



2019 California Solar Initiative

ANNUAL PROGRAM ASSESSMENT



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California Solar Initiative Annual Program Assessment

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Authors

Asal Esfahani
Kerry Fleisher
Tory Francisco
Nora Hawkins
Brian Korpics
Christopher Westling
Shannon O'Rourke

Special Thanks

Lelaine Bonine
Bruce Kaneshiro
Simon Baker
Edward Randolph

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1 Executive Summary

In January 2007, California launched a \$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 California Public Utilities Commission's (CPUC) portion of the solar effort is known as the California Solar Initiative (CSI) program. The CSI program goal is to install 1,940 MW¹ of customer-sited solar capacity, and, along with other statewide solar programs, transition the solar industry to a point where it can be self-sustaining without subsidies.

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 new Solar on 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 state authorized programs, including the New Solar Homes Partnership (NSHP) and publicly-owned utilities' solar offerings, are not included in this report.³

The market for solar generating equipment in California has grown at a rapid pace since the beginning of the CSI program and has continued to grow since the program closed. Through increasing annual rates of new solar installations and cumulative installed capacity over the life of the program, California installed enough solar capacity to achieve the CSI General Market Program goal of installing 1,750 MW of capacity prior to the legislative goal of December 2016 set forth by the legislation authorizing the CSI program, Senate Bill (SB) 1 (Murray, 2006).

1.1 Key Report Contents

This report contains current information on distributed solar energy systems in California, with a primary focus on the large Investor Owned Utilities' (IOU)⁴ service territories. The report includes detailed information on program participation, installed capacity, equipment costs, and program impacts for all the CSI program components, including the General Market program, Single-Family Affordable Solar Homes program (SASH); the

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 (PU) 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." All CSI Annual Program Assessments, beginning with the 2009 report, are available at <http://www.cpuc.ca.gov/General.aspx?id=3747>.

³ Information on non-CPUC jurisdictional solar programs is available at www.gosolarcalifornia.ca.gov.

⁴ The large IOUs under the CPUC's regulatory jurisdiction are Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), San Diego Gas & Electric Company (SDG&E), and Southern California Gas Company (SoCalGas).

Multifamily Affordable Solar Housing program (MASH); the CSI Thermal program; the CSI Thermal Low-income program; and the Research, Development and Demonstration (RD&D) program. This report also includes information on Net Energy Metering (NEM) and other relevant policy updates. Unless stated otherwise, all data is accurate as of December 31, 2018.

1.1.1. Installed Solar Highlights

- Through the end of 2018, approximately 7,228 MW of solar capacity was installed at 835,252 customer sites in the large IOU territories.⁵ This exceeds the state’s goal of 3,000 MW by roughly 241 percent.
- In 2018, 1,217 MW was installed in the IOU territories, a 5.2 percent increase in annual installed capacity compared to 2017.
- Between 2007 and the end of 2018, the average cost of installed systems sized below 10 kilowatts (kW) has decreased 52.6 percent from \$9.61 per watt to \$4.55 per watt. In the same time period, the cost of systems sized with greater than or equal to 10 kW of capacity decreased 60.1 percent from an average of \$9.46 per watt to \$3.72 per watt.^{6,7}
- By the end of 2018, California installed approximately 8,001 MW of solar capacity at 926,986 customer sites. The table below provides the best available minimum estimate of California statewide solar installations.

California Statewide Solar Installations

Data Source and Dates	Total MWs	Total Projects
Solar installations in large California IOU territories		
All IOU interconnections, 1993-2018	7,228	835,252
Solar installations in California POU and other IOU territories		
California DG Statistics, 2008-2018	773	91,734
Total California solar installations	8,001	926,986

Sources: IOU Quarterly Distributed Generation (DG) Interconnection Reports Q4 2018, California DG Statistics, Publicly Owned Utilities Report Summaries, https://www.californiadgstats.ca.gov/downloads/#_pou

⁵ California DG Statistics at <http://www.californiadgstats.ca.gov/charts/>

⁶ California DG Statistics at <http://www.californiadgstats.ca.gov/charts/>

⁷ System prices are quoted in nominal terms.

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 1,895.6 MW.^{8,9}
- PG&E, SCE, and SDG&E¹⁰ 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.
- As the CSI General Market Program is now closed, NEM and the Federal Investment Tax Credit (ITC) play the prominent role in driving customer-sited solar generation.

⁸ California Solar Statistics – Program Totals, (https://www.californiasolarstatistics.ca.gov/reports/agency_stats/). Data updated May 24, 2019.

⁹ 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 Commission Decision (D.)11-12-019 for more details.

¹⁰ The Center for Sustainable Energy (CSE) administers the CSI Program in SDG&E's service territory.

1.1.3. Other Program Highlights

CSI Budget by Program Component

Program Component	Budget* (\$ 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**
Multifamily Affordable Solar Housing (MASH)	\$108	95 MW**
Research, Development, Demonstration, and Deployment (RD&D)	\$50	N/A
Solar water heating Pilot Program (SWHPP)***	\$2.6	750 systems
Sub-Total: CSI Electric (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.****
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 CSI 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 CSI 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.

*Total budget over life of program

**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.

***The SWHPP was a pilot program that preceded the CSI Thermal Program and is now closed.

**** AB 797 (Irwin, 2017)

- **Single-Family Affordable Solar Homes (SASH)**

- Since the program was launched in 2008 through December 2018, SASH has completed a total of 8,228 projects, representing 25.2 MW of installed capacity on eligible homes.¹¹

¹¹ 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 4.2.2.

- 100 percent of the original \$92 million SASH incentive budget was fully subscribed in all IOU territories.
 - Through December 2018, SASH applicants have received or reserved a total of \$29.4 million of the available \$46 million incentive budget authorized for the extended SASH program. There are an additional 454 SASH projects in progress or under review, with a total capacity of 1.4 megawatts, and the SASH program is still accepting new applications.
 - Since the SASH third-party ownership (TPO) model was made available in 2015 through December 2018, over 80 percent of SASH 2.0 capacity installed use this 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 4.2.1.3.
- **Multifamily Affordable Solar Housing (MASH)**
 - Since the program was launched in 2008, MASH has completed 480 projects, equaling 41.9 MW of installed capacity. There are an additional 140 MASH projects in progress or under review, with a total capacity of 17.9 MW.¹²
 - MASH applicants have received or reserved 100 percent of the original \$95 million MASH incentive budget.
 - The additional \$50 million incentive budget authorized for the extended MASH program is also fully subscribed in all IOU service territories. However, if funding becomes available in an IOU territory due to project cancellations, the program could reopen to new applications.
- **New 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 greenhouse gas (GHG) allowance auction proceeds, SOMAH has a program budget of up to \$100 million annually and is expected to launch in Q3 of 2019.

¹² 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 4.3.2.

- **DAC-SASH** – The Disadvantaged Communities Single-Family Solar Homes (DAC-SASH) program was created in June 2018 through CPUC Decision (D.)18-06-027. DAC-SASH will provide \$3.00/watt incentives for solar installations on owner-occupied, single family homes located in disadvantaged communities. All participants in DAC-SASH must be eligible for either the California Alternate Rates for Energy (CARE) program or the Family Electric Rate Assistance (FERA) program. The program is anticipated to launch by fall 2019.
- **CSI Thermal Program**
 - From January 2010 to December 2018, the program approved 9,958 applications for natural gas-displacing solar thermal systems for \$173.3 million in incentives received out of the available \$250 million CSI Thermal incentive 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 will not exceed the initial \$250 million ceiling, AB 797 mandates the allocation of 50% of the CSI Thermal budget to low-income residential housing or building in disadvantaged communities (DACs).¹³
- **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
 - Grid integration and production technologies
 - The CSI RD&D Program closed on December 31, 2016. All solicitations and projects are now complete.¹⁴

¹³ The CSI Thermal program defines disadvantaged communities as a community identified by the California Environmental Protection Agency (CalEPA) pursuant to Section 39711 of the Health and Safety Code.

¹⁴ Final reports and individual research briefs for all projects funded under the CSI RD&D Program can be found at <http://www.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.¹⁵

1.1.4. Net Energy Metering (NEM)

- As of December 31, 2018, 7,002 MW out of the 7,228 MW of customer-sited solar capacity interconnected to the grid in the large IOU territories was enrolled in a NEM tariff. Only 3.11 percent of customer-sited solar capacity was not enrolled in a NEM tariff.
- In January 2016, the CPUC approved Decision (D.)16-01-044 adopting a NEM successor tariff, which continued the existing NEM structure while making 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.

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. The CSI program promotes customer adoption of solar PV and solar thermal technologies through financial incentives. Existing residential homes, as well as non-residential, including commercial, industrial, government, non-profit, and agricultural, properties within the service territories of the large electric and gas IOUs are eligible for CSI program participation.¹⁶

The goals of the CSI program are to:

¹⁵ Please see:

http://calsolarresearch.ca.gov/images/stories/documents/Prog_Report/CSI_RDD_ProgramReport_ResearchBriefs_20170131.pdf

¹⁶ 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.

- 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.

The CSI program focuses 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 does 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.¹⁷ 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 (RECs) associated with the system's generation and may sell the RECs to retail sellers to contribute to the RPS targets.

2.1 CSI Program Components

The CSI program has several components, with a Program Administrator for each large IOU territory. 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 kW to one MW. The General Market Program Administrators are PG&E, SCE, and Center for Sustainable Energy (CSE) in SDG&E's territory. The goal of the general market rebate 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** provides solar incentives to qualifying single-family, low-income households. The SASH program is administered through a statewide Program Manager, GRID Alternatives (GRID). The original SASH program had a budget of \$108 million and the reauthorized SASH program has a budget of \$54 million. The SASH program offers job training to

¹⁷ See SB 2 (2011).

volunteers and workforce development participants and offers competitive opportunities for solar installers through a subcontractor program.

- **The CSI Multifamily Affordable Solar Housing (MASH) Program** provides 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). As of December 31, 2018, PG&E, SCE and CSE are fully subscribed within each respective service territory, and their waitlists are currently 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 for the CSI RD&D program.
- **The CSI Thermal Program** provides incentives to eligible solar thermal technologies including solar water heating (SWH) systems. 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 to new applications on December 31, 2016. PG&E, SoCalGas, and CSE administer the CSI Thermal Program for the gas-displacing solar thermal systems which has a budget of \$250 million. The CSI Thermal program now consists of three customer classes: single-family residential, multifamily/commercial, and solar pool heating. Additionally, there are separate low-income programs for the single-family residential and multifamily/commercial customer classes.

2.2 CSI Program Budget

The CSI program has two funding streams, depending on whether the incented solar technology is used for electricity generation or displacing natural gas consumption. The electric portion of the CSI program has 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, to continue until the incentives are exhausted or until 2021, whichever is earlier. CSI Thermal, the natural gas-displacing portion of the CSI program, was funded 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* (\$ 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**
Multifamily Affordable Solar Housing (MASH)	\$108	95 MW**
Research, Development, Demonstration, and Deployment (RD&D)	\$50	N/A
Solar water heating Pilot Program (SWHPP)***	\$2.6	750 systems
Sub-Total: CSI Electric (Electric-Displacing) Budget	\$2,367	1,940 MW
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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 CSI 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 CSI 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.

*Total budget over life of program

**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.

***The SWHPP was a pilot program that preceded the CSI Thermal Program and is now closed.

**** AB 797 (Irwin, 2017)

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.

