PG&E

CSI Solar Production Data AMI Handling

Technical Feasibility Report

July 16, 2012

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I. Introduction

DEKRA respectfully submits this technical feasibility report on behalf of Pacific Gas and Electric Company (PG&E) to the California Public Utility Commission (CPUC). This report is in response to Ordering Paragraph 7 (OP7) of the CPUC's California Solar Initiative (CSI) Phase I Modifications Decision D.11-07-031, which set forth a requirement for PG&E to report on the feasibility of integrating Automated Metering Infrastructure (AMI) with solar photovoltaic (PV) systems to make solar production data available to CSI participants, due July 14, 2012:

> "*The CSI Program Administrators (namely Pacific Gas and Electric Company, Southern California Edison Company, and the California Center for Sustainable Energy) shall report within one year of this decision to 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.*"

PG&E understands "solar production data" stipulated in OP 7 to be interval data reflecting the CSI participants' PV systems' absolute energy generation. This data is not netted out against consumption of the PV's generation onsite or by the customer's consumption of energy from PG&E; rather it is gross PV interval generation data.

Moreover, this feasibility report addresses technical functionality only. Whether using SmartMeter technology or AMI to make absolute PV production data available to CSI participants is ultimately the best choice - given cost, customer need, market development, or other considerations - remains unknown, and is beyond the scope of this PG&E/DEKRA report's scope.

Based on interviews with PG&E staff across the company's various departments relevant to this topic, a sequence of legal and technical constraints was identified and is set forth in the following six sections, which support the conclusion in the final section:

- General Overview

- Metering

- Data Transmission (Backhaul)

- Backend Meter Data System (Backend)

- Data Presentment System

- Customer Service
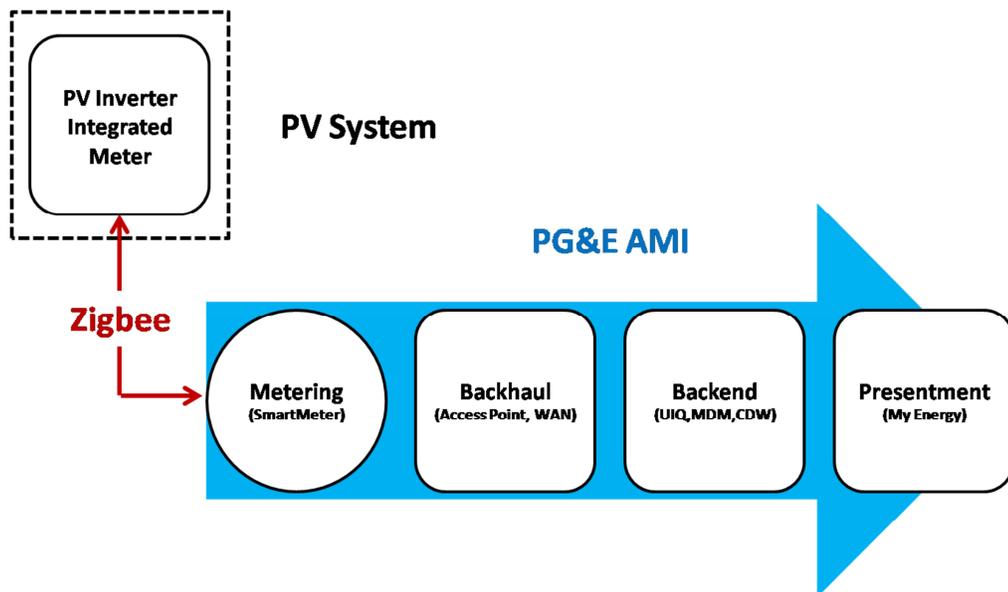
II. Definition List

- Absolute PV production data

  Overall energy production of the photovoltaic system, before any loads are encountered.

- ANSI C12.20

  The C12.20 standard establishes the physical aspects and performance criteria for a revenue meter's accuracy class. Class .5 meters have ± 0.5% accuracy; class 2 meters have ± 0.2% accuracy.

