CPUC California Solar Initiative

2010 Impact Evaluation

Final Report
Executive Summary

Submitted to:

Southern California Edison
and
California Public Utilities Commission
Energy Division

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Executive Summary

ES.1 On the CSI 2010 Impact Evaluation

The purpose of an impact evaluation is to assess the changes resulting from a program or policy. The evaluation seeks to answer the questions of how well the program is working and the affects on both participants and non-participants. As the California Solar Initiative (CSI) enters its fifth year, the 2010 impact evaluation investigates how the CSI has affected California's electricity system, the California solar PV market, and the environment.

The 2010 impact evaluation also looks at the CSI within the historical context of the development of California's solar PV industry. California has long been a leader in renewable energy and the CSI is built on a foundation of supportive solar policies and past solar programs. Consequently, impacts of the CSI are measured against this broader solar backdrop.

An impact evaluation should also help inform future direction. To that extent, this impact evaluation examines and makes recommendations regarding interconnection, market transformation, and the potential implications of Net Energy Metering (NEM) PV systems.

There are two caveats to this 2010 impact evaluation. First, we were not always able to obtain statistically valid random sample sizes. Metered data are provided by some but not all participants. In those few instances where we did not have a random sample population, we took steps to minimize sample bias with the data provided. Second, we provide statistically valid impact results only for the CSI General Market (CSI GM) and the Self-Generation Incentive Programs as metered data were not available for the other programs.[1]

[1] Please see sections 3 and 6 for additional descriptions of sampling and impacts estimation methods.

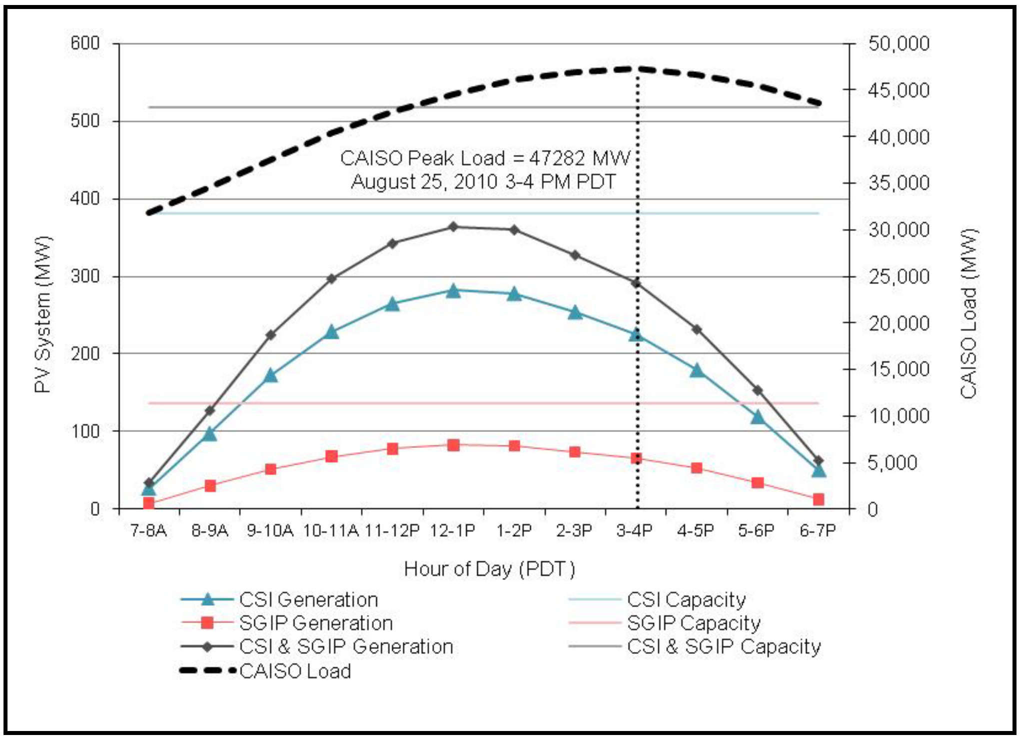
ES.2 Key Findings

The following represent key findings from the report.

