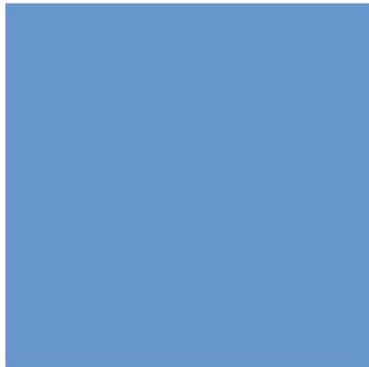
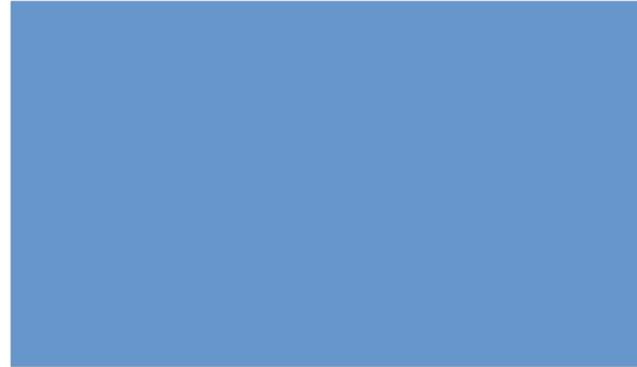




# California Solar Initiative



ANNUAL PROGRAM ASSESSMENT



JUNE 2018



# California Solar Initiative Annual Program Assessment

June 2018

Prepared by the  
California Public Utilities Commission

## Authors

Asal Esfahani  
Mary Claire Evans  
Kerry Fleisher  
Sara Kamins, Supervisor

## Special Thanks

Bruce Kaneshiro  
Edward Randolph  
Lelaine Bonine  
Chad Worth, Energy Solutions  
Andrew Ace, Pacific Gas and Electric Company  
Cathleen Monahan, GRID Alternatives

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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 MW<sup>1</sup> 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.<sup>2</sup> Other state authorized programs, including the New Solar Homes Partnership (NSHP) and publicly-owned utilities' solar offerings, are not included in this report.<sup>3</sup>

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 has already installed enough solar capacity to achieve the CSI General Market Program goal of installing 1,750 MW of capacity by the end of 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 major Investor Owned Utilities' (IOU)<sup>4</sup> 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 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.

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<sup>1</sup> This goal includes the CSI General Market Program goal of installing 1,750 MW of capacity by the end of 2016.

<sup>2</sup> Public Utilities (PU) Code Section 913.7 states, "On or before June 30, 2009, and by June 30<sup>th</sup> 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>.

<sup>3</sup> Information on non-CPUC jurisdictional solar programs is available at [www.gosolarcalifornia.ca.gov](http://www.gosolarcalifornia.ca.gov).

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

### 1.1.1. Installed Solar Highlights

- Through the end of 2017, approximately 6,228 MW of solar capacity were installed at 725,426 customer sites in the large investor-owned utility (IOU) territories.<sup>5</sup> This exceeds the state’s goal of 3,000 MW installed by roughly 208 percent.
- In 2017, 1,262 MW were installed in the IOU territories, a 4.8 percent decrease in annual installed capacity compared to 2016. This is the first time since 2014 that the solar market fell, and it is too early for the availability of data over time necessary to make any meaningful conclusions explaining these trends.
- Between 2007 and the first quarter of 2018, the average cost of installed systems below 10 kW has decreased 54.1 percent from \$9.61 per watt to \$4.49 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.<sup>67</sup>
- By the end of 2017, California had installed approximately 6,725MW of solar capacity at 787,531 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 |
|--|--------------|----------------|
| <b>Solar Installations in California IOU Territories</b> |              |                |
| All IOU Interconnections, 1993-2017                      | 6,228        | 725,426        |
| <b>Solar Installations in California POU Territories</b> |              |                |
| CEC, 2008-2016   | 498          | 62,105         |
| <b>Total California Solar Installations</b>              | <b>6,725</b> | <b>787,531</b> |

Sources: IOU Quarterly Distributed Generation (DG) Interconnection Reports Q1 2018 and Publicly Owned Utilities Report Summaries, 2008-2016 at [http://www.energy.ca.gov/sb1/pou\\_reports/index.html](http://www.energy.ca.gov/sb1/pou_reports/index.html).

<sup>5</sup> Source: IOU Quarterly Distributed Generation (DG) Interconnection Reports Q1 2017. The Quarterly DG Interconnection Report is submitted in response to a standing CPUC data request. The Reports contain Confidential Customer-Specific and Trade Secret Information and cannot be disclosed publicly pursuant to PU Code Sections 583 and 8380, Government Code Section 6254(k), and Civil Code 1798.24.

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

<sup>7</sup> 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, 2017, the CSI General Market Program had installed 1,891 MW.<sup>8,9</sup>
- Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE) and San Diego Gas and Electric Company (SDG&E)<sup>10</sup> 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) are playing a larger role in making customer-sited solar generation cost-effective relative to available CSI incentives. In 2017, in the large IOU territories, 99 percent of customer-sited solar projects were interconnected through the NEM tariff without participating in the CSI Program.<sup>11</sup>

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<sup>8</sup> California Solar Statistics – Program Totals, ([https://www.californiasolarstatistics.ca.gov/reports/agency\\_stats/](https://www.californiasolarstatistics.ca.gov/reports/agency_stats/)). Data updated May 3, 2017.

<sup>9</sup> 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 D.11-12-019 for more details.

<sup>10</sup> The Center for Sustainable Energy (CSE) administers the CSI Program in SDG&E’s service territory.

<sup>11</sup> Source: IOU Quarterly DG Interconnection Reports Q1 2017. Data is through December 31, 2016.

### 1.1.3. Other Program Highlights

**CSI Budget by Program Component**

| Program Component   | Budget*<br>(\$ 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   |
| <b>Sub-Total: CSI Electric (Electric-Displacing) Budget</b>                                   | <b>\$2,367</b>           | <b>1,940 MW</b>   |
| CSI Thermal Program (Gas-Displacing)  | \$250                    | Cost effective deployment of solar thermal systems to reduce natural gas consumption in California.**** |
| <b>Total CSI Budget</b>   | <b>\$2,617</b>           |   |
| Re-authorized SASH Program  | \$54                     | 15 MW   |
| Re-authorized MASH Program  | \$54                     | 35 MW   |
| <b>Total CSI Budget including re-authorized SASH/MASH programs</b>                            | <b>\$2,724</b>           |   |

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, SASH has completed a total of 7,038 projects, representing 21.5 MW of installed capacity on eligible homes.<sup>12</sup>
- 100 percent of the original \$92 million SASH incentive budget was fully subscribed in all IOU territories.

<sup>12</sup> 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.

