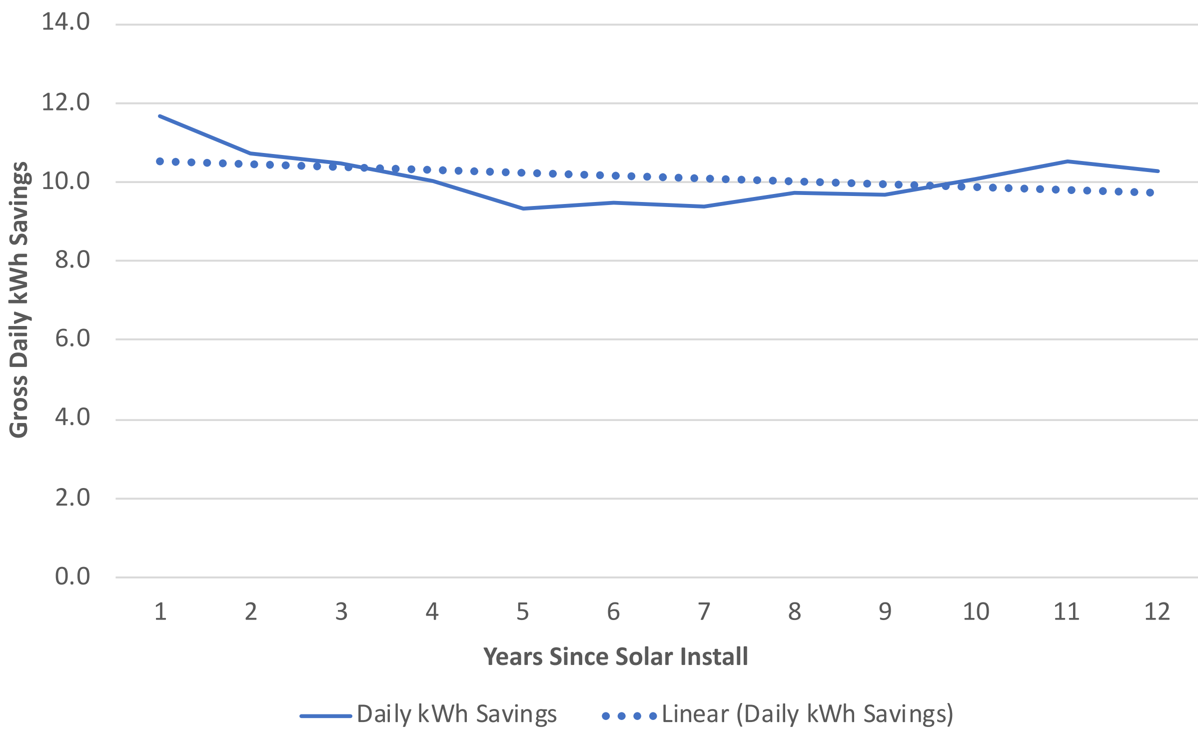
4.8.3 Persistence of Savings

This section provides estimates for the average savings attributable to the solar panels over time. Figure 31 presents the results of the modeled daily gross energy savings over time for the 2009 to 2011 SASH 1.0 program participants. We do not see evidence of a sudden drop-off of savings around year 10, when the inverters are expected reach the end of their useful life. The overall trendline suggests there is a 7.3 percent decrease in savings over 12 years, or 0.61 percent per year. This is likely a combination of panel degradation (which was expected to be ~0.5% per year),[32] system failure (e.g., inverter failure, disconnection), and increased energy consumption (e.g., installing additional electric appliances, purchasing an electric car). There was a slight decrease in savings initially that persisted until year five. This was expected, as customers received smaller electricity bills after installing solar; when electricity is more affordable, there is less

[32] The National Renewable Energy Laboratory INREL) estimated a degradation rate of around 0.5 percent per year but noted that it could be higher in hotter climates. Jordan, Dirk and Sarah Kurtz. "Overview of Field Experience – Degradation Rates & Lifetimes." NREL presentation at Solar Power International conference in Anaheim, CA, September 14, 2015. https://www.nrel.gov/docs/fy15osti/65040.pdf

incentive to conserve. However, savings leveled off in year six and then increased slightly until year 12.

Figure 31: Estimated Gross Daily kWh Savings Over Time



Source: Evergreen analysis of energy consumption of program participants for program years 2009-2020.

4.9 Cost Effectiveness

This section provides the cost-benefit ratios by IOU and SASH 1.0 and 2.0 for the Total Resource Cost (TRC) test, Societal Cost Test (SCT), and Ratepayer Impact Measure (RIM) test. These assessments replicated the format and general content requirements of the 2001 CPUC California Standard Practice Manual for performing economic analysis of demand-side programs and projects. Detailed methodology and input data are in Appendix A.

Cost-Benefit Test Results

Table 46 presents cost-benefit ratios by IOU and SASH 1.0 and 2.0. For the TRC and RIM tests, the cost-benefit ratios are less than one, meaning the costs exceed the benefits from the total resource and ratepayer perspectives.[33] These findings are to be expected given the high costs of providing near-full to full incentives for PV systems to program participants.

[33] Evergreen's findings are generally consistent with previous SASH 1.0 cost-benefit analyses, which found that the SASH program was not cost effective but increasing in cost-effectiveness over time. However, methods could not be replicated exactly.

For the SCT, which includes the additional benefit of the monetary value of carbon reduced, ratios for all IOUs are greater than or equal to one for SASH 2.0, indicating cost effectiveness. The SASH 1.0 SCT ratio for SCE (1.13) also implies cost effectiveness, and the SASH 1.0 SCT ratios for SDG&E and PG&E are approaching cost effectiveness (0.78 and 0.88, respectively). On average, ratios increased from SASH 1.0 to SASH 2.0, attributable in part to declining system equipment and installation costs and lower administrative costs.

Table 46: SASH Program Cost-Benefit Ratios

Program	IOU	TRC	SCT	RIM
SASH 1.0	PG&E	0.55	0.88	0.11
	SCE	0.74	1.13	0.08
	SDG&E	0.48	0.78	0.08
	Average	**0.59**	**0.93**	**0.09**
SASH 2.0	PG&E	0.60	1.00	0.10
	SCE	0.68	1.12	0.09
	SDG&E	0.69	1.10	0.09
	Average	**0.66**	**1.07**	**0.10**
Overall	PG&E	0.58	0.94	0.10
	SCE	0.71	1.12	0.08
	SDG&E	0.58	0.94	0.09
	Average	**0.62**	**1.00**	**0.09**

The finding that the program is relatively more cost-effective from the societal perspective is due to the use of a lower (societal) discount rate as well as the incorporation of the carbon reduced per PV system metric. The use of a lower discount rate relative to the TRC and RIM tests led to a higher net present value (NPV) of the benefits to the consumer and IOU. For example, for the SCT for PG&E SASH 1.0 (3% discount rate), the net present value sum of consumer and IOU benefits was $14,867 per PV installation, whereas for the TRC test for PG&E SASH 1.0 (6.93% discount rate), the NPV sum of consumer and IOU benefits per PV installation was $9,337.

Evergreen used 2009-2021 values of the Social Cost of Carbon to find the average monetary value of carbon reduced per PV system, which was added to total benefits. This amounted to an additional benefit of at least $2,000 for each IOU, and thus contributed to the finding of greater cost-effectiveness for the SCT.

In contrast to the high SCT values, Evergreen calculated an average RIM test ratio of 0.09 for SASH 1.0 and SASH 2.0. This implies that the program caused rates to increase for non-participants and that the program is not close to being cost effective from the ratepayer perspective. The finding of cost-ineffectiveness is not unexpected, as unlike the SCT and TRC test, the RIM test considers the consumer bill savings to be an additional cost to the utility. However, the RIM ratios observed are particularly low.

There are two notable limitations to Evergreen's cost-benefit analysis. First, we used a combination of E3's Avoided Cost Calculators to obtain avoided cost values by IOU from 2009 to 2035. While using a combination of calculators allowed Evergreen to consider avoided costs across the PV system lifetime, it likely led to additional fluctuations in values that were a product of the updates to the calculators themselves. Next, the monetary value of carbon reduction is the only non-energy benefit (NEB) considered, and it was only accounted for in the SCT. The "Carbon Reduced Over System Life (Tons)" was the only NEB-related metric provided by GRID. While it was feasible to obtain NEB estimates from the CPUC's Low-Income Public Purpose Test (LIPPT), incorporating additional NEBs (that were not directly linked to program data) would have risked overstating the true value of program benefits.

4.10 Environmental Benefits

GRID Staff reported that most participating customers were motivated to participate by lower energy bills. Part of the program's charge, however, was to educate customers on environmental benefits as well. This section explores the perceptions of environmental benefits and the actual calculated impacts.

4.10.1 Greenhouse Gas (GHG) Emissions Analysis

The Evergreen team estimated the GHG impacts of the SASH program PV systems in reference year 2021. This evaluation relies on avoided grid emissions rates developed by WattTime as part of the SGIP GHG Signal efforts.

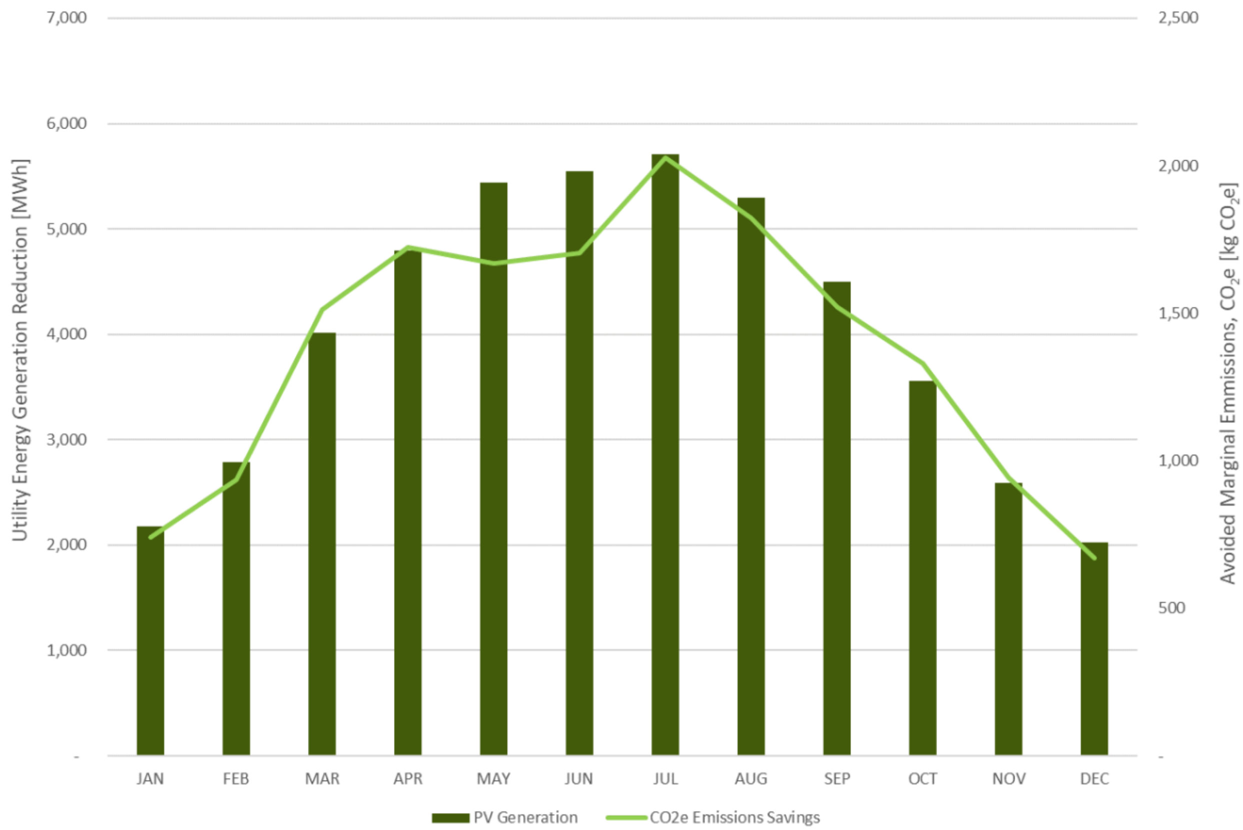
Program PV systems are estimated to reduce GHG emissions by 16,570 metric tons (Mtons) of CO_2 equivalent (CO_2e) or 16,601 Mtons of CO_2 using 2021 emission rates. Criteria pollutant reductions equate to 518 kg of methane (CH_4) reduction and 64 kg of nitrogen oxides (NO_X) reduction (Table 47).

Table 47: Distribution of estimated GHG impacts by IOU

IOU	CO_2 Emissions Savings (Mton CO_2)	CH_4 Emissions Savings (kg CH_4)	NO_x Emissions Savings (kg NO_x)	CO_2e Emissions Savings (Mton CO_2e)
PG&E	7,389	229	28	7,403
SCE	7,313	230	28	7,327
SDG&E	1,868	58	7	1,871
TOTAL	**16,570**	**518**	**64**	**16,601**

Figure 32 shows estimated GHG savings by month along with the estimated total PV system generation from SASH projects. Note that the magnitude of GHG savings is not directly aligned with the PV system generation alone. More GHG savings result from specific months due to the source-mix of the avoided electricity that would have been provided by the electric utility. July was the month with the highest share of top 200 demand hours and was also the month that provides the most GHG savings from SASH PV systems.

