2023 CALIFORNIA SOLAR INITIATIVE

Annual Program Assessment

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California Solar Initiative Annual Program Assessment

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Prepared by the
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Authors

Brett Palmer
Cherie Chan
Christopher Westling
Erica Petrofsky
Joshua Litwin
Sarah Lerhaupt
Tory Francisco

Special Thanks

Dan Buch
Jill Walker
Leuwam Tesfai
Terrie Prosper

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1 Executive Summary

In January 2007, California launched the Go Solar California campaign, a multi-entity $3.3 billion ratepayer-funded effort to install 3,000 megawatts (MW) of new distributed solar over the next decade and transform the market for solar energy by reducing the cost of solar generating equipment. The portion of the solar effort overseen by the California Public Utilities Commission (CPUC) was known as the California Solar Initiative (CSI) program. The CSI program components were the General Market program, Single-Family Affordable Solar Homes program (SASH); Multifamily Affordable Solar Housing program (MASH); CSI Thermal program; CSI Thermal Low-Income program; and Research, Development and Demonstration (RD&D) program.

By many measures, these program components have been a success and have accomplished the market transformation goals, delivering the opportunity to install lower-cost solar generation to homeowners and apartment-dwellers across California. While the solar market in California has matured considerably since the CSI program launched in 2007, it is still not self-sustaining as subsidies continue to support rooftop solar through the net billing tariff structure that was adopted in December 2022. This report details the accomplishments of the Go Solar California campaign components managed by the CPUC. All components closed by the end of 2021.

The CSI program goal was to install 1,940 MW[1] of customer-sited solar capacity, and, along with other statewide solar programs, transition the solar industry to a point where it could be self-sustaining without subsidies. The market for solar generating equipment in California grew at a rapid pace from the beginning of the CSI program and has continued to grow since the program closed, in part due to the subsidies afforded from the net energy metering tariff and the continuing subsidies provided to customer-sited solar through the net billing tariff structure adopted by the commission in December of 2022. California installed enough solar capacity to achieve the CSI General Market Program goal of installing 1,750 MW of capacity prior to December 2016. By the end of 2022, approximately 12,244 MW of customer-sited solar projects had been installed at over 1.43 million locations within the service territories of the state's three major investor-owned utilities (IOU). This total, which is over six times the CSI program goal, includes 31.2 MW of capacity under the SASH program and 66.8 MW of capacity under the MASH program.

This Annual Program Assessment meets the statutory requirement for a yearly report to the Legislature on the progress of the CSI program.[2] This Assessment also discusses the Solar on

[1] This goal includes the CSI General Market Program goal of installing 1,750 MW of capacity by the end of 2016.
[2] Public Utilities Code Section 913.7 states, "On or before June 30, 2009, and by June 30th of every year thereafter, the CPUC shall submit to the Legislature an assessment of the success of the California Solar Initiative Program."

Multifamily Affordable Housing (SOMAH) and Disadvantaged Communities Single-family Solar Homes (DAC-SASH) programs which are separate from the CSI program but similarly provide incentives for the installation of behind-the-meter solar. Other front-of-meter, on-site generation alternatives, including the Disadvantaged Communities Green Tariff (DAC-GT) and the Community Solar Green Tariff (CSGT) programs, are also described. With the general market for customer-sited solar in California thriving, the CPUC is placing its emphasis on promoting equity of access to solar power through the SOMAH, DAC-SASH, DAC-GT, and CSGT programs.

Other state authorized programs, including the New Solar Homes Partnership (NSHP) managed by the California Energy Commission (CEC) and publicly owned utilities' solar offerings, are not discussed in this Assessment, although the solar capacity installed under the NSHP is included in the totals reported here.

1.1 Key Report Contents

This report contains current information on distributed solar energy systems in the large investor-owned utility (IOU)[3] service territories in California. It includes detailed information on program participation, installed capacity, equipment costs, and program impacts for all the CSI program components, including the General Market program, SASH program; the MASH program; the CSI Thermal program; the CSI Thermal Low-income program; and the RD&D program. This report also includes information on net energy metering (NEM), which is the tariff that has been utilized to subsidize by many of these programs, and other relevant policy updates. Unless stated otherwise, all data is accurate as of December 31, 2022.[4]

1.1.1 Installed Solar Highlights

- Through the end of 2022, approximately 12,244 MW of solar capacity was installed at 1,437,637 customer sites in the large IOU territories.[5] This exceeds the state's Go Solar California goal of 3,000 MW by over 400 percent.
- In 2022, 1,108 MW was installed in the IOU territories.

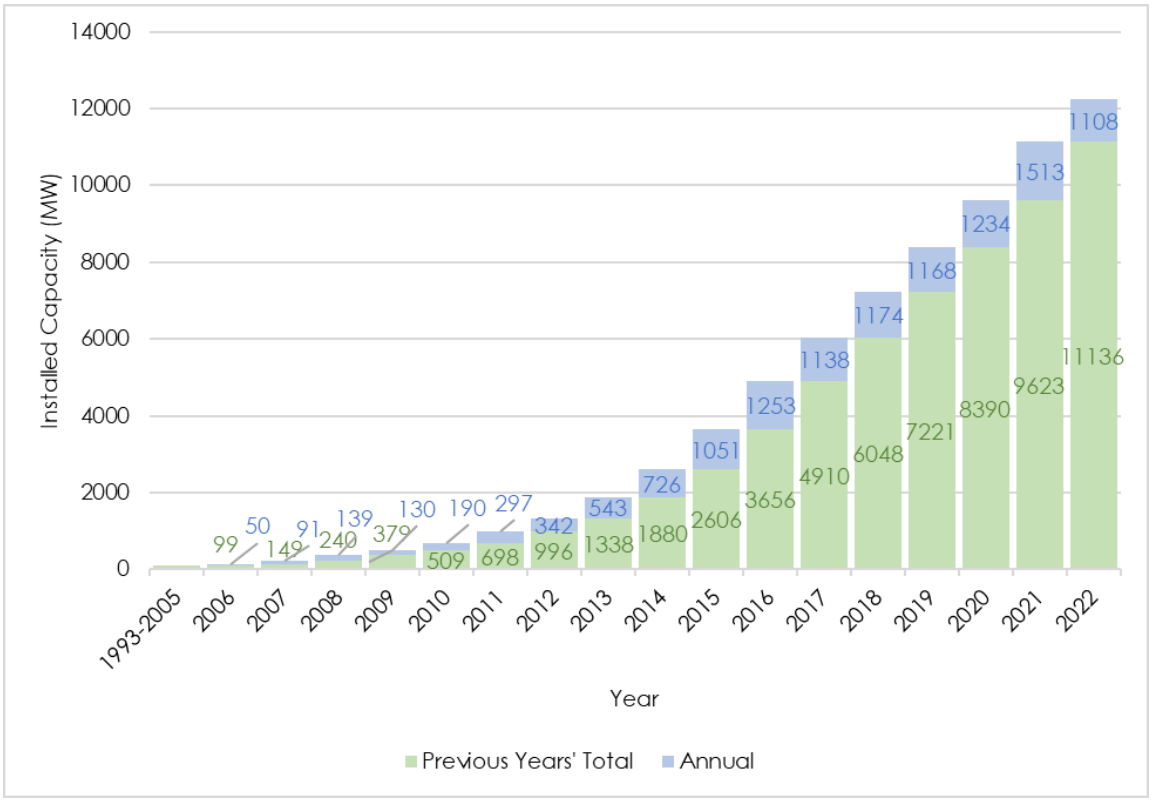
All CSI Annual Program Assessments, beginning with the 2009 report, are available at https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/california-solar-initiative/csi-progress-reports.

[3] The large IOUs under the CPUC's regulatory jurisdiction are Pacific Gas and Electric Company (PG&E). Southern California Edison Company (SCE), San Diego Gas & Electric Company (SDG&E), and Southern California Gas Company (SoCalGas).

[4] Please note that some subtotals in this report do not add up to their respective totals due to rounding.

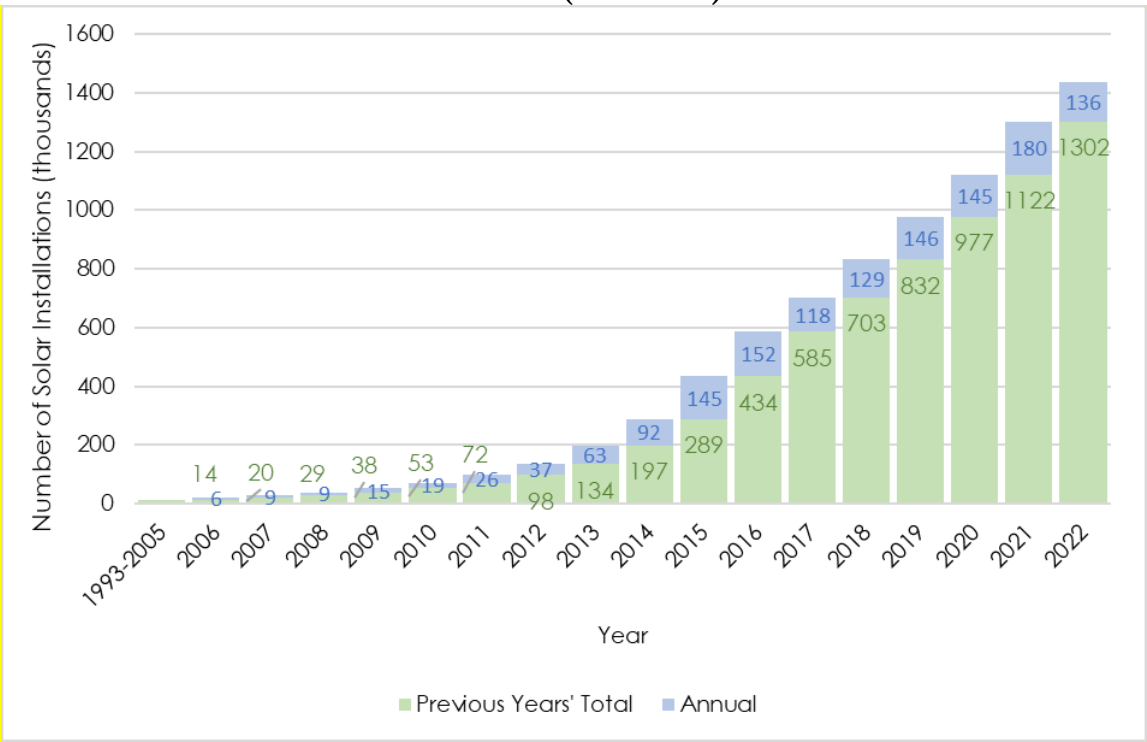
[5] California Distributed Generation Statistics (California DG Stats) website, (formerly named "California Solar Statistics") at californiadgstats.ca.gov.

Figure i: Customer-Sited Solar MW Installed Capacity in CA's IOU Territories, 1993-2022 (MW)



Source: California DG Statistics Interconnected Project Sites Data Set (californiadgstats.ca.gov), updated February 28, 2023. Year defined by date of interconnection application approval. *Notes*: Data includes all solar photovoltaic (PV) systems interconnected under Rule 21 within PG&E, SCE, and SDG&E service territories. Data does not include systems within publicly owned utility (POU) territories.

Figure ii: Number of Installed Customer-Sited Solar Projects in CA's IOU Territories, 1993-2022 (thousands)



Source: California DG Statistics Interconnected Project Sites Data Set (californiadgstats.ca.gov), updated February 28, 2023. Year defined by date of interconnection application approval. *Notes:* Data includes all solar PV systems interconnected under Rule 21 within PG&E, SCE, and SDG&E service territories. Data does not include systems within POU territories.

1.1.2 CSI General Market Program Highlights

- The CSI General Market program, which closed to new applications on December 31, 2016, exceeded its goal of installing 1,750 MW by the end of 2016. As of December 31, 2018, the CSI General Market Program had installed 1,935 MW.[6,7]

- Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), and San Diego Gas & Electric Company (SDG&E)[8] installed enough solar capacity for both their residential and non-residential (commercial, industrial, government, non-profit, and agricultural properties) CSI customer classes to exceed their installation goals.

[6] CSI Working Dataset, (californiadgstats.ca.gov/downloads). Data accessed April 29, 2020.
[7] The overall MW totals exceed the 1,750 MW CSI goal due to additional CSI incentive funding that was authorized in SB 585. This funding was authorized as a result of different rebates being offered to taxable and non-taxable entities, which caused CSI budgeting uncertainty. See CPUC Decision (D.)11-12-019 for more details.
[8] The Center for Sustainable Energy (CSE) administered the CSI Program in SDG&E's service territory.

- As the CSI General Market Program is now closed, the successor NEM called the Net Billing Tariff (NBT) and the Federal Investment Tax Credit are the primary financial drivers and subsidies of customer-sited solar generation.

1.1.3 Other Program Highlights

Table i: CSI Budget by Program Component

Program Component	Budget[9] ($ millions)	Goal
General Market Solar Program (includes PV and electric-displacing solar thermal technologies)	$2,098	1,750 MW
Single-family Affordable Solar Homes (SASH)	$108	95 MW[10]
Multifamily Affordable Solar Housing (MASH)	$108	95 MW[10]
Research, Development, Demonstration, and Deployment (RD&D)	$50	N/A
Solar water heating Pilot Program (SWHPP)[11]	$2.6	750 systems
Sub-Total: CSI Electric-Displacing Budget	**$2,367**	**1,940 MW**
CSI Thermal Program (Gas-Displacing)	$250	Cost effective deployment of solar thermal systems to reduce natural gas consumption in California.[12]
Total CSI Budget	**$2,617**	**-**
Re-authorized SASH Program	$54	15 MW
Re-authorized MASH Program	$54	35 MW
Total CSI Budget including re-authorized SASH/MASH programs	**$2,724**	**-**

Notes: D.06-12-033 established a 1,750 MW goal for the General Market Program and a 1,940 MW goal for the overall program. D.10-01-022 established the CSI Thermal Program pursuant to Assembly Bill 1470. D.11-12-019 approved an extra $200 million of funding for the General Market program. D.15-01-027 reauthorized $108 million in additional funds for the CSI low-income programs and adopted a 50 MW low-income capacity goal separate from the CSI goals established in SB 1 (Murray, 2006).