- SASH applicants have received or reserved a total of \$19.1 million of the available \$46 million incentive budget authorized for the extended SASH program.
- Since the SASH third-party ownership model was made available in 2015, over 70 percent of SASH 2.0 use this unique model to help finance the installation of solar PV projects 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 450 projects, equaling 37.8 MW of installed capacity. There are an additional 208 MASH projects in progress or under review, with a total capacity of 25.1 MW.<sup>13</sup>
  - 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.
- **CSI Thermal Program**
  - Since January 2010, the program has approved 6,737 applications for natural gas-displacing solar thermal systems for \$95.8 million in incentives received out of the available \$205 million CSI Thermal incentive budget.
  - in 2017, 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).<sup>14</sup>
- **Research, Development, Demonstration and Deployment (RD&D) Program**
  - The CSI RD&D Program has conducted five project solicitations since its inception, resulting in grant funding for 37 projects, totaling \$41.2 million. Funded projects have focused on the following areas:

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<sup>13</sup> 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.

<sup>14</sup> 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.

- 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.<sup>15</sup>
  - In December 2016, Itron, Inc., the CSI RD&D Program Manager, completed the RD&D Program Report, 2008-2016, which provides an overview of program’s solicitation process and briefs on the projects funded.<sup>16</sup>

#### 1.1.4. Net Energy Metering (NEM)

- As of December 31, 2017, 6,011 MW out of the 6,228 MW of customer-sited solar capacity interconnected to the grid in the large IOU territories was enrolled in NEM. Only 3 percent of customer-sited solar capacity was not enrolled in a NEM tariff.
- In January 2016, the CPUC approved D.16-01-044 adopting a NEM successor tariff, which continues 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 July 2016 in SDG&E’s service territory and in December 2016 in PG&E’s service territory. NEM 2.0 went into effect on July 1, 2017 in SCE’s service territory.

## 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.<sup>17</sup>

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<sup>15</sup> 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>.

<sup>16</sup> Please see:

[http://calsolarresearch.ca.gov/images/stories/documents/Prog\\_Report/CSI\\_RDD\\_ProgramReport\\_ResearchBriefs\\_20170131.pdf](http://calsolarresearch.ca.gov/images/stories/documents/Prog_Report/CSI_RDD_ProgramReport_ResearchBriefs_20170131.pdf)

<sup>17</sup> 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.

The goals of the CSI program are to:

- Install 1,940 MW of distributed solar generation capacity in the large electric IOU service territories, and displace 585 million therms of natural gas usage, or the equivalent output of 200,000 solar thermal systems; and
- Transform the market for solar energy systems to be price competitive and self-sustaining.

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.<sup>18</sup> 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 kilowatt (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

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<sup>18</sup> 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). The popularity of this fully subscribed program resulted in the expansion of the Virtual Net Energy Metering (VNEM) tariffs, which allow a building owner to share bill credits for solar production with the building’s tenants.
- **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, Southern California Gas Company (SoCalGas) and CSE administer the CSI Thermal Program for the gas-displacing solar thermal systems. 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 incentive 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*<br>(\$ 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**   |
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| Solar water heating Pilot Program (SWHPP)***  | \$2.6                    | 750 systems   |
| <b>Sub-Total: CSI Electric (Electric-Displacing) Budget</b>                                   | <b>\$2,367</b>           | <b>1,940 MW</b>   |
| CSI Thermal Program (Gas-Displacing)  | \$250                    | Cost effective deployment of solar thermal systems to reduce natural gas consumption in California.**** |
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| Re-authorized MASH Program  | \$54                     | 35 MW   |
| <b>Total CSI Budget including re-authorized SASH/MASH programs</b>                            | <b>\$2,724</b>           |   |

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 [http://www.californiasolarstatistics.ca.gov/reports/budget\\_forecast/](http://www.californiasolarstatistics.ca.gov/reports/budget_forecast/) and budget updates for the CSI Thermal incentive buckets are available online at <http://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 [www.californiadgstats.ca.gov](http://www.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.<sup>19</sup> 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.<sup>20</sup> As a result, the CPUC has revised and reissued the CSI program Handbook 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.
- 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.

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<sup>19</sup> 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.

<sup>20</sup> See, General Order 96-B here: [http://docs.cpuc.ca.gov/PUBLISHED/GENERAL\\_ORDER/164747.htm](http://docs.cpuc.ca.gov/PUBLISHED/GENERAL_ORDER/164747.htm)

- 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.

### **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 and 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 and marketing and outreach budgets.

### 3 Solar Projects Installed in California Through 2016

This section of the report summarizes data on the cumulative installed capacity<sup>21</sup> 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).<sup>22</sup> However, any references to “statewide” data in this report include solar installations within POU service territories.<sup>23</sup>

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<sup>21</sup> 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.

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

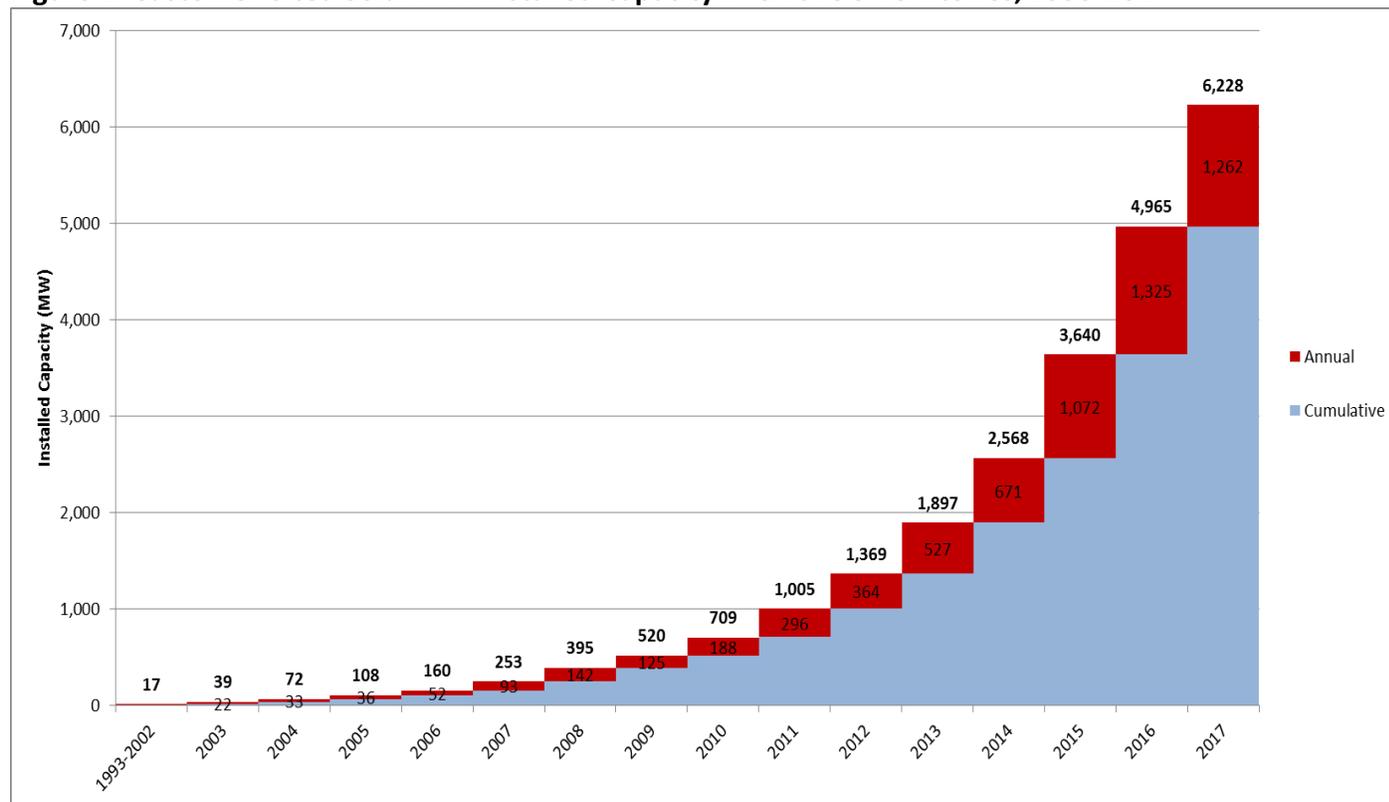
<sup>23</sup> Data on the POU’s customer-sited solar programs can be found on the CEC’s website at [http://www.energy.ca.gov/sb1/pou\\_reports/index.html](http://www.energy.ca.gov/sb1/pou_reports/index.html).