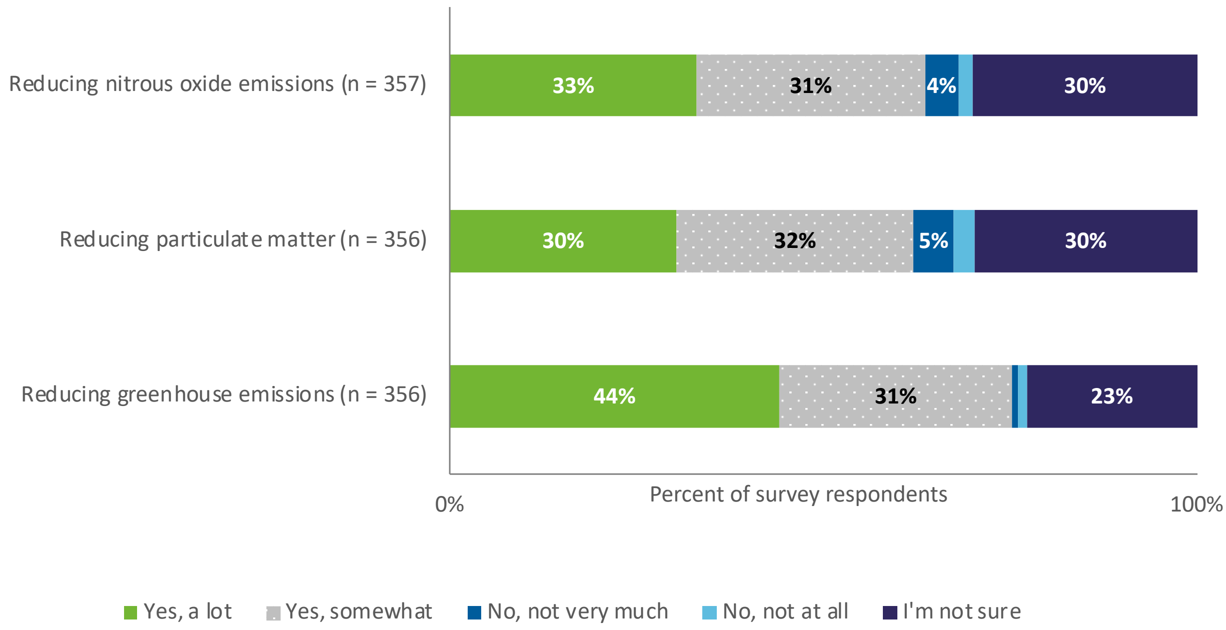
Figure 32: Estimated GHG Impacts and SASH Generation



4.10.2 Customer Perceptions

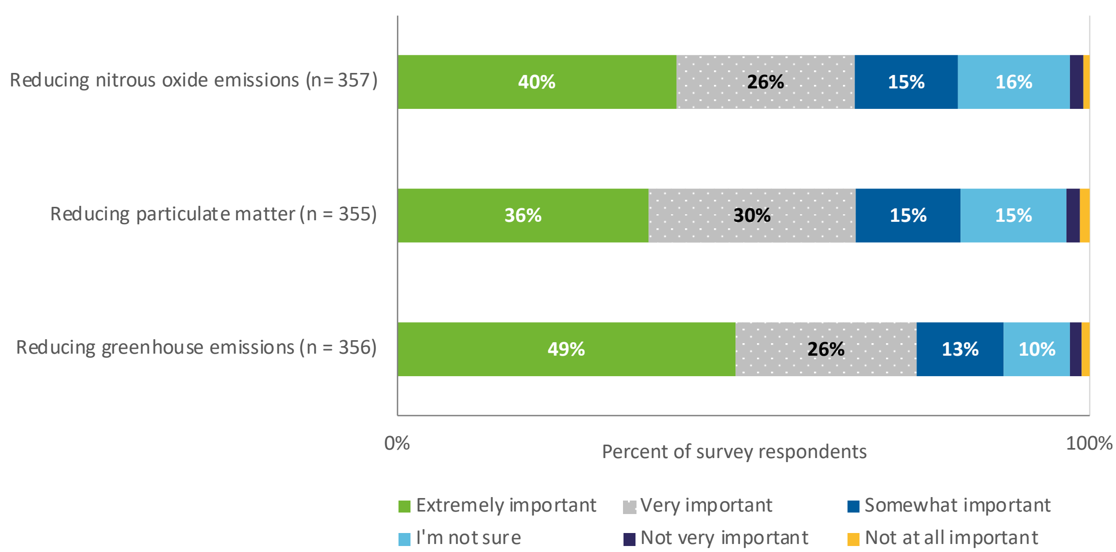
The survey found that over half of participant respondents believed that the SASH program was responsible somewhat or a lot for reducing nitrogen oxides emissions, particulate matter, and GHG emissions (Figure 33). Non-participant respondents were equally likely to report that the program could help in the reduction of emissions and provide environmental benefits.

Figure 33: Participant Perception of Program's Environmental Impact



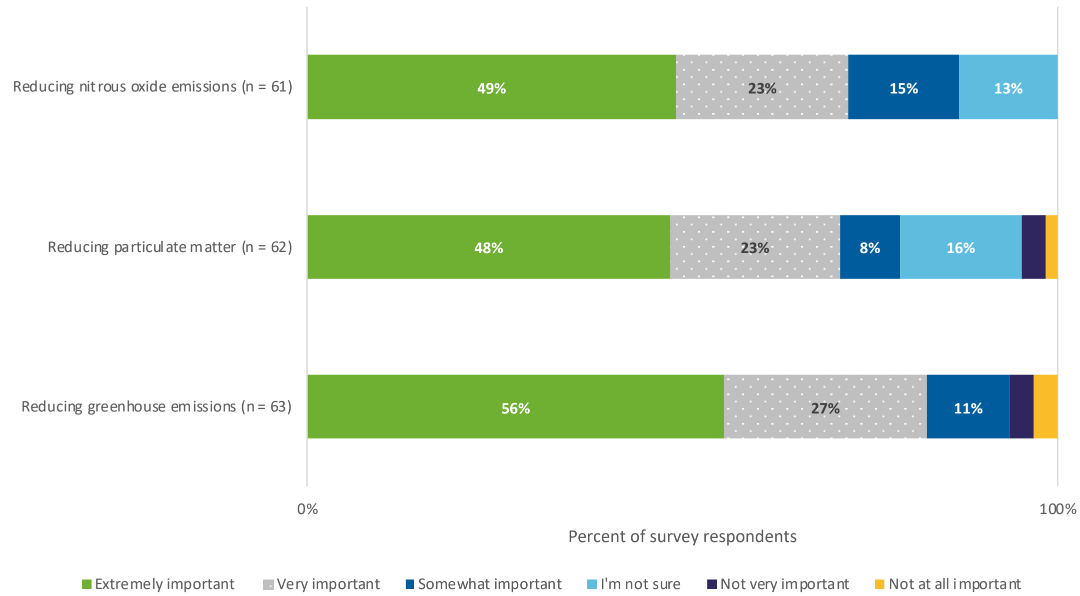
Although participants and non-participants had similar perceptions of the program's impact on environmental benefits, participants were more likely to report that those benefits were important to them personally. Figure 34 shows that most participants did report that the reduction of the emissions listed were important.

Figure 34: Importance of the Programs' Environmental Benefits (Participants)



In contrast, Figure 35 shows that more non-participant respondents said the benefits were not at all important to them, indicating that participants may have been more likely to care about environmental benefits than non-participants.

Figure 35: Importance of the Programs' Environmental Benefits (Non-Participants)



4.11 Workforce Development and Job Training

A defining feature of the SASH program was its integrated workforce development mandate. In this section, we present findings from the trainee web survey, the onsite field visits, and interviews with trainees to characterize the workforce development mandate of the SASH program to answer the following questions:

1. What job training programs were leveraged?
2. How many local jobs were created?
3. What were the longer-term job outcomes for trainees?

Findings related to training and volunteer outcomes, career progression, and barriers to participating in the trainings are below. Further findings from the trainee survey on program marketing and the value of different elements of the training program are in Sections 6.5 and 6.6.

4.11.1 Training Program Background

To promote green jobs in low-income communities, GRID administers Install Basic Training (IBT), a solar installation training program. GRID designed the IBT course with the help of a consulting firm, Accenture, and runs it out of its regional offices. The IBT courses provide classroom instruction, lab activities, and real-world experience on solar installations to participants. The goal of the IBT program is to provide an effective, efficient, and equitable pathway into the solar industry.

The IBT program was not funded by SASH and is still running though the SASH program has closed. The IBT program integrated well with the workforce development goals of the program. Each SASH installation required at least one trainee to be present to gain on-the-job experience. Trainees could either be volunteers or IBT members.

GRID often partners with municipalities or CBOs to offer trainings that provide a stipend for the IBT classes. This external funding allows for greater reach, as targeted communities may not be able to participate without compensation.

GRID also utilizes volunteers as part of its mission to educate local communities about solar opportunities. We differentiate between these two groups in our analysis due to the significant differences in experience for the participants.

GRID-provided data were often missing a trainee type (volunteer or trainee) so for analysis purposes, we used self-reported data from survey respondents to identify if they were IBT trainees (n = 48) or volunteers (n = 51). Table 48 shows the range of responses for trainees that were listed in GRID's database. In our analysis, we use the self-reported experience of the participants.

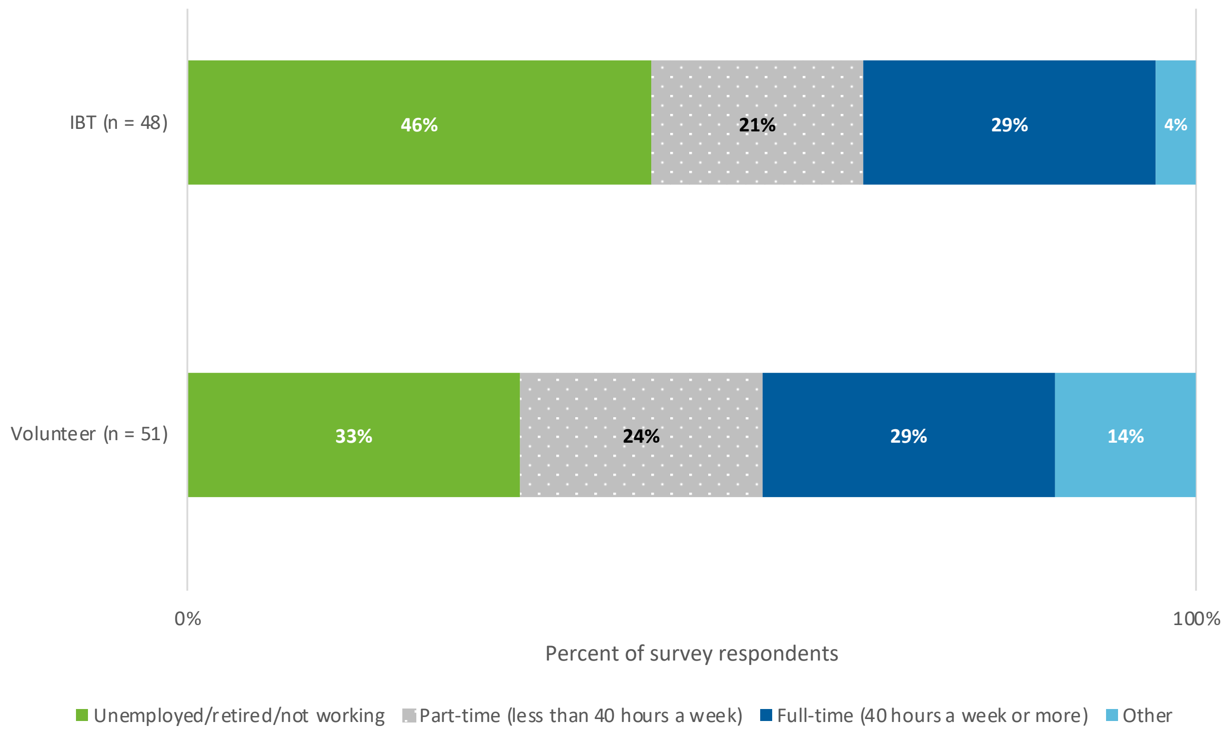
Table 48: Trainee Types Surveyed (n = 99)

Category for Survey Analysis	Program Data Trainee Type	N
IBT Trainee	Paid Cohort Trainee	5
	Paid Intern	2
	SolarCorps (paid internship with GRID)	3
	Unpaid Cohort Trainee	12
	Unpaid Intern	1
	Not Reported	25
Volunteer	SolarCorps (paid internship with GRID)	2
	Unpaid Cohort Trainee	1
	Not Reported	48

4.11.2 Training and Career Outcomes

Most IBT participants and about a third of volunteers reported that they were unemployed, retired, or not working before participating with GRID (46% and 33%, Figure 36). The percentage of those who worked full-time before was the same for both groups (29% for both the IBT participants and the volunteers).[34]

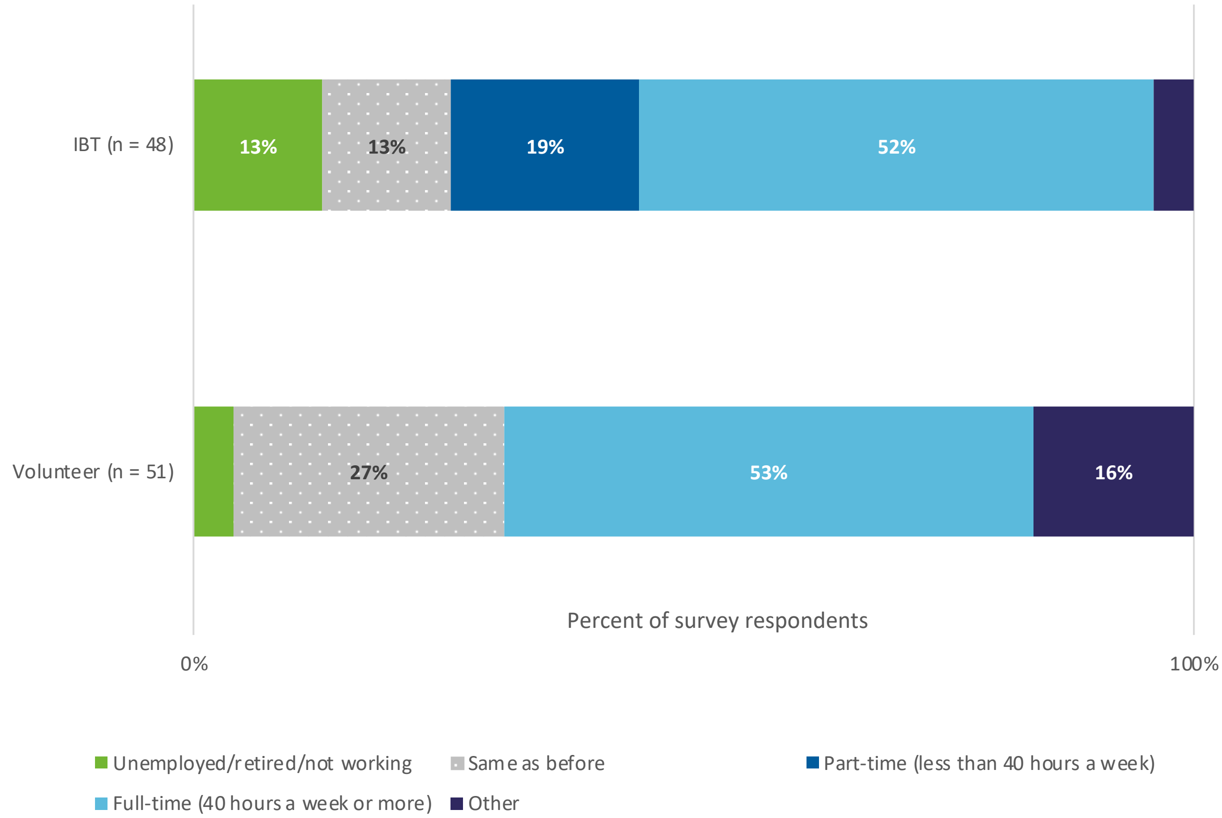
Figure 36: Employment Status Before Participation



After participation, respondents were more likely to report that they had a full-time job. As shown in Figure 37, participants in both groups (52% of IBT participants and 53% of volunteers) reported that they are now working full time. There was also a significant reduction of unemployment, with only 13 percent of those who attended the IBT course and 4 percent of the volunteers reporting as such.