The CSI General Market incentive buckets are available online at californiasolarstatistics.ca.gov/reports/budget_forecast and 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 sites also break down the CSI dollars confirmed, under review, and paid, according to the type of project and customer class.

In 2015, the CPUC and Program Administrators successfully transferred the responsibility for collecting solar project data 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 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 2015, the CPUC adopted a number of regulatory decisions establishing the CSI program, as well as various CSI program components.¹⁸ Rules and procedures for the CSI program are currently developed within Rulemaking (R.)12-11-005.

In addition to formal regulatory decisions, the CPUC and CSI Program Administrators 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 Program Administrators have hosted quarterly public CSI program forums to discuss potential program changes with stakeholders.

The Program Administrators periodically file 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 (G.O.) 96-B.¹⁹ As a result, the CPUC has revised and reissued the CSI Program Handbook²⁰ numerous times since the program first began.

2.3.1.CSI General Market Program Decisions

Key CPUC decisions related to the CSI program include (but are not limited to):

- **D.06-01-024** adopted the CSI program.
- **D.06-08-028** adopted Performance-based Incentives (PBI), an administrative structure, and other program start-up elements.
- **D.06-12-033** modified earlier decisions to conform to SB 1.
- **D.07-05-007** modified the incentive adjustment mechanism to account for program dropouts.
- **D.07-05-047** established interim marketing and outreach objectives for the program.

¹⁸ The CPUC has developed the CSI Program in a series of Rulemakings (R.) 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.

¹⁹ See General Order 96-B here: <https://www.cpuc.ca.gov/generalorders/>

²⁰ See CSI Program Handbook here: <https://www.cpuc.ca.gov/General.aspx?id=5367>

- **D.07-07-028** and **D.08-01-030** modified metering and performance monitoring requirements for the program.
- On July 29, 2008, the Assigned Commissioner issued a Ruling establishing an Evaluation Plan for the CSI program.
- **D.10-09-046** modified the CSI General Market budget and shifted \$40 million from the program administration budget into the incentive budget as partial mitigation for higher than anticipated performance payments under the PBI mechanism.
- **D.11-07-031** modified prior CSI decisions, including D.06-08-033 and D.08-10-036, based on a comprehensive CPUC staff proposal.
- **D.11-12-019** modified the CSI budget requirement, effectively adding \$200 million in rebate funding, in response to SB 585 (Kehoe, 2011).
- **D.13-10-026** modified the CSI budget requirement in response to a petition for modification submitted by the Center for Sustainable Energy.
- **D.13-10-026** modified the CSI General Market budget.
- **D.14-11-001** transferred the responsibility for collecting solar statistics from CSI to the NEM interconnection process.
- **D.15-12-023** shortened the PBI payment minimum reporting period for the CSI General Market program.
- **D.16-12-055** granted the joint Motion of the CSI General Market Program Administrators to establish a program closure date of December 31, 2019 for the administration of remaining project installations and incentive payments.
- **D.17-10-004** granted, in part, the Motion of the CSI General Market Program Administrators to modify or retire remaining reporting requirements.
- **D.19-02-006** granted a petition for modification by the Program Administrators to modify the performance-based incentive buyout payment structure and schedule for the CSI General Market Program.

2.3.2. Other CSI Program Component Decisions

- **D.06-08-028** established the Solar Water Heating (SWH) Pilot program in SDG&E territory.
- **D.07-09-042** established the CSI RD&D program.
- **D.07-11-045** established the CSI SASH program.
- **D.08-10-036** established the CSI MASH program.
- **D.10-01-022** established the CSI Thermal program to provide solar water heating incentives statewide.
- **D.11-10-015** established the Low-income Solar water heating Component of the CSI Thermal program.
- **D.11-11-005** established the eligibility of propane-displacing technologies for the CSI Thermal program.

- **D.12-08-008** modified incentives for the CSI Thermal program.
- **D.13-02-018** established a PBI structure for the CSI Thermal program and expanded program eligibility to process heat, solar cooling, and combination systems.
- **D.13-08-004** established the eligibility of swimming pool technologies for the CSI Thermal program.
- **D.14-03-041** established a transition period pursuant to AB 327 for customers enrolled in NEM tariffs.
- **D.14-05-033** clarified existing policy that storage devices that are 1) paired with NEM-eligible generation facilities, and 2) meet the Guidebook requirements to be considered an "addition or enhancement" to NEM-eligible systems are exempt from interconnection application fees, supplemental review fees, costs for distribution upgrades, and standby charges when interconnecting under the current NEM tariffs.
- **D.15-01-027** extended the CSI MASH and SASH programs.
- **D.15-01-035** increased early-stage CSI Thermal incentives and revised the CSI Thermal customer class budgets.
- **D.15-10-004** expanded the eligibility requirements of the CSI Thermal Programs for a single-family low-income customer.
- **D.16-01-044** adopted a NEM successor tariff that continues the existing NEM structure while making adjustments to align the costs of NEM successor customers more closely with those of non-NEM customers.
- **D.16-04-020** adopted NEM Bill Credit Estimation Methodology for Generating Facilities Paired with Small Storage Devices
- **D.16-07-009** granted SCE's petition for modification of D.10-01-022 to combine CSI Thermal administrative & marketing and outreach budgets.
- **D.16-12-007** granted PG&E's petition for modification of D.10-01-022 to combine CSI Thermal administrative & marketing and outreach budgets.
- **D.17-12-022** outlined the program design for the Solar on Multifamily Affordable Housing (SOMAH) Program. The SOMAH program provides financial incentives for the installation of solar energy PV systems on multifamily affordable housing properties throughout California.
- **D.18-02-008** modified D.16-04-020 to modify the bill credit estimation methodology for NEM-eligible facilities paired with small storage.
- **D.18-06-027** established three new programs to enhance access to renewable energy for households in disadvantaged communities (DACs), including a new program focused on behind the meter solar: the DAC- Single-family Solar Homes (DAC-SASH) program. DAC-SASH is based on the SASH program and will provide incentives to install onsite solar to qualifying low-income households who reside in owner-occupied, single family homes in Disadvantaged Communities.
- **D.18-09-044** established a suite of consumer protection measures for NEM customers, including a requirement that solar providers submit a valid Contractors

State License Board (CSLB) license in order to interconnect residential solar systems on single-family homes, among other things.

- **D.19-01-030** modified D.14-05-033 to allow large NEM-eligible facilities paired with energy storage using alternating or direct current configurations to take service under a NEM tariff
- **D.19-03-015** modified D.17-12-022 to provide increased flexibility for year-to-year administrative expenditures in the implementation of SOMAH.
- **D.19-04-019** clarified that nonbypassable charges for customers on the NEM successor tariff shall be assessed on the net kilowatt-hours consumed in each metered interval.

3 Solar Projects Installed in California Through 2018

This section of the report summarizes data on the cumulative installed capacity²¹ and number of solar projects installed in California IOU territories. It also provides a table showing all customer-sited solar generation installed statewide. The IOU 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 (LADWP) or Sacramento Municipal Utility District (SMUD), nor does it include data from multi-jurisdictional utilities, such as Pacific Power’s California Solar Incentive Program (CSIP).²² However, any references to “statewide” data in this report include solar installations within POU service territories.²³

3.1 Investor-Owned Utility Territory Solar Installations

Through the end of 2018, approximately 7,228 MW of solar capacity were installed at 835,252 sites in the large IOU territories.²⁴ The solar installations included 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 FERC-

²¹ All data in this assessment are for grid-tied solar 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.

²² The CSIP is authorized to provide incentives for 4 MW of solar energy through July 1, 2015.

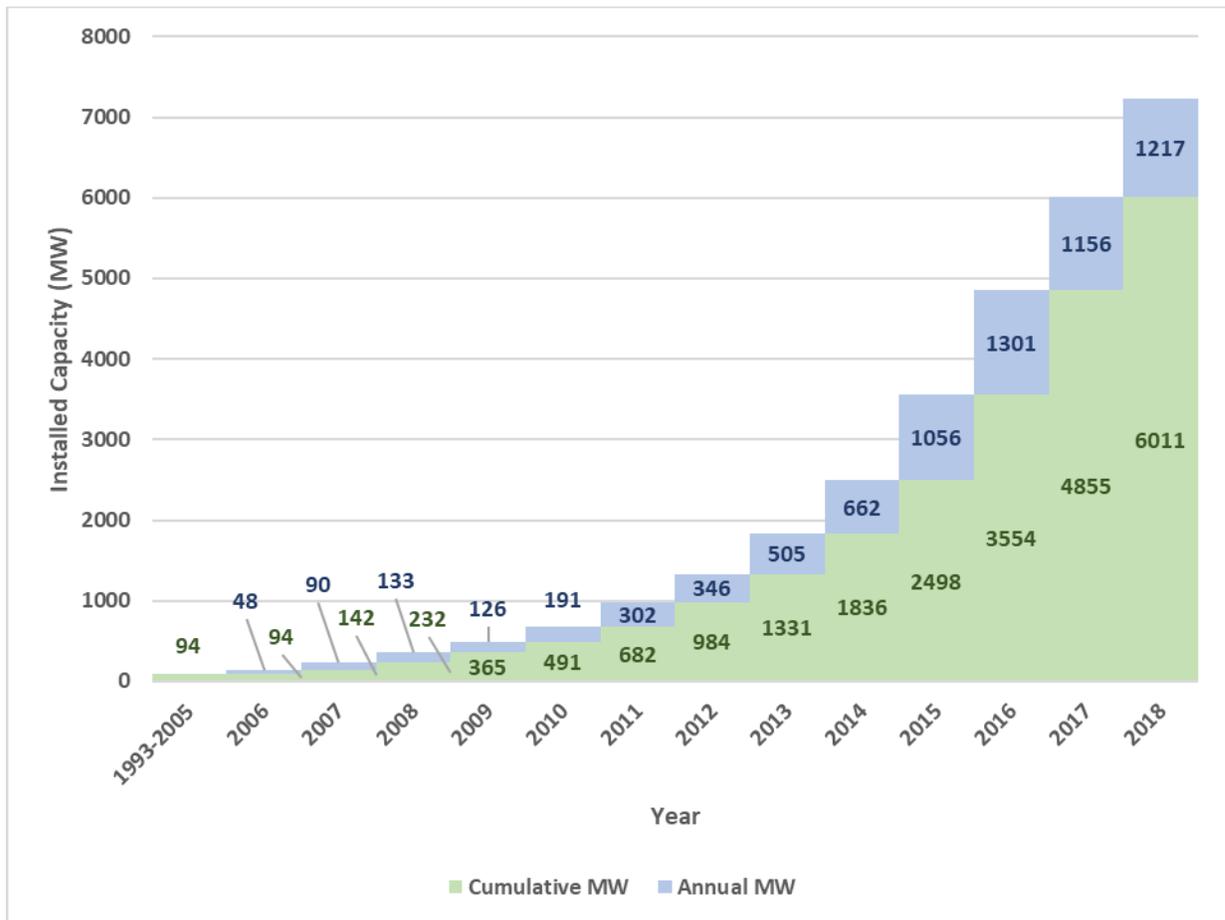
²³ Data on the POU’s customer-sited solar programs can be found on the CEC’s website at https://energyarchive.ca.gov/sb1/pou_reports/.

²⁴ Source: IOU Quarterly DG Interconnection Reports Q4 2018.

jurisdictional interconnection tariffs that participate in CAISO markets. They do not include data on installations in POU territories.