### 3.1 Investor-Owned Utility Territory Solar Installations

Through the end of 2016, approximately 5,036 MW of solar capacity were installed at 606,185 sites in the IOU territories.<sup>24</sup> The solar installations included in Figures 1 and 2 are interconnected on customer sites under Rule 21, the CPUC-jurisdictional interconnection tariff, and do not include solar power plants installed under FERC-jurisdictional interconnection tariffs that participate in CAISO markets. Figures 1 and 2 include data on solar PV installations. 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 2017, customers installed 1,262 MW, a 4.8 percent decrease in annual installed capacity compared to 2016. Therefore, both the absolute number of installations and the year-over-year growth rate showed a negative trend compared to the prior year.

**Figure 1: Customer-Sited Solar MW Installed Capacity in CA’s IOU Territories, 1993-2017**



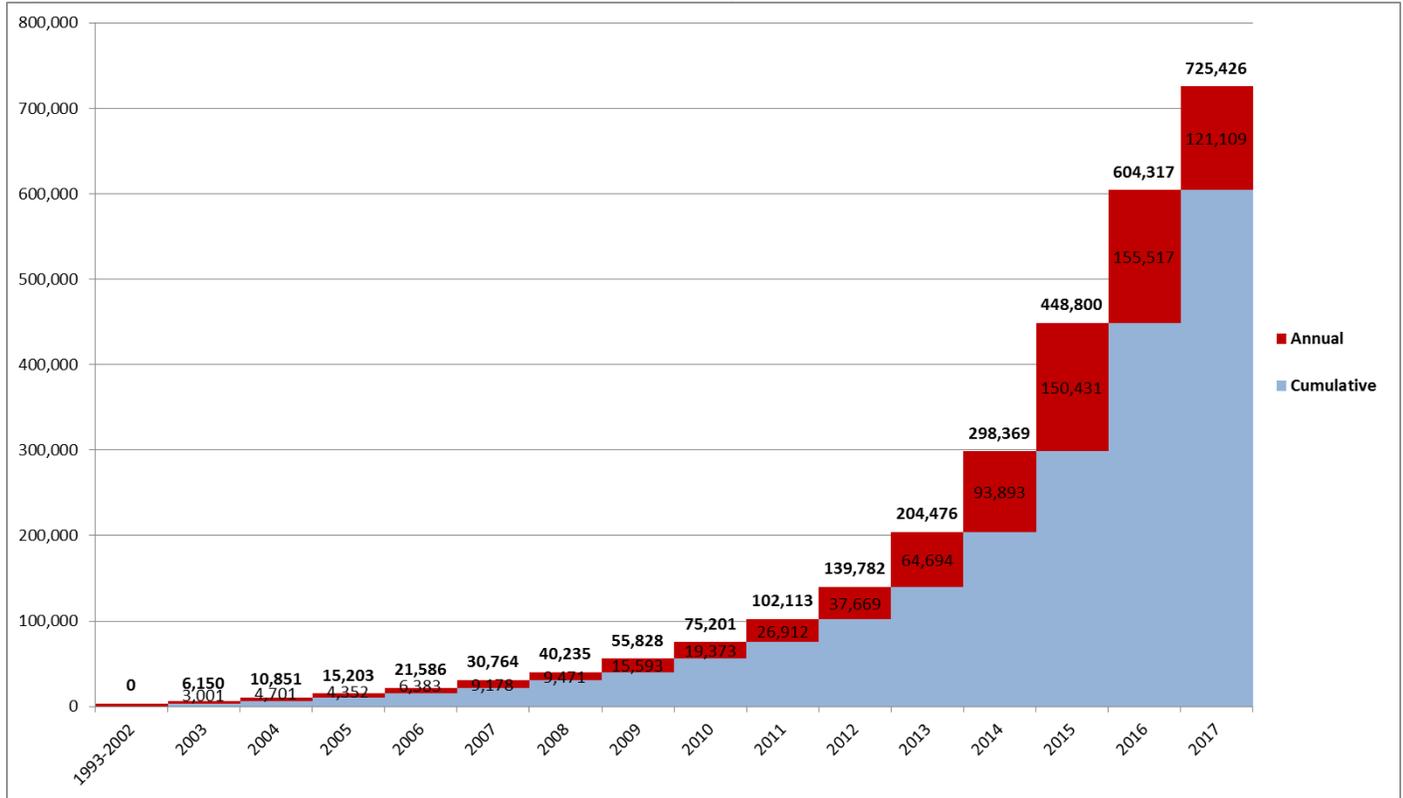
Source: IOU Quarterly Distributed Generation (DG) Interconnection Reports Q1 2018.

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 121,109 solar projects installed in the IOU territories in 2017, or 22 percent less than in 2016.

<sup>24</sup> Source: IOU Quarterly DG Interconnection Reports Q1 2017.

**Figure 2: Number of Installed Customer-Sited Solar Projects in CA's IOU Territories, 1993-2017**



Source: IOU Quarterly Distributed Generation (DG) Interconnection Reports Q1 2018.

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 2017, California had installed approximately 6,725MW of solar capacity at 787,531 customer sites. As detailed in Table 2, this statewide solar data combines information on IOU interconnections through 2017, along with data on POU solar installations through 2016. The CPUC tracks IOU interconnection data on a quarterly basis. POU solar data is collected by the California Energy Commission (CEC), and the information for the previous year’s installations is published annually in July. The statistics shown in Table 2 provide the best available minimum estimate of California statewide solar installations.

