BEFORE THE CALIFORNIA PUBLIC UTILITIES COMMISSION

REPORT

THE FEASIBILITY OF USING ADVANCED METERING INFRASTRUCTURE FOR THE PURPOSE OF IDENTIFYING SOLAR GENERATION AMONG CURRENT AND FUTURE CSI PARTICIPANTS

SUBMITTED BY

CALIFORNIA CENTER FOR SUSTAINABLE ENERGY

IN COLLABORATION WITH

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JULY 17, 2012

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1. Introduction

San Diego Gas & Electric Company (SDG&E) and the California Center for Sustainable Energy (CCSE) respectfully submit this report regarding the feasibility of using Advanced Metering Infrastructure (AMI) for the purpose of identifying solar generation among current and future CSI participants to the California Public Utilities Commission (CPUC). This feasibility report is submitted in response to Ordering Paragraph 7 of CPUC Decision (D.)11-07-031, the decision implementing California Solar Initiative (CSI) Phase 1 Modifications (). Ordering Paragraph 7 states:

> *The CSI Program Administrators (namely Pacific Gas and Electric Company, Sothern California Edison Company, and the California Center for Sustainable Energy) shall report within one year of the decision to the Energy Division on the feasibility of using advanced metering infrastructure data to make solar production data available to CSI participants, and ensure a copy of this report is sent to the service list of this rulemaking.*

2. Background

The ability to study production data from solar generating systems is a key element in determining the performance of incentivized solar systems. However, even with California's long history of solar incentive programs, it was not until 2007 (when the CSI Program was launched) that performance data collection was initiated to help monitor and measure solar system performance. This initial approach to CSI data collection required all customers receiving solar incentives to install a meter that was linked to a Performance Monitoring and Reporting Service (PMRS). The intent of PMRS is to provide the System Owner with real time remote access to the production of their system. In addition, PMRS sends service alerts to the Contractor and System Owner to address issues that affect system performance. A third benefit of the requirement is that the PMRS provider will deliver quarterly 15-minute interval kilowatt-hour (kWh) energy production data to the CSI Program for a period of five years.

The monitoring and measuring of the performance data is mutually beneficial for consumers, rate payers, and policy makers. For consumers, as stated above, having the ability to view system production without having to physically go to the location of the inverter allows for the System Owner to take steps toward efficiently managing a poorly functioning or non-functioning system. Without this service, the System Owner runs the risk of discovering that the system was non-operational upon receipt of their utility bill, at which point significant cost savings may be lost. For ratepayers, PMRS is an assurance that the subsidized system will continue to produce at the expected capacity for its usable life. Finally, for policymakers, the collection of performance data via PMRS is one component that helps determine if the CSI program has helped reach the strategic policy goals called out at the outset of the CSI Program.

CSI Program Data Collection Standards; PMRS and PDP

As previously mentioned, at the beginning of the CSI Program, an approach to performance data gathering was created with the advent of PMRS and Performance Data Provider (PDP) Services that had stakes in the two types of financial incentives offered from the CSI Program: the Performance Based Incentive (PBI) and Expected Performance Based-Buydown (EPBB) incentive. The PBI incentive is paid on a monthly basis for a period of five years based on the exact kilowatt-hours the system produces, while the EPBB incentive is a one-time incentive based on the expected performance of the system. To ensure PBI incentives are accurately paid, it was necessary for the CSI Program to adopt the items listed below for purposes of metering and monitoring. Some of the requirements (as denoted) cross-over into the requirements set for EPBB projects.