- AMI (Automated Metering Infrastructure)

  Systems that measure, collect, and analyze energy usage, and communicate with metering devices such as electricity meters, gas meters, heat meters, and water meters, either on request or on a schedule. These systems generally include hardware, software, communications, consumer energy displays and controllers, customer associated systems, Meter Data Management (MDM) software, and supplier business systems.

- California Solar Initiative (CSI)

  The California Solar Initiative (CSI) is overseen by the California Public Utilities Commission (CPUC) and provides incentives for solar system installations to customers of the state's three investor-owned utilities (IOUs): Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E). The CSI Program provides upfront incentives for solar systems installed on existing residential homes, as well as existing and new commercial, industrial, government, non-profit, and agricultural properties within the service territories of the IOUs.

- Mesh communications network

    Mesh networking (topology) is a type of networking where each node must not only capture and disseminate its own data, but also serve as a relay for other nodes. Each node must collaborate to propagate the data in the network.

- Over-the-Air Programming (OTA)

    Various wireless methods of distributing new software/firmware updates or configuration settings to smart meters.

- Photovoltaic System (PV)

    Photovoltaic systems use solar panels to convert sunlight into electricity. A system is made up of one or more solar panels, usually a controller or power converter, and the interconnections and mounting for the other components.

- Photovoltaic System Inverter Meter

    The inclusion of an electric energy meter within a PV DC-to-AC inverter.

- Smart Energy Profile (SEP) standard

    This standard, created and managed by the ZigBee Alliance, addresses the interoperability of products that monitor, control, inform and automate the delivery and use of energy and water. SEP version 2.0 is currently under development, and will offer IP-based control to advanced metering infrastructure and home area networks, for improved security.

- Wide Area Network (WAN)

    A telecommunication network that covers a broad area.

III. General Overview

A. Description

As part of a statewide effort to upgrade the power grid, Pacific Gas and Electric Company (PG&E) has been upgrading all of its customers to SmartMeter™[1] technology. SmartMeter AMI is a key part of the Smart Grid upgrade process. PG&E is currently on track to install 10 million meters using SmartMeter technology by the end of 2013.

SmartMeter AMI is comprised of a network infrastructure and an electric application suite that includes advanced metering administration software for configuring, upgrading, and managing the SmartMeter utility network.

The SmartMeter software suite automates the process of collecting meter data and exporting that data to PG&E's Meter Data Management System (MDMS). Having continuous connectivity with meters enables PG&E to improve energy efficiency, increase the accuracy of customer billing, supports remote disconnect and reconnect services, and improves outage detection, isolation and restoration services.

B. Constraints

While assessing the capability of PG&E's SmartMeter AMI to make absolute PV production data available to CSI participants, DEKRA identified the following General constraints:

Customer Privacy. It is unclear how the collection, storage/preservation, and dissemination of data from CSI participants' privately-owned PV systems by PG&E would be viewed from a legal or public relations standpoint; for instance, whether customers would need to affirmatively "opt-in". These concerns would need to be addressed by the CPUC prior to any further investigation of feasibility.

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[1] SmartMeter™ is a trademark of SmartSynch, Inc. and is used by permission.

Not all PG&E CSI customers presently have SmartMeter AMI. PG&E is currently in the process of offering SmartMeter technology at each net energy metering customer location. PG&E expects to substantially complete these installations in 2013.

IV. Metering

A. Description

The PG&E SmartMeter AMI consists of intelligent endpoints that rely on a wireless radio frequency mesh communications network topology. The IP-based mesh network includes SmartMeters, Access Points, and Relay Devices all equipped with network interface cards (NICs) that provide the interconnectivity.

Every electric SmartMeter device comes equipped with a ZigBee Home Area Network (HAN) gateway. When enabled, the gateway can transmit customer usage data to the utility for secure customer viewing through PG&E's customer-facing website, as well as to a ZigBee enabled HAN In-Home Display (IHD) unit. The IHD units can then present energy use, pricing, and energy alert information to allow customers to take actions that potentially minimize energy use and therefore lower their bill.

The PG&E SmartMeter AMI only measures and calculates net production data, not the absolute PV production data of the PV system. Depending on the energy demand of the customer's premise, some PV generation is used onsite and the balance in real time is delivered back to the grid in the form of negative energy flow. The PG&E SmartMeter AMI currently only measures and reports the net flow of electricity across it, which would not account for any portion of PV generation being consumed on site. The available communication channel is via the ZigBee interface and must be certified to the Smart Energy Profile (SEP).