ES.2.1 2010 Impacts of CSI GM and SGIP

- **Energy delivery**: CSI GM and SGIP PV systems generated over 800,000 MWh of electricity during 2010. That is enough energy to meet the electricity requirements of approximately 135,000 homes for a year. CSI GM systems contributed over 620,000 MWh of this total; a 59% increase from the amount generated in 2009.
- **Capacity factor**: The weighted annual average estimated capacity factor for all CSI GM and SGIP PV systems in 2010 was 0.19 (0.20 for CSI GM systems and 0.16 for SGIP systems).
- **Coincident peak**: The 2010 CAISO load peaked on August 25 from 3:00 to 4:00 PM Pacific Daylight Time (PDT) at 47,282 MW. In 2010, there were over 36,600 CSI GM and SGIP PV systems online at the time of the CAISO system peak. CSI GM and SGIP PV systems had a capacity factor of 0.56 for the 2010 CAISO system peak hour.

Figure ES-1: CAISO Peak Day CSI and SGIP PV Performance



- **GHG and Air Pollution Emission Reductions**:

  Overall, the CSI GM program and the SGIP provided nearly 400,000 tons of CO_2 emission reductions during 2010. In addition, the CSI GM program and the SGIP provided over 52,000 pounds of PM10 and over 92,000 pounds of NOx emissions reductions during 2010.

ES.2.2 Estimated 2010 Impacts of Examined Public Purpose Programs

Table ES-1: Annual Energy Generation and Capacities—CA Public Purpose Program PV Systems

Program	PV Systems (n)	Rated Capacity (MW)	Generation (MWh)*	Annual Capacity Factor (kWh/kW rebated)
CSI - General Market	41,663	438	622,031	0.20
CSI - MASH	49	2	1,925	0.19
CSI - SASH	372	1	907	0.19
Subtotal - All CSI	*42,084*	*441*	*624,863*	*0.20*
SGIP	890	136	191,512	0.16
ERP	28,033	123	168,580	0.16
NSHP	3,282	9	14,392	0.19
Subtotal - Non-CSI	*32,205*	*268*	*374,483*	*0.16*
All	**74,289**	**709**	**999,347**	**0.18**

* The uncertainty on all estimates in Table ES-1 is better than 90/10 confidence level.

- **Energy delivery**: All programs (i.e., CSI GM, SGIP, ERP, MASH, SASH, and NSHP) combined contributed nearly 1,000,000 MWh of electricity during 2010.

  On an annual basis, the CSI GM program contributes 62% of the total generation, and is orders of magnitude larger than its counterparts, MASH and SASH. The other major contributions are from SGIP and ERP PV systems, with 19% and 17%, respectively.

- **GHG emission reductions**: All programs combined provided over 486,000 tons of GHG emissions reduction (as CO_2Eq).

  The CSI GM program contributes the most reduction at 62%, or over 300,000 tons, while the SGIP contributes over 93,000 tons or approximately 19%. ERP PV systems contribute another 17%, or 82,000 tons; and NSHP, MASH, and SASH combine to make up the remaining 1.7%.

Section 6 and Appendix C of the main report have more detail and information on the energy and emission impacts of CSI and other programs.