**Table 2: California Statewide Solar Installations**

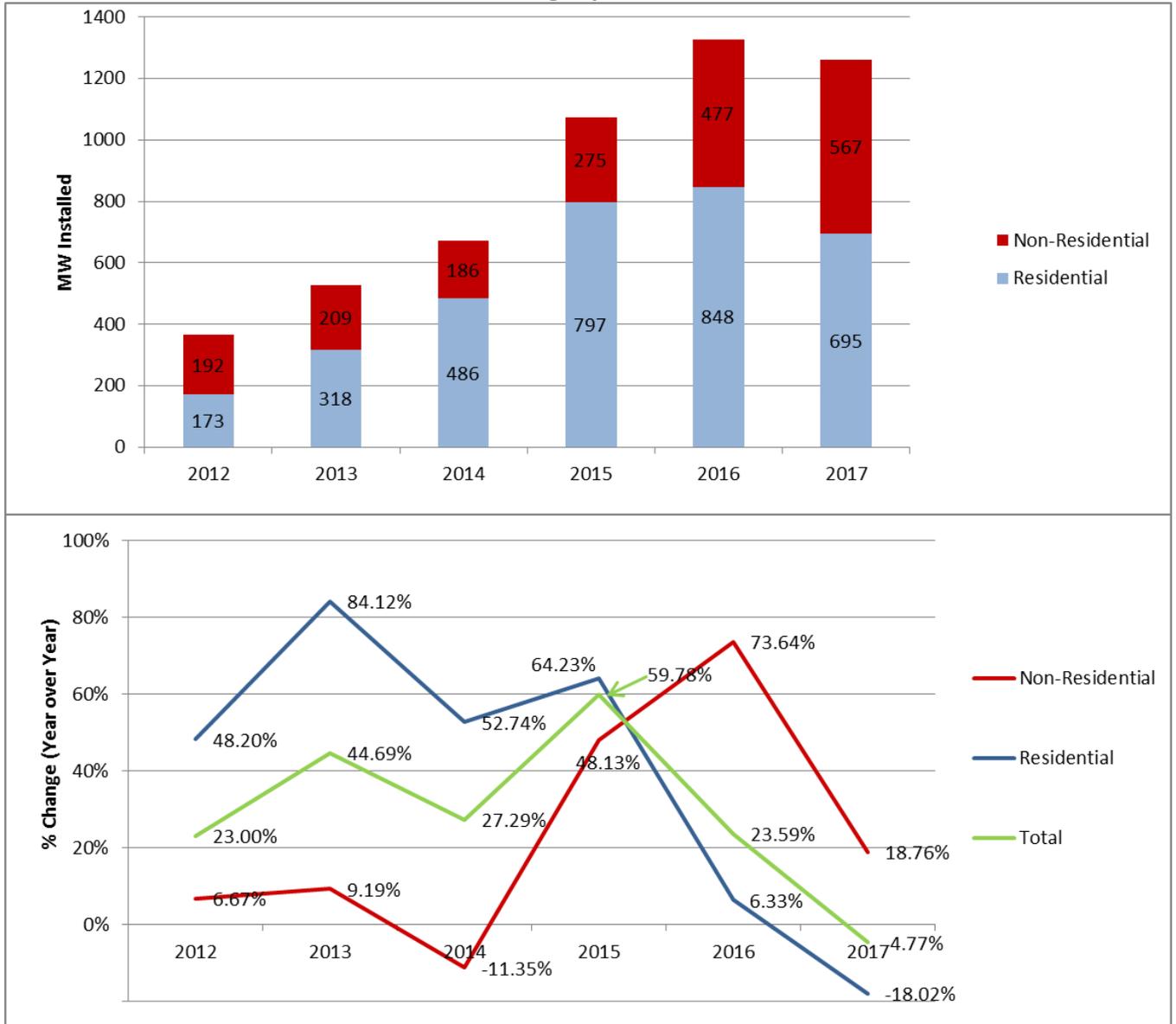
| Data Source and Dates                                    | Total MWs    | Total Projects |
|--|--------------|----------------|
| <b>Solar Installations in California IOU Territories</b> |              |                |
| All IOU Interconnections, 1993-2017                      | 6,228        | 725,426        |
| <b>Solar Installations in California POU Territories</b> |              |                |
| CEC, 2008-2016   | 498          | 62,105         |
| <b>Total California Solar Installations</b>              | <b>6,725</b> | <b>787,531</b> |

Sources: IOU Quarterly Distributed Generation (DG) Interconnection Reports Q1 2018 and Publicly Owned Utilities Report Summaries, 2008-2016 at [http://www.energy.ca.gov/sb1/pou\\_reports/index.html](http://www.energy.ca.gov/sb1/pou_reports/index.html).

## 3.3 California Solar Adoption Trends

There was a sharp downward trend in the solar market in 2017. As Figure 3 shows, The solar market demonstrated negative growth for the first time since 2014, due to continued drops in the residential sector and the relatively weak growth in the commercial sector. This is the first time since 2014 that the solar market fell, and it is too early for the availability of data over time necessary to make any meaningful conclusions explaining these trends.

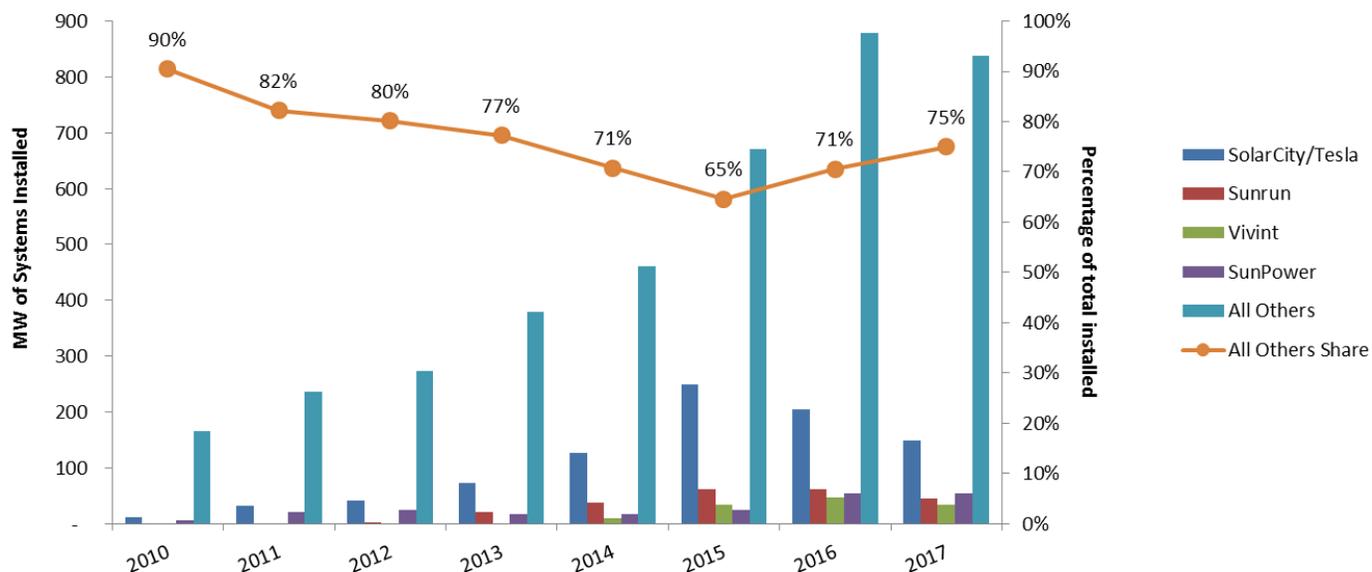
**Figure 3: Customer Sited Solar PV Year over Year Growth by Customer Class, Total MWs and Percent Changes per Year**



Source: IOU Quarterly DG Interconnection Reports Q1 2018.