- **Single-Family Affordable Solar Homes (SASH)**
    - Since the program was launched in 2008, through February 2023, SASH has completed a total of 9,816 projects, representing 31.3 MW of installed capacity on eligible homes.[13]

[9] Total budget over life of program.
[10] The CPUC decisions on MASH and SASH did not explicitly adopt a 95 MW per program goal; however, the CPUC did adopt a total CSI program goal of 1,940 MW in D.06-12-033.
[11] The SWHPP was a pilot program that preceded the CSI Thermal Program and is now closed.
[12] AB 797 (Irwin, 2017).
[13] These numbers include both SASH 1.0 and SASH 2.0 projects. A more detailed breakdown between the original SASH 1.0 program and reauthorized SASH 2.0 program can be found in Section 4.2.1.

- The original $92 million SASH incentive budget was fully expended in all IOU territories in 2014. In 2015, the CPUC extended the SASH program, with nearly $46 million in additional incentive funding authorized.[14]

- Through February 2023, SASH applicants have received or reserved a total of $45.65 million of the available $45.9 million incentive budget authorized for the extended SASH program. As of December 31, 2021 – the SASH program closed to new applications in all the IOU service territories.

- Since the SASH third-party ownership (TPO) model was made available in 2015 through February 2023, over 85 percent of SASH 2.0 capacity that was installed used the TPO model to finance the installation of solar photovoltaic (PV) systems for low-income customers at no cost to the SASH participants. More information on the SASH TPO Model is provided in Section 4.2.1.1.3.

- **Multifamily Affordable Solar Housing (MASH)**

  - Since the program was launched in 2008, 649 MASH projects have been completed, equaling 66.8 MW of installed capacity as of April 2023.[15]

  - MASH applicants have received or reserved 100 percent of the original $95 million MASH incentive budget.

  - Due to project cancellations and adjustments to incentive claims, SCE and PG&E briefly reopened their MASH Programs for new applications in 2020. The MASH program is closed.

[14] Decision 15-01-027.
[15] These numbers include both MASH 1.0 and MASH 2.0 projects. A more detailed breakdown between the original MASH 1.0 program and reauthorized MASH 2.0 program can be found in Section 4.2.2.

Table ii: Summary of CSI Low-Income Program Participation

Program	Number of Completed Projects[16]	Total Paid Incentives ($ millions)	Total Installed Capacity (MW)
SASH 1.0	5,266	92.08	16.0
SASH 2.0	4,552	45.65	15.2
MASH 1.0	379	86.82	27.4
MASH 2.0	270	51.28	39.4
Total	**10,467**	**275.83**	**98.0**

Sources: MASH: Data request response from IOUs 4/4/2023. SASH: Data request response from GRID Alternative 3/29/2023. All system capacity measured in CEC-AC PTC MW.

- **Newer non-CSI programs that incentivize behind-the-meter solar**

    - **SOMAH** – The Solar on Multifamily Affordable Housing (SOMAH) program provides financial incentives for installing solar PV systems on multifamily affordable housing. SOMAH has an overall target to install 300 MW by 2030. Eligible properties include multifamily affordable housing in the PG&E, SCE, SDG&E, Liberty Utilities, and PacifiCorp utility territories. Funded through utility greenhouse gas (GHG) allowance auction proceeds from California's cap-and-trade program, SOMAH has a program budget of up to $100 million annually from 2016 through June 30, 2026.

      The SOMAH program began accepting applications on July 1, 2019. The waitlists at the program's start in the PG&E, SCE, and SDG&E territories have now cleared. Each IOU territory's annual incentive budget varies based on their specific GHG allowance auction proceeds. By the end of 2022, 432 applications with 65.2 MW of capacity had been submitted into the program, with participation in most SOMAH-eligible IOU territories except PacifiCorp and 32 percent of the total active applications located in disadvantaged communities. By IOU territory there are 220 active applications in PG&E, 101 in SCE, 37 in SDG&E, 2 in Liberty and 0 in PacifiCorp. Completed projects' capacity is 13.25 MW with incentives of $24.8 million, with 22 projects in PG&E, 37 projects in SCE, and 13 projects in SDG&E territory.

    - **DAC-SASH** – The Disadvantaged Communities Single-Family Solar Homes (DAC-SASH) program was created in June 2018 through CPUC Decision (D.)18-06-027 and launched in fall 2019. DAC-SASH provides $3.00/watt incentives for solar installations on owner-occupied, single-family homes located in disadvantaged

[16] Figures represent only completed projects and do not include pending applications.

communities. All participants in DAC-SASH must be income-eligible for either the California Alternate Rates for Energy (CARE) program or the Family Electric Rate Assistance (FERA) program. By the end of December 2022, 1,721 DAC-SASH projects had been installed.

- **CSI Thermal Program**

  - From January 2010 to December 2022, the program approved 12,354 applications for natural gas-displacing solar thermal systems for $180 million in incentives dispersed or reserved out of the available $250 million CSI Thermal budget.

  - In 2017, Assembly Bill (AB) 797 (Irwin) authorized the CSI Thermal program to continue operation from January 1, 2018 to July 31, 2020. Although the overall budget was kept at $250 million, AB 797 mandated the allocation of 50 percent of the CSI Thermal budget to low-income residential housing or building in disadvantaged communities (DACs).[17]

Table iii: CSI Thermal Installed Projects by Sector and Displaced Fuel through 2022

Number of Applications	Total Incentives ($ thousands)	Total Project Costs ($ thousands)	Total Annual Energy Savings (therms)
12,354	$180,466	$322,400	9,931,820

Source: CSI Thermal Program Data (californiadgstats.ca.gov), accessed April 17, 2023.

- **Research, Development, Demonstration, and Deployment (RD&D) Program**

  - The CSI RD&D Program conducted five project solicitations, resulting in grant funding for 37 projects, totaling $41.2 million. Funded projects focused on the following areas:

    - Integration of solar PV into the electricity grid,
    - Energy generation technologies and business development, and
    - Grid integration and production technologies

  - The CSI RD&D Program (which focused primarily on CSI General Market) closed on December 31, 2016. All solicitations and projects are now complete.[18]

[17] The CSI Thermal program defines disadvantaged communities as a community identified by the California Environmental Protection Agency pursuant to Section 39711 of the Health and Safety Code.
[18] Final reports and individual research briefs for all projects funded under the CSI RD&D Program can be found at calsolarresearch.ca.gov/final-project-reports.

- In December 2016, Itron, Inc., the CSI RD&D Program Manager, completed the RD&D Program Report, 2008-2016, which provides an overview of the program's solicitation process and briefs on the projects funded.[19]

1.1.4 Net Energy Metering (NEM)

- In January 2016, the CPUC approved D.16-01-044 adopting a NEM successor tariff (NEM 2.0), which continued the existing NEM structure with adjustments to align the costs of NEM successor customers more closely with those of non-NEM customers. The NEM successor tariff went into effect in SDG&E's service territory on June 29, 2016, in PG&E's service territory on December 15, 2016, and in SCE's service territory on July 1, 2017. The program provides customer-generators full retail rate credits for energy exported to the grid and requires them to pay an interconnection fee and non-bypassable charges to align NEM customer costs more closely with non-NEM customer costs.

- The Decision on NEM consumer protections (D.18-09-044) authorized ratepayer funding for a consultant to conduct a formal and independent evaluation of the NEM successor tariff to analyze the costs and benefits of customer-sited renewable resources taking service on the tariff and its variants. The evaluation was issued on January 21, 2021. It examined the effects of the tariff, and assisted the CPUC in its review of NEM 2.0.

- The CPUC opened Rulemaking (R.)20-08-020 in August 2020, to develop a successor to existing NEM 2.0 tariffs pursuant to the requirements of California Assembly Bill 327 (2013, Perea). On December 15, 2022, the CPUC adopted D.22-12-056, establishing the Net Billing tariff (NBT) as a successor to NEM 2.0. The R.20-08-020 proceeding is expected to conclude in 2023.[20]

[19] See: https://calsolarresearch.org
[20] Information on this rulemaking is available at cpuc.ca.gov/nemrevisit.

2 Introduction

The CSI Program is the solar incentive program for the large California IOUs: PG&E, SCE, and SDG&E, plus SoCalGas exclusively for the CSI Thermal program. Over the years, the CSI program has promoted customer adoption of solar PV and solar thermal technologies through financial incentives. Through various components of the program, existing residential homes, as well as commercial, industrial, government, non-profit, and agricultural properties within the service territories of the large electric and gas IOUs have been eligible for participation in the CSI program.[21] All components for non-residential customers were closed by August 2020. The goals of the CSI program were to:

- Install 1,940 MW of distributed solar generation capacity in the large electric IOU service territories, and displace 585 million therms of natural gas usage, or the equivalent output of 200,000 solar thermal systems; and

- Transform the market for solar energy systems to be price competitive and self-sustaining.

While the CSI program has helped to transform the California rooftop solar market from a nascent industry to a competitive marketplace with standardized product offerings, the rooftop solar market is still not self-sustaining as subsidies continue through the net billing tariff structure adopted in December 2022. The CSI program focused exclusively on customer-sited solar energy systems used to offset some or all onsite energy consumption. Solar PV systems funded by the program reduce the customer's electricity consumption from the grid, while solar thermal systems reduce the customer's natural gas consumption. The CSI program did not fund wholesale solar power plants, which are designed to serve the electric grid and contribute to the state's Renewables Portfolio Standard (RPS) requirement.[22] The electricity generated by CSI systems, however, indirectly contributes to California's RPS by reducing demand when serving customer load. In addition, the owner of the CSI system owns the renewable energy credits associated with the system's generation and may sell the credits to retail sellers to contribute to the RPS targets.

[21] The electric-displacing portion of the CSI program, which covers solar PV and some solar thermal systems, was authorized by the CPUC in a series of regulatory decisions between 2006 and 2011. In addition, the Legislature expressly authorized the CPUC to create the CSI program in 2006 in SB 1 (Murray, 2006). The gas-displacing solar thermal portion of the CSI was authorized by the Legislature in AB 1470 (Huffman, 2007) and implemented by the CPUC in early 2010 after the required evaluation of a pilot program in the San Diego area.
[22] *See* SB 2 (2011).

2.1 CSI Program Components

The CSI program has several components, with a Program Administrator (PA) for each large IOU territory. In addition to the components listed for each of the programs below, these programs were also subsidized by the Net Energy Metering (NEM) tariff. The CSI budget is overseen by the CPUC. The CSI program components are:

- **The CSI General Market Solar Program**, which closed on December 31, 2016, provided incentives for residential and non-residential PV systems from one kilowatt (kW) to one megawatt (MW) in capacity. The General Market PAs were PG&E, SCE, and the Center for Sustainable Energy (CSE) in SDG&E's territory. The goal of the program was to incentivize 1,750 MW of customer-side solar capacity using a 10-year budget of $2.1 billion for incentives and program administration.

- **The CSI Single-Family Affordable Solar Homes (SASH) Program** provided solar incentives to qualifying single-family, low-income households. The SASH program is administered through a statewide Program Manager, GRID Alternatives. The original SASH program had a budget of $108 million and the reauthorized SASH program has a budget of $54 million. The SASH program offered job training to volunteers and workforce development participants and competitive opportunities for solar installers through a subcontractor program.

- **The CSI Multifamily Affordable Solar Housing (MASH) Program** provided solar incentives to multifamily low-income housing facilities. The original MASH program had a budget of $108 million and the reauthorized MASH program has a budget of $54 million. The MASH program is administered by PG&E, SCE, and CSE (in SDG&E's service territory). By the end of 2021, PG&E, SCE and CSE's MASH Programs were fully subscribed within each respective service territory, and their waitlists were closed to new applications.

- **The CSI Research, Development, Demonstration and Deployment (RD&D) Program**, which closed on December 31, 2016**,** had a budget of $50 million and provided grants to develop and deploy solar technologies with the ability to advance the overall goals of the CSI program, including achieving targets for capacity, cost, and a self-sustaining solar industry in California. Itron Inc. served as the Program Manager.

- **The CSI Thermal Program**, which closed on July 31, 2020, provided incentives to eligible solar thermal technologies including solar water heating (SWH) systems. PG&E, SoCalGas, and CSE administered the $250 million CSI Thermal Program for gas-displacing solar thermal systems. The CSI Thermal program consisted of three customer classes: single-family residential, multifamily/commercial, and solar pool heating.

Additionally, there were separate low-income programs for the single-family residential and multifamily/commercial customer classes. The CSI Thermal program provided up to $100.8 million to electric-displacing solar thermal systems through a carve-out component of the CSI General Market budget, which closed on December 31, 2016.

2.2 CSI Program Budget

The CSI program had two funding streams to incentivize solar technology used for electricity generation and for displacing natural gas consumption. The electric portion of the CSI program originally had a 10-year budget of $2.4 billion, collected from electric ratepayers as authorized by SB 1 (Murray, 2006). AB 217 (Bradford, 2013) extended the CSI low-income programs with $108 million in new funding, which continued the incentives until the end of 2021. CSI Thermal, the natural gas-displacing portion of the CSI program, was directed by AB 1470 (Huffman, 2007), which authorized $250 million in incentives for solar thermal technologies to be collected from gas ratepayers through 2017.