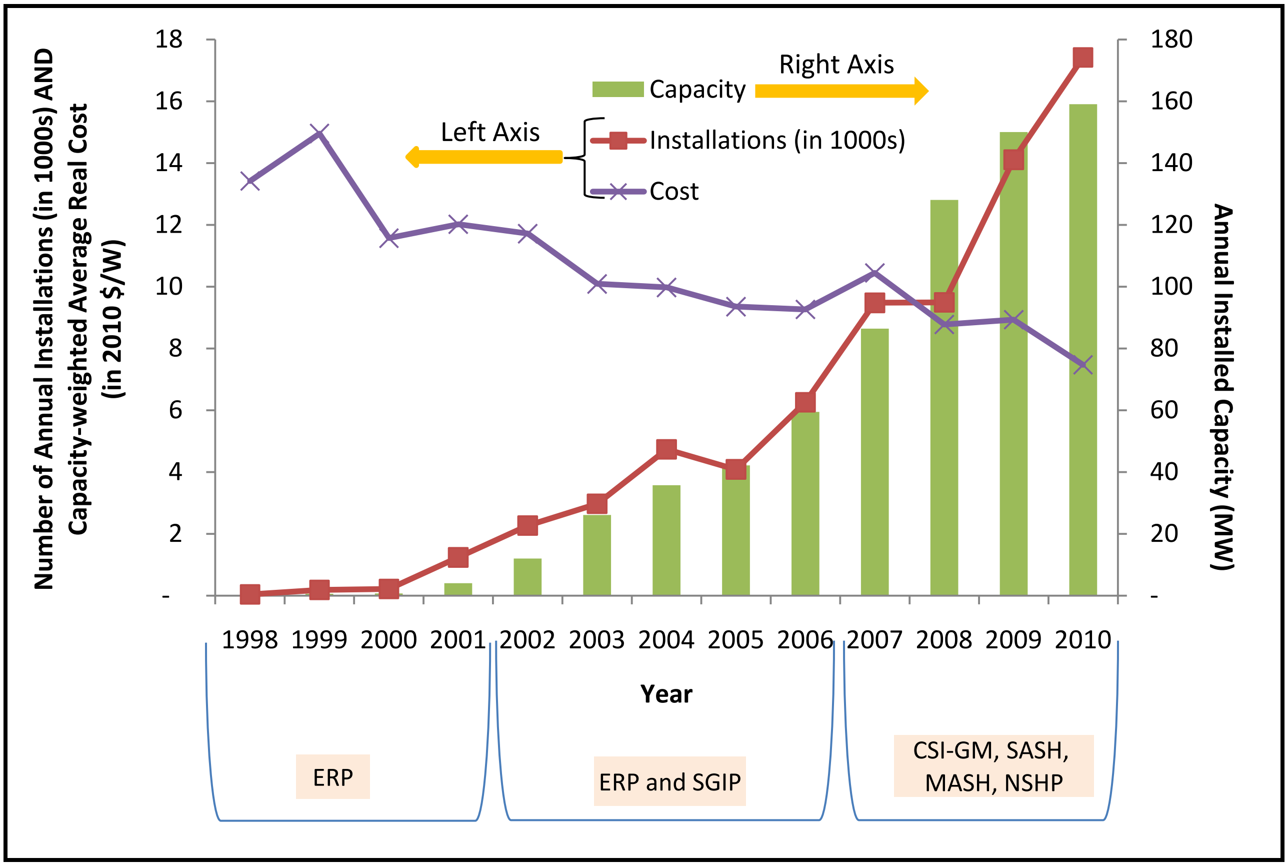
ES.2.3 The CSI in Perspective

- **The CSI has accelerated both the growth of PV systems and installed capacity in California's PV market**

  As a result of the CSI, California represents the fastest growing PV market in the country and provides nearly two-thirds of the country's total amount of installed PV capacity.[2]

- **PV costs under the CSI have decreased rapidly**

Figure ES-2: California IOU Public Purpose Program PV Systems—Trend in Annual Installed Capacity, Number of Installations, and Costs



- **While the CSI is only mid-way to its 2016 goal, additional pressure for PV growth is likely and may pose challenges**

  As of the end of 2010, there were close to 42,000 PV systems installed under the CSI, representing nearly 440 MW of capacity. For the CSI to reach its goal of 1,940 MW by the end of 2016, 60,000 additional PV systems will need to be added for an installed

[2] Sterkel, M. "California Perspective on High Penetration PV," CPUC presentation at High Penetration Solar Forum, March 2011

capacity of nearly 1,500 MW. As California already has over 70,000 installed PV systems, this will bring the total number of PV systems to over 140,000 by the end of 2016.

This may be a conservative estimate of the future number of installed PV systems in California. California's policy goals on the Renewables Portfolio Standard (RPS) and Governor Brown's Distributed Generation (DG) target may increase this number five-fold, bringing the total number of installed systems to well over 500,000 and the total installed capacity to over 5,000 MW by 2020.[3]

- **Rapid growth in the CSI is leading to changes in California's PV markets**

  At the end of 2010, the top 10 module manufacturers accounted for 86% of the total CSI GM installations and 83% of the total installed CSI GM capacity. However, new players have been entering the market and changing the dynamics of the top 10 players. In the first two years of the CSI GM, the top 10 module manufacturers held 95% of the residential market share, but by the end of 2010, this had dropped to 75%. Even more dramatic change has occurred in the non-residential sector, where the top 10 module manufacturers' market share dropped from 95% in 2007 to 69% by the end of 2010.