While residential solar experienced lower growth rates in recent years, smaller solar companies are seeing sustained growth in their market share, as compared to the larger, consolidated companies such as Vivint, Sunrun, and SolarCity. Figure 4 shows the upward trend in smaller companies’ market share over the past two years.

**Figure 4: Residential NEM PV Systems by Installation Company**



Source: California DG Statistics NEM Currently Interconnected Data Set at (<http://californiadgstats.ca.gov/downloads/>, data), updated March 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. CSI program participants are eligible for utility interconnection and NEM tariffs that facilitate solar by allowing solar customers to feed excess electricity into the grid. 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 cap<sup>25</sup>, whichever is earlier. SDG&E reached its NEM cap in

<sup>25</sup> 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.

July 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' current progress towards the 5 percent NEM program cap.

**Table 3: Progress towards the 5 Percent NEM Program Cap<sup>26</sup>**

|                  | 5 Percent NEM Cap | Progress Toward NEM Cap |
|------------------|-------------------|-------------------------|
| <b>PG&amp;E</b>  | 2,409 MW          | Reached December 2016   |
| <b>SCE</b>       | 2,240 MW          | Cap Not Reached         |
| <b>SDG&amp;E</b> | 607 MW            | Reached July 2016       |

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 D.14-03-041, establishing a 20-year transition period for customers to remain on NEM 1.0 tariffs.<sup>27</sup> 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 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 MW<sup>28</sup> will pay a pre-approved one-time interconnection fee, based on each IOU's historical 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.
- 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

<sup>26</sup> 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.

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

<sup>28</sup> 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.

July 2016 in SDG&E’s service territory, December 2016 in PG&E’s service territory, and July 1, 2017 in SCE’s service territory.

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 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, 2017**

|                  | MW Installed |              |                 | Project Count  |                |                 |
|------------------|--------------|--------------|-----------------|----------------|----------------|-----------------|
|                  | Total PV     | PV on NEM*   | % PV not on NEM | Total PV       | PV on NEM*     | % PV not on NEM |
| <b>PG&amp;E</b>  | 3,201        | 3,106        | 3%              | 349,731        | 349,427        | 0.09%           |
| <b>SCE</b>       | 2,162        | 2,065        | 4%              | 251,391        | 251,292        | 0.04%           |
| <b>SDG&amp;E</b> | 865          | 840          | 3%              | 124,304        | 124,190        | 0.09%           |
| <b>Total</b>     | <b>6,228</b> | <b>6,011</b> | <b>3%</b>       | <b>725,426</b> | <b>605,746</b> | <b>0.09%</b>    |

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

Source: IOU Quarterly Interconnection Reports 2018 Q1. Data is through December 31, 2017.

## 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.<sup>29</sup>

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 1,891 MW of installed capacity since program inception.<sup>30</sup>

On December 16, 2016, the CPUC issued Decision 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 incentives reserved by December 31, 2016. 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.<sup>31</sup> The calculator considers major design characteristics of the solar energy system, such as panel type, installation tilt, shading, orientation, and solar insolation available by location. The average reserved incentive for EPBB systems from the beginning of the CSI program to date was \$5,128.<sup>32</sup>

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

<sup>29</sup> 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.  
<sup>30</sup> California Solar Statistics – Program Totals, at [https://www.californiasolarstatistics.ca.gov/reports/agency\\_stats/](https://www.californiasolarstatistics.ca.gov/reports/agency_stats/). Data updated June 6, 2018.

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

<sup>32</sup> Source: California Solar Statistics - CSI Working Data Set at [https://www.californiasolarstatistics.ca.gov/data\\_downloads/](https://www.californiasolarstatistics.ca.gov/data_downloads/). Data updated June 6, 2018. Calculation includes only projects reported as “In Payment” by December 31, 2016.

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 \$281,134.<sup>33</sup>

#### 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.

**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.

<sup>33</sup> Source: California Solar Statistics - CSI Working Data Set at [https://www.californiasolarstatistics.ca.gov/data\\_downloads/](https://www.californiasolarstatistics.ca.gov/data_downloads/). Data updated June 6, 2018. Calculation includes only projects reported as “In Payment” by December 31, 2016.

Table 6 presents the capacity target by utility territory and customer class, showing how all of 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         |
| <b>Subtotals<br/>(Res and Non-Res)</b> |            | <b>252.4</b> | <b>512.3</b> | <b>265.6</b> | <b>539.5</b> | <b>59.5</b>  | <b>120.8</b> |
| <b>Totals</b>                          |            | <b>764.8</b> |              | <b>805</b>   |              | <b>180.3</b> |              |
| <b>Percent</b>                         |            | <b>43.7%</b> |              | <b>46.0%</b> |              | <b>10.3%</b> |              |

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, May 2018.

Note: Incentive Step 1 MWs were reserved under the Self-Generation Incentive (SGIP) Program in 2006.

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.<sup>34</sup>

#### 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.

#### 4.1.2.2 Average System Costs for Program Participants

Between 2007 and the first quarter of 2018, the average cost of installed systems below 10 kW has decreased 54.1 percent from \$9.61 per watt to \$4.49 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

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

average of \$9.46 per watt to \$3.72 per watt.<sup>35, 36</sup> These significant cost decreases point to the success of the CSI in contributing towards a sustainable solar industry in California.

#### 4.1.2.3 Solar Installations outside the CSI Program

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.<sup>37</sup> Table 8 below shows that almost all customer-sited solar projects interconnected in 2017 did not receive CSI incentives.

**Table 8: Solar PV Capacity Installed in 2016 and 2017: CSI vs. Non-CSI**

|                  | MW Installed in 2016 |                  |   | MW Installed in 2017 |                  |   |
|------------------|----------------------|------------------|---|----------------------|------------------|---|
|                  | CSI                  | All PV           | % Installations not receiving CSI rebates | CSI                  | All PV           | % Installations not receiving CSI rebates |
| <b>PG&amp;E</b>  | 6                    | 659,778          | 99.9990%                                  | 2                    | 688,290          | 99.9997%                                  |
| <b>SCE</b>       | 90                   | 461,519          | 99.9804%                                  | 41                   | 429,254          | 99.9904%                                  |
| <b>SDG&amp;E</b> | 14                   | 203,982          | 99.9931%                                  | 5                    | 144,585          | 99.9968%                                  |
| <b>Total</b>     | <b>111</b>           | <b>1,325,280</b> | <b>99.9916%</b>                           | <b>48</b>            | <b>1,262,129</b> | <b>99.9962%</b>                           |

Source: <https://www.californiadgstats.ca.gov/charts/csi>, accessed May 27, 2018; IOU Q1 2018 Quarterly DG Interconnection Reports.