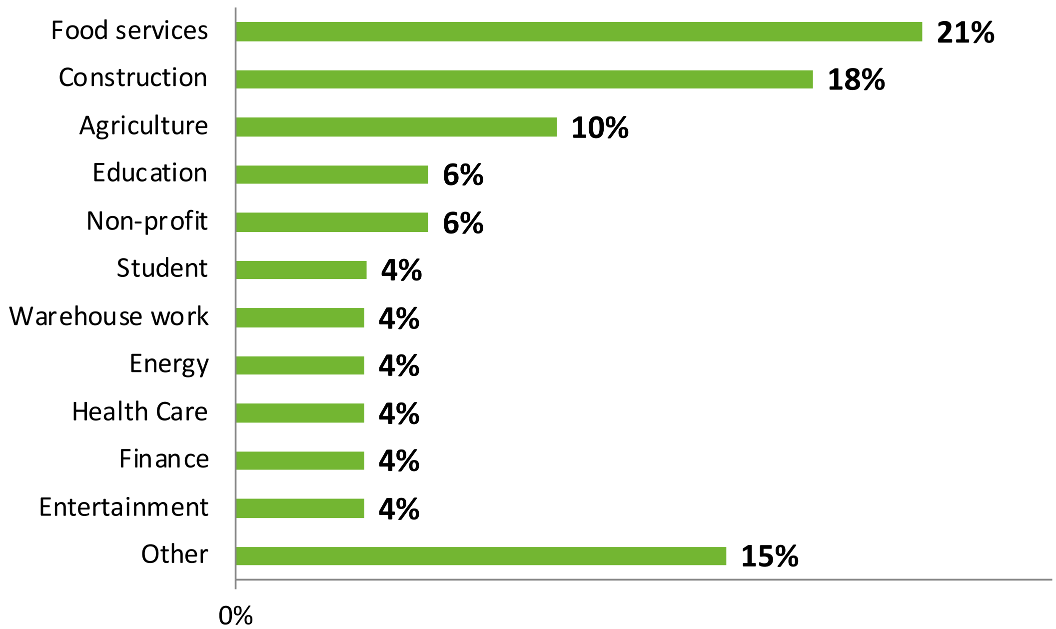
[34] Those that selected "other" were asked to specify. Answers from both sets of participants included involvement at educational institutions (5), commission-based and technical work (2), and incapacitation due to health reasons (1).

Figure 37: Employment Status After Participation



Most participants (92%) had not been employed in the solar industry before participating in the training. We asked participants to specify types of employment before GRID involvement. Respondents reported work experience before participating in GRID's course or installation programs. Twenty-one percent of respondents indicated that they worked in food services, while 18 percent said construction. Figure 38 displays all other responses chosen.

Figure 38: Type of Employment Before Participation (n = 51)

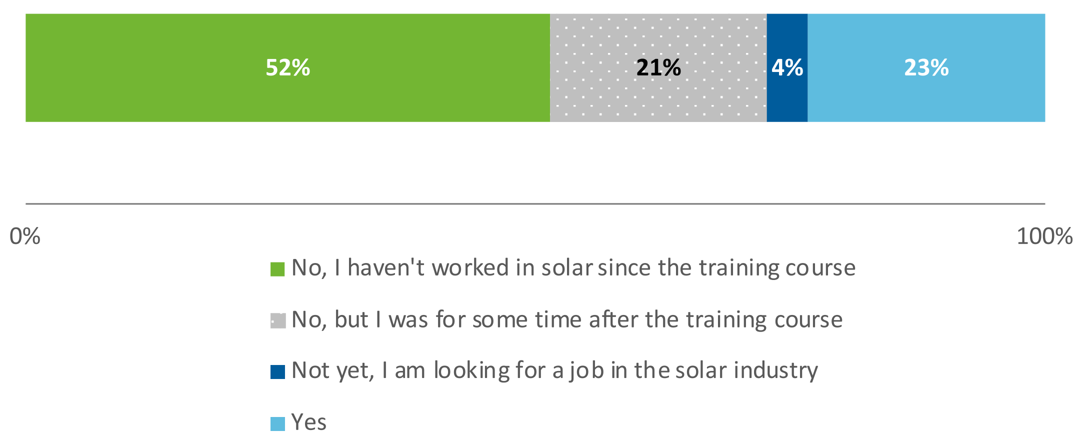


For those that selected “Other,” respondents filled in free text to indicate that they were working in science research, technology, engineering, pharmacy, and fiber optics.

4.11.3 Career Progression

Figure 39 shows that over half of all respondents have not worked in the solar industry since the training course (52%). The other respondents either worked in the solar industry for some time, currently work in the solar industry, or are looking for employment in the solar industry. Compared to the pre-employment industries, however, the number of people in the solar industry did increase significantly after participation (8% to 23%), indicating that the program is doing a good job at increasing green jobs.

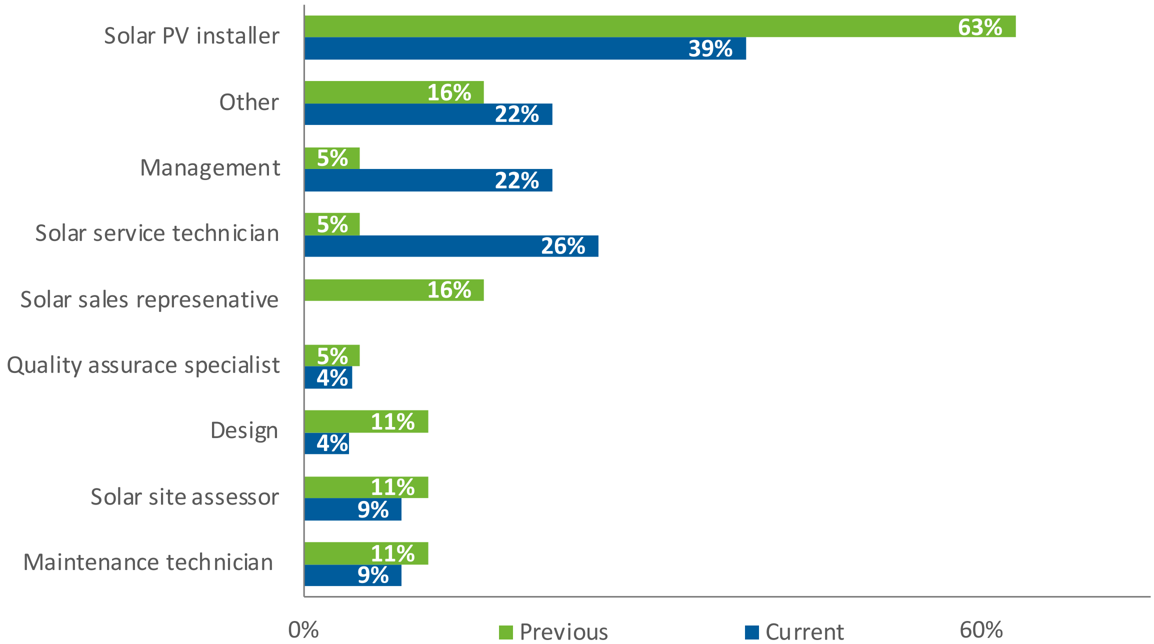
Figure 39: Solar Industry Employment Since Participation (n = 99)



Of the respondents now working in the solar industry (n = 23), the majority (70%) found employment within six months of participating in GRID's training or volunteer opportunity. In fact, 92 percent were employed in the solar industry within two years of GRID involvement.
Of respondents employed in the solar industry, there was a shift in their role after their involvement with GRID, as shown in Figure 40.

Sixteen percent of previous roles shared fit into the "Other" category. Less than a quarter (22%) of respondents with current roles in the solar industry fit into the "Other" category. The "Other" category comprises roles that were too sparse or specialized compared to the other respondents' replies or the multiple-choice options provided. For example, respondents with previous roles in the solar industry whose roles were categorized into "Other" shared responses such as "Business Development Officer" and "Installation Scheduler". Additionally, respondents with current roles in the solar industry whose roles were categorized into "Other" shared responses such as "Constructions Operations Specialist", "Foreman", and "instructor".

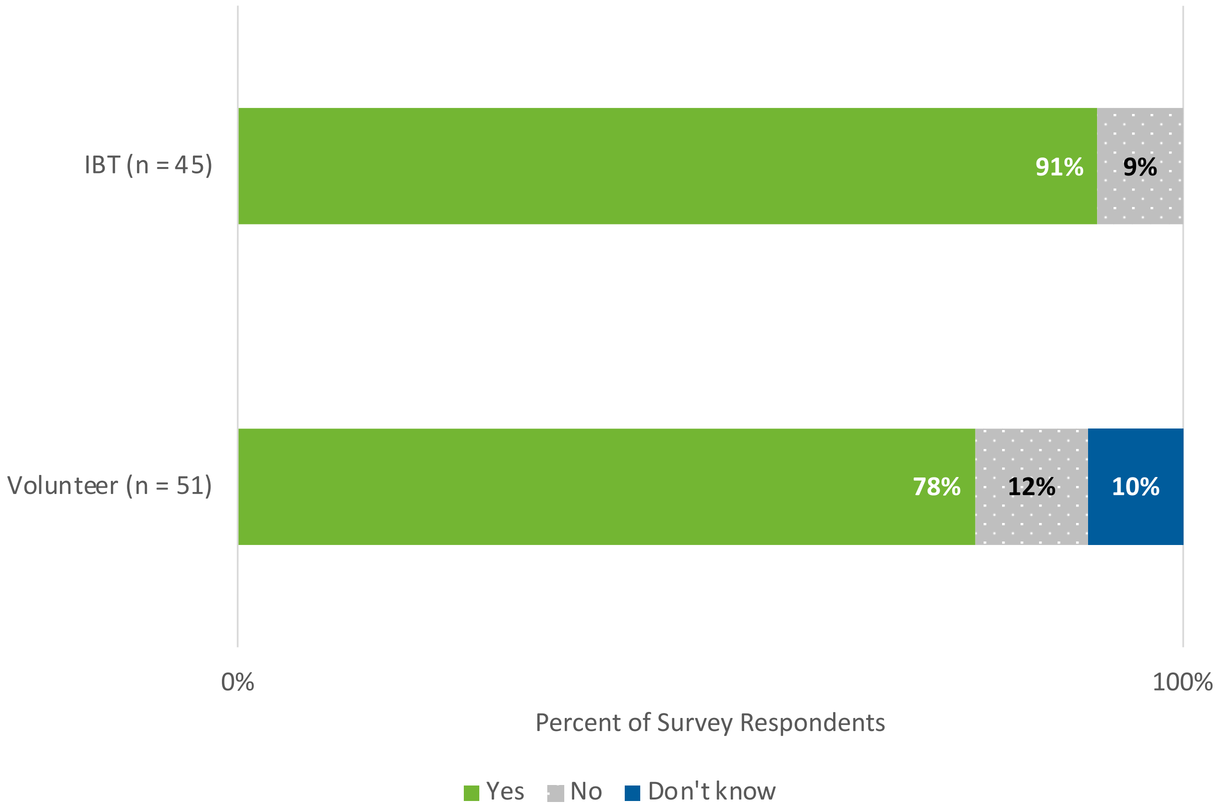
Figure 40: Roles in Solar Industry (n = 42)



Very few participants shared reasons for no longer working in the solar industry. Of those that shared (n = 3), the responses were “I am in the greenhouse building industry”, “Back injury”, and “Because I went back to my trade which is electrician”.

Both IBT and volunteer respondents mostly reported that involvement with GRID projects improved their career opportunities (Figure 41), with volunteers reporting “don’t know” more frequently than IBT respondents.

Figure 41: Belief in Improvement of Career Opportunities after Participation



The participants who said 'yes' to whether they believed spending time with the SASH projects doing on-site installations improved their career opportunities in the solar industry were further asked to describe how the on-site training helped them do so. The 36 IBT participants and 34 volunteers gave several explanations as to how they believed their career prospects were improved, most of which are summarized by Table 49 below.