- **The number of third-party-owned systems has been growing under the CSI GM**

  Overall, 16% of the systems accounting for 37% of installed capacity were owned by third parties.

Table ES-2: CSI GM Systems—Trend in Third-Party Ownership

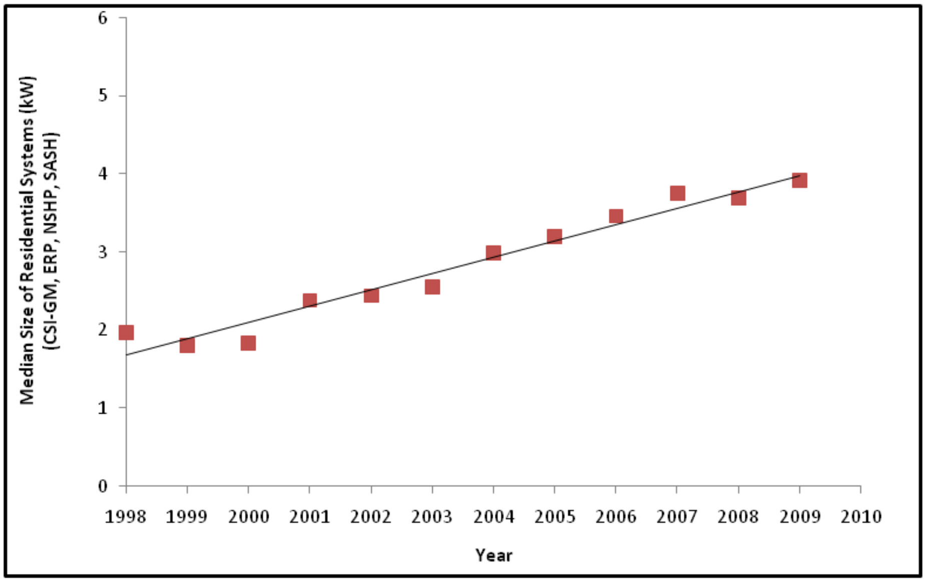
Year	Installed Systems –All CSI GM	Installed Systems –Third-Party-Owned (% of Total)	Installed Capacity –All CSI GM (MW)	Installed Capacity –Third-Party-Owned (% of Total)
2007	3,440	10%	25	29%
2008	8,435	10%	113	43%
2009	13,044	13%	145	39%
2010	16,744	22%	155	31%
Total	**41,663**	**16%**	**438**	**37%**

3 See CPUC, "33% Renewables Portfolio Standard: Implementation Analysis Preliminary Results," June 2009 discussion of the high DG case

- **The size of residential PV systems is growing**

  Between 1998 and the end of 2010, the median size of residential PV systems more than doubled; going from approximately 1.8 kW to 3.7 kW. This follows somewhat the decline in PV system costs that have decreased by 44% from $13.4/W in 1998 to $7.5/W in 2010.

Figure ES-3: Median Residential System Size



- **Incentive structures have led to growth but not market optimization**

  While there has been rapid growth of solar PV in California, statistical analysis indicates purchasers of PV systems do not necessarily take advantage of solar resources appropriately or that there is insufficient benefit for them to take advantage of good solar resources. If the purpose of future solar PV growth is to encourage PV electricity production at lower costs, incentives may be restructured to help the market allocate PV systems to maximize solar resources.

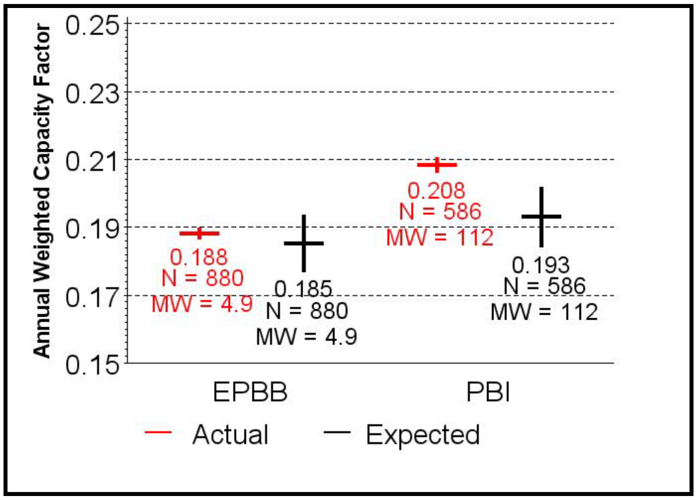
Section 2 of the main report presents more detailed information on program status.