Table 1: CSI Budget by Program Component

Program Component	Budget[23] ($ millions)	Goal
General Market Solar Program (includes PV and electric-displacing solar thermal technologies)	$2,098	1,750 MW
Single-family Affordable Solar Homes (SASH)	$108	95 MW[24]
Multifamily Affordable Solar Housing (MASH)	$108	95 MW[24]
Research, Development, Demonstration, and Deployment (RD&D)	$50	N/A
Solar water heating Pilot Program (SWHPP)[25]	$2.6	750 systems
Sub-Total: CSI Electric-Displacing Budget	**$2,367**	**1,940 MW**
CSI Thermal Program (Gas-Displacing)	$250	Cost effective deployment of solar thermal systems to reduce natural gas consumption in California.[26]
Total CSI Budget	**$2,617**	**-**
Re-authorized SASH Program	$54	15 MW
Re-authorized MASH Program	$54	35 MW
Total CSI Budget including re-authorized SASH/MASH programs	**$2,724**	**-**

Notes: CPUC D.06-12-033 established a 1,750 MW goal for the General Market Program and a 1,940 MW goal for the overall program. D.10-01-022 established the CSI Thermal Program pursuant to AB 1470. D.11-12-019 approved an extra $200 million of funding for the General Market program. D.15-01-027 reauthorized $108 million in additional funds for the CSI low-income programs and adopted a 50 MW low-income capacity goal separate from the CSI goals established in SB 1 (Murray, 2006).

In most cases, the budgets are allocated across the IOUs in proportion to their annual electric sales: PG&E at 43.7 percent, SCE at 46 percent, and SDG&E at 10.3 percent. Historical budget updates for the CSI Thermal incentive buckets are available online at csithermalstats.org. The online reports provide each program's capacity goals, original dollar allocations, and capacity and dollars confirmed, under review, and remaining. The site also provides the CSI dollars confirmed, under review, and paid, according to the type of project and customer class.

In 2015, the CPUC and PAs transitioned solar project data collection from CSI to the NEM interconnection process per CPUC Decision (D.)14-11-001, which mandated a more comprehensive database of solar installations given that the CSI General Market incentives were

[23] Total budget over life of program.
[24] The CPUC decisions on MASH and SASH did not explicitly adopt a 95 MW per program goal; however, the CPUC did adopt a total CSI program goal of 1,940 MW in D.06-12-033.
[25] The SWHPP was a pilot program that preceded the CSI Thermal Program and is now closed.
[26] AB 797 (Irwin, 2017).

exhausted. The solar data collected through the NEM interconnection process is now downloadable from the California DG Statistics website at californiadgstats.ca.gov.

2.3 CSI Program Regulatory Process

Between 2006 and 2019, the CPUC adopted a number of regulatory decisions to implement the CSI program, as well as various CSI program components.[27] Previous versions of this report contain lists of the most significant CSI program decisions. Rules and procedures for the CSI program have been developed and modified within the now closed R.12-11-005 and R.14-07-002.

In addition to formal regulatory decisions, the CPUC and CSI PAs have made numerous CSI program changes based on regular informal feedback from program stakeholders and in response to issues that arise during program implementation. To gather feedback on the program, the CSI PAs hosted quarterly public CSI program forums to discuss potential program changes with stakeholders.

The PAs periodically filed requests with the CPUC to change program rules. These requests are referred to as advice letters and are consistent with the CPUC-established CSI Program Handbook process. The advice letters are processed by CPUC staff in accordance with General Order 96-B.[28] As a result, the CPUC has revised and reissued the CSI Program Handbook[29] numerous times since the program first began.

3 Solar Projects Installed in California Through 2022

This section of the report summarizes data on the cumulative installed capacity[30] and number of customer-sited solar projects installed in California IOU territories. The data includes solar projects interconnected under any of the IOU non-wholesale solar programs, including CSI, New Solar Homes Partnership (NSHP), Emerging Renewables Program (ERP), and the Self-Generation Incentive Program (SGIP). IOU data does not include solar projects installed in publicly owned utility (POU) areas, such as Los Angeles Department of Water and Power or

[27] The CPUC has developed the CSI program in a series of Rulemakings since 2006, including R.08-03-008 and R.06-03-004, with precedents from earlier proceedings such as R.04-03-017. Each of the decisions noted herein occurs in one of those dockets, unless otherwise noted.
[28] See General Order 96-B here: https://www.cpuc.ca.gov/Home/Proceedings-and-Rulemaking/CPUC-general-orders
[29] See CSI Program Handbook here: https://www.cpuc.ca.gov/-/media/cpuc-website/files/legacyfiles/c/6442454547-csi-handbook-2017.pdf
[30] All data in this assessment are for grid-tied solar photovoltaic (PV) (i.e., interconnected to the utility grid), unless otherwise noted. All solar in this report is customer-side of the meter self-generation designed to serve onsite load. All references to capacity are reported in "CEC-AC" units, which is the industry standard for net electricity output in MW based on the California Energy Commission's Alternating Current rating of solar panels. The "CEC-AC" rating tends to be slightly less than the nameplate capacity.

Sacramento Municipal Utility District, nor does it include data from multi-jurisdictional utilities, such as Pacific Power's former California Solar Incentive Program (CSIP).[31]

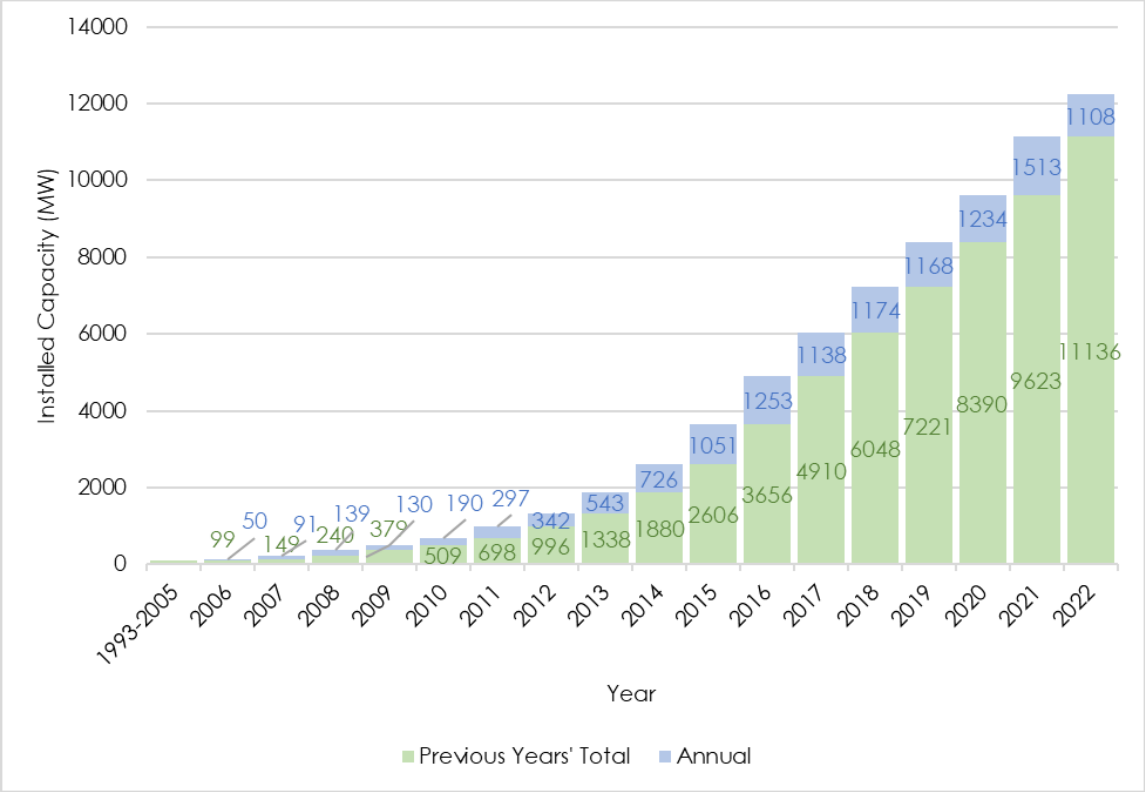
3.1 Investor-Owned Utility Territory Solar Installations

Through the end of 2022, approximately 12,244 MW of solar capacity were installed at 1,437,637 sites in the large IOU territories.[32] The solar installations included in Figures 1 and 2 are interconnected on customer sites under Rule 21, the CPUC-jurisdictional interconnection tariff, and do not include solar power plants installed under Federal Energy Regulatory Commission (FERC)-jurisdictional interconnection tariffs that participate in California Independent System Operator (CAISO) markets. They do not include data on installations in POU territories. This data set excludes systems that were decommissioned after being interconnected.

Figure 1 shows the amount of solar capacity installed by customers by year in IOU territories. In 2022, customers installed 1,108 MW of solar.

[31] Previous CSI Annual Program Assessments included data from POUs in order to provide a statewide overview of solar project installations. This year's Annual Program Assessment excludes such data because the California Energy Commission stopped collecting POU data at the end of 2018.
[32] Source: California DG Statistics Interconnected Project Sites Data Set (californiadgstats.ca.gov), accessed March 28, 2021.

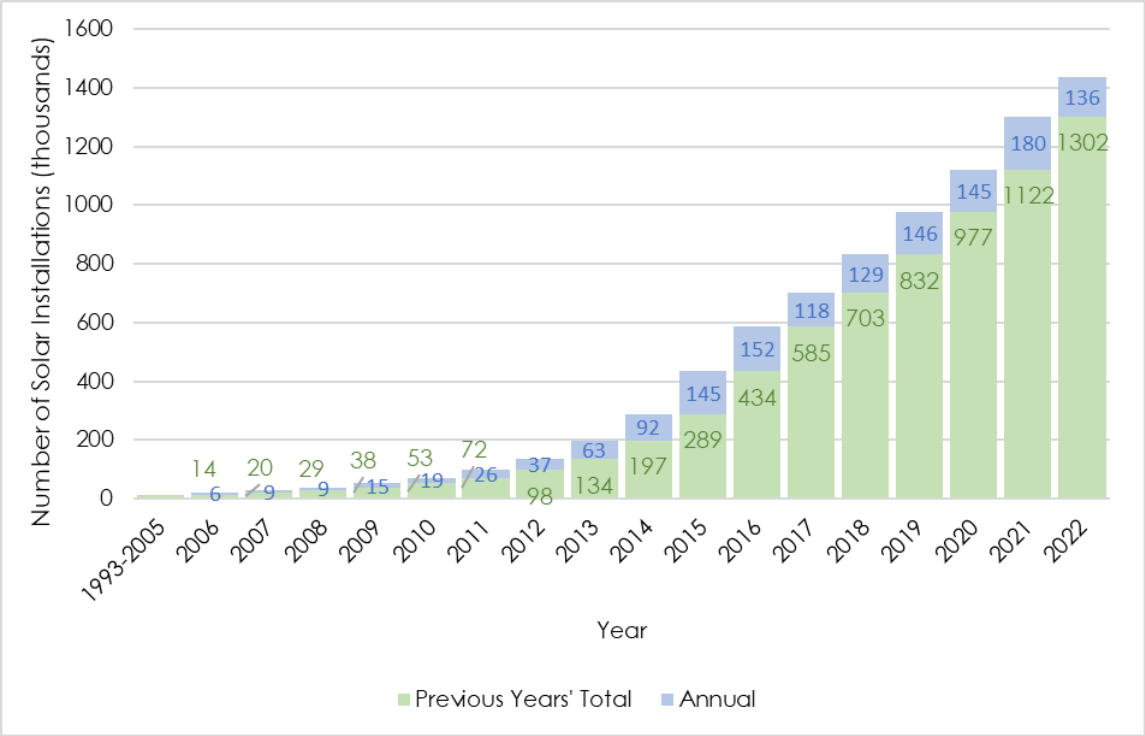
Figure 1: Customer-Sited Solar MW Installed Capacity in CA's IOU Territories, 1993-2022 (MW)



Source: California DG Statistics Interconnected Project Sites Data Set (californiadgstats.ca.gov), updated February 28, 2023. Year defined by date of interconnection application approval. *Notes*: Data includes all solar PV systems interconnected under Rule 21 within PG&E, SCE, and SDG&E service territories. Data does not include systems within POU territories.

Figure 2 shows the number of installations by year. There were 135,849 solar projects installed in the IOU territories in 2022.

Figure 2: Number of Installed Customer-Sited Solar Projects in CA's IOU Territories, 1993-2022 (thousands)



Source: California DG Statistics Interconnected Project Sites Data Set (californiadgstats.ca.gov), updated February 28, 2023. Year defined by date of interconnection application approval. *Notes:* Data includes all solar PV systems interconnected under Rule 21 within PG&E, SCE, and SDG&E service territories. Data does not include systems within POU territories.

3.2 Net Energy Metering

The vast majority of solar customers are enrolled in NEM (NEM 1.0) or NEM successor (NEM 2.0) tariffs, established under Public Utilities Code Sections 2827 and 2827.1, respectively. The NEM programs subsidize onsite renewable energy (mostly solar, in practice) installations designed to offset a portion, or all, of the customer's electrical energy usage. Under NEM 1.0 and 2.0, customers receive a bill credit (in dollars) based on the retail rate (including generation, transmission, and distribution rate components) for any excess generation (in kWh) that is exported back to the grid. In periods when a customer's bill is negative (because the amount of energy the solar system exported to the grid exceeded the amount of energy consumed by the customer), the bill credits are carried forward up to one year, at which point customers may elect to receive net surplus compensation for any electricity produced in excess of on-site energy usage.

3.2.1 NEM 1.0 Program Cap

Pursuant to AB 327 (Perea, 2013), every large electrical corporation was required to make a NEM tariff available to eligible customer-generators until July 1, 2017, or the date when a utility reached its 5 percent NEM program cap.[33] The three large IOUs hit their respective caps in 2016 and 2017.