B. Constraints

While assessing the capability of PG&E's SmartMeter AMI to make absolute PV production data available to CSI participants, DEKRA identified the following Metering constraints:

Inverter Meters cannot communicate with SmartMeters. A ZigBee-enabled solution to sub meter generation data from solar inverters would need to be available. It may be possible to use either an inverter with a built in ZigBee meter, or a ZigBee-enabled sub meter to perform the functionality. The availability of either

self-contained inverter meters or external ZigBee sub meters is not known. ZigBee is the current AMI industry standard protocol for communication within the HAN, and the AMI system is designed to communicate using this protocol. Classes of PGE&E's SmartMeters include a ZigBee radio chip and HAN grade firmware. Any version of a ZigBee-enabled inverter meter or separate sub meter would need to undergo acceptance testing with PG&E's electric application/firmware vendor.

SmartMeters may require network message testing or new firmware. Depending on the method of data integration, additional message testing and/or changes to the meter firmware would be required. It is possible to use the ZigBee gateway on the meter to route simple network messages through the SSN (Silver Spring Networks) network. The messages would contain usage data generated by the inverter meter and be routed through the network to an alternative server that collects the absolute PV production data and does not use the native system vendor SSN smart meter data collection channel(s). If this system were to be used, however, the implications of this additional message traffic would need to be tested. Alternatively, if absolute PV production data were to be handled within the current AMI data system, new SmartMeter firmware would be required to handle the additional PV generation channel or to route data traffic. In addition to the logistical and network implications of pushing new firmware to all SmartMeters, the new firmware would require extensive integration testing and pilot deployment.

Inverter meters are less accurate than SmartMeters. The Inverter Meters are required to self-report at +/-5% per CEC-300-2008-007-CMF, whereas SmartMeters report at +/-0.5% per revenue standard ANSI C-12.20. To report and value absolute PV production data in a meaningful way, it is recommended that the accuracy of vendors' Inverter Meters be brought into conformity with ANSI C12.20.

V. Data Transmission

A. Description

Data Transmission, or "Backhaul", refers to the transmission of data from the SmartMeter to the Access Point, and then from the Access Point to PG&E backend system components. Backhaul to the PG&E backend system is accomplished over a secured, third party public wireless network.

Access Points (APs) and Relays provide the connections between the RF mesh network linking all the intelligent endpoints and the utility's backhaul WAN links. The APs support the utility's various WAN backhaul technologies, and the Relays extend the RF coverage in spots where another mesh meter isn't located and an Access Point remains out of range. Both devices help propagate the RF signal and help to optimize the RF mesh network.

B. Constraints

While assessing the capability of PG&E's SmartMeter AMI to make absolute PV production data available to CSI participants, DEKRA identified the following Transmission constraints:

There may not be enough bandwidth to move the absolute PV production data. A backhaul bandwidth architectural review and modeling would be required to determine capacity requirements for core billing and non-billing data transmission. This may identify the need to increase planned capacity to move the absolute PV production data through PG&E's SmartMeter AMI to the backend system components, whether as an additional AMI data channel or separate network message.

The network would need validation testing. The PG&E SmartMeter AMI was engineered to collect data from utility-owned and certified meters. The performance and security impacts of additional data from private sources have not been assessed and would need to be thoroughly tested and verified.

VI. Backend Meter Data System

A.   Description

SmartMeter data which are used for billing, customer presentment, or other utility uses are received, validated, and stored/preserved in PG&E's backend meter data system ("backend"). Specifically, these are the SSN Utility IQ (UIQ) system, the Meter Data Management System (MDM), and the Customer Data Warehouse (CDW).

The PG&E SmartMeter AMI interfaces directly with critical SmartMeter Backend systems. The SmartMeter Backend is comprised of the following systems; Meter Data Management (MDM), Customer Information System (CIS), Customer Data Warehousing (CDW) and Outage Information System (OIS).