Table 49: Respondent Belief on How Participation Improved Career Prospects (n = 70, multiple responses allowed)

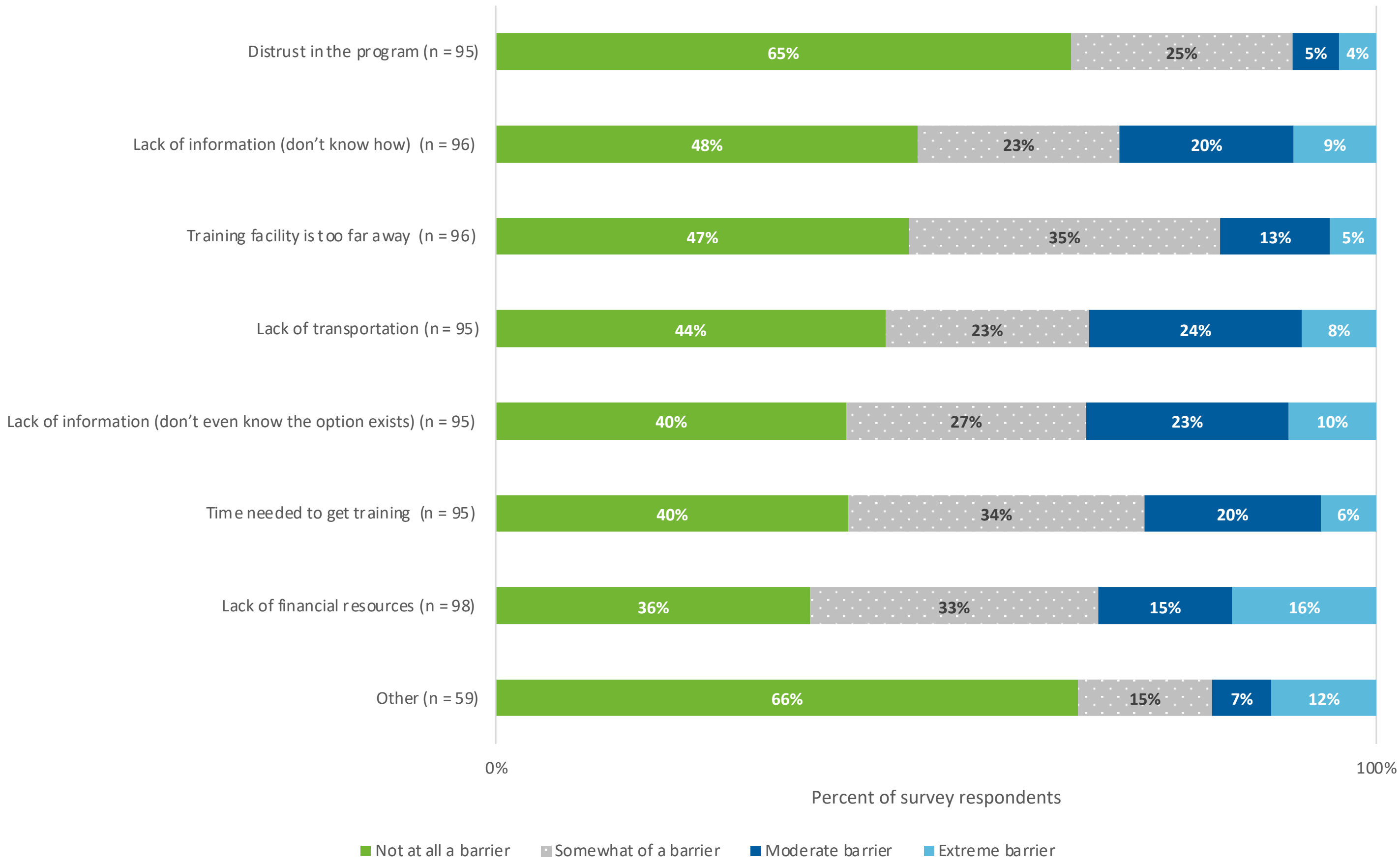
Gaining more technical knowledge and hands-on experience (52, 70%) 	"…It was very educational for my experience in construction." (IBT) "Before the on-site training I didn't know how to approach solar installations. After attending an on-site training for solar installation, I feel that I gained new techniques for and knowledge about solar panels and ways to mount them for the greatest results." (Volunteer)
Assistance with employment and	"When I went to apply in the solar field, they were impressed I had installed previously so they felt I would be an asset in the office environment due to my field knowledge." (IBT)

networking opportunities (34, 49%) 	"It 100% helped me find work. I met people who spent time teaching me more and directed me to courses that I could take outside of GRID, and by following their advice, I found work fairly quickly." (Volunteer)
Personal development (8, 11%) 	"It made me more knowledgeable, and I could hold more conversations with employers on different aspects of the solar industry. It also made me more familiar with site assessment and solar equipment, which solar suppliers look for." (IBT) "Installing solar with GRID inspired my career. I absolutely loved the vibe on the volunteer-based construction sites. Everyone wanted to learn and do their best work. The gratifying nature of the non-profit service with tangible results was inspiring." (Volunteer)

4.11.4 Barriers to Participation

Participants in both courses were asked how much of a barrier various factors are to getting hands-on experience in the industry (Figure 42). Most respondents said that the options listed were "not at all a barrier"; however, a lack of financial resources, lack of time, and lack of information were most reported as moderate or extreme barriers.

Figure 42: Barriers to Gaining Experience in the Industry (n varies)



Those who chose 'other' barriers were asked to further specify; nine participants offered an answer. These answers included:

- Inclusivity issues due to gender and language barriers (5);[35]
- Personal motivation (2);
- The strenuous and unstable nature of the work environment due to a lack of breaks and constant schedule changes (2);
- Family and childcare responsibilities (1);
- Not having enough opportunities to do installations (1); and
- Transportation issues (1).

GRID's IBT program did a good job at connecting job trainees and the SASH installations to give participants hands-on experience that ultimately increased the number of people with jobs in the solar industry. The program helps trainees overcome barriers to obtaining a job on their own by

[35] Inclusivity barriers were identified as having "English speaking requirements" or "being female."

providing training, transportation, and experience. The SASH requirement to include job trainees helped provide those opportunities for the program and the individuals involved.

5 Conclusions

The goals listed in the decision to authorize the program did not specify a targeted number of kW installed, homes served, or guidance on the type of customers that should be prioritized through the Single-Family Affordable Solar Housing (SASH) program; therefore, the evaluation cannot conclusively say if the program successes listed above met the intended goals of the CPUC. The program did see many successes, however, and we discuss them in this section.

5.1 Program Accomplishments

Through the installation of 9,501 projects from 2009 to March 2022, the program realized the following accomplishments:

- 30,003 kW (CEC-AC[36]) total installed capacity with an average of 3.2 kW per home
- Estimated reduced greenhouse gas (GHG) emissions of 16,601 metric tons of CO_2 equivalent (similar to the average carbon footprint for one year for 738 California households), along with criteria pollutant reductions of 519 kg of methane (CH4) reduction and 64 kg of nitrogen oxides (NOx) reduction[37]
- Participation from customers in all eligible investor-owned utility (IOU) service territories, with 46 percent of projects in PG&E's, 42 percent in SCE's, and 11 percent in SDG&E's service territories
- $133.9 million in incentives paid out for installation projects with an average of $14,089 going to each project[38]
    - $92 million in incentives paid out for SASH 1.0 projects, with an average of $17,489 per project
    - $41.9 million in incentives paid out for SASH 2.0 projects, with an average of $9,876 per project

[36] A rating system used to determine the eligibility of a solar system by the California Energy Commission.

[37] https://rael.berkeley.edu/wp-content/uploads/2018/04/Jones-Wheeler-Kammen-700-California-Cities-Carbon-Footprint-2018.pdf

[38] Analysis of incentives was done on the 9,501 projects that were considered fully complete as of March 2022. There were additional projects that were installed but not yet interconnected, or where incentives had not yet been paid out. Those projects were excluded from this analysis of per-project incentive costs.

- $160 million total spent (administration, marketing and outreach [M&O], and incentives) out of a $160.7 million total budget with an average of $16,907 spent per project on administration, M&O costs, and incentives[39]
    - $108.7 million spent on administration, M&O, and incentives for SASH 1.0, with an average of $20,501 per project
    - $51.3 million spent for SASH 2.0, with an average of $12,050 per project
- Solar system performance slightly better than projected (105 percent of projected performance)
- Reports of lower bills (81% of surveyed customers)
- An average of 67 percent decrease in energy consumption (5 MWh per year) for an average total annual bill savings of $904 per year (91% reduction in annual bill costs)
- High customer satisfaction and appreciation for the services provided by the program
- Increased solar industry participation from volunteers and trainees after participation in trainings and/or volunteer opportunities created by the program (8 percent worked in the industry before the program and 23 percent reported working in the industry afterwards)

Overall, the programs were responsible for increasing the number of homes with solar rooftops and for providing an opportunity for low-income customers to benefit from solar power. The programs were not cost effective from a total resource or ratepayer perspective. However, this was expected given the cost of providing near-full incentives for PV systems to program participants. The programs were cost effective from a societal perspective, where the monetary value of carbon reductions outweighed the program costs.

5.2 Findings and Lessons Learned

While this program has ended, we identified lessons that may be helpful for similar solar programs in the future. This section is organized in the following subsections:

1. Lessons learned related to goals of the program
2. Lessons learned related to barriers to solar installation
3. Lessons learned for tracking and collecting valuable data in future programs.

5.2.1 Lessons Learned Related to Program Goals

As mentioned previously, the goals listed in the decision to authorize the program did not specify a targeted number of kW installed, homes served, or guidance on the type of customers that should

[39] Analysis of administration and M&O costs was done on the 9,559 projects that were started as of March 2022. These costs are reported on a semi-annual basis and include administration and M&O time spent before a project is fully completed.

be prioritized through SASH. However, five goals were clear from the decision authorizing the program:

1. Decrease electricity use by solar installation and reduce energy bills without increasing monthly expenses.
2. Provide full and partial incentives for solar systems for low-income participants.
3. Offer the power of solar and energy efficiency to homeowners.
4. Decrease the expense of solar ownership with a higher incentive than the General Market California Solar Initiative (CSI) program.
5. Develop energy solutions that are environmentally and economically sustainable.

Program Goals 1 & 3: Decrease electricity use by solar installation and reduce energy bills without increasing monthly expenses. Offer the power of solar and energy efficiency to homeowners.

Based on analysis of customer energy bills, SASH participants *avoided* the increases in bill costs observed in the matched comparison group, while *saving* money on their energy bill after installing solar. On average, SASH 1.0 participants experienced a 60 percent decrease in energy consumption (4.4 MW per year) resulting in total bill savings of $1,032 per year, while SASH 2.0 participants were estimated to have a 67 percent decrease in energy usage (5.0 MW per year), resulting in bill savings of $904 per year. The SASH program successfully reduced energy bills without increasing monthly expenses for most participants.

GRID referred customers to the Energy Savings Assistance (ESA) program as part of the SASH participation process to reduce energy usage alongside the installation of solar panels, but we found that only 11 percent of participants were enrolled in the program. GRID also provided energy efficiency education to customers to help them understand how to reduce their usage, and 55 percent of survey respondents that reported lower electricity usage believed their usage decreased due to a better understanding of energy usage in the home or a greater sense of environmental consciousness due to the program.

Lessons learned and implications are in the following table.

Lessons Learned		Implications	
	- Future programs should set measurable goals for bill savings and/or reduction in energy usage to better track successes. - Future programs should send an annual follow up letter and email to customers reminding them of related programs. - Future programs should be sure to offer referrals to parallel programs to eligible customers who are not interested in participating.		A set numerical goal in terms of bill savings or reduction in energy usage would help to assess if future programs are doing a good job at meeting intended targets. Timing the referrals to related programs to happen after the main contact points for future programs (i.e., enrollment or installation) could help increase parallel enrollment if presented at a time when the homeowner is less overwhelmed. Additionally, including bi-annual reminders for CARE enrollment will help ensure customers stay on the CARE rate after their involvement. This will ensure that the outreach time spent by Program Administrators (PAs) are still used to share information about other programs, regardless of participation in the intended program.

Program Goals 2 & 4: Provide full and partial incentives for solar systems for low-income participants. Decrease the expense of solar ownership with a higher incentive than the General Market CSI Program.

As of March 1, 2022, GRID had completed 9,501 SASH projects for a total of 30,003 kW (CEC-AC) for low-income households. GRID offered solar systems to be no-cost to low-income customers by combining the SASH incentive and leveraging other sources of funding external to the program. The SASH program succeeded in its goal to provide full and partial incentives, and to decrease the expense of solar ownership for this population.

Lessons Learned		Implications	
	- Future programs should research baseline adoption metrics among the eligible population, then set specific, time-constrained goals to measure success. - Future programs should leverage GRID's model of administering SASH, utilizing local sources of grant funding to help cover full costs of installation so the program is no cost to low-income households.		A set numerical goal in terms of a targeted number of installations per year would help to assess if future programs are doing a good job at meeting their goals. Offering a no-cost program can help to combat customer trust issues.

Program Goal 5: Develop energy solutions that are environmentally and economically sustainable.

In market rate solar installations, there is a trend of increased energy usage after installation.[40] An analysis of SASH savings over time, however, found that there was not the expected drop off in savings from increased consumption, and the overall trendline suggests there is a 7.3 percent decrease in savings over 12 years (0.61% per year). This decrease is smaller than expected, suggesting that SASH was successful in developing solutions that are sustainable.

To evaluate cost effectiveness of the program, we used the Total Resource Cost (TRC) test, Societal Cost Test (SCT), and Ratepayer Impact Measure (RIM) test. For the TRC and RIM tests, the cost-benefit ratios are less than one, meaning the costs exceed the benefits from the total resource and ratepayer perspectives. These findings are to be expected given the high costs of providing near-full to full incentives for PV systems to program participants.

For the SCT, which includes the additional benefit of the monetary value of carbon reduced, ratios for all IOUs are greater than or equal to one for SASH 2.0, indicating cost effectiveness. On average, ratios increased from SASH 1.0 to SASH 2.0, attributable in part to declining system equipment and installation costs and lower administrative costs.

[40] In the CSI impact evaluation, PG&E residential customers increased their consumption by an average of 7.1 percent during the first year after installing solar. Though these systems were incentivized, it is a clear example of the pattern we expected to see, where solar installations often lead to increases in consumption

5.2.2 Lessons Learned Related to Barriers to Participation

Evergreen identified a set of barriers that have hindered installation progress but found that GRID did a good job of addressing these and became more effective over the years. The biggest barriers were:

1. Trust in a “free” program
2. Customers with homes that were not “solar-ready”
3. Tree location

Trust in a “Free” Program: Many participants and non-participants reported having heard about solar from external sales teams before GRID’s outreach and were skeptical that the SASH program was truly “free.” GRID used testimonials and case studies to try to reduce this distrust. Interestingly, participants were more likely to report this barrier (44%) compared to non-participants (22%), indicating that ultimately, GRID was effective in convincing the more skeptical group to participate. GRID leveraged partnerships with trusted organizations and municipalities, such as cities, job training organizations, and local libraries, as well as customer referrals, to build up credibility within the communities.