- Minimum system size threshold with a ratcheting mechanism (PBI)
- Qualified list of performance meters (PBI and EPBB)
- Qualified list of PMRS Providers (PBI and EPBB)
- Qualified list of Performance Data Providers (PDP) (PBI)
- Meter accuracy standards of +/-2% (PBI)
- Meter accuracy standards of +/-5% (EPBB)
- Meter measurement and time granularity of acquired data (kilowatt hours in 15 minute intervals) (PBI)

- Meter certification by an independent third party Nationally Recognized Testing Lab (NRTL) (PBI and EPBB)
- Meter communication/data transfer protocols (PBI and EPBB)
- Meter data access (PBI and EPBB)
- Meter display (PBI and EPBB)
- Meter memory and storage (PBI and EPBB)
- Minimum communication requirements (PBI and EPBB)

While the requirements listed above are mandatory for the payment of PBI incentives, EPBB metering via PMRS contained one caveat from the outset of the program that allowed CSI customers to by-pass the installation of performance meters and subsequently the submission of performance data to the CSI Program. This caveat was a PMRS cost cap that allowed solar project integrators to opt out of installing performance meters via PMRS providers if the cost of the meter and PMRS was greater than 1% of the total cost of the solar generating system for projects less than 30 kW. For EPBB projects 30 kW and greater the cost cap was listed at 0.5% of the total cost of the solar generating system.

CSI data shows that a majority of EPBB systems less than 15 kW take the cost cap exemption because, as with the price of PMRS, it typically exceeded 1% of the total system cost. In D.11-07-031, dated July 14, 2011, the Commission opted to remove the PMRS cost cap exemption and require all EPBB systems over 10 kW to take PMRS service and report the data to the CSI Program Administrators on a quarterly basis for five years. The effective increase in the amount of EPBB systems that pay for PRMS service has prompted the question of whether existing utility smart meters are a feasible option for providing PRMS service.

3. Capturing Solar Data via AMI Technology

Without the addition of a second meter, it is currently not feasible to use SDG&E's existing advanced metering infrastructure (AMI) capabilities at the customer's point of service to make solar production data available to CSI participants or the utility. Currently, SDG&E's AMI meters capture the kWh consumption a solar customer is using from the grid, and the excess kWh generation being delivered to the grid. It cannot measure the customer's absolute PV production at the inverter. The existing AMI meters also support external Home Area Network (HAN) communications through a Zigbee radio interface. Although the advancements in consumer technologies can utilize HAN communications to provide kWh consumption information from individual appliances, including a solar generator, the current and deployed infrastructure of solar inverters would not typically be able to operate on the HAN in the same manner. Overall, technology constraints exist that inhibit the current capability of AMI technology to provide PMRS service. Some of those constraints include:

- Communication between the existing inverters and AMI meters is not currently available

- The need for developing more accurate inverter output metering equipment and standards
- Standardized data protocols, data reporting, and the capabilities for common data storage need to be finalized and adopted
- Development of compatible Zigbee firmware at both AMI meters and inverters would need to be developed, installed, and maintained

SDG&E sees the value in utilizing the HAN functionality to provide absolute PV production data but has only touched on a few technology-based developments that are necessary to provide PMRS service. There will be additional infrastructure, customer privacy, and customer service issues during the implementation of these protocols, all of which will come at a cost that may make this option prohibitive to CSI participants. Moreover, these developments are not limited to SDG&E infrastructure; the solar industry would have to modify their products, including inverters, to implement an AMI performance measurement scenario. SDG&E recommends that the CPUC continue to utilize the abilities provided by third-party PMRS providers. This option is not only a current and existing market but will be the lowest cost solution available at this time.

4. Advanced Metering Infrastructure (AMI)

SDG&E's Advanced Metering Infrastructure (AMI), in general, consists of meters that can provide interval data through communication technologies to a centralized MDM (Meter Data Management) system. MDM systems generally interface with utility back office systems to provide the full benefit of interval data. AMI is a key component in SDG&E's vision to create a smart grid along with substation automation, supervisory control and data acquisition (SCADA), and the deployment of intelligent electronic devices (IED), such as reclosers, relays, capacitor bank monitors, breaker monitors, etc. Currently, almost all of SDG&E's 1.4 million customers have AMI meters installed; approximately 17,000 of those are solar customers.