#### 4.1.2.4 2017 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 1 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-on-year through 2016. Beginning in 2017, however, there was a slight 4.8 percent downturn in the market overall. Although during this period non-residential solar installations grew by 18.8 percent in capacity (see Figure 3), the year-on-year growth rate was down from the previous year when capacity in the non-residential sector grew by 73.6 percent. This, together with an 18.0 percent decrease in residential solar PV installations by capacity, accounts for the overall dip in the 2017 market. As Table 9 shows, the CSI General Market program approved applications for a relatively small capacity total in 2016.

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

<sup>36</sup> System prices are quoted in nominal terms.

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

**Table 9: 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 | 35.7                         | 0.8         | 36.5  |

Source: California Solar Statistics – Monthly, Quarterly, and Annual Statistics, data accessed May 17, 2017, data current as of May 23, 2018. ([https://www.californiasolarstatistics.ca.gov/reports/monthly\\_stats/](https://www.californiasolarstatistics.ca.gov/reports/monthly_stats/)).

#### 4.1.2.5 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.<sup>38</sup> The study, released in April 2014, found:

- 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 Commission 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

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

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

### **4.2.1.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 D.07-11-047 as part of the CSI program. GRID Alternatives (GRID) was selected as the statewide Program Manager for the SASH program.<sup>39</sup> 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.<sup>40</sup>

In January 2015, pursuant to AB 217, the CPUC reauthorized the SASH program in D.15-01-027. In this Decision, the CPUC authorized the extension of SASH with an additional \$54 million in funding and an installed capacity goal for the program of 15 MW. The SASH program 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).

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<sup>39</sup> 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.

<sup>40</sup> 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>).

For clarity in this report, the original SASH program is referred to as SASH 1.0 and the recent 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 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 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 | <b>\$108.34</b> |

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 | <b>\$54</b> |

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

#### 4.2.1.2 SASH Program Eligibility

The SASH program is open to customers of the large electric IOUs who qualify as single-family, low-income households as defined 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.

#### 4.2.1.3 SASH Program Incentives

The SASH incentives are higher than the CSI General Market program on a \$/watt basis. The SASH 1.0 incentives varied depending on the household's income level and eligibility for the California Alternate Rates for Energy (CARE)<sup>41</sup> 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

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

savings and include ironclad consumer protection measures as required in D.15-01-027.<sup>42</sup> 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 expected to play a significant role in funding SASH 2.0 projects. Of the 1,768 SASH 2.0 projects completed through the end of 2017, nearly 1,300 are third-party owned, or over 70 percent of all capacity installed under SASH 2.0.

### **4.2.2.SASH Program Progress**

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

Under SASH 1.0, a total of 5,262 projects and 16 MW has been installed on eligible homes, and 100 percent of the available \$92 million SASH 1.0 incentive budget has been encumbered.<sup>43</sup> SASH 2.0 has completed a total of 1,768 projects, resulting in 5.49 MW of installed capacity, with another 1.31 MW currently in progress. These applicants have received or reserved over \$19.1 million of the available \$46 million SASH 2.0 incentive budget for their residential solar systems.

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 2016, the SASH program paid an average of \$4,828 in incentives per kilowatt installed. The General Market program paid an average of \$1,015 per kilowatt installed over the same period.<sup>44</sup>

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<sup>42</sup> 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>.

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

<sup>44</sup> 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>). Data updated 4/12/17.

#### 4.2.2.1 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% 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 over 66,000 installation workday positions for volunteers in CA since the inception of the SASH program, and over 13,600 of these positions have been filled by groups of students from CA job training programs.<sup>45</sup> 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 15% of SASH SPP projects have exceeded this expectation by having more two or even three trainees work on the SASH installations. Through 2017, over 50 CA contractors have installed projects under the SASH SPP model, and the SPP program has created 2,195 paid workday opportunities for 235 recent graduates of job-training programs.

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<sup>45</sup> 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.

## 4.3 Multifamily Affordable Solar Housing (MASH) Program

### 4.3.1. MASH Program Background

The second low-income solar program in the CSI Program targets affordable multifamily housing. In October 2008, the CPUC adopted D.08-10-036, which established the \$108.3 million MASH program for solar installations on existing multifamily affordable housing that meet the definition of low-income residential housing established in PU Code Section 2852.<sup>46</sup> 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 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 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. Due to significant demand, at the time of this report, MASH 2.0 incentive funding was fully subscribed in all service territories. If funding becomes available in an IOU territory due to project cancellations, however, the program may reopen to new applications.

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<sup>46</sup> D.08-10-036, Appendix A, *mimeo.*, p. 1

### 4.3.1.1 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

### 4.3.1.2 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.

### 4.3.1.3 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 of 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   |
|--|------------------|--|
| 1C: PV System Offsetting Common Area Load, Non-VNEM Tenant Load, or VNEM Tenant Load with <50 percent Tenant Benefit | \$1.10/watt      | <ul style="list-style-type: none"> <li>• Provide job training opportunity to more than one trainee, with one additional trainee for each 10 kW up to 50 kW</li> <li>• 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</li> <li>• Portion of system allocated to offsetting one of the following:                         <ul style="list-style-type: none"> <li>○ Common Area Load</li> <li>○ Non-VNEM Tenant Load</li> <li>○ VNEM Tenant Load where tenant receives less than 50 percent of economic benefit of allocated generation</li> </ul> </li> </ul> |

| Track   | Incentive Amount | Eligibility Requirements   |
|---|------------------|--|
| 1D: PV System<br>Offsetting VNEM<br>Tenant Load with<br>≥50 percent<br>Tenant Benefit | \$1.80/watt      | <ul style="list-style-type: none"> <li>• Provide job training opportunity to more than one trainee, with one additional trainee for each 10 kW up to 50 kW</li> <li>• 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</li> <li>• Portion of PV system allocated to offsetting:               <ul style="list-style-type: none"> <li>○ VNEM Tenant Load where tenant receives at least 50 percent of economic benefit of allocated generation</li> </ul> </li> </ul> |

### 4.3.2.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.

To date, MASH 1.0 has completed 379 projects, representing 27.4 MW of installed capacity. There are an additional 6 MASH 1.0 projects in process, with a total capacity of 1.5 MW.<sup>47</sup>

To date, 71 projects representing 10.4 MW of capacity have been completed under MASH 2.0. There are an additional 202 MASH 2.0 applications, representing 25.1 MW currently under review.<sup>48</sup>

<sup>47</sup> Data as of 5/30/18 from California DG Stats Low-Income Solar PV Data Set available at: <http://www.californiadgstats.ca.gov/downloads/>

<sup>48</sup> Ibid.