AB 327 also directed the CPUC to establish a transition period for customers enrolled in the NEM 1.0 program, and to adopt a successor tariff or contract to NEM by December 31, 2015. In March 2014, the CPUC adopted Decision (D.)14-03-041, establishing a 20-year transition period for customers to remain on NEM 1.0 tariffs.[34] Specifically, the Decision established a transition period of 20 years, beginning the year the system was interconnected, during which participating systems may continue to take service under NEM 1.0.

3.2.2 NEM Successor Tariff

In January 2016, the CPUC approved D.16-01-044 adopting a NEM successor tariff (NEM 2.0) that continued the existing NEM 1.0 structure while making adjustments to align the costs of NEM 2.0 customers more closely with those of non-NEM customers. D.16-01-044 added a number of new elements to the NEM tariff, including the following:

- NEM 2.0 customers with systems under 1 MW[35] pay a pre-approved one-time interconnection fee, based on each IOU's historic interconnection costs. The fee is $75 to $132 depending upon the IOU. NEM 2.0 customers with systems 1 MW and larger must pay all interconnection costs.
- NEM 2.0 customers must pay non-bypassable charges on each kWh of electricity they consume from the grid in each metered interval.
- All residential NEM 2.0 customers must take service on an available time-of-use rate.

Customers were eligible to continue enrolling in the NEM 1.0 tariff until July 2017 or the date, if earlier, when their utility reached its NEM 1.0 program cap. The NEM 2.0 tariff went into effect in SDG&E's service territory on June 29, 2016, in PG&E's service territory on December 15, 2016, and in SCE's service territory on July 1, 2017.

[33] The NEM program cap is reached when the total installed NEM capacity exceeds 5 percent of the total non-coincident peak demand of every customer within an IOU's territory.
[34] See docs.cpuc.ca.gov/PublishedDocs/Published/G000/M089/K386/89386131.PDF.
[35] The Decision extends eligibility for the NEM successor tariff to eligible systems larger than 1 MW in size, however these customers are required to pay all Rule 21 interconnection study and distribution system upgrade fees for the facility.

A very small number of customer-generators, especially those whose systems are unlikely to export energy to the electric grid, opt to take utility service under a non-NEM tariff. Less than one percent (0.11 percent) of customer-sited solar installations in the IOU territories do not take service under a NEM tariff.

3.2.3 Revisiting the NEM Successor Tariff

On August 27, 2020, the Commission initiated R.20-08-020 to develop a successor to the NEM 2.0 tariff, as part of its commitment in D.16-01-044 to review the current tariff.[36] The Order Instituting Rulemaking (OIR) stated that "[p]ursuant to the requirements of Assembly Bill (AB) 327, this successor will be a mechanism for providing customer-generators with credit or compensation for electricity generated by the renewable facilities that a) balances the costs and benefits of the renewable electrical generation facility and b) allows customer-sited renewable generation to grow sustainably among different types of customers and throughout California's diverse communities."[37]

The CPUC issued an evaluation of NEM 2.0 in January 2021.[38] The evaluation found that NEM 2.0 was not cost-effective and placed a cost burden on electric customers not participating in a NEM tariff. Further, the evaluation found that the cost burden disproportionately harmed lower-income and disadvantaged ratepayers.

On December 15, 2022, the CPUC adopted D.22-12-056, establishing the Net Billing tariff (NBT) as a successor to NEM 2.0. The NBT adopts a new design that credits customers for the electricity they export based on its value to the grid, compared to NEM 2.0, which compensated exports at retail rates. It also applies new electricity rates to imports from the grid to financially incentivize customers to shift their electricity usage to daytime hours when there is an abundance of clean energy on the grid and less overall demand. Taken together, these modifications to the tariff incentivize the adoption of battery storage paired with rooftop solar to support grid reliability and the reduction of greenhouse gas emissions.

The NBT took effect on April 15, 2023. The CPUC is considering additional matters in R.20-08-020, such as enhanced consumer protections, an evaluation of the NBT, and changes to several NEM subtariffs. This proceeding is expected to conclude in 2023.

[36] Information on this rulemaking is available at cpuc.ca.gov/nemrevisit.
[37] OIR Sec. 2.2, p. 6-7
[38] The NEM 2.0 evaluation may be accessed at cpuc.ca.gov/nem2evaluation.

3.3 Consumer Protections

The CSI General Market Program had a number of built-in consumer protections. In the CSI program, incentives were based on actual or expected performance, which were determined through standardized calculators. This approach incentivized developers to design systems for optimal production and required that this information be disclosed to consumers, providing transparency on the performance of the system. Additionally, all equipment was required to have a 10-year manufacturer performance warranty, and system performance monitoring was required for most systems. Contractors were also required to have a valid Contractors State License Board (CSLB) license and were required to submit a "high cost justification and acknowledgement form" to consumers if costs were unusually high.

With the sunset of the CSI General Market Program, the CPUC acknowledged the need to consider what consumer protection elements should be carried forward for NEM customers. The NEM Successor Tariff Decision, D.16-01-044, continued some of the CSI General Market Program consumer protections for NEM 2.0. Under NEM 2.0, a solar provider must provide a minimum 10-year warranty, or service agreement on all equipment or installation, and all major solar system components must be on the verified equipment list maintained by the California Energy Commission (CEC). The Decision also directed Energy Division staff, in collaboration with stakeholders, to consider further NEM consumer protection measures including a solar information packet for consumers.

In 2018, the CPUC adopted D.18-09-044, which established a process for creating a solar information packet for consumers. The packet has been created and is called the Solar Consumer Protection Guide.[39] The Decision also requires that solar providers upload three new documents before interconnecting a residential NEM customer to the grid in the large IOU territories: the solar installation contract, a signed copy of a CPUC Solar Consumer Protection Guide, and a signed copy of the CSLB Solar Disclosure Document. In February 2020, the CPUC adopted D.20-02-011, which further strengthened the provisions of D.18-09-044 by mandating an audit trail when customers sign the Solar Consumer Protection Guide electronically and authorized the creation of a citation program to address non-compliant solar providers. In August 2020, the CPUC adopted D.20-08-001, which standardized inputs and assumptions for calculating estimated electric utility bill savings from residential solar energy systems. In June 2021, the CPUC adopted D.21-06-026, which enhanced the semi-annual interconnection audits, required each IOU to develop a web-based search engine of all interconnection applications for use by agency staff, and authorized the establishment of a public list of non-compliant solar providers on the CPUC website.

[39] The Solar Consumer Protection Guide may be accessed at cpuc.ca.gov/solarguide.

4 CSI Program Components

The overarching CSI program contained multiple program components, or sub-programs. These include incentive programs targeting solar electric technologies: CSI General Market, SASH, and MASH. The CSI Thermal program provided incentives for solar thermal technologies that displace natural gas usage. These programs are discussed in more detail below.

4.1 General Market Solar Program

4.1.1 General Market Program Background

The CSI General Market solar program, the largest CSI program component, closed to new applications on December 31, 2016. The program's incentive budgets for each IOU territory were exhausted by 2015. The program offered incentives to all eligible customer-sited solar electric generating (typically PV) systems in the large IOU service territories.[40] The CSI General Market program achieved a total of 1,935 MW of installed capacity.[41] Pursuant to D.16-12-055, the CSI General Market program closed in all service territories on December 31, 2019.[42]

It is important to note that, beyond the budget directly allocated for the General Market solar program, this program was also subsidized in part by the Net Energy Metering (NEM) tariff.

Table 2 presents the capacity target by utility territory and customer class, showing how all the incentives were originally allocated over the expected 10-step life of the program. Actual allocations by step varied due to dropouts and other factors.

[40] The "loading order" was introduced in the Energy Action Plan, which was jointly adopted in 2003 by the CPUC, the CEC and the California Power Authority. The loading order is a list of preferred energy resources - the first of which is energy efficiency.
[41] CSI Working Dataset (californiadgstats.ca.gov/downloads/#_li). Data accessed April 29, 2020.
[42] See the 2020 CSI Annual Program Assessment for information on the general market incentive types, incentive levels, targets by program administrator and customer type, and applications received per year. Previous reports are available at https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/california-solar-initiative/csi-progress-reports.

Table 2: CSI General Market MW Targets by Utility and Customer Class

Step	MW in Step	PG&E (MW)		SCE (MW)		SDG&E (MW)	
		Res	Non-Res	Res	Non-Res	Res	Non-Res
1	50	--	--	--	--	--	--
2	70	10.1	20.5	10.6	21.6	2.4	4.8
3	100	14.4	29.3	15.2	30.8	3.4	6.9
4	130	18.7	38.1	19.7	40.1	4.4	9.0
5	160	23.1	46.8	24.3	49.3	5.4	11.0
6	190	27.4	55.6	28.8	58.6	6.5	13.1
7	215	31.0	62.9	32.6	66.3	7.3	14.8
8	250	36.1	73.2	38.0	77.1	8.5	17.3
9	285	41.1	83.4	43.3	87.8	9.7	19.7
10	350	50.5	102.5	53.1	107.9	11.9	24.2
Subtotals (Res and Non-Res)		**252.4**	**512.3**	**265.6**	**539.5**	**59.5**	**120.8**
Totals		**764.7**		**805.1**		**180.3**	
Percent		**43.7%**		**46.0%**		**10.3%**	

Source: D.06-12-033, Appendix B, Table 11. *Notes*: The MWs for Incentive Step 1 were reserved under the Self-Generation Incentive program in 2006. Non-Residential (Non-Res) includes commercial, government, and non-profit facilities.

Once the incentives reserved for each customer class within a utility territory reached the capacity target for a given step, the incentive level offered dropped to the next lower step.

4.1.2 General Market Program Progress

All six General Market customer classes exceeded their capacity targets. Table 3 denotes the amount of MW that were completed in each step, compared to the original number of MW allocated to the step by D.06-12-033. The "Actual" MW numbers are equal to the "Original" MW numbers minus dropouts from previous steps.

Table 3: Incentive MW Available by Step, Program Administrator, and Customer Class

Step	MW in Step	PG&E (MW)				SCE (MW)				CSE in SDG&E Territory (MW)			
		Residential		Non-Residential		Residential		Non-Residential		Residential		Non-Residential	
		Original	Actual	Original	Actual	Original	Actual	Original	Actual	Original	Actual	Original	Actual
1	50	-	-	-	-	-	-	-	-	-	-	-	-
2	70	10.1	11.8	20.5	12.3	10.6	9.2	21.6	15.3	2.4	2.2	4.8	7
3	100	14.4	12.9	29.3	22.6	15.2	14.1	30.8	23.9	3.4	3.2	6.9	4.3
4	130	18.7	18	38.1	29.6	19.7	19.3	40.1	19.5	4.4	4.2	9.0	5.2
5	160	23.1	22.7	46.8	56.8	24.3	22.1	49.3	68.6	5.4	5.1	11.0	14.6
6	190	27.4	26	55.6	71.9	28.8	23.7	58.6	36.7	6.5	5.7	13.1	9
7	215	31.0	27.2	62.9	55.5	32.6	30.9	66.3	58.6	7.3	6.6	14.8	14
8	250	36.1	35.8	73.2	60.3	38.0	40.6	77.1	96.7	8.5	9.2	17.3	24.8
9	285	41.1	41.2	83.4	69.3	43.3	42.0	87.8	80.2	9.7	10	18.9	18.6
10	350	50.5	61.3	102.5	123.1	53.1	105.4	107.9	174.6	36.9	46.3	8.2	9.1

Source: CSI General Market Program Administrators, April 2019. Note: Incentive Step 1 MWs were reserved under the Self-Generation Incentive Program in 2006.

4.1.1.1 CSI Program Impact on Solar PV Market Transformation

One of the goals of the CSI program was to create a self-sustaining solar PV market in California. In 2013, the CPUC hired Navigant Consulting, Inc. to evaluate the extent of the transformation of California's customer-side solar PV market since the adoption of the CSI program, and to assess the degree to which the customer-side solar PV market would be sustainable after the CSI General Market sunset. The study, released in April 2014, found:

- The customer-side solar PV market showed significant progress toward market transformation since the initiation of the CSI program;
- While other regulatory and global market factors played an important role, the CSI program had an indispensable role in transforming the solar PV market in California, especially in creating a long-term policy signal to in-state suppliers of customer-sited solar PV products and services; and
- The long-term sustainability of the solar PV market in California would depend on NEM 2.0 regulation and the retail rate reform process that was under consideration before the CPUC in 2014 and 2015.

The final CSI Impact Evaluation of program years 2011-2016 was released in January 2021.[43]

While the solar market in California has matured considerably since the CSI program launched

[43] See the 2020 CSI Annual Program Assessment for additional information on installed system costs, the numbers of installations using CSI and not using CSI, and the size of CSI incentives, versus other incentives, in the later years of the program.

in 2007, it is still not self-sustaining as subsidies continue to support rooftop solar through the net billing tariff structure that was adopted in December 2022.

4.2 CSI Low-Income PV Solar Programs

4.2.1 Single-Family Affordable Solar Homes (SASH) Program

SASH Program Background

The SASH program, one of the two low-income components of the CSI program, provided incentives for solar PV systems for eligible low-income owners of existing homes. The CPUC approved the SASH program in November 2007 in D.07-11-047 as part of the CSI program. GRID Alternatives (GRID) was selected as the statewide Program Manager for the SASH program.[44] GRID is a non-profit organization providing renewable energy services, equipment, and training in low-income communities throughout California since 2001. As Program Manager for the SASH program, GRID identifies eligible low-income households, markets the SASH program, and installs PV systems for eligible SASH participants.[45]

In January 2015, pursuant to AB 217 (Bradford, 2013), the CPUC reauthorized the SASH program in D.15-01-027. In this Decision, the CPUC authorized the extension of SASH with an additional $54 million in funding and an installed capacity goal for the program of 15 MW. The SASH program was reauthorized through 2021, or until all available incentives are encumbered, whichever occurs first. The reauthorized SASH program opened in May 2015.