Meter Functionality

As for limitations of the existing AMI metering equipment, it needs to be clearly understood that the existing AMI meter located at the customers Point of Service is only capable of measuring the voltage available to customer and total current being drawn by customer load (delivered energy) or the excess current being generated from PV systems (received energy) that is not being used by the customers load. From these two quantities (volts and amps), the customer's demand (kW) and energy consumed over time (kWh) can be calculated. These energy quantities are stored in memory registers of the AMI meter and are displayed for customer verification and meter reading and also are recorded in intervals of time as Load Profile or Interval Data. SDG&E's AMI meters currently being deployed on PV customer homes utilizing a 2-channel 15-minute interval configuration, as shown in Figure 1.

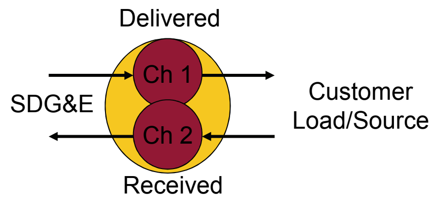
FIGURE 1

SDG&E
A Sempra Energy utility

Meter Applications

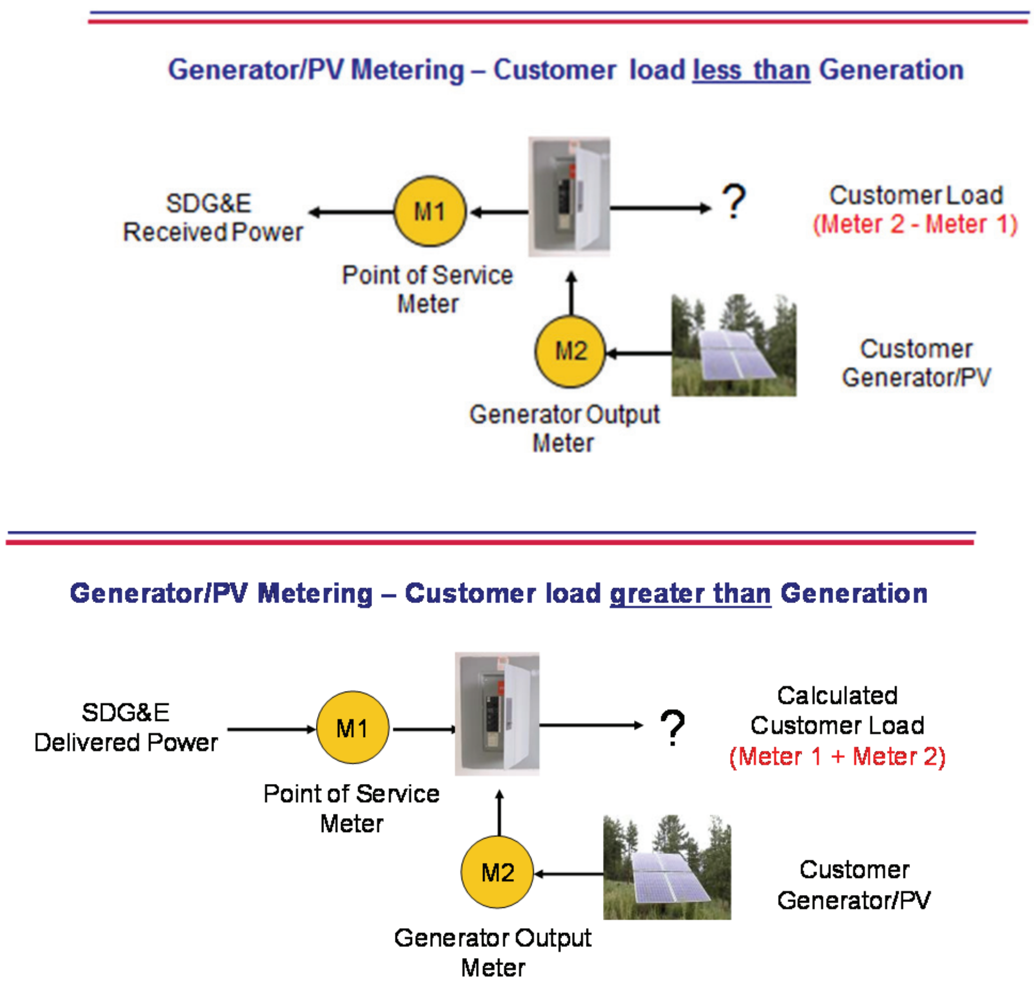
Bi-directional & NET Metering (kWh, kW)