**Table 19: MASH Program Progress**

| Status of Application |               | Total | CSE | PG&E | SCE  |
|-----------------------|---------------|-------|-----|------|------|
| MASH 1.0              | Number        | 379   | 41  | 191  | 147  |
| Completed             | Capacity (MW) | 27.4  | 2.6 | 11.3 | 13.5 |
| MASH 1.0              | Number        | 6     | 0   | 6    | 0    |
| Pending               | Capacity (MW) | 1.5   | 0   | 1.5  | 0    |
| MASH 2.0              | Number        | 71    | 18  | 32   | 21   |
| Completed             | Capacity (MW) | 10.4  | 2.9 | 4.2  | 3.4  |
| MASH 2.0              | Number        | 202   | 4   | 114  | 84   |
| Pending               | Capacity (MW) | 25.1  | 0.6 | 12.3 | 12.2 |

Source: CSI Low-Income Solar PV working data set as of May 30, 2018. All system capacity measured in CEC-AC MW.

Between 2006 and 2017, the MASH program paid an average of \$2,630 in incentives per kilowatt installed. The General Market program paid an average of \$965 per kilowatt installed over the same period.<sup>49</sup>

## 4.4 Virtual Net Metering (VNEM)

Multi-tenant buildings are 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.<sup>50</sup>

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 2017, in PG&E, SCE, and SDG&E's service territory there were 312 projects with a total of nearly 15.2 MW of solar capacity on the VNEM tariff who are not participants in the MASH program.

<sup>49</sup> 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>). Data updated 4/12/17.

<sup>50</sup> D.08-10-036

**Table 20: VNEM Projects Outside of the MASH Program by Utility Territory through 2017**

| Utility                               | PG&E  | SCE   | SDG&E | Total  |
|---------------------------------------|-------|-------|-------|--------|
| VNEM Projects outside of MASH Program | 206   | 29    | 77    | 312    |
| Total Capacity (kW, CEC-AC)           | 9,322 | 1,002 | 4,894 | 15,218 |

Source: Data request to IOUs, June 2018.

## 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 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. D.13-02-018 allowed incentives for process heating and cooling, and for space heating. D.13-08-004 allowed incentives for swimming pools at multifamily and commercial sites. Subsequently, D.15-01-035 increased early-step incentive levels for the single-family and multifamily/commercial gas-displacing customer classes, and revised project rebate caps and customer class budgets.

On May 6, 2016, Energy Division approved 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.<sup>51</sup> In February 2017, due to

<sup>51</sup> 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>).

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 have 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)<sup>52</sup>. 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 January 1, 2018, the CSI Thermal incentive budget available for the program extension through July 2020 equaled \$82.7 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 Commission 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;<sup>53</sup>
- 3) Incentives for industrial process heat natural gas-displacing systems.

The four Program Administrators of the CSI Thermal program are: PG&E, SoCalGas, SCE,<sup>54</sup> and CSE (on behalf of SDG&E).

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<sup>52</sup> 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.

<sup>53</sup> 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.

<sup>54</sup> 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.

## 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 21.

**Table 21: 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                                 |
| <b>Total</b> | <b>100%</b>       | <b>\$250 million</b>                    |

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 22 displays each PA's budget for natural gas-displacing solar thermal systems as of December 31, 2017.

**Table 22: 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                                 |
| <b>Total</b> | <b>\$82.70</b>                          |

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

Table 23 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 funds to the Low-Income program and 10 percent to the Industrial sector.

**Table 23: CSI Thermal Gas-Displacing Overall Program Budget, 2018-2020**

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

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 24.

**Table 24: 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                                 |
| <b>Total</b> | <b>\$50.43 million</b>                  |

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 CSI Thermal PAs filed an advice letter collapsing all incentives steps from 4 to 2 tiers.<sup>55</sup> For the single-family market, the

<sup>55</sup> 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.

average system rebate starts at \$3,493 in step one and declines over two steps to an average of \$2968. 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 D.15-01-035, all customer classes have maximum system incentive caps.<sup>56</sup> Incentive levels decline when the total incentive budget for a particular 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.<sup>57</sup>

**Table 25: 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/<br>Multifamily                   | \$20.19<br>PBI - \$10.10      | N/A  | \$800,000                    | \$10,118,000        |
|              | Commercial/Multifamily<br>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/<br>Multifamily                   | \$17.16<br>PBI - \$8.58       | N/A  | \$800,000                    | \$2,530,000         |
|              | Commercial/Multifamily<br>Pool Heating       | \$5.00                        |  | 50% of total project costs*  | \$1,198,000         |
| <b>Total</b> |  |                               |  |                              | <b>\$22,189,000</b> |

Source: CSI Thermal Program Handbook, May 2018.

<sup>56</sup> 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.

<sup>57</sup> SoCalGas Advice Letter No. 5102

#### 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 26: 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 27: 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 7,033 applications for \$96.2 million in incentives (see Table 28). 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 28: CSI Thermal Installed Applications by Sector and Displaced Fuel through 2017**

| Customer Class                     | Number of Applications | Total Incentives (\$ thousands) | Total Project Costs (\$ thousands) | Total Annual Energy Savings     |
|------------------------------------|------------------------|---------------------------------|------------------------------------|---------------------------------|
| Commercial/Multifamily Pools (Gas) | 759                    | \$10,839                        | \$16,018                           | 1,776,346 therms                |
| Commercial/Multifamily Residential | 864                    | \$35,318                        | \$76,082                           | 1,379,795 therms<br>89,210 kWh  |
| Gas                                | 857                    | \$35,282                        | \$75,853                           | 2,028,772 therms                |
| Electric*                          | 6                      | \$32                            | \$209                              | 80,553 kWh                      |
| Propane *                          | 1                      | \$4                             | \$20                               | 8,657 kWh                       |
| Single Family Residential          | 3,003                  | \$14,118                        | \$27,187                           | 278,955 therms<br>841,927 kWh   |
| Gas                                | 2,714                  | \$13,775                        | \$24,898                           | 332,395 therms                  |
| Electric*                          | 242                    | \$269                           | \$1,884                            | 664,792 kWh                     |
| Propane*                           | 47                     | \$74                            | \$405                              | 177,135 kWh                     |
| Multifamily low-income (Gas)       | 789                    | \$28,820                        | \$56,835                           | 1,345,120 therms                |
| Single-Family low-income (Gas)     | 1618                   | \$7,080                         | \$7,622                            | 206,674 therms                  |
| Subtotal Gas                       | 6,737                  | 95,795                          | \$181,226                          | 5,689,307 therms                |
| Subtotal Electric                  | 248                    | \$300                           | \$2,093                            | 745,345 kWh                     |
| Subtotal Propane                   | 48                     | \$77                            | \$425                              | 185,792 kWh                     |
| Total                              | 7,033                  | \$96,173                        | \$183,744                          | 5,689,307 therms<br>931,137 kWh |
| per Therm                          | -                      | \$16.84/therm                   | \$ 31.85/therm                     | -                               |
| per kWh                            | -                      | \$0.40/kWh                      | \$2.70/kWh                         | -                               |

Sources: [http://www.csithermalstats.org/program\\_totals.html](http://www.csithermalstats.org/program_totals.html) and Current CSI-Thermal Program Data public export (<http://csithermalstats.org>); data accessed May 27, 2018.