Figure 1 shows the amount of solar capacity installed by customers by year in IOU territories. In 2018, customers installed 1,217 MW of solar, a 5.2 percent increase in annual installed capacity compared to 2017.

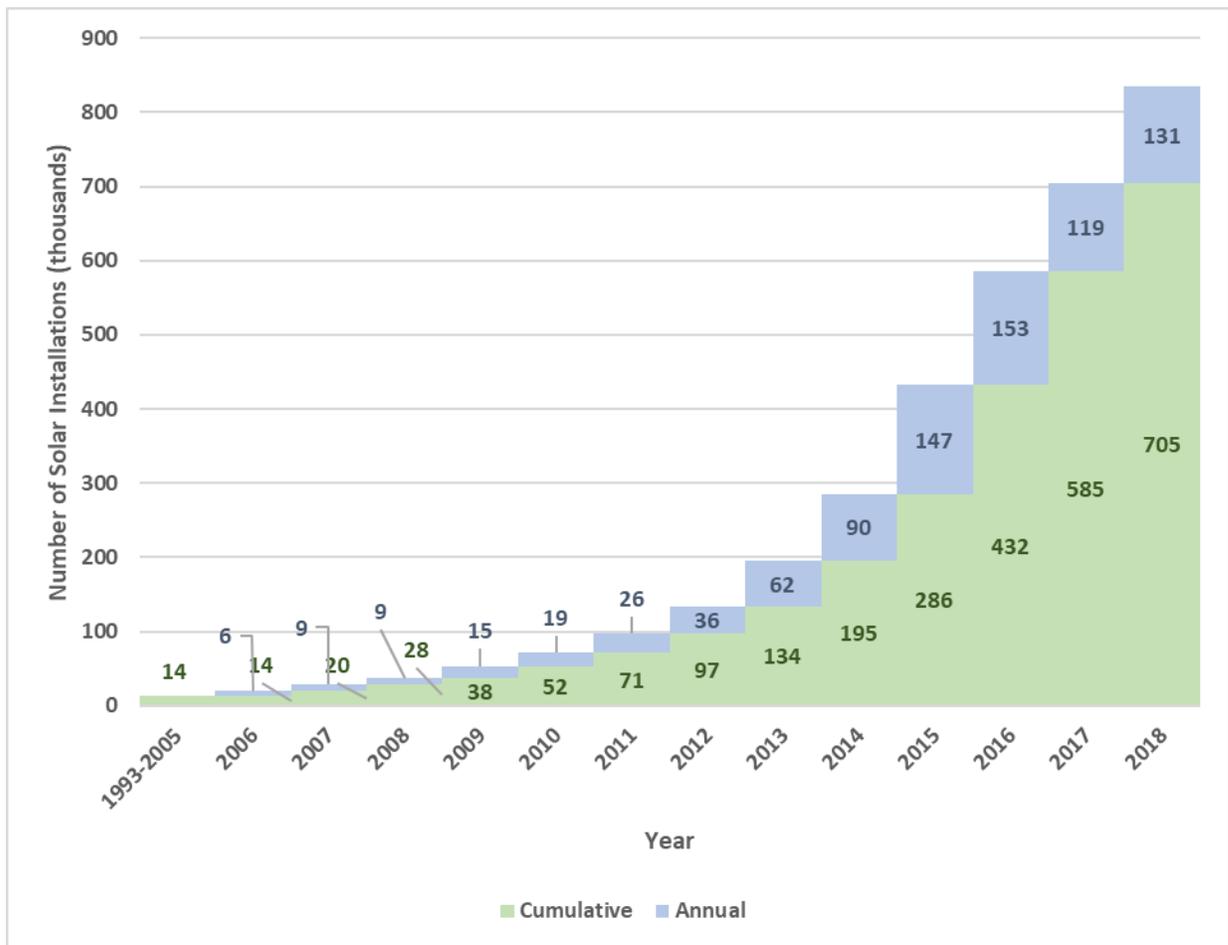
Figure 1: Customer-Sited Solar MW Installed Capacity in CA’s IOU Territories, 1993-2018 (MW)



Source: California DG Statistics NEM Currently Interconnected Data Set and Rule 21 Interconnections Dataset at (<http://californiadgstats.ca.gov/downloads>), updated December 31, 2018. 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 130,940 solar projects installed in the IOU territories in 2018, or 9.04 percent more than in 2017.

Figure 2: Number of Installed Customer-Sited Solar Projects in CA's IOU Territories, 1993-2018 (thousands)



Source: California DG Statistics NEM Currently Interconnected Data Set and Rule 21 Interconnections Dataset at (<http://californiadgstats.ca.gov/downloads>), updated December 31, 2018. 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 California Statewide Solar Installations

By the end of 2018, California had installed approximately 8,001 MW of solar capacity at 926,986 customer sites. As detailed in Table 2, this statewide solar data combines information on IOU interconnections through the end of 2018, along with data on POU solar installations through 2018. The CPUC tracks IOU interconnection data on a quarterly basis. POU solar data is collected by the California Energy Commission (CEC). The statistics shown in Table 2 provide the best available minimum estimate of California statewide solar installations.

Table 2: California Statewide Solar Installations

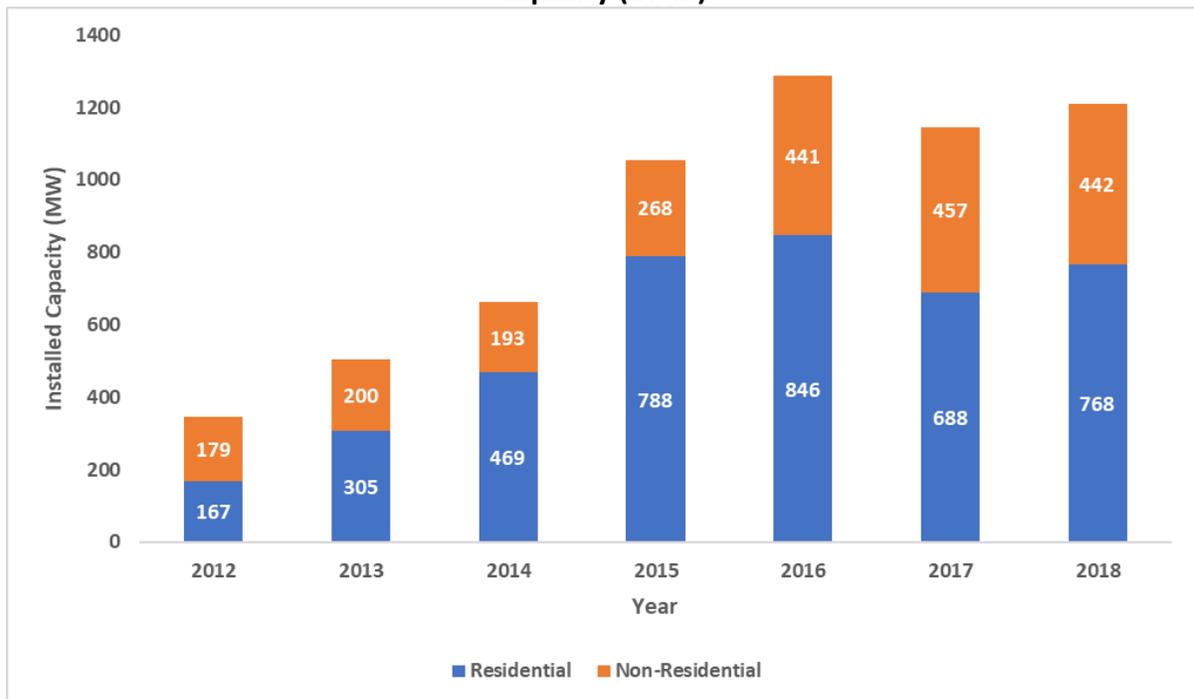
Data Source and Dates	Total MWs	Total Projects
Solar Installations in California IOU Territories		
All IOU Interconnections, 1993-2018	7,228	835,252
Solar Installations in California POU Territories		
CEC, 2008-2016	773	91,734
Total California Solar Installations	8,001	926,986

Sources: IOU Quarterly Distributed Generation (DG) Interconnection Reports Q4 2018 and Publicly Owned Utilities Report Summaries, 2008-2018 at https://www.californiadgstats.ca.gov/downloads/#_pou

3.3 California Solar Adoption Trends

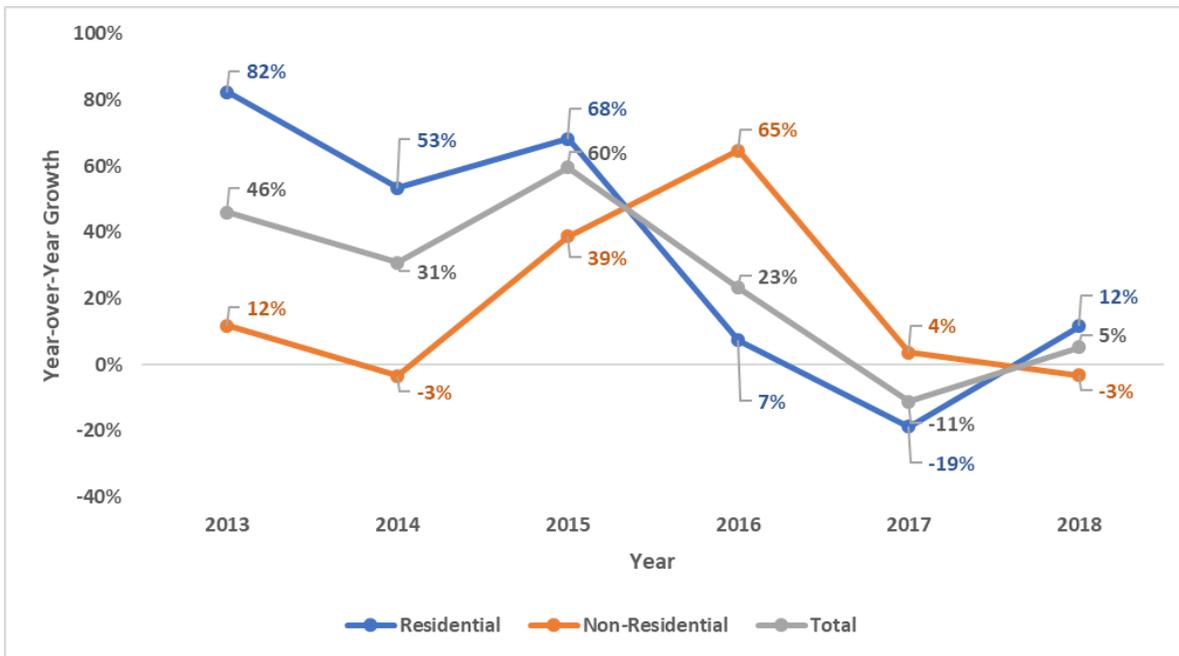
There was a marked downward trend in solar adoption in 2017. As Figure 3 and Figure 4 show, in 2017 the solar market grew at a reduced rate compared to the growth rate for the previous year for the first time since 2014. This was due to continued drops in the residential sector growth and the relatively weak growth in the commercial sector. However, 2018 demonstrated an increased growth rate compared to the 2017 growth rate, with project installations growing by 5.03 percent.

Figure 3: Customer-Sited Solar PV Annual Interconnections by Customer Class in Installed Capacity (MWs)



Source: California DG Statistics NEM Currently Interconnected Data Set and Rule 21 Interconnections Dataset at <http://californiadgstats.ca.gov/downloads>, updated December 31, 2018. Year defined by date of interconnection application approval.