The SASH program was designed to be a comprehensive low-income solar program. In addition to providing incentives to install PV systems, SASH was structured to promote or provide energy efficiency services, opportunities for workforce development and green jobs training, and broad community engagement with low-income communities. To achieve this, the SASH program provided consumer education on solar and energy efficiency technologies to the diverse volunteer base that contributed to SASH installations. This outreach helps further the broader goals of promoting the use of PV-solar technology statewide and helping build broad-based community support for solar electric technologies and energy efficiency. In addition, GRID sub-

[44] D.07-11-045 ordered the SASH Program to be administered by a single statewide program manager to "ensure consistency and equity in program delivery statewide while working with a diverse group of stakeholders and service providers." (p. 45, Conclusion of Law 10). GRID was selected through a competitive solicitation process.
[45] For more information about the SASH Program, including GRID's latest quarterly program status report, see:https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/california-solar-initiative/csi-single-family-affordable-solar-homes-program. For more details on the SASH program's rules and requirements, see Appendix D to the CSI Handbook, available at:https://gridalternatives.org/sites/default/files/SASH%202.0_Handbook%20Update_FINAL.pdf.

contracted with qualified solar contractors to install SASH projects through the SASH Sub-Contractor Partnership Program (SPP).

For clarity in this report, the original SASH program is referred to as SASH 1.0 and the 2015 reauthorization of the SASH program is referred to as SASH 2.0. At the time of this report, both SASH 1.0 and SASH 2.0 incentive funding is fully encumbered in all three IOU service territories. PG&E and SDG&E transitioned to SASH 2.0 in January 2015 and SCE transitioned in October 2015.

SASH Program Budget

The SASH 1.0 budget was $108.3 million, allocated according to the information in Table 4 and Table 5.

Table 4: SASH 1.0 Budget Allocations by IOU Service Territory

Utility	PG&E	SCE	SDG&E	Total
Percentage	43.7%	46.0%	10.3%	**100%**
Total Budget ($ millions)	$47.3	$49.8	$11.2	**$108.3**

Source: D.07-11-045

Table 5: SASH 1.0 Budget Allocations by Functions

Function	Allocation
Administration	10%
Marketing and Outreach	4%
Measurement and Evaluation	1%
Incentives	85%

Source: D.07-11-045

The SASH 2.0 budget was $54 million, allocated as described in Table 6 and Table 7.

Table 6: SASH 2.0 Budget Allocations by IOU Service Territory

Utility	PG&E	SCE	SDG&E	Total
Percentage	43.7%	46.0%	10.3%	**100%**
Total Budget ($ millions)	$23.60	$24.84	$5.56	**$54**

Source: D.15-01-027

Table 7: SASH 2.0 Budget Allocations by Functions

Function	Allocation
Administration	10%
Marketing and Outreach	4%
Measurement and Evaluation	1%
Incentives	85%

Source: D.15-01-027

SASH Program Eligibility

The SASH program was available to low-income customers of the large electric IOUs who lived in owner-occupied single-family homes that meet the definition of low-income housing established in Public Utilities Code Section 2852. This code section allows owner-occupied residences that are part of a larger multifamily complex to qualify under certain conditions. GRID created a statewide database of eligible homes in collaboration with the California Housing Partnership Corporation (CHPC). The database was instrumental in the effort to establish relationships and identify resources within targeted local jurisdictions.

SASH Program Incentives

SASH incentives were higher than the CSI General Market program on a dollar per watt basis. SASH 1.0 incentives varied depending on the household's income level and eligibility for the California Alternate Rates for Energy (CARE)[46] program. SASH 2.0 incentives are set at the same level for all SASH customers. SASH 1.0 and 2.0 incentive rates did not decline over time like the incentive rate in the market-transforming CSI General Market program.

Under SASH 1.0, eligible participating households were provided a one-time payment under the CSI EPBB structure to help reduce the up-front cost of installation. The SASH 1.0 program had one fully-subsidized (i.e. covers the full installed cost of the system) and six highly-subsidized incentive payment levels based on the applicant's income relative to the area median income (AMI), tax liability, and eligibility for the CARE program.

SASH 2.0 provides incentives at $3.00/watt to all customers whose total household income is below 80 percent of the AMI. Eligible participating households are provided a one-time payment under the CSI EPBB structure to help reduce the up-front cost of installations. However, due to the significant reduction in funding for SASH 2.0 compared to SASH 1.0, and in acknowledgement of the maturation of the market for third-party financed products, the CPUC authorized GRID to develop and utilize a Third-Party Ownership (TPO) Model for SASH to help finance the installation of solar PV projects for low-income customers at no cost

[46] CARE provides a minimum 20 percent discount on the energy bills of qualifying low-income customers.

to SASH participants. The SASH TPO model has been deliberately designed to maximize household savings and include ironclad consumer protection measures as required in D.15-01-027.[47] Through this unique "families-first" TPO model, GRID is able to leverage the Federal Investment Tax Credit to help finance SASH 2.0 projects, while providing additional benefits to participating families, including a performance guarantee, system monitoring, and 20-year warranty coverage.

The SASH TPO model played a significant role in funding SASH 2.0 projects. Of the 4,553 SASH 2.0 projects completed through the end of February 2023, 3,717 are third-party owned, or roughly 82 percent of all projects installed under SASH 2.0.[48]

SASH Program Outcomes

Since the SASH program launched in 2008, it experienced substantial growth in program applications and made significant progress in key areas, including: expanding the SPP; increasing marketing and outreach efficiency; building partnerships with volunteers and job-training/workforce programs; and broadening the affordable housing client database.

Under SASH 1.0, a total of 5,266 projects and over 16 MW were installed on eligible homes, and 100 percent of the available $92 million SASH 1.0 incentive budget was encumbered.[49] As of February 2023, SASH 2.0 completed a total of 4,553 projects, resulting in 15.23 MW of installed capacity. These participants have received $45.65 million of the available $46 million SASH 2.0 incentive budget for their residential solar systems.[50]

Nearly all the completed SASH installations were made at no cost to homeowners. In addition to ratepayer funding, GRID leveraged funding from local jurisdictions, project sponsorships, and GRID's non-profit fundraising. Since the SASH incentive does not cover 100 percent of installation costs and homeowners are largely unable to fund the additional incremental costs, identifying gap financing from third-party sources has been critical to achieving the long-term goals of SASH.

SASH Workforce Development Efforts

The SASH program was structured to provide workforce development and job-training opportunities at every installation. In implementing the SASH program, GRID provided opportunities for job trainees and local volunteers to assist with installations, engage their

[47] Resolution E-4719, June 15, 2015, and D.15-01-027, Minimum Consumer Protection standards for SASH TPO model, at pgs. 52-53. D.15-01-027 online at docs.cpuc.ca.gov/PublishedDocs/Published/G000/M145/K938/145938475.PDF.
[48] Data request response from GRID Alternative 3/29/2023.
[49] SASH Program data as of December 31, 2021 available at: californiadgstats.ca.gov/downloads/#_li.
[50] Data request response from GRID Alternative 3/24/2022.

communities, and participate in solar and energy efficiency programs. These volunteer and job-training opportunities strengthened California's solar industry by imparting broad consumer education and providing a means for individuals from diverse backgrounds to learn about PV-solar design and installation through hands-on experience.[51]

GRID has partnered with more than 80 California job-training programs to incorporate GRID's volunteer-based installation projects into their construction training curricula. GRID dedicates approximately 20 percent of its installations for these trainees to gain hands-on experience with real-world solar installations that have conditions and requirements comparable to what they would encounter in private industry. This provides a double benefit to the low-income community since many solar job trainees reside in the same neighborhoods that the SASH Program aims to serve. GRID has created over 88,040 installation workday positions for volunteers in California since the inception of the SASH program through February 2023, and over 20,500 of these positions have been filled by students from California job training programs.[52]

Under both SASH 1.0 and SASH 2.0, the SASH SPP provides opportunities for licensed California contractors to participate in SASH installations. Qualified contracting companies agree to a reduced cost model and commit to hiring at least one eligible job trainee for each SASH installation. Though the SASH program requires contractors to hire a minimum of one eligible job trainee per installation, over 15 percent of SASH SPP projects have exceeded this expectation by having more two or even three trainees work on the SASH installations. Through February 2023, over 54 California contractors have installed projects under the SASH SPP model, and the SPP program has created 2,700 paid workday opportunities for 270 graduates of job-training programs.

4.2.2 Multifamily Affordable Solar Housing (MASH) Program

MASH Program Background

The second low-income CSI program targets affordable multifamily housing. In October 2008, the CPUC adopted D.08-10-036, which established the $108.3 million MASH program for solar installations on existing multifamily affordable housing that meet the definition of low-income residential housing established in Public Utilities Code Section 2852.[53] The MASH program was

[51] Promotion of economic and workforce development opportunities as is done in the SASH program aligns with California policies such as the CPUC Environmental and Social Justice Action Plan and directives in Executive Orders N-79-20 and N-19-19.
[52] An installation workday is a standard 8-hour workday. GRID's installations typically span 2 days and consist of teams of approximately 8-10 individual volunteers or job trainees each day.
[53] D.08-10-036, Appendix A, *mimeo.*, p. 1.

designed to operate until January 1, 2016, or until all funds available from the program's incentive budget were allocated, whichever occurred first.

In January 2015, pursuant to AB 217 (Bradford, 2013), the CPUC reauthorized the MASH program through D.15-01-027. In this Decision, the CPUC authorized the extension of MASH with an additional $54 million in funding and a 35 MW installed capacity goal for the program. The MASH program was reauthorized through 2021, or until all available incentives were encumbered, whichever occurs first.

The goals of the MASH program were to:

a) stimulate adoption of solar power in the affordable housing sector;
b) improve energy utilization and overall quality of affordable housing through application of solar and energy efficiency technologies;
c) decrease electricity use and costs without increasing monthly household expenses for affordable housing building occupants; and
d) increase awareness and appreciation of the benefits of solar among affordable housing occupants and developers.

For clarity in this report, the original MASH program is referred to as MASH 1.0 and the reauthorization of the MASH program is referred to as MASH 2.0. By the end of 2013, MASH 1.0 incentive funding was fully encumbered in all three IOU service territories. The CPUC authorized the MASH Program Administrators to implement MASH 2.0 in each service territory upon complete subscription of the incentive funding in that service territory, and CPUC approval of an advice letter implementing the new program rules. The MASH program Administrators began implementation of MASH 2.0 in all three IOU service territories in August 2015, when the CPUC approved the MASH 2.0 rules.

By the end of 2021, PG&E, SCE and CSE's MASH Programs were fully subscribed within each respective service territory, and their waitlists were closed to new applications. The MASH 1.0 budget was $108.3 million, allocated as described in Table 8 and Table 9.

Table 8: MASH 1.0 Budget Allocations by IOU Service Territory

Utility	PG&E	SCE	SDG&E	Total
Percentage	44%	46%	10%	**100%**
Total Budget ($ millions)	$47.3	$49.8	$11.2	**$108.3**

Source: D.08-10-036.

Table 9: MASH 1.0 Budget Allocations by Function

Function	Allocation
Administration and Marketing and Outreach	10%
Measurement and Evaluation	2%
Incentives	88%

Source: D.08-10-036.

The MASH 2.0 budget is $54 million, allocated according to the information in Table 10 and Table 11.

Table 10: MASH 2.0 Budget Allocations by IOU Service Territory

Utility	PG&E	SCE	SDG&E	Total
Percentage	43.7%	46.0%	10.3%	**100%**
Total Budget ($ millions)	$23.60	$24.84	$5.56	**$54**

Source: D.15-01-027

Table 11: MASH 2.0 Budget Allocations by Function

Function	Allocation
Administration and Marketing and Outreach	6%
Measurement and Evaluation	1%
Incentives	93%

Source: D.15-01-027

MASH Program Eligibility

The MASH program was available to multifamily affordable housing properties that meet the definition of "low-income residential housing" per Public Utilities Code Section 2852, which requires that at least 20 percent of the onsite tenants are low-income. The MASH program also provides eligibility for certain pre-identified tenant units to enroll with their utility's virtual net energy metering (VNEM) tariffs, as described in the VNEM section below.

In implementing the new energy efficiency and job training policy requirements of AB 217 (Bradford, 2013), the CPUC required that to be eligible for MASH 2.0, MASH properties must conduct an energy efficiency walkthrough audit, and must provide a job training opportunity for up to five trainees per MASH system installation.

MASH Program Incentives

Due to reduced funding levels for the MASH 2.0 program compared to the MASH 1.0 program, the CPUC reduced the incentive levels for both the common area and tenant load incentive

tracks. The CPUC renamed the new incentive levels Track 1C and 1D. The CPUC also created an additional requirement that, in order to receive the higher incentive level for tenant load, a MASH project would have to allocate generation to MASH property tenants by utilizing VNEM to share bill credits and guarantee that the tenants would retain at least 50 percent of the economic benefits of the generation allocated to them. Table 12 below displays the MASH 2.0 incentive tracks, 1C and 1D, and the eligibility requirements for MASH 2.0.