\* 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 29, SoCalGas has received the most applications, followed by PG&E, CSE, and SCE.

**Table 29: CSI Thermal Applications by Program Administrator through 2017**

| Program Administrator | Complete and Pending applications | Total Incentive (\$ thousand) |
|-----------------------|-----------------------------------|-------------------------------|
| PG&E                  | 1,739                             | 32,838                        |
| CSE                   | 532                               | 10,642                        |
| SCE*                  | 45                                | 67                            |
| SoCalGas              | 5,181                             | 73,469                        |
| <b>Total</b>          | <b>7,497</b>                      | <b>117,016</b>                |

Source: [http://www.csithermalstats.org/program\\_totals.html](http://www.csithermalstats.org/program_totals.html); data accessed May 27, 2018.

\* 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 3.7 percent of the applications received to date have been for electric-displacing solar water heating systems (see Table 28).

### 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.

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.<sup>58</sup> In accordance with the 2014 CSI Thermal M&E Plan, the CPUC retained Itron through a competitive solicitation to

<sup>58</sup> The CSI Thermal Measurement and Evaluation Plan is available at: (<http://www.cpuc.ca.gov/General.aspx?id=7623>).

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 and Impact Evaluation Reports. Itron and the CPUC's Energy Division are currently in the process of finalizing the CSI Thermal Impact Evaluation Report.

## **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 is 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 has conducted five solicitations for projects since it began. 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.

**Table 30: 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:<br>Grid Integration   | \$9M              | 6                                     | \$5.6M                            | \$6.5M                 |
|                            | Secondary Areas:<br>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                 |
| <b>Solicitations Total</b> |   |                   | 36                                    | \$31.2                            | \$29.7                 |
| Solar Energy Center        |   |                   | 1                                     | \$10                              | -                      |
| <b>CSI RD&amp;D Total</b>  |   |                   | <b>37</b>                             | <b>\$41.2M</b>                    | <b>\$29.7M</b>         |

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

Several CSI RD&D projects have 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 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 ([www.calsolarresearch.ca.gov](http://www.calsolarresearch.ca.gov)).

#### 4.6.2.RD&D Program Evaluation

Pursuant to requirements in D.07-09-042, the CPUC commissioned an independent evaluation of the CSI RD&D program. Results of the evaluation provide the Commission 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 2017<sup>59</sup>. 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)<sup>60</sup> and California Distributed Generation Statistics (California DG Stats)<sup>61</sup> 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 IOU territories.

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

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<sup>59</sup> The CSI RD&D Program – Program Evaluation can be found at <http://www.calsolarresearch.org/>.

<sup>60</sup> See, [www.californiasolarstatistics.com](http://www.californiasolarstatistics.com).

<sup>61</sup> See [www.californiadgstatistics.com](http://www.californiadgstatistics.com).

CSS data is populated entirely from PowerClerk, the CSI program’s online database and application interface. The CSS data 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.
- 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 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”<sup>62</sup> 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 (CTS) site as a public-facing database for the CSI Thermal program. The CTS site launched in February 2015 and contains extensive CSI Thermal program data. The website contains data on all of the customer classes and can also be filtered by backup commodity (natural gas, electricity, or propane). CTS data is populated by the csithermal.com database, and uses Tableau software, which allows for user generation of unique charts and graphics. Video tutorials are posted on the website to assist users. The CTS 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.<sup>63</sup>

- The CPUC’s Annual Program Assessment to the Legislature (this document), required by statute every year no later than June 30<sup>th</sup>.

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<sup>62</sup> See [www.csithermal.com/tracker](http://www.csithermal.com/tracker)

<sup>63</sup> See <http://www.cpuc.ca.gov/General.aspx?id=3747>.

- The Annual CSI Data Annex report. This elaborates on the data annex information available online, showing trends over time, including trends in NEM participation and Program Administrator efficiency in processing CSI applications.
- 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 Evaluation Plan

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:<sup>64</sup>
  - [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 up-to-date information on the CSI program accomplishments, including energy, capacity, and environmental impacts and PV system performance degradation. A final impact evaluation for program years 2011-2016 will be conducted now that the CSI General Market program is closed to new applications.

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<sup>64</sup> See <http://www.cpuc.ca.gov/General.aspx?id=7623>.

- **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](#), commissioned via a competitive solicitation and delivered in January 2016, focused on the current effects of customer-sited solar on CAISO’s net load curve.<sup>65</sup> 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.<sup>66</sup> 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. <sup>67</sup> Based on participant economics, the study suggested that the residential solar PV market would be self-sustaining by 2017, with a mixed outlook for non-residential customers.
- **CSI Thermal Performance Data, Impact, and Technology Project (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

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<sup>65</sup> A competitive solicitation was issued in January 2015 to perform the third bi-annual study. The Commission retained DNV-GL in May 2015.

<sup>66</sup> See <http://www.cpuc.ca.gov/General.aspx?id=7623>.

<sup>67</sup> See <http://www.cpuc.ca.gov/General.aspx?id=7623>.

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 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: [www.GoSolarCalifornia.org](http://www.GoSolarCalifornia.org).

The California Public Utilities Commission Energy Division web site provides information related to the CSI program, including regulatory updates and documents for the Distributed Generation Docket R.12-11-005: [http://www.cpuc.ca.gov/Demand\\_Side/](http://www.cpuc.ca.gov/Demand_Side/)

E-mail for CSI inquiries: [energy@cpuc.ca.gov](mailto:energy@cpuc.ca.gov)

Telephone for CSI inquiries: 415-355-5586

The CSI Thermal program provides program information at [www.CSIThermal.com](http://www.CSIThermal.com)

## 7 CSI Thermal Program Administrator Contacts

### PG&E

CSI Thermal program:  
[www.pge.com/csithermal](http://www.pge.com/csithermal)  
Email: [solar@pge.com](mailto:solar@pge.com)  
877-743-4112

### Center for Sustainable Energy (San Diego territory)

CSI Thermal Program:  
[www.energycenter.org/swh](http://www.energycenter.org/swh)

Email: [SWH@energycenter.org](mailto:SWH@energycenter.org)  
877-333-SWHP

### So Cal Gas

CSI Thermal Program:  
[www.socalgas.com/rebates/solar/](http://www.socalgas.com/rebates/solar/)  
Email: [swh@SoCalGas.com](mailto:swh@SoCalGas.com)  
1-800-Gas-2000