ES.2.4 PV System Performance

- **Overall, CSI GM systems perform better than expected**

  Similar to 2009,[4] Performance Based Incentive (PBI) systems delivered 7.8% more energy than expected and EPBB systems performed 1.6% better than expected. Much of the PBI overperformance appears to be linked to tracking systems.

Figure ES-4: Actual and Expected Performance by Incentive Type



- **Parallel metering validated third-party data values**

  Analysis of parallel metering data showed there is not a statistical difference between Itron and third-party data. Third-party metering showed very slightly higher energy than Itron metering but not in a statistically significant manner.

- **Examination of capacity changes showed a trend that residential customers could be installing additional PV capacity without recourse to incentives**

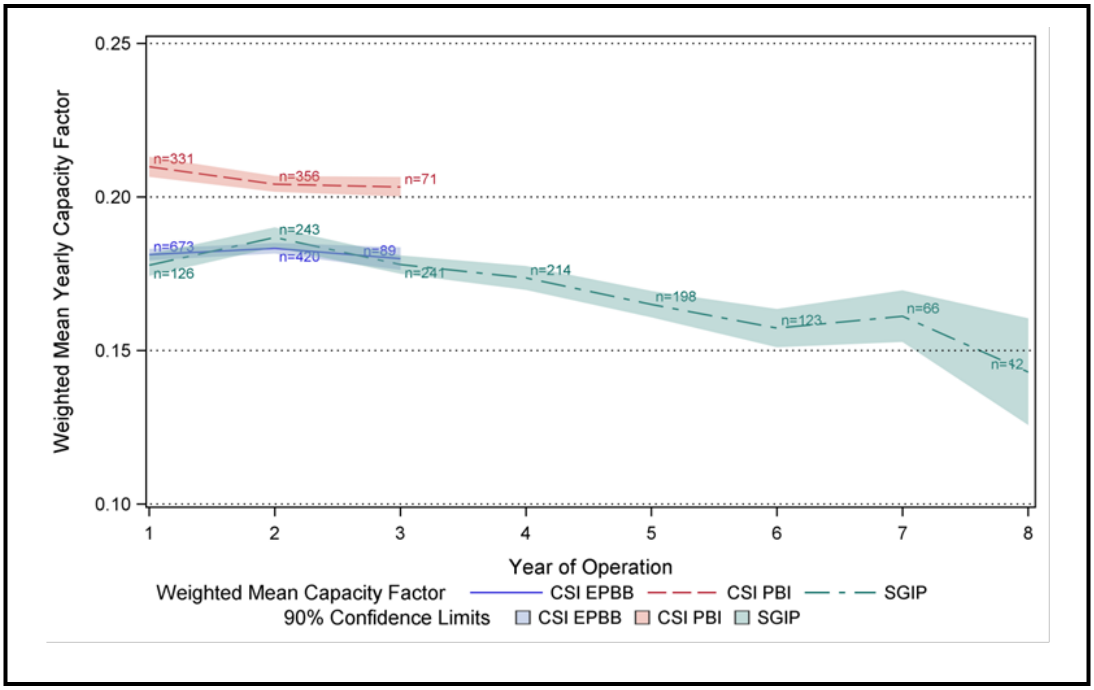
  The residential sector shows an increase in added generation capacity to already installed EPBB systems. While capacity additions on a few systems showed significant changes for individual systems, we found there to be little overall impact on the program for PBI systems.

4 Itron, Inc., *CPUC California Solar Initiative: 2009 Impact Evaluation Final Report*, June 2010, http://www.cpuc.ca.gov/PUC/energy/Solar/eval09.htm

- **PBI PV systems tend to performance better initially, as well as over time**

  Overall, the better initial performance is due in part to more tracking systems. The better performance over time may be evidence that the additional financial incentive act to ensure continued maintenance of the system.