Table 12: MASH 2.0 Incentive Tracks

Track	Incentive Amount	Eligibility Requirements

1C: PV System Offsetting Common Area Load, Non-VNEM Tenant Load, or VNEM Tenant Load with <50 percent Tenant Benefit	$1.10/watt	• Provide job training opportunity to more than one trainee, with one additional trainee for each 10 kW up to 50 kW
		• Conduct onsite walkthrough energy audit at American Society of Heating, Refrigerating, Air-Conditioning Engineers (ASHRAE) Level I or higher, or enroll in a utility, Regional Energy Network (REN), Community Choice Aggregator (CCA) or federally-provided whole-building multifamily energy efficiency program
		• Portion of system allocated to offsetting one of the following:
		  ○ Common Area Load
		  ○ Non-VNEM Tenant Load
		  ○ VNEM Tenant Load where tenant receives less than 50 percent of economic benefit of allocated generation

1D: PV System Offsetting VNEM Tenant Load with ≥50 percent Tenant Benefit	$1.80/watt	• Provide job training opportunity to more than one trainee, with one additional trainee for each 10 kW up to 50 kW • Conduct onsite walkthrough energy audit at ASHRAE Level I or higher, or enroll in a utility, REN, CCA, or federally provided whole-building multifamily energy efficiency program • Portion of PV system allocated to offsetting: ○ VNEM Tenant Load where tenant receives at least 50 percent of economic benefit of allocated generation

MASH Program Progress and Project Attributes

As MASH sunsets, the progress of the program has been measured in terms of reserved projects reaching completion, interconnection and providing bill benefits to property owners and to tenants. By the end of 2021, PG&E, SCE, and CSE's MASH Programs were fully subscribed within each respective service territory, and their waitlists were closed to new applications.

There were 379 projects, representing 27.4 MW of installed capacity, completed under MASH 1.0. Through April 2023, 270 projects representing 39.4 MW of capacity have been completed under MASH 2.0.[54]

Table 13: MASH Program Progress

Status of Application		CSE	PG&E	SCE	Total
MASH 1.0 Completed	Projects	41	191	147	**379**
	Capacity (MW)	2.6	11.3	13.5	**27.4**
MASH 1.0 Pending	Projects	0	0	0	**0**
	Capacity (MW)	0.0	0.0	0.0	**0**
MASH 2.0 Completed	Projects	23	137	110	**270**
	Capacity (MW)	3.7	18.1	17.7	**39.4**
MASH 2.0 Pending	Projects	0	0	0	**0**
	Capacity (MW)	0	0	0	**0**

Source: Data request response from MASH Program Administrators 4/4/2023.
All system capacity measured in CEC-AC PTC MW.

4.2.3 Summary of CSI Low-Income Program Participation

Table 14: Summary of CSI Low-Income Program Participation

Program	Number of Completed Projects[55]	Total Paid Incentives ($ millions)	Total Installed Capacity (MW)
SASH 1.0	5,266	92.08	16.0
SASH 2.0	4,552	45.65	15.2
MASH 1.0	379	86.82	27.4
MASH 2.0	270	51.28	39.4
Total	**10,467**	**275.83**	**98.0**

Sources: MASH: Data request response from MASH Program Administrators 4/4/2023. SASH: Data request response from GRID Alternatives 3/29/2023.

[54] Data request response from MASH Program Administrators 4/4/2023.
[55] Figures represent only completed projects and do not include pending applications.

All system capacity measured in CEC-AC PTC MW.

4.3 Virtual Net Energy Metering (VNEM)

Multi-tenant buildings have been a challenging segment for solar PV adoption due to the problem of distributing the benefits of system output among individually metered occupants. To help address this issue, the CPUC directed the IOUs to file tariffs for VNEM in 2008.[56]

Under VNEM, the utility meters the PV system's energy output, then allocates credits for that energy to the building owners' and/or tenants' individual utility accounts, based on a pre-arranged allocation agreement. The MASH program piloted the VNEM tariffs.

The CPUC expanded VNEM to all multi-tenant, multi-meter properties in 2011 and made all NEM-eligible technologies VNEM-eligible. As of the end of 2022, in PG&E, SCE, and SDG&E's service territory there were 1,691 projects with a total of over 89 MW of solar capacity on the VNEM tariff who are not participants in the MASH program.

VNEM tariffs are currently under review in the R.20-080-020 proceeding.

Table 15: VNEM Projects Outside of the MASH Program by Utility Territory through 2022

Utility	PG&E	SCE	SDG&E	Total
VNEM Projects Outside of MASH Program	896	412	383	**1,691**
Total Capacity *(kW, CEC-AC)*	44,831	19,774	25,094	**89,699**

Source: Data request to IOUs, April 2023.

4.4 Other PV Solar Programs

Table 16: Approved Capacity and Projects for Other PV Solar Programs through 2022

Program	Number of Projects[57]	Total Capacity (MW)
SOMAH	432	65.2
DAC-SASH	2,135	8.1
DAC-GT	24,417 customers	70.62

[56] CPUC Decision (D.)08-10-036.
[57] Figures represent projects that have been completed, approved, or applied for.

Program	Number of Projects[57]	Total Capacity (MW)
CSGT	-	15.67
Total	**-**	**159.59**

4.4.1 Solar on Multifamily Affordable Housing (SOMAH) Program

AB 693 (Eggman, 2015) established a successor program, Multifamily Affordable Housing Solar Roofs Program, with up to $100,000,000 annually (from 2016 to June 30, 2026) in funding from shares of GHG allowance auction proceeds from the IOUs. The program provides incentives for the installation of solar distributed generation projects sited on existing multifamily affordable housing.

On December 22, 2017, the CPUC issued D.17-12-022 establishing and re-naming MASH as the Solar on Multifamily Affordable Housing (SOMAH) Program. The SOMAH Program, while similar to the MASH program, provides incentives to install 300 MW of solar on multifamily affordable housing in the service territories of IOUs by 2030. Pursuant to D.17-12-022, a competitive solicitation for a statewide program administrator was held and a team consisting of the CSE, GRID, the Association for Energy Affordability (AEA), and the California Housing Partnership Corporation (CHPC) was selected.

SOMAH provides fixed capacity-based incentives for qualifying solar energy systems using the Expected Performance Based Buydown (EPBB) methodology. The EPBB incentive payment relies on verified solar energy system characteristics such as location, system size, shading, and orientation. The SOMAH incentive value depends on the capacity of the installed system, the energy percentage split between tenant and common area serving load, and the other funding resources that the project may leverage, such as the Federal Investment Tax Credit (ITC) or the Low-income Housing Tax Credits (LIHTC).

The Commission eliminated a past rule reducing the incentive levels annually in recognition of the ongoing need of SOMAH program participants and raised the SOMAH incentive level (D.23-03-007)

Table 17: SOMAH Program Incentive Rate by Tax Credit Funding and Tenant/Common Area Allocation

Tax Credits		$ per AC Watt Incentive			
ITC[58]	LIHTC	Tenant		Common	
		2021-2022	2023[59]	2021-2022	2023[60]
No	No	$2.97	$3.50	$1.02	$1.19
No	Yes	$2.09	$2.45	$0.74	$0.87
Yes	No	$2.09	$2.45	$0.74	$0.87
Yes	Yes	$1.49	$1.75	$0.56	$0.65

Source: https://calsomah.org/incentives-finance

On October 1, 2018, the SOMAH Program Administrator filed two Tier 3 Advice Letters including the SOMAH Program Handbook and Program Implementation Plan. Both Advice Letters were approved with minor modifications on March 28, 2019 in Resolution E-4987.[61]

The SOMAH program began accepting applications on July 1, 2019. With much anticipation, the SOMAH program opened with more than 200 applications received on day one, and waitlists were started in PG&E, SCE and SDG&E territories. By the end of 2022, 432 applications with 65.2 MW of capacity had been submitted into the program, with participation in most SOMAH-eligible IOU territories, except PacifiCorp, and 32 percent of the total projects located in disadvantaged communities.[62] Because each IOU territory's annual incentive budget varies based on their specific GHG allowance auction proceeds, the SOMAH Program Administrator maintains five individual reservation queues and up to five waitlist queues. On April 23, 2020, the Commission issued D.20-04-012 that determined there is adequate participation and interest in SOMAH program, and revenues continue to be available for the program. The Decision authorized continued allocation of funds to the SOMAH program through June 30, 2026. In May 2020, the SOMAH program received its next round of incentive funding via the approval of the IOUs' Energy Resource Recovery Account (ERRA)/Energy Cost Adjustment Clause (ECAC) applications. On June 5, 2020, the Commission issued Resolution E-5054, which approved revisions to the SOMAH Program Handbook to limit participation of a photovoltaic (PV) project to either the SOMAH Program or the MASH Program. On December 22, 2020, Energy Division disposed of CSE's Advice Letter 118-E-A that updates the SOMAH Program Handbook to implement an optional two-payment incentive

[58] Table 17 does not reflect the recently adopted tax credits from the federal Inflation Reduction Act (2022), however future program participants that utilize those credits will have their SOMAH incentive level reduced accordingly per D.23-03-007.
[59] D.23-03-007
[60] Ibid
[61] Resolution E-4987: docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&DocID=279170414
[62] SOMAH Semi-Annual Progress Report: July 1, 2021 – Dec. 31, 2021. Available at https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/somah/pa_somah-semiannual-progress-report_-january-2022.pdf.

structure that may be selected in preference to the existing single incentive payment structure. In 2022, there was a drop off in new applications and some applications fell out of the queue mainly citing financial difficulties.[63] On March 21, 2023, the Commission modified D.17-12-022 with D.23-03-007 that determined that the SOMAH program is an equity program and as such the need for incentives is on-going. The Decision raised the incentive level and ended the annual incentive step-down. It also signaled a forthcoming ruling to assess a higher incentive level for properties in disadvantaged communities and other broader programmatic changes.

4.4.2 Disadvantaged Communities – Single-family Solar Homes (DAC-SASH) Program

Although solar adoption and investment has increased throughout the state, participation in disadvantaged communities (DAC) has lagged. To address this gap, AB 327 (Perea, 2013) directed the CPUC to develop "specific alternatives designed for growth among residential customers in disadvantaged communities."

On June 22, 2018, the CPUC issued D.18-06-027, which, pursuant to AB 327, created three new programs to improve access to renewable generation for residential customers in DACs. D.18-06-027 defined DACs, for the purpose of the programs created, as census tracts that are among the top 25 percent most impacted census tracts statewide using CalEnviroScreen 3.0 scoring, plus 22 additional census tracts that do not have an overall ranking but score among the highest five percent of CalEnviroScreen's Pollution Burden category. Of the three programs created, one is for behind-the-meter solar: the DAC Single-family Solar Homes (DAC-SASH) program.

The DAC-SASH program is modeled largely after the SASH program and provides participants the same $3.00/watt incentive that was established for the SASH 2.0 program. DAC-SASH also allows for the use of a Third-Party Ownership model as long as it complies with the minimum Consumer Protection Standards established for SASH.[64] Unlike SASH, DAC-SASH does not require participants to live in low-income housing as defined in Public Utilities Code Section 2852. Instead, DAC-SASH participants must be eligible for either the California Alternate Rates for Energy (CARE) program or the Family Electric Rate Assistance (FERA) program and must live in owner-occupied, single-family homes located in DACs as defined by D.18-06-027. As of January 1, 2021 homeowners are also eligible if they reside in "California Indian Country," as a result of D.20-12-003. This change was in response to GRID's 2020 petition to modify the

[63] CSE Petition for Modification of D.17-12-022 (
[64] Resolution E-4719, June 15, 2015, and D.15-01-027, Minimum Consumer Protection standards for SASH TPO model, at pgs. 52-53. D.15-01-027 online at docs.cpuc.ca.gov/PublishedDocs/Published/G000/M145/K938/145938475.PDF.

program that, among other things, requested the inclusion of tribes in addition to DACs as the geographic threshold.[65]

D.18-06-027 established an annual budget of $10 million for DAC-SASH beginning in 2019 and continuing through 2030. It adopted the same budget allocations established for SASH, as shown below.

Table 18: DAC-SASH Budget Allocations by IOU Service Territory

Utility	PG&E	SCE	SDG&E	Total
Percentage	43.7%	46.0%	10.3%	**100%**
Total Budget 2019-2030 ($ millions)	$52.44	$55.20	$12.36	**$120**

Source: D.18-06-027

Table 19: DAC-SASH Budget Allocations by Functions

Function	Allocation
Administration	10%
Marketing and Outreach	4%
Measurement and Evaluation	1%
Incentives	85%

Source: D.18-06-027

As required in D.18-06-027, the PA for DAC-SASH was selected through a competitive solicitation. In February 2019, GRID was selected as the PA for DAC-SASH. The DAC-SASH program launched after approval of the DAC-SASH Handbook and Program Implementation Plan in September 2019. As of the end of 2022, 1,721 DAC-SASH projects had been installed equaling over 6,500 kW and utilizing over $19.5 million in incentives. Another 225 applications were confirmed under DAC-SASH for an additional 904.6 kW.[66]

4.4.3 Disadvantaged Communities – Green Tariff (DAC-GT) Program

The Disadvantaged Communities - Green Tariff (DAC-GT) program is the second program created under D.18-06-027, pursuant to AB 327. It enables income-qualified, residential customers in DACs who may be unable to install solar on their roof to benefit from grid-scale clean energy projects and receive a 20 percent bill discount.

[65] D.20-12-003 and the 2021 DAC-SASH Marketing, Education, and Outreach (ME&O) plan.
[66] Disadvantaged Communities – Single-family Solar Homes (DAC-SASH) program Semi-annual Progress Report January 2023, available at https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/solar-in-disadvantaged-communities/dac-sash-q3-4-2022-semi-annual-report_01302023.pdf.

The DAC-GT program is modeled after the Green Tariff portion of the Green Tariff/Shared Renewables Program. DAC-GT allows customers who are not able to take advantage of SOMAH or DAC-SASH through onsite solar, to still benefit from solar energy. The program has a total capacity allocation of 158 MW.

D.18-06-027 ordered that these programs be funded first through available GHG allowance proceeds and that if those funds are exhausted, then the programs be funded through public purpose program funds.[67] There are 12 approved DAC-GT Program Administrators including the three large investor-owned utilities and nine Community Choice Aggregators. As of December 31, 2022, 24,417 customers had been enrolled using interim Renewable Portfolio Standard (RPS) resources and 70.62 MW of new solar projects were approved.