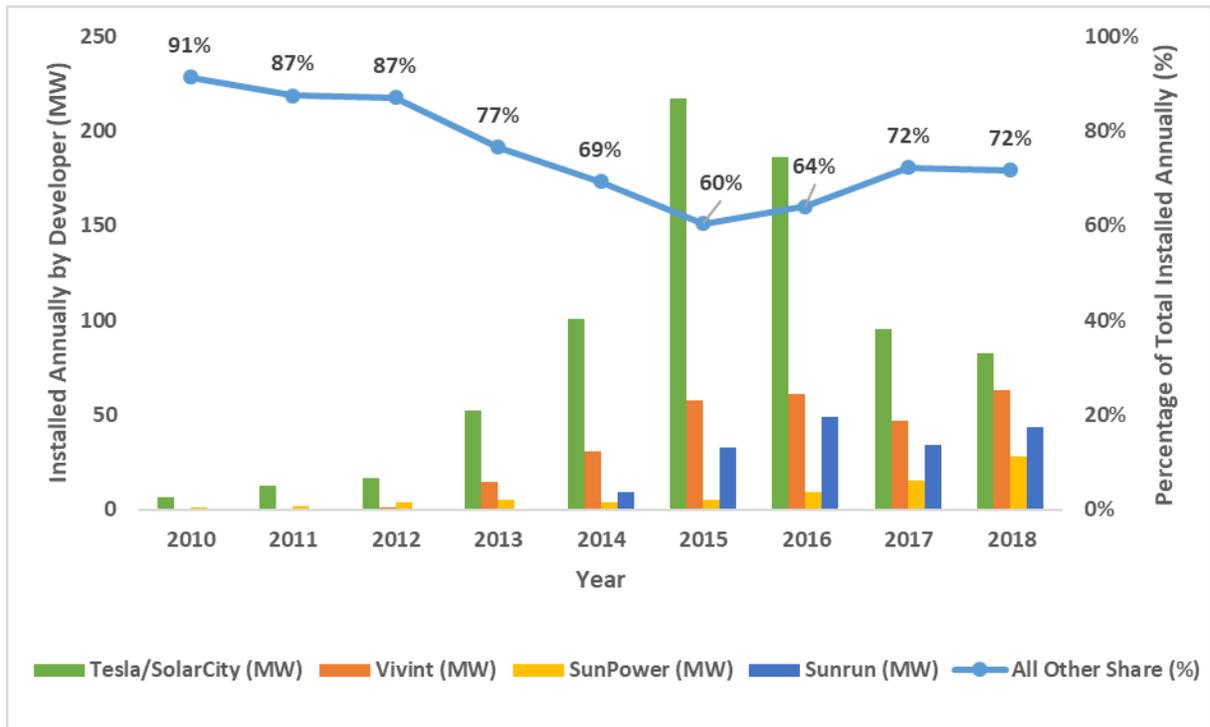
Figure 4: Customer-Sited Solar PV Growth by Customer Class Year-over-Year by Installed Capacity (MWs)



Source: California DG Statistics NEM Currently Interconnected Data Set and Rule 21 Interconnections Dataset at (<http://californiadgstats.ca.gov/downloads>), updated December 31, 2018. Year defined by date of interconnection application approval.

While residential solar experienced lower growth rates in recent years, smaller solar companies are seeing sustained growth in their market share, as compared to larger companies such as Vivint, Sunrun, SunPower, and Tesla. Figure 5 shows the upward trend in smaller companies’ market share over the past two years.

Figure 5: Residential NEM PV Systems by Installation Company



Source: California DG Statistics NEM Currently Interconnected Data Set at (<http://californiadgstats.ca.gov/downloads>), updated December 31, 2018.

3.4 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 (PU Code) Sections 2827 and 2827.1, respectively. The NEM 1.0 program supports onsite solar installations up to 1 MW in capacity designed to offset a portion, or all, of the customer’s electrical energy usage. Under NEM, 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.

3.4.1.NEM 1.0 Program Cap

Pursuant to AB 327 (Perea, 2013), every large electrical corporation is required to make a NEM tariff available to eligible customer-generators until July 1, 2017, or the date when a

utility reaches its 5 percent NEM program cap²⁵, whichever is earlier. SDG&E reached its NEM cap in June 2016, PG&E reached its NEM cap in December 2016, and SCE did not reach its cap by the July 1, 2017 deadline. Table 3 shows the large IOUs’ progress towards the 5 percent NEM program cap.

Table 3: Progress towards the 5 Percent NEM Program Cap²⁶

	5 Percent NEM Cap	Progress Toward NEM Cap
PG&E	2,409 MW	Reached December 2016
SCE	2,240 MW	Did not reach by July 2017 deadline
SDG&E	607 MW	Reached June 2016

Source: California DG Statistics NEM Currently Interconnected Data Set at (<http://californiadgstats.ca.gov/downloads>), updated December 31, 2018.

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.²⁷ 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.

3.4.2. NEM Successor Tariff

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

- NEM 2.0 customers with systems under 1 MW²⁸ will pay a pre-approved one-time interconnection fee, based on each IOU’s historic interconnection costs. The fee is \$75 - \$132 depending upon the IOU. NEM 2.0 customers with systems 1 MW and larger must pay all interconnection costs.

²⁵ The NEM program cap is reached when the total installed NEM capacity exceeds 5% of the total non-coincident peak demand of every customer within an IOU’s territory.

²⁶ The NEM program cap is reached when the total installed NEM capacity exceeds 5% of the total non-coincident peak demand of every customer within an IOU’s territory.

²⁷ See <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M089/K386/89386131.PDF>.

²⁸ 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.

- NEM 2.0 customers must pay non-bypassable charges on each kilowatt-hour (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 reaches its NEM 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.

Some solar projects, especially those that are unlikely to export generation to the electric grid, opt to take utility service under a non-NEM tariff. Table 4 shows the total solar interconnections compared to the number of interconnected systems on solar NEM 1.0 and 2.0 tariffs in IOU territories. Only 3.14 percent of customer-sited solar capacity in the state does not take service under a NEM tariff.

Table 4: Solar PV Interconnections and NEM Projects through December 31, 2018

	MW Installed			Project Count		
	Total PV	PV on NEM*	% PV not on NEM	Total PV	PV on NEM*	% PV not on NEM
PG&E	3,748	3,575	4.6%	398,066	397,684	0.096%
SCE	2,443	2,393	2.0%	293,627	293,337	0.099%
SDG&E	1,037	1,035	0.2%	143,559	143,557	0.001%
Total	7,228	7,002	3.11%	835,252	834,578	0.08%

* RES-BCT projects are included in the NEM figures for purposes of this graph.

Source: IOU Quarterly Interconnection Reports Q4 2018. Data is through December 31, 2018.

3.5 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 systems to be designed for optimal production and requiring this information be disclosed to consumers, provided 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 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 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 Decision (D.)18-09-044, which establishes a process for creating a solar information packet for consumers. The Decision also requires that solar providers upload three new documents before interconnecting a residential NEM customer to the grid in the large investor-owned utility (IOU) territories. These documents include: the solar installation contract, a signed copy of a CPUC solar information packet, and a signed copy of the CSLB Solar Disclosure Document. The remaining phase of the NEM proceeding will continue considering ways to enhance NEM consumer protections, including consideration of proposals from stakeholders regarding complaint mediation, enhanced enforcement, citation, or an administrative penalty mechanism under CPUC authority.

4 CSI Program Components

The overarching CSI program contains multiple program components, or sub-programs. These include incentive programs targeting solar electric technologies: CSI General Market, and SASH, and MASH. The CSI Thermal program provides incentives to 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, 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. Incentives were based on either the actual or expected performance of a solar system, so that higher

performing systems receive a larger incentive than lower performing systems. The CSI General Market program placed emphasis on performance to optimize California ratepayer investment in solar. In addition, consistent with the state's Energy Action Plan and "loading order", the CSI program required participants to complete energy efficiency audits before installing their systems to encourage applicants to invest in cost-effective energy efficiency measures prior to sizing their solar system.²⁹

The General Market program was divided into residential and non-residential programs and is administered by three Program Administrators: PG&E, SCE, and CSE. CSE administers the CSI program in SDG&E's service territory. The CSI General Market program has achieved a total of 1,895.6 MW of installed capacity since program inception.³⁰

On December 16, 2016, the CPUC issued Decision (D.)16-12-055 establishing a fixed program closure date of December 31, 2019 to allow for the completion of all remaining administrative tasks related to the CSI General Market program in all service territories. Although the program is closed to new applications, additional time was allotted to oversee the installation of projects with existing incentive reservations and to administer all remaining Performance Based Incentive (PBI) payments (the PBI structure is discussed in more detail in the following section).

4.1.1.1 General Market Incentive Types

Currently, the CSI General Market program is in its final stages of paying out all reserved incentives by December 31, 2019. The CSI General Market program pays solar energy system owners an incentive based on system performance. The incentives are either through an upfront lump-sum payment based on expected performance, or a monthly payment based on actual performance over two years.

The Expected Performance Based Buy-down (EPBB) incentive is the upfront lump-sum incentive and is available only for smaller (less than 30 kW) systems. The EPBB incentive is a capacity-based incentive that is adjusted based on expected system performance calculated using an EPBB calculator.³¹ The calculator considers major design characteristics of the solar energy system, such as panel type, installation tilt, shading, orientation, and solar insolation

²⁹ 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.

³⁰ California Solar Statistics – Program Totals, at https://www.californiasolarstatistics.ca.gov/reports/agency_stats/.

³¹ The EPBB calculator is publicly available at <http://www.csi-epbb.com/>.

available by location. The average reserved incentive for EPBB systems from the beginning of the CSI program to date was \$5,129.³²

The Performance Based Incentive (PBI), which is paid out based on actual measured performance of a solar energy system over the course of two years. The PBI is paid on a fixed dollar per kilowatt-hour (\$/kWh) of generation basis and is the required incentive type for larger systems, although smaller systems may opt to be paid based on PBI. Beginning in January 2010, all systems 30 kW and larger have been required to take the PBI incentive. Because PBI systems are large solar arrays that primarily serve commercial and institutional customers, cumulative payments to PBI system owners sometimes exceed one million dollars per project. The average reserved incentive for PBI systems from the beginning of the CSI program to date was \$291,815.³³

4.1.1.2 General Market Incentive Level Design

The CSI program’s financial incentives declined in steps as more capacity was installed. The declining incentives, required by PU Code Section 2851, were intended to help the program meet its goal of creating a self-sustaining solar industry by reducing rebates as the solar industry grows. Each step had an installed MW target that triggered the subsequent step down in incentive level. The capacity targets per incentive step were further broken down into allocations across customer type and across the three IOU service territories. Table 5 presents the rebate levels by incentive step, rebate type (EPBB or PBI), and customer sector. It is worth noting that the EPBB rebates in step 10 for residential and commercial were less than 5 percent of the average system installation cost.

³² Source: California Solar Statistics - CSI Working Data Set at https://www.californiasolarstatistics.ca.gov/data_downloads/. Data updated May 30, 2019. Calculation includes only projects reported as “Completed.”

³³ Source: California Solar Statistics - CSI Working Data Set at https://www.californiasolarstatistics.ca.gov/data_downloads/. Data updated May 30, 2019. Calculation includes only projects reported as “Completed.”