- Future programs should follow GRID’s model and leverage partnerships with trusted organizations and municipalities, as well as customer referrals, to build up credibility within communities they are aiming to serve.

Customers Not “Solar-Ready”: We found that some (13%, n = 1,280) eligible customers required additional services before they could participate in SASH. The most common service required was an electrical service upgrade ($2,394 on average, n = 595), and the most expensive service required was roof repairs ($3,946 on average, n = 88). To ensure that customers could participate in SASH at no cost, GRID fundraised to pay for these services but was not always able to. Many eligible non-participants surveyed (20%) reported that they could not move forward with participation due to these additional services needed.

- Future programs should consider implementing a fund for or permit incentives to cover additional services that may be required to allow customers that are not solar-ready to participate.

Tree Location: Eleven percent of non-participants said that they could not move forward with the project due to the cost of tree trimming required before installation. A solar installer also noted that they tried to balance the value of the shade of a tree in keeping cooling costs down on a home with the benefits of solar when scoping out a project. Other eligible non-participants also reported that they did not move forward with the program simply because they did not want to or could not remove shade trees (though we did not ask directly, 5% of respondents wrote in this response).

- Future programs should be aware that tree trimming (the need for or the desire not to do so) may create barriers to program participation.

6 Additional Findings

6.1 Additional TPO Model Details

6.1.1 Unaccounted Costs of Participating in the TPO Model

The costs of participating in the third-party ownership (TPO) model that were unique when compared to an ownership structure (not inclusive of costs of owned projects) are:

1. The pre-paid 25-year power purchase agreement (PPA) GRID Alternatives (GRID) paid to the TPO
2. Staff and administrative time spent coordinating the TPO relationships
3. Staff time coordinating the TPO model with homeowners

PPA Agreement Amount. GRID tracked the 25-year PPA cost on a per-project basis, but the agreement has changed over the years of its relationships with TPO companies.

Staff TPO Coordination Time. Staff and administrative time spent coordinating with TPO partners was not analyzed. Anecdotally, many staff members reported that the solar companies, Sunrun in particular, can be hard to communicate with. They often will not hear back about service questions, project concerns, or contract issues without multiple attempts to contact them.

Staff Homeowner Coordination Time. The final cost we considered in this evaluation is the cost of staff time explaining and serving as a liaison between the homeowner and the TPO company. During the evaluation, GRID staff reported that explaining the model was confusing to participants. Many participants require detailed walkthroughs of the contracts and multiple explanations before they feel comfortable. One example is the application – for TPO systems, both a contract for SASH and a contract with the TPO partner are required. The SASH contract through GRID emphasizes that the system install is at no cost to the customer. However, on Sunrun's contract, it states a dollar amount that the customer agrees to pay for the 25-year PPA. This contradiction confused potential customers. Customers were also confused beyond the application step and cited concerns when it came to servicing their equipment or contacting Sunrun for maintenance.

This evaluation could only quantify costs per project based on installation, materials, and professional services costs. The 25-year PPA cost was not provided in a disaggregated format for analysis in time for this report.

6.1.2 Unaccounted Benefits of Participating in the TPO Model

The benefits of participating in the TPO model that were unique when compared to an ownership structure (not inclusive of benefits of owned projects) are:

1. The payment from the TPO to GRID as the installation contractor
2. Less staff and administrative time searching for additional funding to cover the gap between the incentive and installation and equipment costs
3. Homeowner received monitoring and production guarantees

TPO Payment. Interviews with GRID found that though the TPO model can be complex, the net benefit provided by the agreement (funding to pay GRID as a contractor minus the cost of the 25-year PPA) helped GRID cover the gap between the incentive received through the SASH program and the total cost of solar. This evaluation did not capture the gross value of the TPO payment received but does capture the net value between the cost of the PPA and the payment from the TPO, provided in a separate, confidential memo to the CPUC Energy Division.

Staff Time Saved. GRID staff reported that they spent less time searching for external funding for SASH projects when they are TPO because the gap in financing is smaller; however, this staff time was not tracked or documented.

Homeowner Monitoring Benefits. Finally, the homeowner benefitted from TPO systems because of the monitoring and production guarantees. If a system went offline or underproduced, the TPO company would fix the system or pay the homeowner for the amount of guaranteed production. For owned systems, the homeowner was responsible for monitoring their systems on their own, and typically were not aware if their system was offline until they received their electricity bill. Though there were production and monitoring guarantees, our evaluation found that TPO systems were sometimes not reporting or being properly monitored.

6.1.3 Compare the Complexity of the TPO Model and the Benefits

Without full cost and benefit data, such as the cost of the PPA, the amount of staff time spent on TPO coordination and searching for other sources of gap financing, or the full amount the TPO pays GRID, we were unable to calculate the net benefit or cost of the TPO model. Summarizing the need for more data mentioned throughout this section, the evaluation would require the following:

- Collect full cost agreement for the 25-year PPA
- Collect GRID staff time spent on TPO coordination
- Track GRID staff time spend on searching for other sources of gap financing
- Collect full amount of TPO payment to GRID

Without these values, we could only report on GRID's perspectives and customer experiences.

Through onsite visits and customer survey responses, we found that customers were confused about their ownership model. Across all respondents, only 65 percent accurately reported the own/lease status of their solar panels. People who reported that they lease their system were more likely to report accurately (97% vs. 79%), as shown in Table 50.

Table 50: Reported vs Actual Ownership

Reported Ownership	Actual Ownership	n	%
Owned System (n = 159)	Own	125	79%
	TPO	34	21%
TPO (n = 119)	Own	4	3%
	TPO	115	97%
Not sure (n = 89)	Own	30	34%
	TPO	59	66%

There did not appear to be a correlation between the year installed and the number of people reporting their ownership correctly, indicating it was not a function of time causing people to forget (Table 51). Nor does it seem to be someone other than the person who was involved with GRID at the time of signing the contract responding to the survey, as would be more common in larger households (Table 52).

Table 51: Incorrect Ownership Reporting, by Year Installed

Year Installed	N correctly reported	Total N	% Correct
2010 – 2012	40	45	89%
2013 – 2015	43	59	73%
2016 – 2018	88	151	58%
2019 – 2022	67	110	61%

Table 52: Incorrect Ownership Reporting, by Household Size

Household Occupancy	N correctly reported	Total N for HH occ & responded to Q	% Correct
1 – 2	82	127	65%
3 – 5	104	161	65%
6+	35	50	70%

This confusion about TPO systems and owned systems was observed during evaluation field visits as well. During a homeowner orientation meeting, homeowners spent a lot of time asking questions about the ownership model and returned to the topic frequently. GRID staff interviews found that outreach coordinators would need to remind homeowners that their system is TPO throughout the process. Staff members say that even with this confusion, once the system was installed, customers were happy to benefit from the TPO model's offerings, such as guaranteed production, monitoring, and service and equipment warranties.

6.2 Additional Eligibility Findings

We used historic distance data to estimate the number of eligible households within a reasonable range from each GRID regional office. Table 53 and Table 54 show eligibility estimates for households within the maximum and averages distances travelled for projects by each regional office.

Table 53: Eligibility Estimates by GRID Office, Max Distance

GRID Regional Office	Distance Assumed (mi)	Households Served by IOU	HUD QT Households		Estimated Eligible Households		
			N	% of all IOU HH	N	% of HUD QT	% of all IOU HH
Bay Area	106	2,829,634	494,838	17.5%	73,210	14.8%	2.6%
Bay Area/North Coast	132	94,717	26,952	28.5%	3,516	13.0%	3.7%
Central Valley	146	930,904	153,525	16.5%	21,550	14.0%	2.3%
Greater Los Angeles	76	2,510,757	352,369	14.0%	60,384	17.1%	2.4%
Inland Empire	467	1,699,526	228,697	13.5%	34,012	14.9%	2.0%
North Valley	115	875,753	151,528	17.3%	17,674	11.7%	2.0%
San Diego	56	1,035,539	184,353	17.8%	25,731	14.0%	2.5%
No office within distance		13,504	5,975	44.2%	1,098	18.4%	8.1%

Table 54: Eligibility Estimates by GRID Office, Average Distance

GRID Regional Office	Distance Assumed (mi)	Households Served by IOU	HUD QT Households		Estimated Eligible Households		
			N	% of all IOU HH	N	% of HUD QT	% of all IOU HH
Bay Area	19	1,221,321	266,640	21.8%	33,897	12.7%	2.8%
Bay Area/North Coast	53	59,724	16,986	28.4%	2,683	15.8%	4.5%
Central Valley	44	393,438	54,953	14.0%	6,852	12.5%	1.7%
Greater Los Ang eles	22	1,550,627	222,982	14.4%	35,596	16.0%	2.3%
Inland Empire	68	2,443,730	334,956	13.7%	54,393	16.2%	2.2%
North Valley	32	540,423	92,737	17.2%	10,237	11.0%	1.9%
San Diego	12	597,084	140,482	23.5%	18,931	13.5%	3.2%
No office within distance		3,183,987	468,502	14.7%	74,587	15.9%	2.3%

Figure 43 displays these findings with more detail in Figure 44. Each census tract is colored by the estimated percent of households that are eligible for the program. Note that any tracts that are not HUD qualified are colored gray due to automatic ineligibility. Each GRID regional office has two rings, one with the average distance assumed (blue), and one with the maximum distance assumed (red).

Figure 43: Eligible Households by GRID Regional Offices

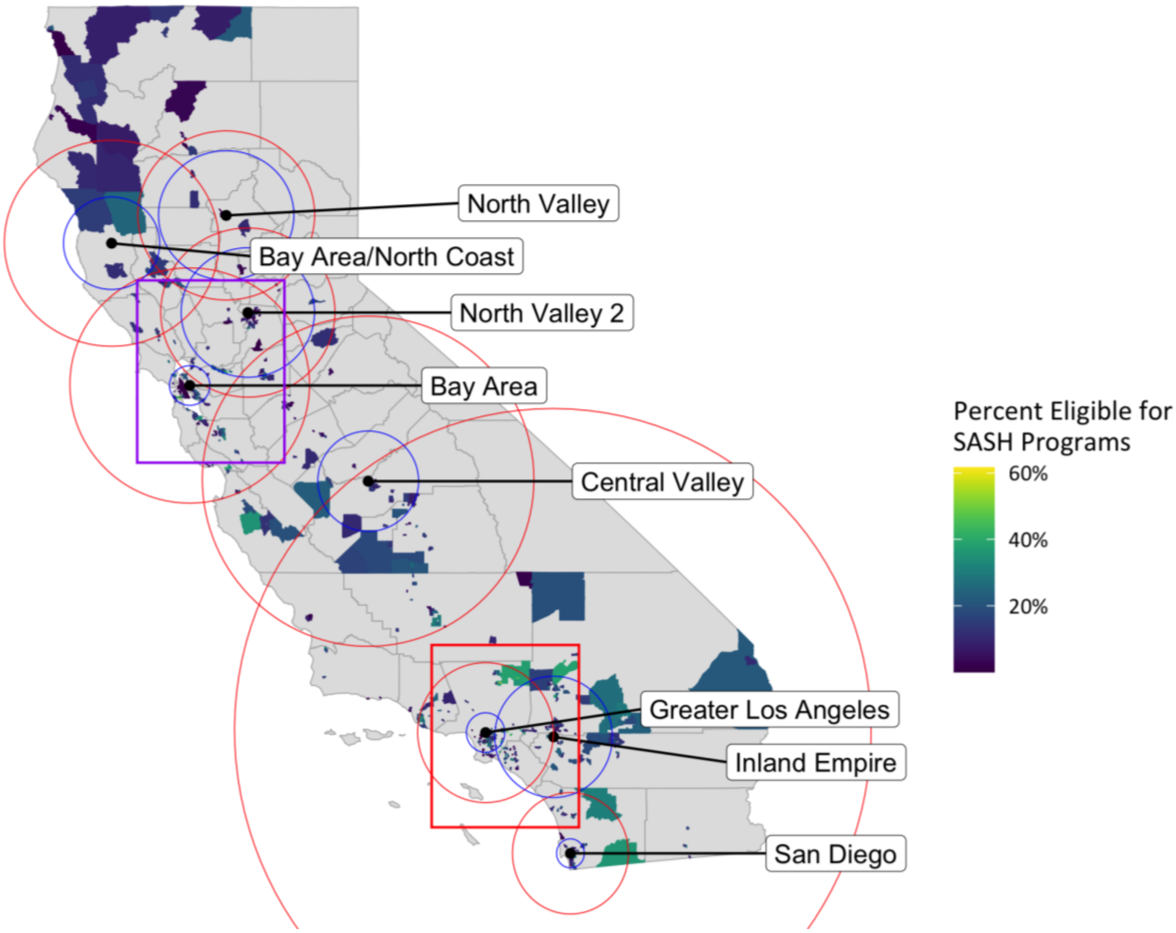
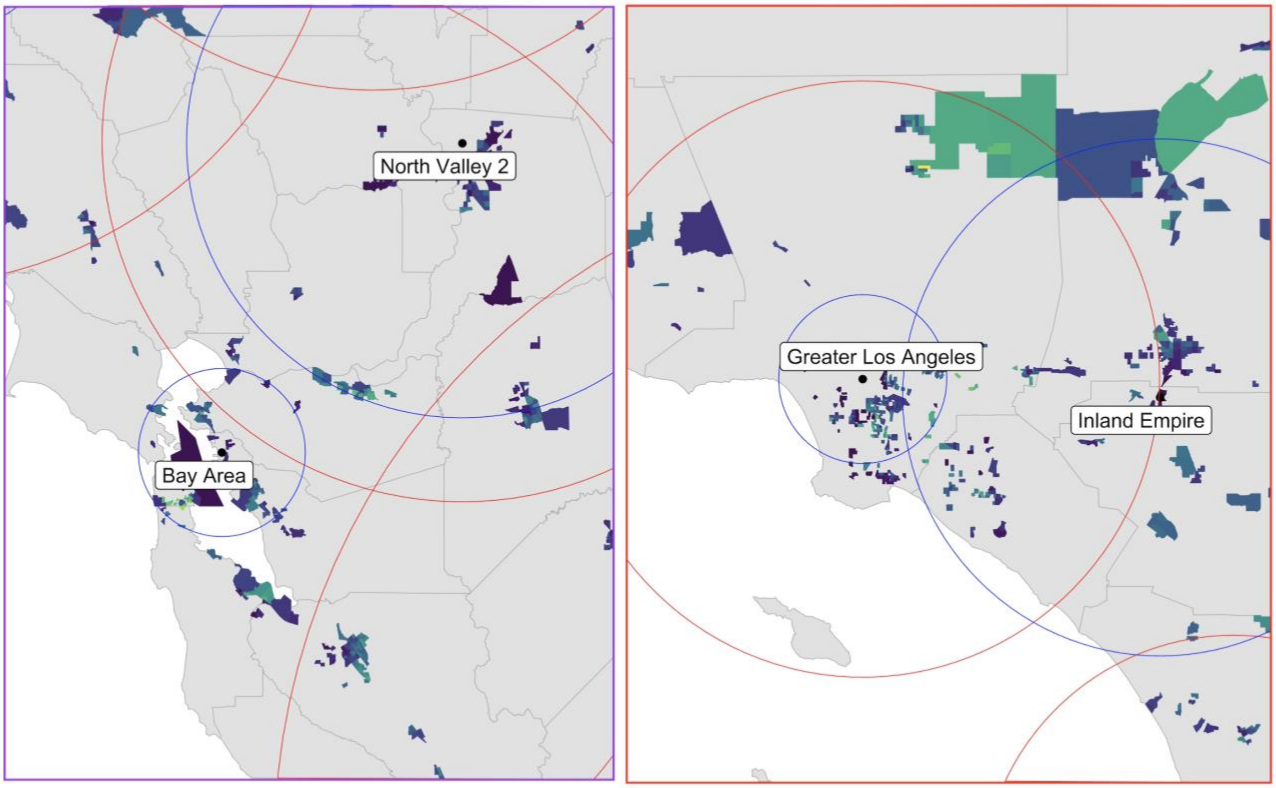