- Measures Delivered and Received energy as seen from the Utility side of the meter
- Records information on separate register and interval channels
- Must be used where different $ are assigned to delivered and received power
- Net values calculated by subtracting received energy from delivered energy



The customer's Point of Service meter is not capable of differentiating where the electricity is being used downstream of the meter. Therefore, there is no way to capture the portion of energy that is contributed by Solar Generation, or how much is being used by an Air Conditioner or any other single load connected to the customer's panel. When you have three varying values at a PV customer's home (SDG&E Contribution, Solar Contribution and Customer Load, as shown below in Figure 2) you must measure at least two of them to be able to determine the third. Therefore, a single meter at the customer's home is only capable of measuring the power being delivered and received at the Point of service.

Figure 2



In order to utilize SDG&E's AMI technology for monitoring the output of the Solar Generator at the inverter, a second meter must be installed at the M2 location of Figure 2. Typically SDG&E does not work on the customer side of the meter and is not responsible for the installation and maintenance of the meter panel and breakers. A properly licensed electrician must install conduit, reroute wire and connect a properly configured single meter socket next to or in proximity of the customers Point of Service Meter. The meter socket would be in series with the PV inverters A/C output wiring and the PV's disconnect or between the PV's disconnect and the customers breaker feeding the inverter control power. Once this socket is installed and inspected by the governing authorities, the utility would install the appropriately configured AMI meters. The existing AMI Collection Engine and RFLAN mesh network would take over the secure reading of all interval data and register values from the PV output meter and store information to be provided for the CSI program to whomever is authorized to receive the customer's data.

AMI meter functionality is rapidly converging across the suppliers to formulate a "typical" set for residential and light commercial meters. The most common features (available from several suppliers) have the following general functions:

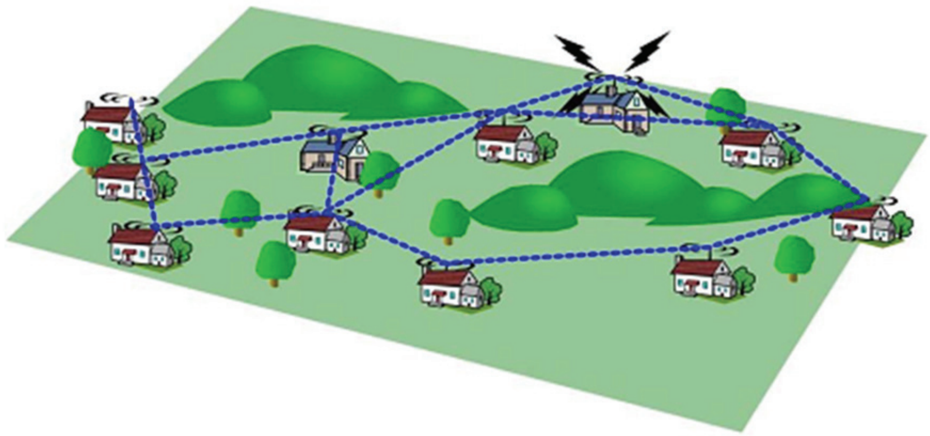
- Interval recording of watt-hour usage with configurable interval limits, with non-volatile storage from several months to years depending upon the number of channels being recorded
- Interfaces to communications hardware (such as radio) or built-in ("*under glass*") communications facilities
- Compatibility with emerging communications standards, including ANSI C12.22
- Remote download of meter firmware revisions and reprogramming commands
- Zigbee Home-area network interfaces to devices at the site such as:
    - Submetering devices