Table 5: CSI Rebate Levels by Incentive Step and Rebate Type

Step	Statewide MW in Step	EPBB Payments (per Watt)			PBI Payments (per kWh)		
		Residential	Non-Residential		Residential	Non-Residential	
			Commercial	Government/ Non-Profit		Commercial	Government/ Non-Profit
1	50	n/a	n/a	n/a	n/a	n/a	n/a
2	70	\$2.50	\$2.50	\$3.25	\$0.39	\$0.39	\$0.50
3	100	\$2.20	\$2.20	\$2.95	\$0.34	\$0.34	\$0.46
4	130	\$1.90	\$1.90	\$2.65	\$0.26	\$0.26	\$0.37
5	160	\$1.55	\$1.55	\$2.30	\$0.22	\$0.22	\$0.32
6	190	\$1.10	\$1.10	\$1.85	\$0.15	\$0.15	\$0.26
7	215	\$0.65	\$0.65	\$1.40	\$0.09	\$0.09	\$0.19
8**	250	\$0.35	\$0.35	\$1.10	\$0.05 (a)/\$0.044 (b)	\$0.05 (a)/\$0.044 (b)	\$0.15 (a)/\$0.139 (b)
9**	285	\$0.25	\$0.25	\$0.90	\$0.03 (a)/\$0.032 (b)	\$0.03 (a)/\$0.032 (b)	\$0.12 (a)/\$0.114 (b)
10**	350	\$0.20	\$0.20	\$0.70	\$0.025	\$0.025	\$0.088

*The non-residential customer class includes commercial, private, government, and non-profit participants.

**Per Senate Bill 585, PBI payments have been revised to reflect a 4% discount rate which creates new PBI rates for Steps 8, 9, & 10. Steps 8a and 9a are the original CSI incentive rates, while 8b and 9b are the revised rates. In compliance with the Final Decision released by the California Public Utilities Commission, these new incentive rates are effective 12/2/2011.

Table 6 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 have varied due to dropouts and other factors.

Table 6: 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
5	160	23.1	46.8	24.3	49.3	5.4	11
6	190	27.4	55.6	28.8	58.6	6.5	13.1
7	215	31	62.9	32.6	66.3	7.3	14.8
8	250	36.1	73.2	38	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. Once the MW capacity in step 10 has been reserved, the program closes or the program administrator can elect to open a waitlist.

4.1.2. General Market Program Progress

All six General Market customer classes have exceeded their capacity targets. Table 7 denotes the amount of MW that are either actively reserved or completed in each step and will be paid out at the given incentive level, compared to the original number of MW allocated to the step set by CPUC Decision (D.)06-12-033. The "Actual" MW numbers are equal to the "Original" MW numbers minus dropouts from previous steps.

Table 7: Incentive MW Available by Step, by 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 (SGIP) Program in 2006.

As Table 8 shows, the CSI General Market program did not approve any applications after 2016.

Table 8: CSI General Market Applications Received by Year (MW)

Year	Annual Stats - Capacity (MW)		
	Non-Residential	Residential	Total
2006	18.4	0	18.4
2007	104.5	30	134.5
2008	65.1	43.2	108.3
2009	88.5	63.6	152.1
2010	270.8	90.6	361.4

2011	121.9	101	222.9
2012	129.9	165.7	295.6
2013	124.4	167.8	292.2
2014	193	31.4	224.4
2015	54.4	2.6	57
2016	34	0.7	34.7
2017	0	0	0

Source: California Solar Statistics – Monthly, Quarterly, and Annual Statistics, data accessed April 29, 2019, data current as of May 30, 2019 (https://www.californiasolarstatistics.ca.gov/reports/monthly_stats/).

There are many ways to measure the progress of the CSI General Market program, including progress towards the two stated goals of the program: 1) Install 1,750 MW of solar PV capacity; and 2) Transform the market for solar to be price-competitive and sustainable. This section reports on the installations, pending and complete; the solar price trends; program participation rates; and program budgets, as well as the program’s effect on the transformation of the solar market. The CSI Measurement and Evaluation (M&E) program component performs more detailed analyses, including cost benefit analyses, impact analyses, and other studies intended to help understand and improve the program’s performance.³⁴

4.1.2.1 General Market Program Trends

Several trends have emerged since the CSI program’s inception in 2007, suggesting that the program has substantially reached its goal of stimulating widespread adoption of solar and creating a self-sustaining market, free of direct cost-support in the form of program rebates.

4.1.2.1.1 Average System Costs for Program Participants

Between 2007 and the end of 2018, the average cost of installed systems below 10 kW has decreased 52.6 percent from \$9.61 per watt to \$4.55 per watt. In the same time period, the cost of systems with greater than or equal to 10 kW of capacity decreased 60.1 percent from an average of \$9.46 per watt to \$3.72 per watt.^{35, 36}

4.1.2.1.2 Solar Installations Outside the CSI Program

³⁴ All CSI Program Measurement and Evaluation reports are available at <http://www.cpuc.ca.gov/General.aspx?id=7623>.

³⁵ California DG Statistics at <http://www.californiadgstats.ca.gov/charts/>.

³⁶ System prices are quoted in nominal terms.

As the CSI General Market incentives were exhausted by 2015, a significant portion of customer-sited solar projects have interconnected through the NEM tariff in the three large IOU territories without participating in the CSI program.³⁷ Table 9 below shows that almost all customer-sited solar projects interconnected in 2017 and 2018 did not receive CSI incentives.

Table 9: Solar PV Capacity Installed in 2017 and 2018: CSI vs. Non-CSI

	MW Installed in 2017			MW Installed in 2018		
	CSI	All PV	% Installations not receiving CSI rebates	CSI	All PV	% Installations not receiving CSI rebates
PG&E	2	688	99.7%	0	657	100%
SCE	41	429	90.4%	18	409	95.6%
SDG&E	5	145	96.6%	1	188	99.5%
Total	48	1262		19	1,254	

Source: <https://www.californiadgstats.ca.gov/charts/csi>, accessed April 29, 2019; IOU Q1 2019 Quarterly DG Interconnection Reports

4.1.2.1.3 2018 Solar PV Market Trends

To understand more recent market trends in the behind-the-meter solar PV sector, it is helpful to examine installation rates during the prior years. Statewide solar installations continued to increase in 2016 despite the lack of available CSI General Market incentives, suggesting that the CSI program’s use of declining incentive levels as the market matured was successful. In the final CSI incentive steps, NEM and the Federal ITC provided a much greater level of financial support to solar projects than the CSI incentives. As Figure 2 in the earlier section above showed, although CSI General Market incentives were exhausted in 2013-2014 across all IOU territories, solar installations continued to grow year-over-year through 2016.

4.1.2.1.4 CSI Program Impact on Solar PV Market Transformation

One of the goals of the CSI program is 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 will be sustainable after the CSI General Market sunset.³⁸ The study, released in April 2014, found:

³⁷ Note: Participation in the CSI Program is not a requirement for customers installing solar energy systems.

³⁸ See <http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=7699>.

- The customer-side solar PV market has shown 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 will depend on NEM 2.0 regulation and the retail rate reform process that was under consideration before the CPUC in 2014 and 2015.

The CPUC subsequently adopted a NEM 2.0 policy in January 2016. The new policy retained most of the elements of the original NEM policy, with adjustments to require customers to pay a small interconnection fee, non-bypassable charges assessed on all energy consumed from the grid, and a requirement that residential customers go on a time-of-use rate. The CPUC found that continuing NEM with these changes is likely to allow customer-sited renewable DG to continue to grow sustainably. NEM 2.0 is currently in effect in all three major IOU service territories.

4.2 CSI Low-Income PV Solar Programs

4.2.1 Single-Family Affordable Solar Homes (SASH) Program

4.2.1.1 SASH Program Background

The SASH program, one of the two low-income components of the CSI program, provides incentives for solar PV systems for eligible low-income homeowners. The CPUC approved the SASH program in November 2007 in Decision (D.)07-11-047 as part of the CSI program. GRID Alternatives (GRID) was selected as the statewide Program Manager for the SASH program.³⁹ 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.⁴⁰

³⁹ 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 Alternatives was selected through a competitive solicitation process.

⁴⁰ For more information about the SASH Program, including GRID’s latest quarterly program status report, see: (<http://www.cpuc.ca.gov/general.aspx?id=3043>). For more details on the SASH program’s rules and requirements, see Appendix D to the CSI Handbook, available at: (<http://www.cpuc.ca.gov/workarea/downloadasset.aspx?id=4585>).

In January 2015, pursuant to AB 217, the CPUC reauthorized the SASH program in Decision (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 is reauthorized through 2021, or until all available incentives are encumbered, whichever occurs first. The reauthorized SASH program opened in May 2015.

The SASH program is designed to be a comprehensive low-income solar program. In addition to providing incentives, SASH is structured to promote or provide energy efficiency services, workforce development and green jobs training opportunities, and broad community engagement with low-income communities. To achieve this, the SASH program provides consumer education on solar and energy efficiency technologies to the diverse volunteer base that contributes 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-contracts 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, SASH 1.0 incentive funding is fully encumbered in all three IOU service territories and the program has moved on to issuing incentive reservations and payments under SASH 2.0. PG&E and SDG&E transitioned to SASH 2.0 in January 2015 and SCE transitioned in October 2015.

4.2.1.1.1 *SASH Program Budget*

The SASH 1.0 budget was \$108.3 million, allocated according to the information in Table 10 and Table 11.

Table 10: SASH 1.0 Budget Allocations by IOU Service Territory

Utility	PG&E	SCE	SDG&E	Total
Percentage	43.7%	46%	10.3%	100%
Total Budget (millions)	\$47.3	\$49.8	\$11.2	\$108.3

Source: D.07-11-045

Table 11: 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 is \$54 million, allocated according to the information in Table 12 and Table 13.

Table 12: SASH 2.0 Budget Allocations by IOU Service Territory

Utility	PG&E	SCE	SDG&E	Total
Percentage	43.7%	46%	10.3%	100%
Total Budget (millions)	\$23.6	\$24.84	\$5.56	\$54

Source: D.15-01-027

Table 13: 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

4.2.1.1.2 SASH Program Eligibility

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

4.2.1.1.3 SASH Program Incentives

The SASH incentives are higher than the CSI General Market program on a dollar per watt basis. The SASH 1.0 incentives varied depending on the household’s income level and

eligibility for the CARE⁴¹ program. The SASH 2.0 incentives are set at the same level for all SASH customers. The SASH 1.0 and 2.0 incentive rates do 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 compared 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 to the SASH participants. The SASH TPO model has been deliberately designed to maximize household savings and include ironclad consumer protection measures as required in Decision (D.)15-01-027.⁴² Through this unique “families-first” TPO model, GRID is able to leverage the Federal Investment Tax Credit (ITC) 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 is playing a significant role in funding SASH 2.0 projects. Of the 2,832 SASH 2.0 projects completed through the end of 2018, nearly 2,200 are third-party owned, or over 80 percent of all capacity installed under SASH 2.0.⁴³

4.2.1.2 SASH Program Progress

Since the SASH program launched in 2008, it has 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.

⁴¹ CARE provides a minimum 20 percent discount on the energy bills of qualifying low-income customers.

⁴² 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 <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M145/K938/145938475.PDF>.