4.4.4 Community Solar Green Tariff (CSGT) Program

The Community Solar Green Tariff (CSGT) program is the third program created under D.18-06-027, pursuant to AB 327. This program enables residential customers in DACs who may be unable to install solar on their roof to benefit from a local solar project and receive a 20 percent bill discount.

The program is a variation of the Green Tariff/Shared Renewables Program. It is structured similarly to the DAC-Green Tariff program but requires each solar project to be located in proximity to the customers it serves. D.18-12-015 extended the CSGT program to include San Joaquin Valley Disadvantaged Communities Pilot Projects[68] and allows CSGT projects to be within a 40-mile radius of the pilot communities they serve, rather than within a 5-mile radius.

The CSGT program also provides participating customers a sense of ownership in locally generated solar power via the required participation of a community sponsor. Community sponsors help ensure interest from the local community and community engagement in project siting. If eligible, community sponsors can receive a 20 percent bill discount on up to 25 percent of a CSGT project's energy output. The program has a total capacity allocation of 41 MW.

There are nine approved CSGT Program Administrators including the three large investor-owned utilities and five Community Choice Aggregators. Unlike DAC-GT, CSGT does not

[67] Since the California Air Resource Board's Cap And Trade Regulation disallows the use of Greenhouse Gas (GHG) allowance proceeds to offset volumetric discounts, GHG funding for a portion of the programs' costs is effectively unavailable and may not be used to offset the 20 percent bill discount and related administrative, IT, and marketing costs. Beginning in 2022, PG&E, SCE, and SDG&E began seeking recovery through the PPP rate component.

[68] D.18-12-015 authorized pilot projects in the communities of Allensworth, Alpaugh, California City, Cantua Creek, Ducor, Fairmead, Lanare, Le Grand, La Vina, Seville, and West Goshen.

allow the use of RPS resources as a stopgap measure. Instead, new projects must be constructed before customers can be enrolled. The first project(s) is expected in 2023 at which time CSGT enrollment will begin. As of December 31, 2022, 15.67 MW of new solar projects were approved.

D.18-06-027 also established that each IOU would file an Application for Review for their DAC-GT and CSGT programs by January 1, 2021. The Commission's Executive Director extended the deadline to May 31, 2022. On August 10, 2022, the Commission issued a ruling that consolidated the applications into a single proceeding, A.22-05-022. Concurrently, with the passage of AB 2316 (Ward, 2022) and AB 2838 (O'Donnell, 2022), the Commission has folded the legislative directive to review its existing customer renewable energy subscription programs including DAC-GT, CSGT and the Green Tariff Shared Renewables (GTSR) programs into this proceeding. This proceeding will review program goals, budget, capacity, design, implementation, and consumer protections and explore new authorization for the Commission to allow the IOUs to terminate their GTSR programs. It will also evaluate whether these programs achieve the specified goals of AB 2316 and will modify the programs as necessary and consider whether to adopt a new community renewable energy program.

4.5 CSI Thermal Program

4.5.1 CSI Thermal Program Background and Overview

The CSI Thermal program was an incentive program for solar thermal technologies that displace natural gas consumption. It was established by legislative language in SB 1 (Murray, 2006), which contained a provision that allowed up to $100.8 million of CSI General Market program funds to be used for incentives for solar thermal technologies that displace electricity. The electric-displacing portion of this program expired alongside the CSI General Market program on December 31, 2016. AB 1470 (Huffman, 2007) authorized the creation of a $250 million program to promote the installation of 200,000 solar water heating systems in homes and businesses that displace the use of natural gas by the end of 2017.

The CPUC established the CSI Thermal program in January 2010 through D.10-01-022. The program began accepting applications from single-family residential customers that install solar water heating systems on May 1, 2010 and from multifamily and commercial customers on October 8, 2010. In March 2012, the CSI Thermal low-income program, which provided higher incentives for low-income residences, began accepting applications. In 2013, the CPUC issued two decisions authorizing new incentives. D.13-02-018 allowed incentives for process heating and cooling, and for space heating. D.13-08-004 allowed incentives for swimming pools at multifamily and commercial sites. Subsequently, D.15-01-035 increased early-step incentive

levels for the single-family and multifamily/commercial gas-displacing customer classes, and revised project rebate caps and customer class budgets.

On May 6, 2016, Energy Division approved temporarily higher incentives for the installation of solar water heating systems to address the need to reduce natural gas use in the region impacted by the Aliso Canyon natural gas leak. The new rules applied only to systems in SoCalGas service territory that are installed by the end of 2016. The modifications include increased incentive rates for general market single family and multifamily/commercial applications, reallocated funds from later Steps 3 and 4 to the new, higher Step 1 incentives for single family and multifamily/commercial general market funds, and removal of the cap limiting the swimming pool incentive from covering more than 50 percent of a project's cost. In February 2017, due to ongoing Aliso Canyon mitigation efforts and the program's success in raising single family residential participation, the CPUC extended the installation deadline for projects that had permit applications dated on or before October 6, 2016 but were not able to finish installation before the initial December 31, 2016 deadline. Projects with the required permitting had until June 16, 2017 to complete installation and receive the higher incentive.

In 2017, AB 797 (Irwin) authorized the CSI Thermal program to continue operation from January 1, 2018 through July 31, 2020. Although the overall budget would not exceed the initial $250 million ceiling, AB 797 mandates the allocation of 50 percent of the CSI Thermal budget to low-income residential housing or buildings in disadvantaged communities (DAC).[69] Another 10 percent of the budget was reserved for industrial applications, which are larger projects that, in general, use process heating to produce basic commodities and materials.

Additionally, AB 797 expanded the program to include homeowners in the San Joaquin Valley Communities without access to natural gas as identified by the CPUC pursuant to Public Utilities Code 783.5 (a)(1). These households rely on propane or wood burning to fulfill their space heating, water heating, and cooking needs.

Per legislative direction, the CPUC established two primary program elements corresponding to the type of water heating fuel being displaced by solar technologies. Incentives for natural gas-displacing systems were provided through a statewide budget of $250 million, as described in detail below. Incentives for electric or propane-displacing systems were drawn from the closed CSI General Market budget in each utility territory. The CSI Thermal program consisted of:

1. incentives for natural gas-displacing systems (including swimming pools);

[69] The CSI Thermal program defines disadvantaged communities as a community identified by the California Environmental Protection Agency pursuant to Section 39711 of the Health and Safety Code.

2. incentives for natural gas-displacing systems serving low-income customers and DACs;[70] and
3. incentives for industrial process heat natural gas-displacing systems.

The four Program Administrators (PA) of the CSI Thermal program were: PG&E, SoCalGas, SCE,[71] and CSE (on behalf of SDG&E). The CSI Thermal program closed to new applications on July 31, 2020.

4.5.2 CSI Thermal Budget

Natural Gas-Displacing Program

For the natural gas-displacing portion of the program, the $250 million program budget was collected during the duration of the program by the three gas IOUs based on the percentages presented in Table 19.

Table 20: CSI Thermal Gas-Displacing Budget Allocation

Utility	Budget Allocation	Total Program Collections ($ millions)
PG&E	39%	$97.5
SDG&E	10%	$25.0
SoCalGas	51%	$127.5
Total	**100%**	**$250 million**

Source: D.10-01-022

During the program extension years, 2018-2020, each PA had access to the remainder of their original budget allocations as of December 31, 2017, which was then adjusted based on program revisions mandated by AB 797. Table 20 displays each PA's budget for natural gas-displacing solar thermal systems as of December 31, 2017.

[70] This category includes the exception provided for communities lacking access to natural gas in the San Joaquin Valley, as identified by the CPUC pursuant to paragraph (1) of subdivision (a) of Public Utilities Code Section 783.5.

[71] Note: As an electric-only utility, SCE offered incentives for electric or propane-displacing systems in their service territory until the program closed at the end of 2016. Similarly, as a gas-only utility, SoCalGas only offers incentives for natural gas-displacing systems in their service territory.

Table 21: CSI Thermal Gas-Displacing 2018-2022 Incentive Budget Allocation

Utility	Total Program Collections ($ millions)
PG&E	$42.33
SDG&E	$8.45
SoCalGas	$31.92
Total	**$82.70**

Source: SoCalGas Advice Letter (AL) 5262-A/PG&E AL 3942-G-A/SCE AL 88-A

Table 21 shows funding for program administration and market outreach activities plus the specific budget reallocations pursuant to AB 797 that shifted 50 percent of program funds to the Low-Income program and 10 percent to the Industrial sector.

Table 22: CSI Thermal Gas-Displacing Overall Program Budget, 2018-2022

CSI Thermal Program Elements	CSI Thermal Program Sub-Elements	Budget ($ millions)
Incentives (82%)	General Market	$22.189
	Low-income/DAC (50% of total funds)	$50.429
	Industrial (10% of total funds)	$10.085
	Subtotal	**$82.703**
Program Administration/Market Facilitation (18%)	General Administration	$6.051
	Marketing and Outreach	$10.086
	Measurement and Evaluation	$2.017
	Subtotal	**$18.154**
Total		**$100.857**

Source: SoCalGas AL 5262-A/PG&E AL 3942-G-A/SCE AL 88-A

CSI Thermal Natural Gas-Displacing Program Incentives

For systems that displace natural gas, general market incentives were available for three different market segments (or customer classes): single-family, commercial/multifamily, and commercial and multifamily solar pool heating. Due to low program participation rates, all budget categories had not advanced past Step 1 in 2018. At that time, because there were only two years left in the program, the CPUC approved an advice letter collapsing all incentive steps from four to two tiers in May 2018.[72] For the single-family market, the average system rebate started at $3,493 in Step 1 and declined over two steps to an average of $2,968. Commercial/multifamily systems

[72] SoCalGas AL 5262-A/PG&E AL 3942-G-A/CSE AL 88-A, dated April 24, 2018 and effective as of May 24, 2018; Disposition Letter issued May 30, 2018.

were incentivized at a slightly lower rate, and solar pool heating systems were incentivized at substantially lower rates due to favorable project economics (see Table 22).

Pursuant to D.15-01-035, all customer classes were subject to maximum system incentive caps.[73] Incentive levels declined when the total incentive budget for a step was exhausted. Step incentive levels, customer class budgets, and individual project caps for natural gas-displacing systems were revised in May 2018 to reflect budget revisions to the program pursuant to mandates in AB 797 (Irwin, 2017).[74]

The Low-Income/DAC budget did not follow a step-down structure, and the incentive level remained the same through the end of the program.

Table 23: Natural Gas-Displacing CSI Thermal General Market Incentive Steps, 2018-2022

Step	Customer Class	Incentive per Therm Displaced	Incentive for Average Solar Water Heating System	System Maximum Incentive	Funding Amount
1	Single-Family	$29.85	$3,493	$4,366	$2,840,000
	Commercial/ Multifamily	$20.19 PBI - $10.10	N/A	$800,000	$10,118,000
	Commercial/ Multifamily Solar Pool Heating	$7.00		50% of total project costs	$4,793,000
2	Single-Family	$25.37	$2,968	$3,710	$710,000
	Commercial/ Multifamily	$17.16 PBI - $8.58	N/A	$800,000	$2,530,000
	Commercial/ Multifamily Pool Heating	$5.00		50% of total project costs	$1,198,000
Total					**$22,189,000**

Source: CSI Thermal Program Handbook, May 2019

[73] The single-family system maximum incentive level is set to 125 percent of the average system cost. Multifamily/commercial projects have a maximum incentive of $800,000 per project. Solar Pool Heating systems have a maximum incentive level of 50 percent of total project costs up to $500,000.
[74] SoCalGas Advice Letter No. 5102

CSI Thermal Industrial Natural Gas-Displacing Program Incentives

AB 797 reserved 10 percent of program funds through a separate budget category for industrial solar thermal systems, which the CSI Thermal program defined as process heating systems that use hot water or other fluid to produce basic materials and commodities.

Table 24: Natural Gas-Displacing Industrial CSI Thermal Incentive Rate

Step	Industrial Incentive per Therm Displaced	Incentive Cap for Industrial Projects
1	$10.10	$800,000

Source: CSI Thermal Program Handbook, May 2018

CSI Thermal Low-income Natural Gas-Displacing Program Incentives

During the program extension years, 2018-2021, the low-income program provided approximately $50.4 million of CSI Thermal incentives to promote the installation of gas-displacing solar water heating systems on single-family and multifamily low-income housing and buildings in DACs. The program budget is broken down by PA in Table 24.

Table 25: CSI Thermal Low-income Program 2018-2022 Budget Allocation

Utility	Total Program Collections ($ millions)
PG&E	$25.81
SDG&E	$5.15
SoCalGas	$19.47
Total	**$50.43**

Source: SoCalGas AL 5262-A/PG&E AL 3942-G-A/SCE AL 88-A

The CSI Thermal program offered higher incentives to low-income customers and installations at buildings located in DACs. Pursuant to AB 797's statutory emphasis on these customers, as of May 2018, incentives in this budget category did not decline to maximize participation rates.

Table 26: CSI Thermal Low-income/DAC Incentive Rate

Step	Single-Family Low-income Incentive per therm displaced	Incentive Cap for Single-Family Low-income Projects	Multifamily Low-income Incentive per therm displaced	Incentive Cap for Multifamily Low-income Projects
1	$36.90	$4,317.00	$20.19	$800,000.00

Source: CSI Thermal Program Handbook, May 2018

4.5.3 CSI Thermal Program Participation

CSI Thermal Program History and Application Statistics

The CSI Thermal program approved 12,354 applications for $180.4 million in incentives through 2022. As seen below, the low-income/DAC single-family customer class received the greatest number of applications. However, due to their much larger average project size, the commercial/ multifamily customer class represented a larger portion of incentive amounts, project costs, and energy savings.