- In-premise customer displays
- Collection of gas and water consumption data from external metering devices
- Controllable end-use devices, such as electric water heaters, air conditioners

SDG&E's Communication Network

SDG&E's Openway solution utilizes wireless radio frequency mesh networks as their local area network (LAN) communications and public wireless networks as their wide-area network (WAN) communications. A mesh network used at SDG&E relies, at its core, on the deployment of smart devices that have the ability to relay communications from peer units. The elements interact so that a self-configuring and self-healing network forms. A Cell Relay or "take-out" point is used to link the communications to back office systems used to process the data. The network requires sufficient density to form the mesh; however, this also can be a drawback since congestion and routing need to be managed to ensure adequate throughput. Figure 3 illustrates how a mesh network works.

FIGURE 3



SDG&E has included home area networks (HAN) as part of its AMI/smart grid implementation. The Zigbee™ wireless communications protocol is emerging as the leading standard protocol for HAN-enabled meters and devices. HAN is an extension of smart grid or AMI technologies into customers' homes. It transmits data between a utility smart meter and home energy devices through a communications gateway. With HAN, utilities and customers can potentially manage load by remotely controlling home devices, such as programmable and communicating thermostats, load control units, in-home display devices, and distributed energy resources.

5. Summary of findings

SDG&E's AMI infrastructure is currently developing into one of the most important tools utility operations can use to communicate with their customers. However, as currently deployed, there are limitations to AMI technology; most importantly an inability to segregate PV data for the uses of optimizing the infrastructure or customer benefit. As stated above, to fully integrate AMI technology with appliances, devices and solar generating systems located on the customer side of the meter, further infrastructure beyond SDG&E's current capacity will be needed. Whether it is the load of an air conditioner or the production coming from a solar generator, the usage of Zigbee communication devices along with Home Area Network communication would need to be utilized in order for the AMI meter to be completely integrated and synced.

One solution that could presently be implemented to get the solar industry and the utility one step closer to AMI and solar monitoring integration is the mandate that all inverters installed on grid-connected solar generating systems installed in California be required to include a Zigbee communication device. Since the State of California currently maintains a list of incentive program eligible solar inverters[1] that are measured for performance test protocols, the State could further modify the protocols to include Zigbee communication devices that would have to be built into inverters.

The mechanism to entice inverter manufacturers to include this extra device is the eligibility of their equipment to receive a solar incentive via the CSI Program or one of the many solar incentive programs administered by the municipal utilities. Once the Zigbee communication is installed in the inverter, the utility smart meter could utilize the HAN and collect the solar production data. In fact, SolarEdge, a manufacturer of inverters currently includes Zigbee

[1] The list of Eligible Inverters can be found at: www.gosolarcalifornia.ca.gov/equipment/inverters.php

technology in their line of solar inverters that enables either wireless mesh network between multiple inverters at a site, or wireless link between a single inverter and a remote internet gateway point.

Once this data is collected, the utility could use it to meet the peak load and reserve requirements of CPUC jurisdictional Load Serving Entities (LSEs). At the same time, SDG&E could provide this data back to the customer in an easily viewable format in real time, identical to the function of PMRS providers. SDG&E has a customer tool named Energy Charts that delivers daily energy use and could easily include solar generation data, allowing the customer to view how exactly the utility calculates net energy metering. This data could also be required to be reported to regulators for purposes of determining solar impact on California's utility regardless of whether or not the system was installed through an incentive program.

CCSE and SDG&E appreciate the opportunity to provide this report regarding the feasibility of using AMI for the purpose of identifying solar generation among current and future CSI participants to the CPUC.