⁴³ SASH Program data as of the end of 2018 available at: <http://www.cpuc.ca.gov/general.aspx?id=3043>

Under SASH 1.0, a total of 5,266 projects and over 16 MW have been installed on eligible homes, and 100 percent of the available \$92 million SASH 1.0 incentive budget has been encumbered.⁴⁴ As of December 31, 2018, SASH 2.0 has completed a total of 2,962 projects, resulting in 9.18 MW of installed capacity, with another 0.61 MW currently in progress. These applicants have received or reserved over \$29.4 million of the available \$46 million SASH 2.0 incentive budget for their residential solar systems.⁴⁵

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 through general non-profit fundraising. Since the SASH incentive does not cover 100 percent of installation costs and individual homeowners are largely unable to fund the additional incremental costs, identifying gap financing from third-party sources was critical to achieving the long-term goals of SASH. As mentioned previously, the approved TPO model will continue to play a key role in funding SASH 2.0 projects.

Between 2006 and 2018, the SASH program paid an average of \$4.74 in incentives per watt installed.⁴⁶ The General Market program paid an average of \$1.02 per watt installed until the program closed in 2016.⁴⁷

4.2.1.2.1 SASH Workforce Development Efforts

The SASH program is uniquely structured to provide workforce development and job-training opportunities at every installation. In implementing the SASH program, GRID provides opportunities for job trainees and local volunteers to assist with installations, engage their communities, and participate in solar and energy efficiency programs. These volunteer and job-training opportunities help strengthen 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.

GRID partners with more than 90 California job-training programs to incorporate GRID's volunteer-based installation projects into their construction training curricula. GRID dedicates approximately 20 percent of its internal 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 come from the same neighborhoods that the SASH Program aims to serve. GRID Alternatives has created

⁴⁴ SASH Program data as of December 31, 2018 available at: <http://www.cpuc.ca.gov/general.aspx?id=3043>

⁴⁵ SASH Program data as of December 31, 2018 available at: <http://www.cpuc.ca.gov/general.aspx?id=3043>

⁴⁶ SASH Program data as of December 31, 2018 available at: <http://www.cpuc.ca.gov/general.aspx?id=3043>

⁴⁷ California DG Stats California Solar Initiative Statistics and Charts <http://www.californiadgstats.ca.gov/charts/csi>

over 74,500 installation workday positions for volunteers in CA since the inception of the SASH program through 2018, and over 16,500 of these positions have been filled by groups of students from CA job training programs.⁴⁸

SASH continues its workforce development efforts under SASH 2.0, with additional data collection and reporting requirements associated with the SASH 2.0 program.

Under both SASH 1.0 and SASH 2.0, the SASH Sub-contractor Partnership Program (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 only one eligible job trainee per installation, over 17 percent of SASH SPP projects have exceeded this expectation by having more two or even three trainees work on the SASH installations. Through 2018, over 52 CA contractors have installed projects under the SASH SPP model, and the SPP program has created 2,255 paid workday opportunities for 247 recent graduates of job-training programs.

4.2.2. Multifamily Affordable Solar Housing (MASH) Program

4.2.2.1 MASH Program Background

The second low-income solar program in the CSI Program targets affordable multifamily housing. In October 2008, the CPUC adopted Decision (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 PU Code Section 2852.⁴⁹ The MASH program was designed to operate until January 1, 2016, or until all funds available from the program's incentive budget were allocated, whichever event occurred first.

In January 2015, pursuant to AB 217, the CPUC reauthorized the MASH program through Decision (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 is reauthorized through 2021, or until all available incentives are encumbered, whichever occurs first.

The goals of the MASH program are to: (a) Stimulate adoption of solar power in the affordable housing sector; (b) Improve energy utilization and overall quality of affordable

⁴⁸ 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.

⁴⁹ D.08-10-036, Appendix A, *mimeo.*, p. 1

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.

As of December 31, 2018, PG&E, SCE and CSE are fully subscribed within each respective service territory, and their waitlists are currently closed to new applications.

4.2.2.1.1 MASH Program Budget

The MASH 1.0 budget was \$108.3 million, allocated according to the information in Table 14 and Table 15.

Table 14: 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	\$108.34

Source: D.08-10-036.

Table 15: 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 16 and Table 17.

Table 16: MASH 2.0 Budget Allocations by IOU Service Territory

Utility	PG&E	SCE	SDG&E	Total
Percentage	43.7%	46%	10.3%	100%
Total Budget (millions)	\$23.6	\$24.84	\$5.56	\$54

Source: D.15-01-027

Table 17: 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

4.2.2.1.2 MASH Program Eligibility

The MASH program is open to multifamily affordable housing properties that meet the definition of “low-income residential housing” per PU 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 VNEM tariffs, as described in the VNEM section below.

In implementing the new energy efficiency and job training policy requirements of AB 217, 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 to up to five trainees per MASH system installation.

4.2.2.1.3 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 18 below displays the MASH 2.0 incentive tracks, 1C and 1D, and the eligibility requirements for MASH 2.0.

Table 18: MASH 2.0 Incentive Tracks

Track	Incentive Amount	Eligibility Requirements
<p>1C: PV System Offsetting Common Area Load, Non-VNEM Tenant Load, or VNEM Tenant Load with <50 percent Tenant Benefit</p>	<p>\$1.10/watt</p>	<ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> ○ Common Area Load ○ Non-VNEM Tenant Load ○ VNEM Tenant Load where tenant receives less than 50 percent of economic benefit of allocated generation
<p>1D: PV System Offsetting VNEM Tenant Load with ≥50 percent Tenant Benefit</p>	<p>\$1.80/watt</p>	<ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> ○ VNEM Tenant Load where tenant receives at least 50 percent of economic benefit of allocated generation

4.2.2.2 MASH Program Progress and Project Attributes

Since the MASH incentives are fully subscribed, the progress of the program has been measured in terms of reserved projects reaching completion and waitlisted projects being brought into the incentive reservation queue when additional funds are made available via system resizing and project dropouts. As of December 31, 2018, PG&E, SCE and CSE are fully subscribed within each respective service territory, and their waitlists are currently closed to new applications.

To date, MASH 1.0 has completed 379 projects, representing 27.4 MW of installed capacity.

To date, 101 projects representing 14.4 MW of capacity have been completed under MASH 2.0. There are an additional 140 MASH 2.0 applications, representing 17.9 MW currently under review.⁵⁰

Table 19: MASH Program Progress

Status of Application		Total	CSE	PG&E	SCE
MASH 1.0 Completed	Number	379	41	191	147
	Capacity (MW)	27.4	2.6	11.3	13.5
MASH 1.0 Pending	Number	0	0	0	0
	Capacity (MW)	0	0	0	0
MASH 2.0 Completed	Number	101	18	44	39
	Capacity (MW)	14.4	2.9	5.0	6.5
MASH 2.0 Pending	Number	140	5	84	51
	Capacity (MW)	17.9	1.0	8.6	8.3

Source: CSI Low-Income Solar PV working data set as of December 31, 2018. All system capacity measured in CEC-AC PTC MW.

Between 2006 and 2018, the MASH program paid an average of \$3,347 in incentives per kilowatt installed. The General Market program paid an average of \$965 per kilowatt installed over the same period.⁵¹

⁵⁰ Data as of December 31, 2018 from California DG Stats Low-Income Solar PV Data Set available at: <http://www.californiadgstats.ca.gov/downloads/>

⁵¹ California DG Stats – Low-Income Solar PV Statistics and Charts (<http://www.californiadgstats.ca.gov/charts/li>) and California Solar Initiative Statistics and Charts (<http://www.californiadgstats.ca.gov/charts/csi>). Installed capacity based on CEC PTC Rating.

4.2.3. Summary of CSI Low-Income Program Participation

Table 20: Summary of CSI Low-Income Program Participation

Program	Number of Completed Projects ⁵²	Total Paid Incentives (\$ millions)	Total Installed Capacity (MW)
SASH 1.0	5266	92.08	16
SASH 2.0	2962	27.55	9.2
MASH 1.0	379	86.82	27.4
MASH 2.0	101	17.85	14.4
Total	8708	224.3	67

Source: CSI Low-Income Solar PV working data set as of December 31, 2018; SASH Program data as of December 31, 2018 available at: <http://www.cpuc.ca.gov/general.aspx?id=3043>. All system capacity measured in CEC-AC PTC MW.

4.3 Virtual Net 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 2008.⁵³

Under VNEM, the utility meters the PV system's output, then allocates energy credits for the energy produced by the PV system 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 original intent of VNEM was to help low-income multifamily residents receive direct benefits of a building's solar system under VNEM.

Based on the merits of these tariffs, the CPUC expanded VNEM to all multi-tenant, multi-meter properties in 2011 and included all NEM-eligible technologies for eligibility. As of the end of 2018, in PG&E, SCE, and SDG&E's service territory there were 404 projects with a total of nearly 22 MW of solar capacity on the VNEM tariff who are not participants in the MASH program.

Table 21: VNEM Projects Outside of the MASH Program by Utility Territory through 2018

Utility	PG&E	SCE	SDG&E	Total
VNEM Projects outside of MASH Program	239	36	129	404

⁵² Figures represent only completed projects and do not include pending applications.

⁵³ Commission Decision (D.)08-10-036

Total Capacity (kW, CEC-AC)	12,000	1,212	8,714	21,926
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Source: Data request to IOUs, May 2019.

4.4 Other Behind the Meter PV Solar Programs

4.4.1. Solar on Multifamily Affordable Housing (SOMAH) Program

Assembly Bill (AB) 693 (Eggman), Stats. 2015, ch. 582, established the Multifamily Affordable Housing Solar Roofs Program, with up to \$100,000,000 annually in funding from shares of greenhouse gas (GHG) allowance auction proceeds from PG&E, SDG&E, SCE, Liberty Utilities Company, and PacifiCorp (collectively the investor-owned utilities or IOUs). The program will provide incentives for the installation of solar distributed generation projects sited on existing multifamily affordable housing.

On December 22, 2017, the Commission issued Decision (D.)17-12-022 establishing the Solar on Multifamily Affordable Housing (SOMAH) Program. The SOMAH Program, while similar to the MASH program, is a new program, and was established to provide upfront incentives to install 300 MW of solar on multifamily affordable housing in the service territories of IOUs by 2030. Pursuant to direction in the authorizing decision, a competitive solicitation for a statewide program administrator was held and a team consisting of the Center for Sustainable Energy (CSE), GRID Alternatives (GRID), the Association for Energy Affordability (AEA), and the California Housing Partnership Corporation (CHPC) was selected.

SOMAH provides fixed, up front, capacity-based incentives for qualifying solar energy systems, using the Expected Performance Based Buydown (EPBB) methodology. The EPBB incentive is paid based on verified solar energy system characteristics such as location, system size, shading, and orientation. The amount of the incentive for SOMAH 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) and Low-income Housing Tax Credits (LIHTC).

At least 51 percent of the system's electric output must directly offset tenant load and be provided to tenants in the form of virtual net energy metering (VNEM) bill credits. The incentive levels will be reduced annually (starting 12 months after the program launch date) by either five percent or based on the National Renewable Energy Lab's cost analysis (whichever is less). Incentive levels may be re-assessed by the Commission at the program

evaluation in 2020 and may be modified at that time. Table 21 below details the current SOMAH incentive levels

Table 22: SOMAH Program Incentive Rate by Tax Credit Funding and Tenant/Common Area Allocation

Tax Credits		\$ per AC Watt Incentive	
ITC	LIHTC	Tenant	Common
No	No	\$3.20	\$1.10
Yes	No	\$2.25	\$0.80
No	Yes	\$2.25	\$0.80
Yes	Yes	\$1.60	\$0.60

Source: D.17-12-022

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-4987.⁵⁴ The SOMAH Program is scheduled to begin accepting program applications by Q3 2019.