Figure 44: Eligible Households by GRID Regional Offices – Bay Area and Greater LA



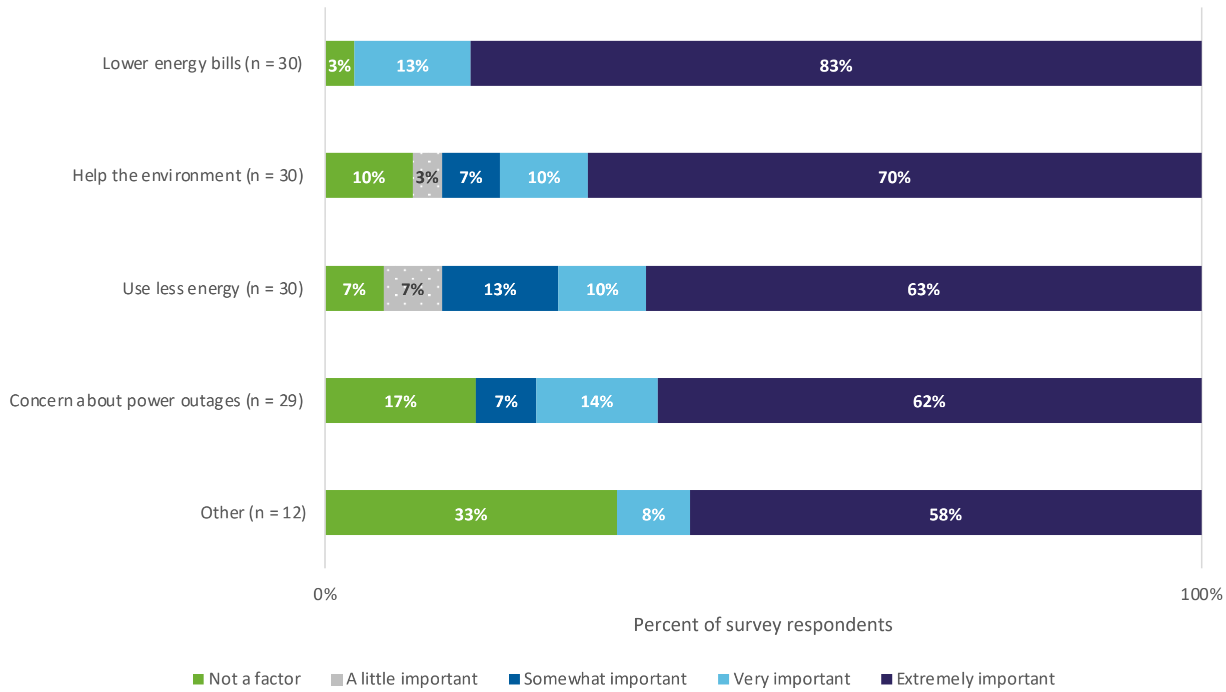
6.3 Market Adoptions of Rooftop Solar

We reviewed non-participant data from 10,728 customers across the three electric IOUs to estimate the market adoption rate of eligible customers.

Based on analysis of IOU CIS data of non-participants, the upper bound of market adoption in the eligible population is about 10 percent (11% for PG&E, 6% for SCE, 10% for SDG&E). Program eligibility was not confirmed in the IOU data, as home type, home ownership, and income level are not reliable variables within the CIS system. Therefore, to estimate the number of eligible customers, we filtered the data for households living in HUD Qualified Tracts that are also enrolled in or eligible for CARE, due to their income requirements being close to SASH. Notably, this is an overestimate because many households in HUD Qualified Tracts were not eligible for SASH, even if they are CARE-eligible.

According to the non-participant survey respondents that installed solar without the use of SASH (n = 30), all listed factors were "extremely important" in their decision to install solar panels on their roofs, with lowering energy bills having the highest percentage of respondents (83%), followed by the desire to help the environment (70%) and using less energy (63%, Figure 45).

Figure 45: Importance of Factors in Decision to Install Solar Panels (Eligible Non-Participants)



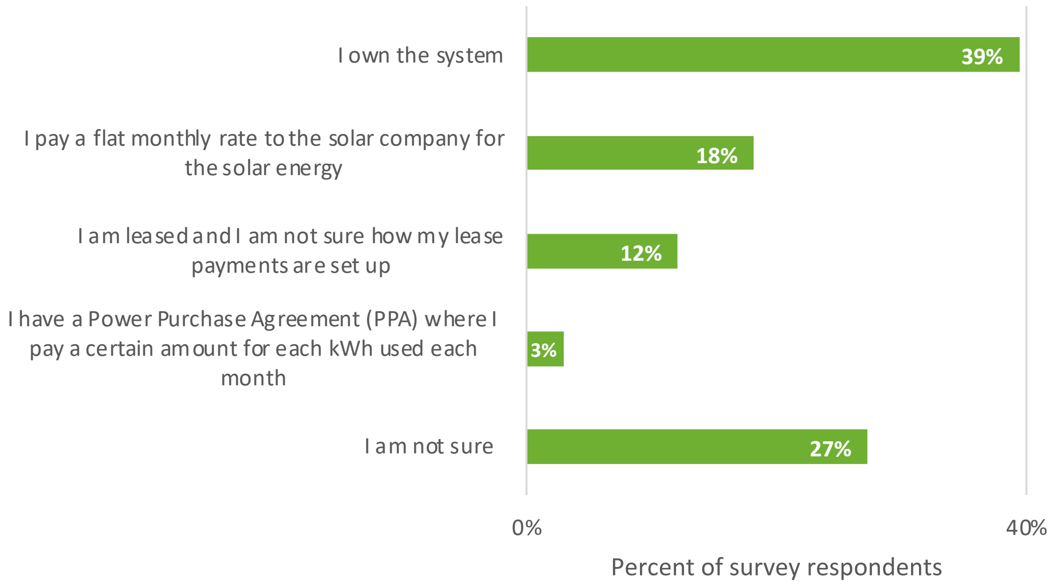
There were respondents (n = 4) who reported that there were other factors that came into play during their decision to install solar panels on their roof.[41] Some of these reasons include:

- Cost concerns due to rising prices (2)
- Low maintenance (1)
- The opportunity to create their own power (1)

Over a quarter of the non-participants that installed solar on their own reported that they were not sure how their solar system was set up (Figure 46). Of those that did understand how their system was set up, most respondents owned their system (39%).

[41] Twelve respondents selected "Other" as a factor. Of those, four selected "Not a factor," and did not write anything in. Another four responded that "Other" was important in their decision but did not write in the other factor. Here, four refers to the number of people that responded "Other" and filled in a response as to what the other factor was.

Figure 46: Description of Solar System, Non-Participants (n = 33)



We examined how this group of low-income homeowners was able to install solar and found that many reported paying for the system on their own with the help of a tax credit or another organization (Table 55).

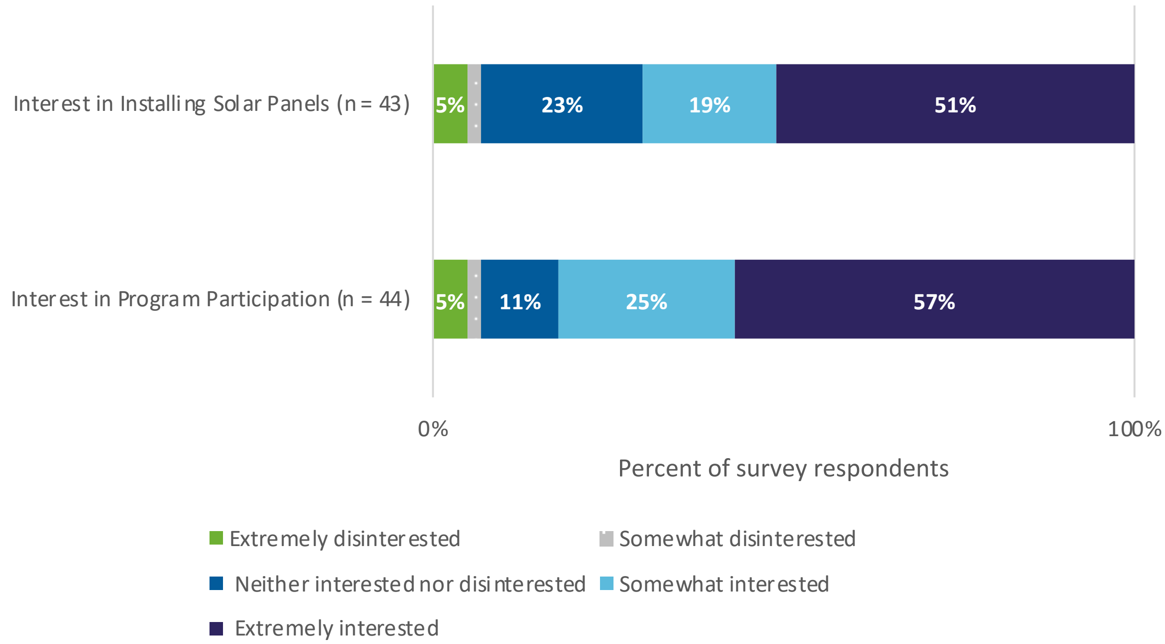
Table 55: Assistance Received (n = 19)

Type of Assistance	N	%
Received a tax credit	8	42%
Received help from another program or organization	6	32%
Paid on own	5	26%

6.4 Non-Participant Perspectives on Solar

We asked eligible non-participants about their interest in installing solar panels and their interest in participating in a program that helped with free solar installation. Many respondents reported that they were extremely interested or somewhat interested in installing solar panels on their home (51% and 19%, Figure 47), and that group increased when asked if they would be interested in a program that helped with free solar installation (57% and 25%). These findings indicate that a lack of interest in a program was a not a large barrier among eligible customers.

Figure 47: Reported Interest in Solar Panel Installation versus Participation in a Program to Install Free Solar Panels



The unaware non-participant respondents who reported an answer regarding their interest in having solar panels installed were further asked to elaborate on why they chose than answer (Table 56).

Table 56: Feedback about Solar Panels (Unaware Non-Participants, n = 40)

Interest	Topics	Quotes
Disinterested (8%)	Cost concerns (2) Personal (1)	"More expensive" "Not interesting at this time"
Neither Interested nor Disinterested (25%)	Personal (6) Cost concerns (3) Need more information (1)	"I have house repairs to contend with before I worry about solar" "Seems not very helpful for our bill" "Unsure how it would benefit me"
Interested (68%)	Lowering Costs (15) Environment and energy (10) Personal (6)	"I need to reduce electricity cost" "Solar panels can help our community's supply and good for the environment" "Save energy for my big family" "It's the future"

Respondents also provided free-text responses to explain their interest in a program that provides ***free solar*** (n = 39)***.*** While the portion of respondents that were interested in a program for free solar is higher than the portion of respondents interested in solar generally, there were still people that were not interested (Table 57).