Figure ES-5: PV Performance over Time by Incentive Type

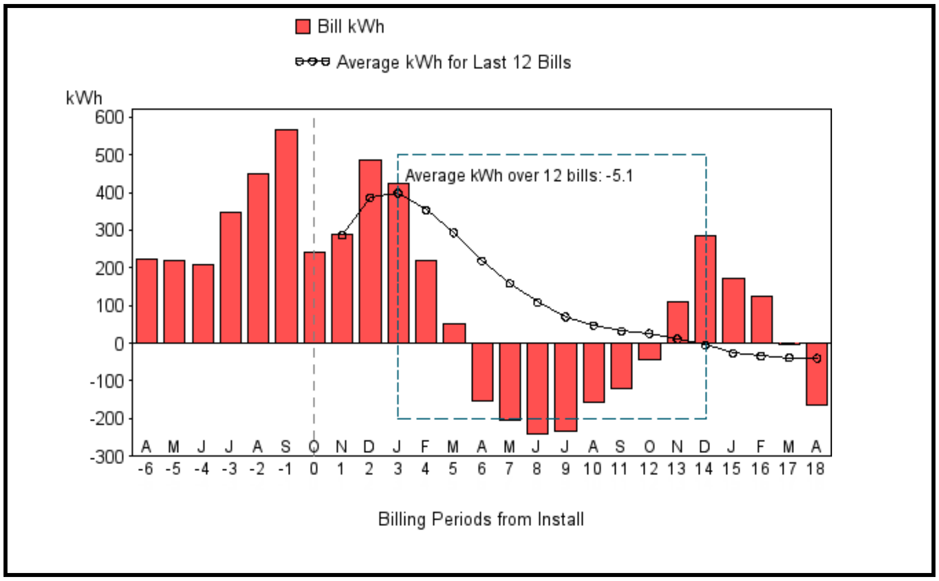


Sections 4 and 5 of the main report present more detailed information on PV performance.

ES.2.5 Energy Exports

- **More than half of the sites (52%) had at least one billing period where the systems generated net excess energy**

Figure ES-6: Graph Example of Frequency of Export over 12-Bill Period



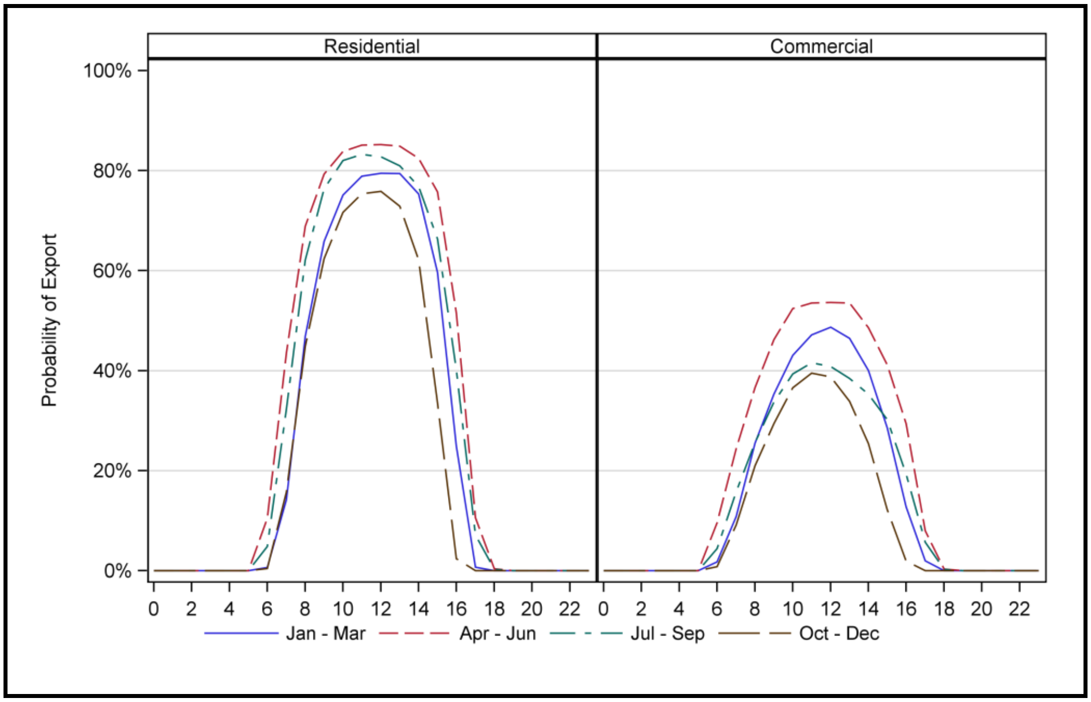
- **Nearly 14% of examined sites qualified as annual net exporters**