Table 27: CSI Thermal Installed Projects by Sector and Displaced Fuel through 2022

Number of Applications	Total Incentives ($ thousands)	Total Project Costs ($ thousands)	Total Annual Energy Savings (therms)
12,354	**$180,466**	**$322,400**	**9,931,820**

Source: CSI Thermal Program Data (californiadgstats.ca.gov), accessed April 17, 2023.

4.5.4 CSI Thermal Measurement and Evaluation (M&E)

Unlike the CSI General Market program, where generation performance can be evaluated at the meter, CSI Thermal technologies offset electric or gas consumption. This requires evaluation of kilowatt-hour and therm savings to assess whether the program is meeting its goals.

D.10-01-022 adopted a $6.3 million total budget for measurement and evaluation (M&E) of the CSI Thermal program. In February 2014, when program participation had risen to a level warranting M&E expenditures, the CPUC released a detailed M&E plan for the program. This plan, available on the CPUC's website, outlined both the field performance data to be collected from a sample of CSI Thermal systems, and the program evaluation studies to be performed with this data.[75] In accordance with the 2014 CSI Thermal M&E Plan, the CPUC retained Itron through a competitive solicitation to complete a Performance Data, Impact, and Technology Project, which includes the installation of performance metering on CSI participating solar thermal systems and publishing of Technology Evaluation, Impact Evaluation. The three final reports under the Performance Data, Impact, and Technology Project can be found on the CPUC CSI Thermal Program Evaluation webpage.[76] In 2019, and in accordance with Public

[75] The CSI Thermal Measurement and Evaluation Plan is available at: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/california-solar-initiative/csi-thermal-program-solar-water-heating.

[76] CSI Thermal Program Evaluation webpage, https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/california-solar-initiative/csi-thermal-program-solar-water-heating.

Utilities Code 2863(a)(4) the CPUC commissioned the CSI Thermal Cost Effectiveness study, which was submitted to the California Legislature in February 2020.[77]

4.6 Research, Development, Demonstration, & Deployment

4.6.1 RD&D Program Background

The CSI Research, Development, Demonstration, and Deployment (RD&D) program was a CPUC-administered program that closed on December 31, 2016. The purpose of the CSI RD&D program was to identify and support projects that would help reach the program goals of installing 1,940 MW of distributed solar by the end of 2016 and creating a self-sustaining, subsidy-free solar market.

The CSI RD&D program conducted five solicitations for projects over the life of the program. The first program solicitation focused on integrating solar PV into the electricity grid. The second program solicitation had two focus areas: energy generation technologies and business development and deployment. The third program solicitation had a primary focus of grid integration with a secondary focus of production technologies, business development, and deployment. The fourth solicitation focused on cost-effective strategies and solutions for integrating large amounts of PV into distribution systems. The fifth solicitation focused on leveraging the value of past or current CSI RD&D investments or other publicly funded research to address the goals of the CSI RD&D program.

The five CSI RD&D solicitations resulted in grant funding for 36 projects totaling $31.2 million. With the additional award of $10 million to the Helios Solar Energy Center at UC Berkeley, the total allocation of CSI RD&D funds to date is approximately $41.2 million. The CSI RD&D program completed all grant making activities and will not conduct any future solicitations.

[77] California Solar Initiative (CSI) Thermal Cost Effectiveness study, https://www.cpuc.ca.gov/-/media/cpuc-website/files/uploadedfiles/cpuc_public_website/content/utilities_and_industries/energy/energy_programs/demand_side_management/customer_gen_and_storage/csi-t-ce-2020.pdf

Table 28: CSI RD&D Final Budget Allocations

Grant Solicitation	Target Areas	Available Funding	No. of Proposals Approved for Funding	Approved CSI RD&D Funding Ceiling	Approved Match Funding
1	Grid Integration	$15M	8	$7.0M	$4.6M
2	Improved PV Production Technologies and Innovative Business Models	$15M	9	$12.8M	$10.2M
3	Primary Area: Grid Integration Secondary Areas: Production Technologies and Business Development and Deployment	$9M $3M	6	$5.6M	$6.5M
4	Grid Integration	$7M	6	$5.1M	$7.9M
5	Small Projects in all target areas	$1M	7	$0.7M	$0.5M
Solicitations Total			36	$31.2	$29.7
Solar Energy Center			1	$10	-
CSI RD&D Total			**37**	**$41.2M**	**$29.7M**

Source: CSI RD&D Program Report, 2006-2016, Itron, 2017

Several CSI RD&D projects made notable contributions to the grid integration of solar and the industry in general. For example, the grant funding awarded to the Electric Power Research Institute for a project based in Fontana, CA of 20 Zero Net Energy (ZNE) homes in a builder community has become a test bed for several research questions around both ZNE and grid integration of solar and storage. Detailed profiles of all CSI RD&D funded projects, project documentation, and reports can be found at calmac.org.

4.6.2 RD&D Program Evaluation

Pursuant to D.07-09-042, the CPUC commissioned an independent evaluation of the CSI RD&D program. Results of the evaluation provide the CPUC and stakeholders an independent, expert conclusion about the CSI RD&D program's legacy impacts on the economics, deployment, and integration of innovative solar technologies in California. The evaluation concluded in March 2017 and resulted in the following findings.[78]

- The Program Manager, Itron, performed very well. It implemented the program in accordance with the original program design. It also played an important and highly effective role in facilitating communication and partnerships within and between

[78] The CSI RD&D Program – Program Evaluation is available at https://www.calmac.org/publications/CSI_RD&D_Program_-_Program_Evaluation_.pdf.

projects, as well as with the broader solar community, helping to engage key stakeholders and reduce duplication of efforts.

- CSI RD&D projects were successful in making progress toward the long-term policy goals established for the program. Grid Integration was the most successful research area, with 20 completed projects. Important accomplishments for these projects included improvement to interconnection requirements, development of software products, improved modeling tools, and inverter system enhancements.

5 Program Reporting and Evaluation

5.1 Program Reporting

5.1.1 CSI General Market Reporting

CSI General Market program data is available on the California Distributed Generation Statistics (California DG Stats)[79] website, (formerly named "California Solar Statistics"). California Solar Statistics, launched in 2010, was a collaborative effort between the CSI Program Administrators and CPUC staff, and contained a wealth of program data. The website originally focused on the CSI General Market program, but later added data on the MASH, SASH, DAC-SASH and SOMAH programs. As the CSI General Market program became fully subscribed, there was a concern that this source of solar PV market data would become outdated. For this reason, the CPUC adopted D.14-11-001, which directs CPUC staff, CEC, and Program Administrators to continue the collection of non-CSI solar PV installation data through the NEM interconnection process.

The CPUC launched California DG Stats in 2016 to maintain access to useful data on all (including non-CSI) solar projects in the three large IOU service territories. It includes data for all behind-the-meter (BTM) generation and storage systems interconnected to the large IOUs.[80]

California DG Stats provides the following data:

- Charts and tables that can be filtered by CSI program administrator, application status, date ranges, customer classes, and system ownership.
- Data on individual BTM installations (while maintaining customer confidentiality) including:
    - system costs,
    - manufacturer, model, capacity, and other technical information, and
    - geographic location.
- A "Find an Active Solar Contractor" feature, which helps prospective solar buyers search local options for solar installations.

[79] See californiadgstats.ca.gov.
[80] Systems interconnected under the Wholesale Distribution Access Tariff (WDAT) are not included in this dataset.

- Monthly updates to the budget status of the General Market, SASH, and MASH programs.

- A Data Annex, containing information about the efficiency of the program's administrative processing.

Market participants (installers, third-party owners, manufacturers, etc.) have praised the benefits of this online data because it is current, comprehensive (covering the vast majority of California's distributed generation PV installations), and in-depth (including a wide array of data fields). Other agencies both in and outside of California have modeled their public-facing solar energy databases after California DG Stats.

5.1.2 Periodic CSI and CSI Thermal Reports

A number of periodic reports are filed publicly and posted to the CPUC's website:[81]

- The CPUC's Annual Program Assessment to the Legislature (this report), required by statute every year no later than June 30. The 2023 CSI Annual Program Assessment to the Legislature is the final annual report for this program.

- SOMAH Program Administration budget reports, SOMAH Program IOU Semi-Annual Administrative Expense Reports, and SOMAH Program Administrator's Semi-Annual Progress Reports.

5.2 Program Evaluations

The CSI Evaluation Plan measures the CSI program's progress towards its goals of deploying 1,940 MW of new solar capacity and helping to create a self-sufficient solar industry in which solar energy systems are a viable mainstream option for both homes and businesses within 10 years, without ratepayer support. A summary of CSI M&E reports is as follows:

- **PV Market Assessment Studies:** In 2014, the CPUC released three studies that address the core questions of how much the distributed generation PV market has been transformed, how much we expect it will be transformed after the CSI program's market interventions, and how we will know the market has been transformed. The PV Market Assessment Studies included:

[81] See https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/california-solar-initiative/csi-progress-reports.

  - Third-Party Ownership Market Impact Study: This study found that third-party ownership had accounted for a significant portion of residential solar installations and demand for this model was growing.

  - CSI Market Transformation Study: This study found that significant market transformation had occurred, but that the sustainability of the industry was dependent on the resolution of NEM policies and residential rate reforms.

  - Solar PV and Residential Roof Study: This study assessed the relationship between roofing and the distributed generation PV market.

- **Impact Evaluations:** Several studies have been published covering CSI program accomplishments, including energy, capacity, and environmental impacts and PV system performance degradation. The Final CSI Impact Evaluation was published in 2021.

- **Impact of Distributed Generation Reports:** These reports were mandated in AB 578 (Blakeslee, 2008) and Public Utilities Code 913.10. The first report was completed in 2010. The second report, delivered in 2013, showed that, while California's solar distributed generation installed capacity was large compared to other states, the impact on the distribution and transmission infrastructures was relatively low. The third report, delivered in 2016, focused on the effects of customer-sited solar on CAISO's net load curve.[82] The report's primary findings included that:

  - Customer-sited solar power was effective at reducing summer peak net load but did not reduce winter and spring peak net load, when the "duck curve" effects are most pronounced.

  - There were tradeoffs in the effects of west-facing and south-facing customer-sited solar, but the findings alone did not support policy to incentivize one type of solar over the other.

  - A diverse portfolio of renewables produced a smoothing benefit to CAISO's net load curve.

  - Large-scale deployment of energy storage, dispatchable demand-response, and time-of-use rates for consumers would help integrate increasing amounts of customer-sited solar.

- **External Financial Audit Report:** In 2010, CPUC audit staff completed a PG&E 2007-08 audit, SCE 2007-08 audit, and SDG&E 2007-08 audit. The 2010-11 audit was

[82] A competitive solicitation was issued in January 2015 to perform the third bi-annual study. The CPUC retained DNV-GL in May 2015.

conducted by an outside firm, and was completed in 2013. The audit did not identify any significant issues with administration of the program. The 2012-14 audit was completed in 2016. As before, the audit did not identify any significant issues with administration of the program.

- **California Solar Initiative Cost-Effectiveness Evaluation:** this study, completed in 2011, looked at cost effectiveness from several perspectives – program administrators, ratepayers, and especially program participants and society overall. Based on participant economics, the study suggested that the residential solar PV market would be self-sustaining by 2017, with a mixed outlook for non-residential customers.

- **CSI Thermal Performance Data, Impact, and Technology Project:** The CPUC contracted with Itron to assess the performance of installed CSI Thermal systems through metering and collecting data from solar water heating systems. In 2016, Itron completed metering on 120 CSI Thermal solar water heating systems to gather data for the study. The project included the publication of a Technology Evaluation Report in 2019, which assessed the costs and benefits of various solar thermal technologies amongst different markets. The project also assessed the CSI Thermal program's impact on electricity and natural gas demand, and effectiveness in reducing greenhouse gas emissions, and compared the actual performance of solar water heating systems against their expected performance. A 2018 CSI Thermal Impact Evaluation Report and 2019 CSI Thermal Impact Evaluation Report were completed.

- **California Solar Initiative (CSI) Thermal Cost Effectiveness Study**: This study, completed in February 2020, looked at cost effectiveness from several perspectives – program administrators, ratepayers, program participants, and society at large. Overall, the study found that the CSI Thermal Program was not currently cost-effective for natural gas-displacing systems. Relatively high installation costs combined with low natural gas prices and low avoided costs made cost-effectiveness a challenge for many of the solar thermal technologies from the four perspectives mentioned above.

- **California Solar Initiative (CSI) Final Impact Evaluation:** This report, published in January 2021, provides the CPUC Staff and California public with important insight into the value and efficacy achieved by the CSI program over its life.

- **CSI SASH and MASH Biennial Report:** In 2016, the CPUC released Navigant Consulting's evaluation of CSI SASH and MASH, program years 2011-13, program design, delivery, operations, and impact. The evaluation consisted of a program administrator assessment and an impact and cost-benefit analysis, which built upon the previous MASH and SASH studies completed in 2011.

- **CSI RD&D Program Evaluation:** Pursuant to requirements in D.07-09-042, the Commission hired Evergreen Economics for an independent evaluation of the CSI RD&D program. The evaluation provides the CPUC and stakeholders with expert conclusions about the CSI RD&D program's legacy impacts on the economics, deployment, and integration of innovative solar technologies in California. The final CSI RD&D Evaluation Report was released in 2017.

Another relevant report, not directly tied to CSI, is an evaluation of the NEM successor tariff that was authorized by the Decision on NEM consumer protections (D.18-09-044). Verdant Associates, LLC conducted the evaluation to analyze the costs and benefits of customer-sited renewable resources taking service on the tariff and its variants. The evaluation was released in January 2021.

6 CSI Program Links and Contact Information

The CPUC Energy Division website provides information related to the CSI program at cpuc.ca.gov/Demand_Side. Additionally, CSI Thermal program information is available at CSIThermal.com. For CSI inquiries please contact energy@cpuc.ca.gov.