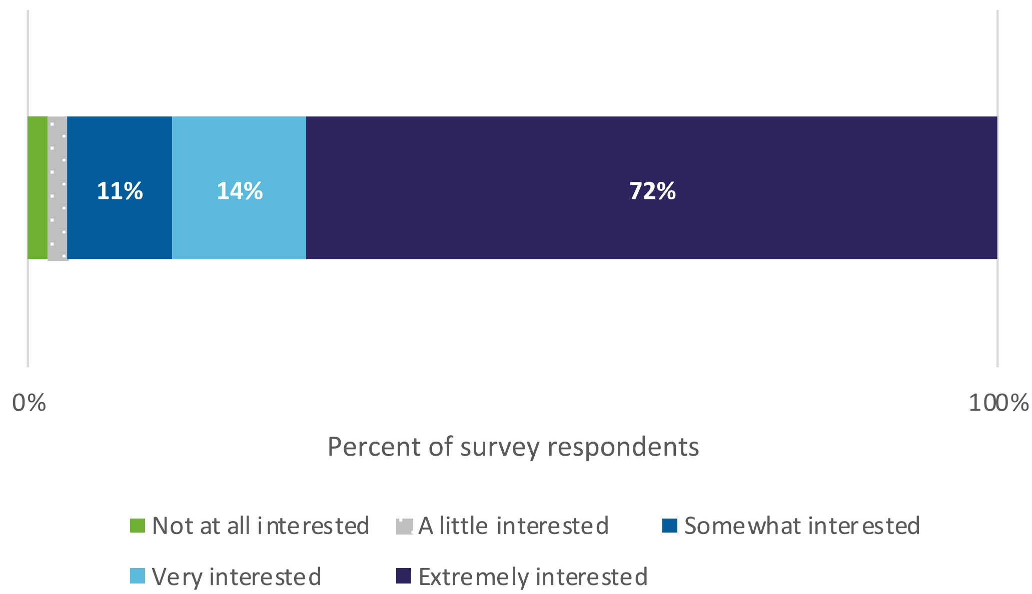
Table 57: Feedback about a Free Program to Install Solar Panels (Unaware Non-Participants, n = 39)

Interest	Topics	Quotes
Disinterested (8%)	Cost concerns (1) Personal (1) Need more information (1)	"Too expensive" "Not at this time" "Nesecito explicación DETALLADA (I need [a] DETAILED explanation)."
Neither Interested nor Disinterested (13%)	Trust (5)	"Cautious about underlying motivations of companies. Probably their presentation is similar to four others I have previously heard from."
Interested (79%)	Lowering Costs (11) Personal (9) Environment and energy (7) Need more information (7)	"Because the cost is expensive" "Energy efficiency is important to me as well as living comfortably within my needs" "I would not have the financial means to do so otherwise, this would help me reduce my bill and have a positive impact on the environment." "I'd like more information"

6.4.1 Motivation for Participation Amongst Non-Participants

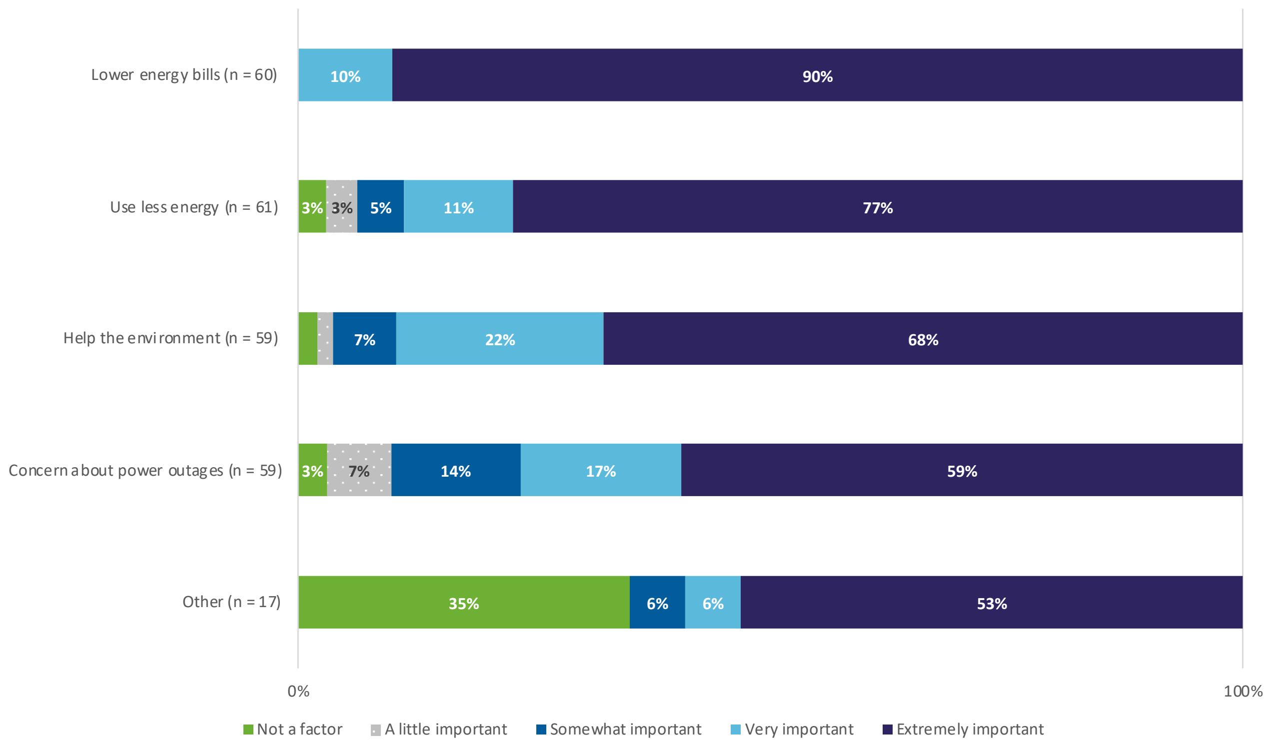
A lack of interest in the program does not appear to be a barrier. Most eligible non-participants responded that they were extremely interested in SASH when they first learned about the program (Figure 48).

Figure 48: Non-Participant Interest in SASH Program (n = 64)



According to the respondents, all listed factors were “extremely important” in their interest in participating, with lowering energy bills having the highest percentage of respondents (90%) followed by the desire to use less energy (77%) and help the environment (68%, Figure 49). Seventeen respondents responded that there were other factors that came into play in forming their interest to install solar panels on their roof, some of which included independent control over electricity usage, the opportunity to get a roof replacement, and cost effectiveness.

Figure 49: Importance of Factors in Interest in Participating



6.5 PV Monitoring System Errors

This section describes the data and documentation issues observed by the Evergreen team throughout the evaluation process in more detail.

6.5.1 Enphase-Enlighten System

The Enphase-Enlighten dashboard allows users to observe daily energy generation over the lifetime of the equipment. The Evergreen team was given administrative access to Enphase-Enlighten's system, so we were able to review for individual days when generation data were missing. Table 29 outlines the daily data availability for the sampled projects that were monitored with Enlighten, from project installation through June 30, 2022.

Table 58: Enphase-Enlighten Sample Daily Availability

Projects Missing Data	Total Instances of Reporting Error	Total Days	Days with Reporting Error	Percent of Days Missing
25 of 48	34	96,776	19,355	20%

Enphase-Enlighten monitoring systems continue to log energy generation during communication outages, then sometimes upload the backlog to the database when communication is reestablished; however, this delayed upload does not occur after every communication error. There are clear instances where communication was lost and generation data never uploaded to the system, such as when generation is zero (0) kWh on one or more days. As shown in Table 59, there are three types of data reporting errors that we observed in the Enphase-Enlighten portal:

1. Retirement of antiquated 3G cellular communication system;
2. Gateway communication errors; and
3. Microinverter reporting errors.

Table 59: PV System Reporting Communication Errors

Program	Antiquated Cellular Connection	Gateway Communication Error	Microinverter Error
SASH 1.0	-	11	5
SASH 2.0	1	5	1
TOTAL	**1**	**16**	**6**

Retirement of antiquated 3G cellular communication systems: Some of the communication errors observed during the evaluation were determined to be related to the ongoing phase-out of the 3G cellular network. Enphase-Enlighten systems use either a cellular network or Wi-Fi. In 2022, mobile carriers were actively discontinuing 3G wireless service, with completion expected by the end of 2023. Enphase-Enlighten monitoring systems that are connected to a 3G network must be reconfigured to resume communication. Affected customers have two options: (1) install a new modem that is compatible with modern wireless networks, or (2) connect the monitoring system to their home's wireless internet network. GRID reported that households with a TPO system were notified of this change in late 2021. Sunrun performed meter or cell modem replacements at no cost to clients for about 1,400 systems as of November 2022. It is unclear how homeowner-owned systems may have received notice, and it is believed that such notice may have only happened once through their Enphase-Enlighten portal and therefore, homeowners may not be aware of the change.

Gateway communication errors: This error indicates that the broadband Internet connection that the Enphase-Enlighten gateway uses to communicate to the Enphase-Enlighten servers is experiencing a problem. This condition does not affect a system's ability to produce power. When the connection is restored, the gateway will catch up with the transmission of all energy data it has stored. This error can occur if the internet service is experiencing an outage or when the router may be unplugged or turned off.

Microinverter reporting errors: Data reporting events are not recorded in the online portal, so determining the completeness of historical energy generation logs is a manual process and potentially inaccurate. To identify partial day outages, the team had to manually inspect generation data and plots of all PV systems, which are challenging to recognize. Outages are less obvious when the system is down for a partial day or when a fraction of the microinverters are not communicating properly, resulting in non-zero but lower than normal energy generation being displayed. We are unable to tell from the online portal whether the outage extends just to the communication system or if the system is truly not generating – see the customer bill impacts section for analysis of persistence.

There were 14 SASH 1.0 and five SASH 2.0 projects with a reporting communication error at the time of this analysis, and these could include one or more errors noted herein, all which limit communication to the Enphase-Enlighten servers.

6.5.2 SolarEdge Data Availability

GRID provided the SolarEdge-monitored PV system energy generation data in monthly increments from June 2021 through July 2022. We identified reporting errors for each sampled project when the generation for a single month was either zero (0) kilowatt-hours (kWh) or approximately 80 percent less than an adjacent month. Identified errors are summarized in Table 60.

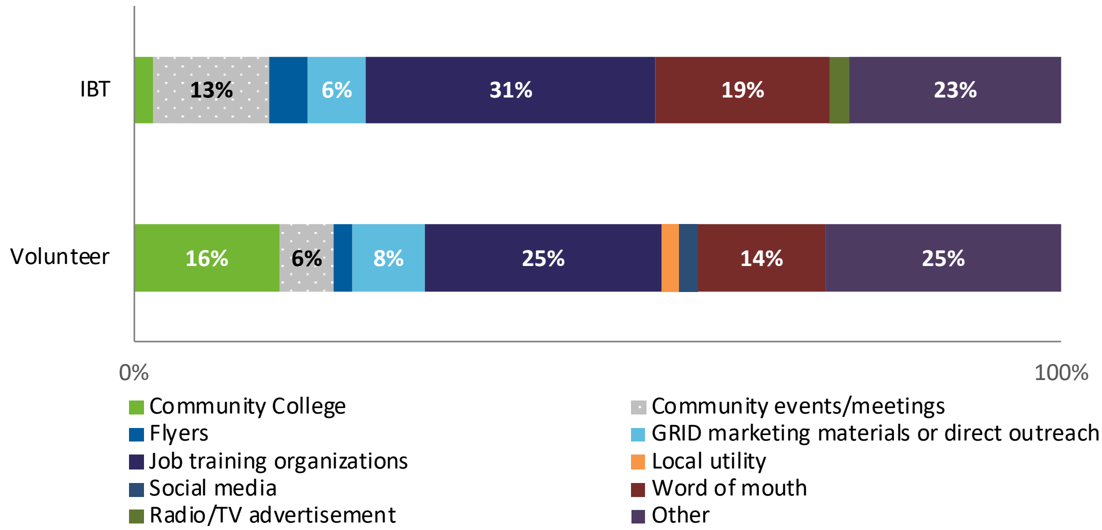
Table 60: SolarEdge Sample Monthly Availability

Projects Missing Data	Total Instances of Reporting Error	Total Months	Months with Reporting Error	Percent Missing
3 of 13	3	151	6	4%

6.6 Marketing for the Training Program

Interviews with GRID and onsite visits found that trainees learned about the IBT program in many ways. GRID staff emphasized the importance of local partnerships with job training organizations and community colleges, and surveyed trainees agreed. Respondents were provided a multiple-choice list. Job training organizations were the main avenue (31% IBT, 25% Volunteer) by which participants learned about the GRID opportunity. Figure 50 displays other options selected.

Figure 50: How Respondents Hear About GRID Training (n = 99)

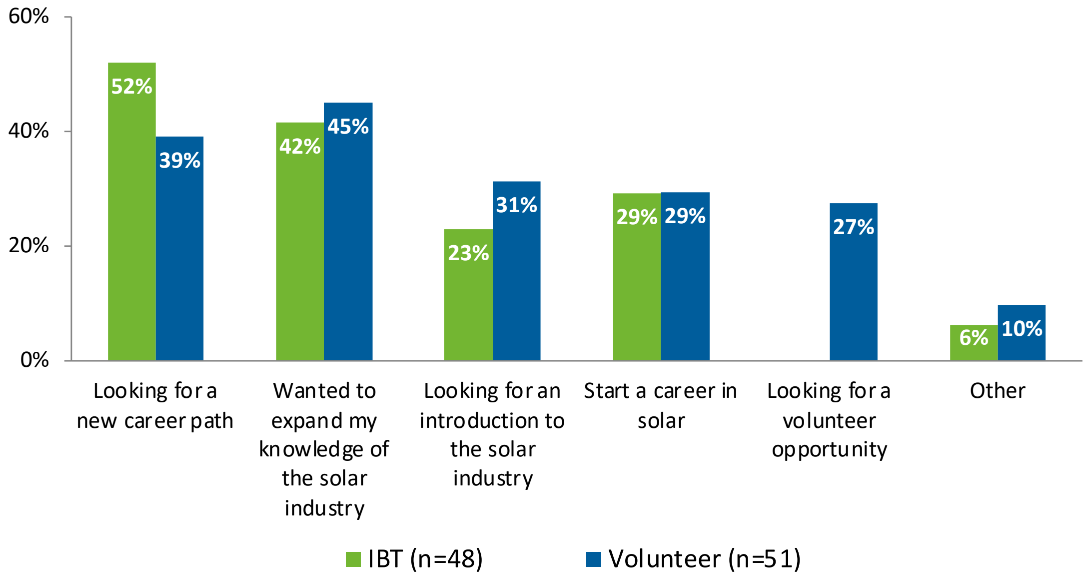


Of those that selected "Other," the most frequent sources cited were:

- IBT: Trade school or employment program (6%), internally (employed at GRID) (4%)
- Volunteer: Volunteer opportunity (8%), university or community college (2%), internally (employed at GRID) (2%)

Trainees reported different motivations for participating in the IBT or volunteer opportunities. About half (52%) of the IBT respondents shared that they were looking for a new career path, while many (45%) of the volunteer respondents noted wanting to expand knowledge of the solar industry (Figure 51).