  For the residential CSI GM participants, who account for 23,959 of the total sites, there is a clear relationship between system size and the frequency of 12-bill net exports. The percentage of residential yearly net exporters across PAs increases from 12.1% for the smaller systems to 18.6% for systems 7.5 kW and larger.

- **Annual net exporters have lower pre-installation consumption**

  For all three PAs the influence of PV generation on billed consumption is clear and the post-installation bill kWh is lower year round. It is also clear that the combination of high PV generation and low AC loads in the spring contributes to higher exports for the annual net export group during this time period.

Figure ES-7: Likelihood of Export by Hour and Quarter for CCSE Sites



- **Hourly analysis indicates a high probability of export during mid-day hours, especially residential systems**

  There is a very high probability that PV generation will be exported to the grid for the mid hours of the day. Residential systems are far likelier to export mid-day than commercial systems. The analysis of the monthly bills as well as the interval data however, indicate that only a fraction of sites will actually show an annual net export of electricity. This implies that, for most sites, there is a substantial amount of consumption off the grid during non-generation hours, making up for the exported PV electricity.

ES.2.6 Recommendations

1. **The CPUC and PAs should increase efforts to streamline interconnection processes as well as PV permitting and plan check processes**.

   The IOUs have stated they are already challenged by the existing level of interconnection requests being received. Installers have repeatedly noted the delays and costs caused by varying permitting practices. However, PV system installations are expected to double for the CSI to meet the 2016 capacity targets. In addition, growth in third-party-owned systems can be expected to continue in both the residential and non-residential sectors. Lastly, implementation of the RPS and DG policies may result in increased levels of PV installations.

2. **The CPUC should investigate the major drivers that would lead homeowners and businesses to install PV without recourse to incentives.**

   The results of our analysis on capacity additions indicates that some small portion of the residential sector may be moving forward with installing additional PV capacity without using incentives. Given the low incentive levels for residential systems in the CSI, continued development of PV may be driven either by third-party owner models or an innovative approach to financing systems at low cost to the homeowner or business owner. A market analysis should be able to identify the financial and demographic characteristics of the homeowners and businesses that can benefit by pursuing PV systems without the use of incentives, the number of utility customers who fit these characteristics, and the overall magnitude of additional PV capacity that could be expected to result. The study should also investigate how possible loss of the ITC would affect the economics of a non-incentive approach. Understanding and even fostering this growth will aid the transition of PV from an incentive driven industry to a mature and self sustaining industry in California.

3. **The CPUC and utilities should investigate the potential grid impacts associated with the high amount of mid-day export occurring as more PV systems are integrated ino the grid. This investigation should include examining synergies between mid-day export from PV systems on commercial centers and location of electric vehicle charging stations associated with increased growth in electric vehicles.**

   The export analysis done in this study suggests that NEM practices enable a high degree of electricity export into the grid during mid-day hours. As the number of PV systems increases, this reverse flow of electricity has implications on sizing and operation of distribution feeders. In addition, there is movement towards HEV, EV, and PHEV vehicles that may have synergy or conversely, may cause adverse affects with mid-day export of electricity. The time needed to charge an EV/PHEV, at eight hours, may result in EV/PHEV users charging their vehicle both at home and at work. Since residential systems are more likely than commercial systems to export energy in mid-day hours, harnessing this excess using vehicles might be prove challenging if most of the HEV, EV, and PHEV vehicles are driven as daily commuters and parked at commercial facilities during the day.