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

As solar adoption and investment have increased throughout the state, participation in disadvantaged communities (DACs) have lagged behind. To address this gap, Assembly Bill (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 Decision (D.)18-06-027 Adopting Alternatives to Promote Solar Distributed Generation in Disadvantaged Communities, which created three new programs to improve access to renewable generation for residential customers in DACs, pursuant to AB 327. Decision (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 that score among the highest five percent of CalEnviroScreen’s Pollution Burden category. Of the three programs created, one is related

⁵⁴ Resolution E-4987: <http://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&DocID=279170414>

to behind the meter solar: the DAC Single-family Solar Homes (DAC-SASH) program. In contrast, the DAC-Green Tariff (DAC-GT) and Community Solar Green Tariff (CSGT) programs enable eligible customers to enroll in rates that provide them 100% renewable energy and are thus distinct from CSI-type programs. The Decision 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.

The DAC-SASH program is based on the SASH program and will provide 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 so long as it complies with the Minimum Consumer Protection Standards established for SASH.⁵⁵ Unlike SASH, DAC-SASH does not require participants to live in low-income housing as defined in PU Code Section 2852. Instead, DAC-SASH participants must be eligible for either the 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 Decision (D.)18-06-027.

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

Table 23: DAC-SASH Budget Allocations by IOU Service Territory

Utility	PG&E	SCE	SDG&E	Total
Percentage	43.7%	46%	10.3%	100%
Total Budget 2019-2030 (millions)	\$52.44	\$55.20	\$12.36	\$120

Source: D.18-06-027

Table 24: 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

⁵⁵ 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 <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M145/K938/145938475.PDF>.

As required in Decision (D.)18-06-027, the Program Administrator (PA) for DAC-SASH was selected through a competitive solicitation. GRID Alternatives was selected as the PA for DAC-SASH in February 2019. The DAC-SASH program will officially launch after the DAC-SASH Handbook and Program Implementation Plan are reviewed and approved by the CPUC, anticipated by Fall 2019.

4.5 CSI Thermal Program

4.5.1.CSI Thermal Program Background and Overview

The CSI Thermal program is an incentive program for solar thermal technologies that displace natural gas consumption. The CSI Thermal program was originally established by legislative language in SB 1, 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 later 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 Decision (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 provides higher incentives for low-income residences, began accepting applications. In 2013, the CPUC issued two decisions authorizing new incentives. Decision (D.)13-02-018 allowed incentives for process heating and cooling, and for space heating. Decision (D.)13-08-004 allowed incentives for swimming pools at multifamily and commercial sites. Subsequently, Decision (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 temporary higher incentives for the installation of solar water heating systems to address the need to reduce natural gas use in the Aliso Canyon natural gas leak-impacted region. 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.⁵⁶ 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 will not exceed the initial \$250 million ceiling, AB 797 mandates the allocation of 50% of the CSI Thermal budget to low-income residential housing or buildings in disadvantaged communities (DACs)⁵⁷. Another 10% of the budget is reserved for industrial applications, larger projects that, in general, use process heating to produce basic commodities and materials. As of December 31, 2018, the CSI Thermal incentive budget available for the program extension through July 2020 equaled \$76.5 million.

Additionally, AB 797 allows for the expansion of 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 currently rely on propane or wood burning to fulfill their space heating, water heating, and cooking needs.

Incentives for natural gas-displacing systems come from 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. Per legislative direction, the CPUC has established two primary program elements corresponding to the type of water heating fuel being displaced by solar technologies. The CSI Thermal program consists of:

- 1) Incentives for natural gas-displacing systems (including swimming pools);
- 2) Incentives for natural gas-displacing systems serving low-income customers and DACs;⁵⁸
- 3) Incentives for industrial process heat natural gas-displacing systems.

⁵⁶ For more information, please consult the CSI Thermal Program Incentives webpage on the CPUC website at <http://www.cpuc.ca.gov/General.aspx?id=3785>.

⁵⁷ The CSI Thermal program defines disadvantaged communities as a community identified by the California Environmental Protection Agency (CalEPA) pursuant to Section 39711 of the Health and Safety Code.

⁵⁸ This category includes the exception provided for communities lacking access to natural gas in the San Joaquin Valley, as identified by the Commission pursuant to paragraph (1) of subdivision (a) of Public Utilities Code 783.5.

The four Program Administrators (PA) of the CSI Thermal program are: PG&E, SoCalGas, SCE,⁵⁹ and CSE (on behalf of SDG&E).

4.5.2.CSI Thermal Budget

4.5.2.1 Natural Gas-Displacing Program

For the natural gas-displacing portion of the program, the \$250 million program budget will be collected during the duration of the program by the three gas IOUs based on the percentages presented in Table 24.

Table 25: CSI Thermal Gas-Displacing Budget Allocation

Utility	Budget Allocation	Total Program Collections (in 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 has access to the remainder of their original budget allocations as of December 31, 2017, which is then adjusted based on program revisions mandated by AB 797. Table 25 displays each PA’s budget for natural gas-displacing solar thermal systems as of December 31, 2017.

Table 26: CSI Thermal Gas-Displacing 2018-2020 Incentive Budget Allocation

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

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

Table 26 shows funds available for program administration and market outreach activities plus the specific budget reallocations pursuant to AB 797 that shift 50 percent of program

⁵⁹ 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.

funds to the Low-Income program and 10 percent to the Industrial sector.

Table 27: CSI Thermal Gas-Displacing Overall Program Budget, 2018-2020

CSI Thermal Program Elements	CSI Thermal Program Sub-Elements	Budget (\$)
Incentives (82%)	General Market	\$22,189,000
	Low-income/DAC (50% of total funds)	\$50,429,000
	Industrial (10% of total funds)	\$10,085,000
	Subtotal	\$82,703,000
Program Administration/Market Facilitation (18%)	General Administration	\$6,051,000
	Marketing and Outreach	\$10,086,000
	Measurement and Evaluation	\$2,017,000
	Subtotal	\$18,154,000
Total		\$100,857,000

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

4.5.2.2 Low-income (Natural Gas-Displacing) Program

During the program extension years, 2018-2020, the low-income program allocates 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 27.

Table 28: CSI Thermal Low-income Program 2018-2020 Budget Allocation

Utility	Total Program Collections (in 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/CSE AL 88-A

4.5.2.3 CSI Thermal Natural Gas-Displacing Program Incentives

For systems that displace natural gas, incentives are available for three different market segments (or customer classes): single-family, commercial/multifamily, and commercial and multifamily solar pool heating. Given all budget categories remain at step 1 due to low

program participation rates and that there are roughly two years left in the program, the CPUC approved an advice letter collapsing all incentives steps from four to two tiers in May 2018.⁶⁰ For the single-family market, the average system rebate starts at \$3,493 in step one and declines over two steps to an average of \$2,968. Commercial / multifamily systems are incentivized at a slightly lower rate, and solar pool heating systems are incentivized at substantially lower rates due to favorable project economics. Pursuant to Decision (D.)15-01-035, all customer classes have maximum system incentive caps.⁶¹ Incentive levels decline when the total incentive budget for a step has been 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 AB 797 mandates.⁶²

⁶⁰ 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.

⁶¹ The single-family system maximum incentive level is set to 125% 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% of total project costs up to \$500,000.

⁶² SoCalGas Advice Letter No. 5102

Table 29: Natural Gas-Displacing CSI Thermal Incentive Steps, 2018-2020

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	\$5.00		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 2018

4.5.2.4 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 system. Industrial solar thermal applications are defined as process heating systems that use hot water or other fluid to produce basic materials and commodities.

Table 30: Natural Gas-Displacing Industrial CSI Thermal Incentive Rate

Step	Industrial Incentive per therm displaced	Incentive Cap for Multifamily Low-income Projects
1	\$10.10	\$800,000

Source: CSI Thermal Program Handbook, May 2018

4.5.2.5 CSI Thermal Low-income (Natural Gas-Displacing) Program Incentives

The CSI Thermal program offers 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 do not decline to maximize participation rates.

Table 31: 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	\$20.19	\$800,000

Source: CSI Thermal Program Handbook, May 2018

4.5.3.CSI Thermal Program Participation

4.5.3.1 CSI Thermal Program History and Application Statistics

The CSI Thermal program has approved 9,372 applications for \$166.9 million in incentives (see Table 31). As seen below, the single-family customer class has received the greatest number of applications. However, due to their much larger average project size, the commercial/ multifamily customer class represents a larger portion of incentive amounts, project costs, and energy savings.

Table 32: CSI Thermal Installed Applications by Sector and Displaced Fuel through 2018

Customer Class	Number of Applications	Total Incentives (\$ thousands)	Total Project Costs (\$ thousands)	Total Annual Energy Savings
Commercial/Multifamily Pools (Gas)	945	\$15,191	\$24,449	2,486,892 therms
Industrial (Gas)	3	\$2,639	\$3,014	52,498 therms
Commercial/Multifamily Residential	1,347	\$64,915	\$127,174	
Gas	1,339	\$64,864	\$126,790	3,548,476 therms
Electric*	7	\$47	\$364	117,804 kWh
Propane *	1	\$4	\$20	8,657 therms
Single Family Residential	3,096	\$15,015	\$30,049	
Gas	2,806	\$14,636	\$27,332	342,339 therms
Electric*	243	\$295	\$2,096	688,849 kWh
Propane*	47	\$84	\$479	193,725 therms
Multifamily Low-Income (Gas)	1,133	\$48,258	\$92,420	2,140,904 therms
Single-Family Low-Income (Gas)	2,428	\$15,222	\$14,683	373,218 therms
Multifamily Disadvantaged Communities (Gas)	131	\$4,546	\$5,906	225,336 therms
Single-Family Disadvantaged Communities	289	\$1,094	\$1,319	36,672 therms
Subtotal Gas	9,074	\$166,449	\$295,914	9,206,335 therms
Subtotal Electric	250	\$342	\$2,460	806,653 therms
Subtotal Propane	48	\$88	\$499	202,382 therms
Total	9,372	\$166,879	\$298,873	
Gas per Therm		\$18.08/therm	\$32.14/therm	
Electricity per kWh		\$0.42/kWh	\$3.05/kWh	
Propane per Therm		\$0.43/therm	\$2.47/therm	

Sources: http://www.csithermalstats.org/program_totals.html and Current CSI-Thermal Program Data public export (<http://csithermalstats.org>), may include applications that were cancelled at a later date.

* The electric and propane- displacing solar thermal funding was available through the CSI General Market program, which closed on December 31, 2016.

4.5.4. CSI Thermal Program Administration

4.5.4.1 CSI Thermal Incentives Received

As mentioned above, the CSI Thermal program is jointly administered by PG&E, SoCalGas, SCE and CSE. While PG&E and CSE administer incentives for both natural gas and electric-displacing systems, SCE administered incentives only for electric-displacing systems, and SoCalGas administers incentives only for natural gas-displacing systems. As shown in Table 32, SoCalGas has received the most applications, followed by PG&E, CSE, and SCE.