Figure 51: Reason for Participation (n = 99)



These findings are congruent with how most respondents learned about the program, given that most participants heard about the opportunity from a learning/training source, and most were interested in participating for a new career or to build upon knowledge of the solar industry.

Some respondents provided additional free-response answers to what they were looking to gain through the training or volunteer opportunity.

Out of the IBT respondents:

- 26% of the responses mentioned career development;
- 24% specifically referenced preparing for or seeking a job in the solar industry; and
- 18% noted wanting transferable skills.

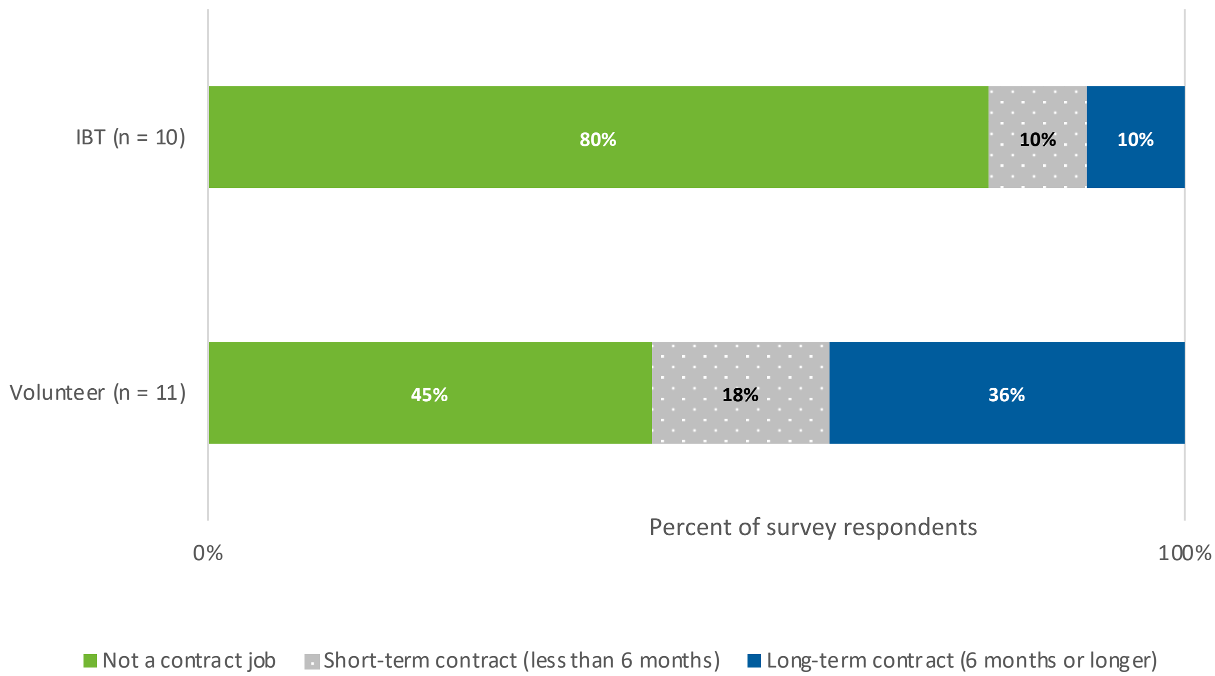
Of the volunteer respondents:

- 38% of the responses pertained to career development;
- 35% noted wanting transferable skills; and
- 29% specifically noted wanting to learn how to work with solar.

6.7 Other Outcomes from the Training Program

For trainees that were working part-time before participating with GRID, the majority of the IBT participants (80%) said that the work that they did was not contractually based, as shown in Figure 52. For the volunteers, almost half (45%) reported that their work was not a contract job.

Figure 52: Part-Time Job Type Before Participation



Of the seven IBT participants that reported having a part-time job after participation, most reported that it was not a contract job (71%). The rest (29%) had a long-term contract.

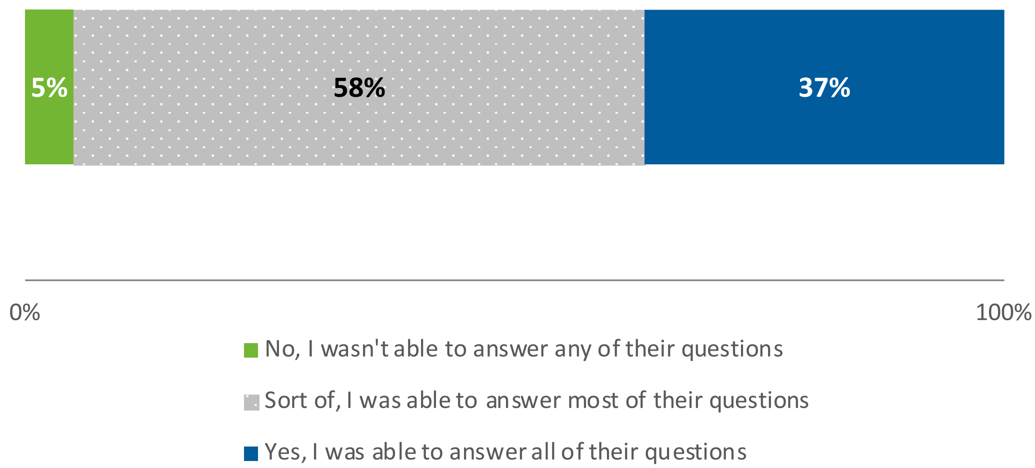
6.7.1 Professional Certifications

As part of the IBT training, participants receive a certification of completion. Half of all IBT respondents said they received some professional certification, while the other half reported that they did not. Of those who received a certification, over half (58%) received both the OSHA 10 and CPR certification. About a third (38%) received Design, Forklift, Auditing, Inverter, or PV 1-3 certifications and the remainder (33%) stated that they received a Certificate of Completion from the GRID training course. Out of the respondents who received a certification (n = 19), most (58%) have pursued or plan to pursue other professional certifications in the solar industry outside of what was received in the GRID training course.

6.7.2 Interactions with Residents

Most respondents (83%) had the opportunity to interact with residents of the homes that were getting solar installed. A little over three-quarters (77%) of respondents who interacted with residents noted that the residents had questions about the installation or overall process. Of the participants who encountered residents with questions, most were able to answer the questions to some extent. Figure 53 captures participant confidence levels fielding resident questions.

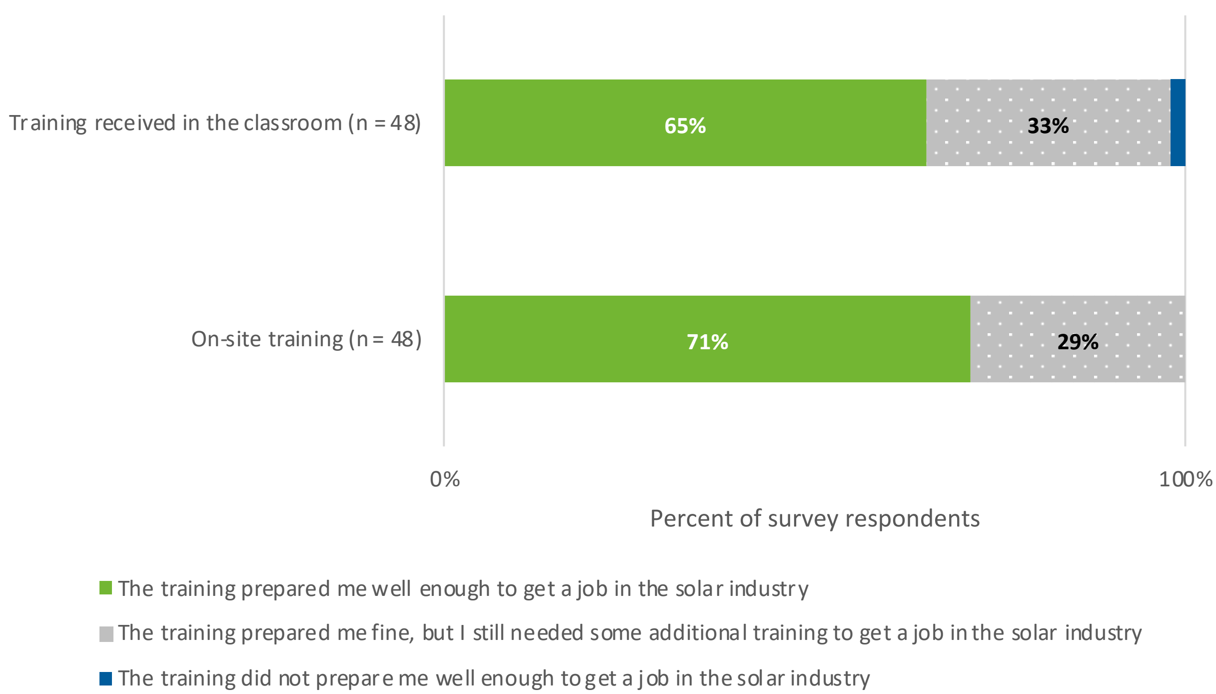
Figure 53: Confidence Answering Resident Questions (n = 57)



6.8 Value of Training Courses

IBT respondents were asked whether they felt that the training that they received on-site and in the classroom provided them with the knowledge and skills necessary to be successful in the solar industry. Participants mostly reported that both modes prepared them well enough to get a job in the solar industry; however, there were some that did not feel prepared (Figure 54).

Figure 54: Preparation by Mode of Learning



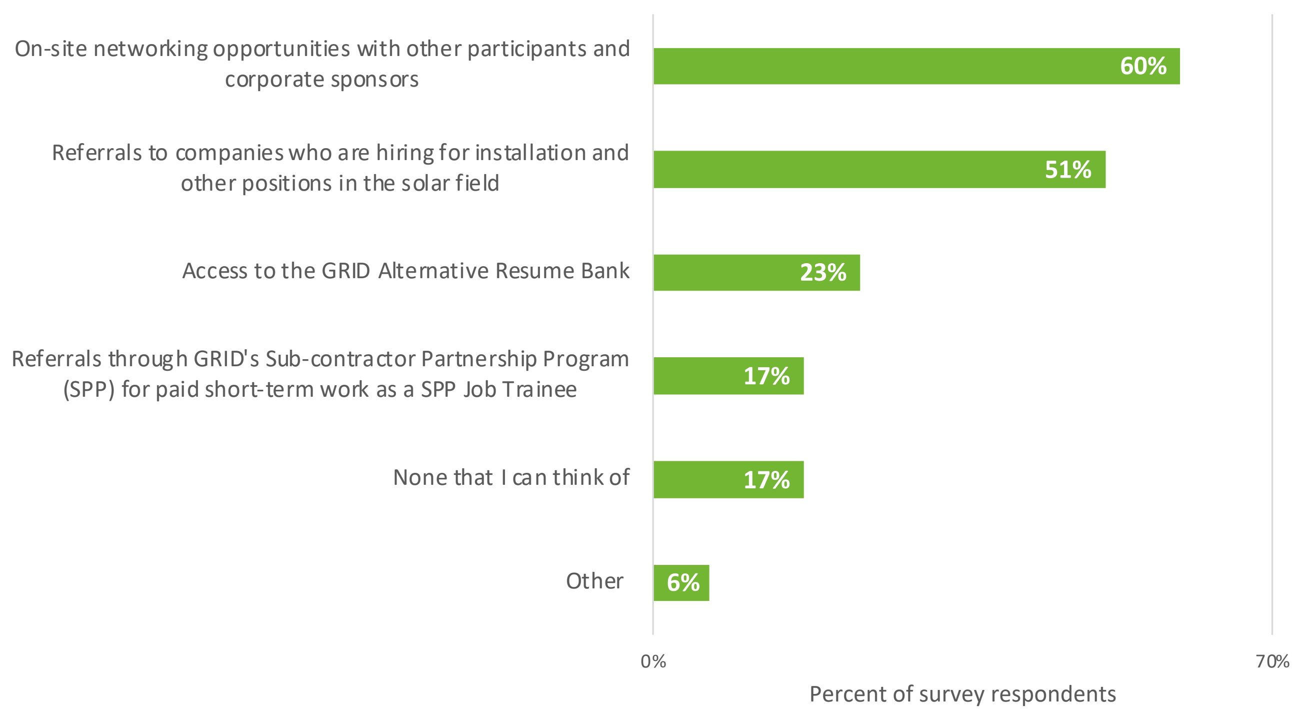
The respondents who reported feeling that the training they received was not enough for them to get a job in the solar industry were asked what they felt they needed to know to be successful. The 13 participants who reported an answer felt that they could have gotten better support to become successfully employed through the following methods:

- Greater access to learning opportunities and more installation and wiring hands-on experience (12)
- Greater access to employment and networking opportunities (3)

One of the respondents also mentioned the difficulty in gaining access to such experiences due to the pandemic.

Respondents were then asked to select the types of networking and employment opportunities received during GRID training, with multiple selections allowed (Figure 55). The most frequented opportunity selected by participants at 66 percent was 'on-site networking opportunities with other participants and corporate sponsors', closely followed by 'referrals to companies who were hiring for installation and other positions in the solar field' (51%). Those who chose 'other' were asked to specify. The answers reported included attaining full-time employment with GRID themselves and recommendations by their colleagues for future employment opportunities.

Figure 55: Opportunities Received During Participation (n = 47, multiple responses allowed)



Most respondents reported that GRID's training course provided them with the opportunities and resources needed to obtain a job in the solar industry extremely well or very well (81%).

Those who reported that the course did not do well in providing them the necessary resources were asked about what the training course could have provided them that would have helped them to obtain employment in the solar industry. Seven participants reported an answer including:

- More hands-on training (2)
- More electives to bypass any onboarding during the hiring process for GRID and other related jobs (1)
- Uniformity in the quality of the GRID training programs offered (1)
- Unconditional support despite not being on the field or a related job (1)

The respondents were also asked whether they would have known how to seek the skills necessary for employment in the solar industry if they had not participated in the GRID training course, to which the majority (79%) said 'no', indicating that the training course is largely instrumental in helping people enter the solar industry.