Table 33: CSI Thermal Applications by Program Administrator through 2018

Program Administrator	Complete and Pending applications	Total Incentive (\$ thousand)
PG&E	2,098	\$48,378
CSE	581	\$13,956
SCE*	45	\$85
SoCalGas	6,648	\$104,461
Total	9,372	\$166,879

Source: CSI Thermal Statistics http://www.csithermalstats.org/program_totals.html, may include applications that were cancelled at a later date.

* SCE's solar thermal program provided funding for electric and propane-displacing systems through the CSI General Market program, which closed on December 31, 2016.

Most water in California is heated with natural gas, and as mentioned previously, because the CSI General Market program closed, there are no longer funds available for electric-displacing solar thermal system installations. Therefore, only about 3.2 percent of the applications received to date have been for electric-displacing solar water heating systems (see Table 31).

4.5.4.2 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.

Decision (D.)10-01-022 adopted a \$6.3 million total budget for 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.⁶³ 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, and Cost-Effectiveness Reports. Itron and the CPUC's Energy Division are currently in the process of finalizing these reports.

4.6 Research, Development, Demonstration & Deployment

4.6.1.RD&D Program Background

The CSI RD&D program was a CPUC administered program, which closed on December 31, 2016. The purpose of the CSI Research, Development, Demonstration and Deployment (RD&D) program was to identify and support projects that 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 and 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 U.C. Berkeley, the total allocation of CSI RD&D funds to date is approximately \$41.2 million. The CSI RD&D program completed all planned grant making activities and will not conduct any more solicitations.

⁶³ The CSI Thermal Measurement and Evaluation Plan is available at: <http://www.cpuc.ca.gov/General.aspx?id=7623>.

Table 34: 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	\$9M	6	\$5.6M	\$6.5M
	Secondary Areas: Production Technologies and Business Development and Deployment	\$3M			
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. The most recent example being the grant funding to EPRI for a project based in Fontana, CA of 20 Zero Net Energy (ZNE) homes in a builder community, which 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, as well as all project documentation and reports can be found at (calsolarresearch.ca.gov).

4.6.2.RD&D Program Evaluation

Pursuant to requirements in Decision (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. A competitive solicitation process in 2015 resulted in a contract with the evaluation firm Evergreen Economics. The program evaluation assessed the impact the CSI RD&D program had on growing the distributed solar market in California to achieve the CSI goals.

The evaluation contract began in January 2016 and concluded in March 2017⁶⁴. The evaluation results include the following findings:

- The Program Manager, Itron, performed very well. Grantees receiving funds from the program gave universally positive feedback on Itron. Itron carried out all the required tasks of the Program Manager very competently and implemented the program in accordance with the original program design. Itron also played an important and highly effective role in facilitating communication and partnerships within and between projects, as well as with the broader solar community, helping to engage key stakeholders and reduce duplication of efforts.
- CSI RD&D projects were mostly 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.
- The program resulted in a substantial amount of knowledge benefits. The creation and dissemination of knowledge benefits may be the most important metric of success when evaluating a research program. By this measure, the CSI RD&D program was very successful and took an essential step toward achieving its longer-term program goals.

5 Program Reporting and Evaluation

5.1 Program Reporting

5.1.1. Online CSI General Market Reporting

CSI General Market program data is provided online at the California Solar Statistics (CSS)⁶⁵ and California Distributed Generation Statistics (California DG Stats)⁶⁶ websites. The CSS site, launched in 2010, is a collaborative effort between the CSI Program Administrators and CPUC staff, and contains a wealth of program data. The website originally focused on the CSI General Market program, but later added data on the MASH and SASH programs.

The California DG Statistics website was launched in 2016 to maintain access to useful data on all (including non-CSI) solar projects in the three large IOU service territories.

⁶⁴ The CSI RD&D Program – Program Evaluation <http://calsolarresearch.ca.gov/>

⁶⁵ See www.californiasolarstatistics.com

⁶⁶ See www.californiadgstats.ca.gov/

California DG Statistics currently includes data for all solar PV systems interconnected through the large IOUs' NEM tariffs.

California Solar Statistics and California DG Stats provide 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 CSI and NEM installations (while maintaining customer confidentiality).
 - System costs
 - Manufacturer, model, capacity, and other technical information
 - Geographic location
- A “Find an Active Solar Contractor” feature, which helps prospective solar buyers search local options for solar installations.
- 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). Outside agencies have modeled their public-facing solar energy databases after the CSS site.

As the CSI General Market program became fully subscribed and stopped accepting applications in 2014, there was a concern that this source of solar PV market data would become outdated. For this reason, the CPUC adopted Decision (D.)14-11-001, which instructs the CPUC, CEC and Program Administrators to continue the collection of non-CSI solar PV installation data through the NEM interconnection process. The new solar data collected through the NEM interconnection dataset is now available on California DG Stats, which provides access to data on all distributed generation solar PV in the IOU territories.

5.1.2. Online CSI Thermal Reporting

The CSI Thermal “Incentive Step Tracker”⁶⁷ informs the public which incentive steps are currently in effect for the various CSI Thermal customer classes, including those in the low-income programs, and how much funding remains in each step.

Using CSS as a model, CPUC staff and the Program Administrators developed the CSI Thermal Statistics site as a public-facing database for the CSI Thermal program. The CSI Thermal Statistics site launched in February 2015 and contains extensive CSI Thermal program data. The website contains data on all customer classes and can also be filtered by backup commodity (natural gas, electricity, or propane). The data is updated weekly and includes the following features:

- Charts and Tables that display key program data and can be filtered by program administrator, application status, date ranges, customer classes, and system ownership.
- A master data set, which includes data on individual installations (while maintaining customer confidentiality).
 - System costs
 - Manufacturer, model, capacity, and other technical information
 - Geographic location and climate zone
- A “Find an Active Solar Contractor” feature, which helps prospective solar buyers search local options for solar thermal installations.
- Bi-weekly updates to the CSI Thermal budget.
- A Data Annex, containing information about the Program Administrators’ processing times for CSI Thermal applications.

5.1.3. Periodic CSI and CSI Thermal Reports

A number of periodic reports are filed publicly and posted to the CPUC’s CSI website:⁶⁸

⁶⁷ See www.csithermal.com/tracker

⁶⁸ See <http://www.cpuc.ca.gov/General.aspx?id=3747>.

- The CPUC’s Annual Program Assessment to the Legislature (this document), required by statute every year no later than June 30th.
- The Program Administrators’ MASH and SASH semi-annual progress reports.
- The Program Administrators’ CSI Thermal quarterly reports that provide programmatic updates and updates on the program’s progress towards its energy displacement goals.

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 conducted and commissioned to be completed is as follows:

- **PV Market Assessment Studies:** In April and May of 2014, the CPUC released three studies that address the core question 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 studies included:⁶⁹
 - [Third-Party Ownership Market Impact Study](#): This study found that third-party ownership has accounted for a significant portion of residential solar installs and demand for this model is growing.
 - [CSI Market Transformation Study](#): This study found that significant market transformation has occurred, but that continued health to the industry is dependent in part on a speedy and favorable resolution of Net Energy Metering policies and of the pending residential rate reforms.
 - [Solar PV and Residential Roof Study](#): This study assessed the relationship between roofing and the distributed generation PV market.
- **Impact Evaluations:** Three studies covering [2007-8](#), [2009](#), and [2010](#) have been published. These studies provide information on the CSI program accomplishments, including energy, capacity, and environmental impacts and PV system performance

⁶⁹ See <http://www.cpuc.ca.gov/General.aspx?id=7623>.

degradation. A final impact evaluation for program years 2011-2016 is in the process now that the CSI General Market program is closed to new applications.

- **Impact of Distributed Generation Reports:** These reports are mandated in AB 578 and PU Code 913.10, with the [first report](#) having been completed in 2010. The [second report](#), delivered in May 2013, showed that, while California’s solar distributed generation installed capacity is large compared to other states, the impact on the distribution and transmission infrastructures is relatively low. The [third report](#), delivered in January 2016, focused on the current effects of customer-sited solar on CAISO’s net load curve.⁷⁰ The report’s primary findings include:
 - Customer-sited solar power is effective at reducing summer peak net load but does not reduce winter and spring peak net load, when the “duck curve” effects are most pronounced.
 - There are tradeoffs in the effects of west-facing and south-facing customer-sited solar, but the findings alone do not support policy to incentivize one type of solar over the other.
 - A diverse portfolio of renewables produces 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 will help integrate increasing amounts of customer-sited solar.
- **External Financial Audit Report:** In 2010, CPUC audit staff completed the 2007-2008 audit for [PG&E](#), [SCE](#), and [SDG&E](#). The [2010-2011 audit](#) was conducted by an outside firm, and was completed in May 2013.⁷¹ The audit did not identify any significant issues with administration of the program. The CSI program audit for years [2012-2014](#) was completed in July 2016. As before, the audit did not identify any significant issues with administration of the program.
- **CSI Cost Effectiveness Study:** This study, completed in April 2011, looked at cost effectiveness from several perspectives – program administrators, ratepayers, and especially program participants and society overall. ⁷² Based on participant

⁷⁰ A competitive solicitation was issued in January 2015 to perform the third bi-annual study. The Commission retained DNV-GL in May 2015.

⁷¹ See <http://www.cpuc.ca.gov/General.aspx?id=7623>.

⁷² See <http://www.cpuc.ca.gov/General.aspx?id=7623>.

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 (pending):** In September 2015, 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 will include the publishing of two Technology Evaluation Reports, which will assess the costs and benefits of various solar thermal technologies amongst different markets. The project will also include the publishing of two Impact Evaluation Reports, which will assess the CSI Thermal program’s impact on electricity and natural gas demand, effectiveness in reducing greenhouse gas emissions, and will compare the actual performance of solar water heating systems against their expected performance.
- **CSI SASH and MASH Biennial Report:** In January 2016, the CPUC released [Navigant Consulting’s evaluation of CSI SASH and MASH program design](#), delivery, operations and impact for program years 2011-2013. 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 Decision (D.)07-09-042, the Commission hired Evergreen Economics for an independent evaluation of the CSI RD&D program. The evaluation provides the Commission 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 on May 11, 2017.
- **CSI Impact Evaluation (pending):** The CSI Impact Evaluation series has provided important analyses of customer-sited solar generation projects installed under the CSI program. Three studies covering 2007-2010 have been published. These studies provide up to date information on the CSI program accomplishments, including energy, capacity, and environmental impacts and PV system performance degradation. In 2018 Itron was selected to perform the final CSI Impact Evaluation. This report is expected for release in Q3 2019.

6 CSI Program Links and Contact Information

The main web portal for the *Go Solar, California!* Campaign provides comprehensive solar e-resources for consumers and professionals: GoSolarCalifornia.org

The CPUC Energy Division website provides information related to the CSI program, including regulatory updates and documents for the Distributed Generation Docket R.12-11-005: cpuc.ca.gov/Demand_Side

For CSI inquiries: energy@cpuc.ca.gov

The CSI Thermal program provides program information at CSIThermal.com.

7 CSI Thermal Program Administrator Contacts

Pacific Gas and Electric

CSI Thermal Program:

pge.com/csithermal

solar@pge.com

+1 877 743 4112

Center for Sustainable Energy (San Diego Gas & Electric service territory)

CSI Thermal Program:

energycenter.org/swh

SWH@energycenter.org

+1 858 244 1177

Southern California Gas

CSI Thermal Program:

socalgas.com/rebates/solar

swh@SoCalGas.com

+1 800 GAS 2000 (+1 800 427 2000)