Each system performs independently of each other, and they have specific interfaces that allow the combined system to interact as a complete end-to-end solution. The SmartMeter electric application directly interfaces with the MDM system and the MDM receives interval meter read data from all SmartMeters. The MDM processes that meter data and subjects it to Validation, Editing & Estimation (VEE) rules[2]. After VEE, the MDM sends the processed usage data to the CIS for derivation, bill calculation, and billing operations. The same meter usage data is also sent to the CDW system, where that daily usage data now resides for Sarbanes-Oxley compliant archiving, and is used for internal and external customer reporting purposes (web presentment).

It is noted that if absolute PV production data were to be communicated through the external SSN server via direct network message, the need of additional data storage capacity of the backend systems mentioned above may be reduced.

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[2] Refer to California Public Utility Commission document "Standards for Validating, Editing, and Estimating Monthly and Interval Data" revision 2.0.

B.   Constraints

While assessing the capability of PG&E's SmartMeter AMI to make absolute PV production data available to CSI participants, DEKRA identified the following Backend Meter Data System constraints:

Backend system components may require new software upgrades for additional functionality for a new data stream. It is known that the SSN UIQ system would require a software version upgrade since it would receive and validate the absolute PV production data. Functionality of other backend system components would require an in-depth review to determine software upgrades needed. Costs and time needed to implement these software upgrades are not known. Alternatively, if the external SSN UIQ server is used via direct network message, the number of backend components requiring upgrade can be minimized.

Integration testing would be required. As absolute PV production data were not included in the enterprise architecture, additional integration testing would need to be performed to assure that all backend components function normally regarding customer revenue data, and to ensure that revenue data would not be impacted by the transmission of the absolute PV production data.

Absolute PV production data would impact data storage/preservation need. A data storage/preservation review would be required to identify the need for additional capacity at the backend system components (SSN UIQ, MDM, CIS, CDW, and presentment components). Costs and time needed to acquire and plan for this additional capacity are not known.

New work processes must be written. Current PG&E staff work instructions for use of the backend system components, including programing, testing, piloting, and implementing upgrades would require revision based on the absolute PV production data.

VII. Data Presentment System

A. Description

Data that is stored/preserved in the CDW can be accessed by the Data Presentment System for analysis and presentment by means of the "My Energy" web portal. This work is currently performed by third party vendors such as OPower and C3.

B. Constraints

While assessing the capability of PG&E's SmartMeter AMI to make absolute PV production data available to CSI participants, DEKRA identified the following Data Presentment System constraints:

Absolute PV production data cannot be used in conjunction with net usage data through the SmartMeter to calculate gross customer consumption. It is reasonable to anticipate that CSI participants would attempt to calculate their consumption data using the PV production and net usage data through the SmartMeter. As discussed in the Metering section of this report, the PV Inverter Meter and the PG&E SmartMeter technology maintain inconsistent degrees of accuracy, rendering any attempt to calculate consumption from these two values error prone. Another complicating factor is the potential mismatch between the data collection intervals of a given PV Inverter Meter and the PG&E SmartMeter onsite. These issues could result in significant customer relations and support issues, as well as increased call center volume. The costs associated with educating customers about the varying accuracies of the equipment used to provide absolute PV production data and net usage data through the SmartMeter are not known.

Additional presentment options may be required. The extra absolute PV production data presentment format would need to be evaluated and researched. A review of current presentment architecture for more effective delivery, considering current vendor capability/performance and CSI participant feedback, would be required.

VIII. Customer Service

A.   Description

Currently, PG&E customer service systems are designed to assist customers with delivered energy and billing issues. The addition of a new data stream - one which is outside PG&E's ability to manage or alter - may likely generate a significant volume of additional customer service calls for PG&E without PG&E having control over methods to mitigate the higher call volume.

B.   Constraints

While assessing the capability of PG&E's SmartMeter AMI to make absolute PV production data available to CSI participants, DEKRA identified the following Customer Service constraints:

Field Tools software upgrade would be required. Field Service Units (FSUs) would require a new firmware upgrade along with the SmartMeter firmware upgrade, and field technicians would require additional training. Costs and time needed to upgrade FSUs and train field technicians on the upgrades are not known. Alternatively, if absolute PV production data uses the external SSN server to communicate via direct network message only, FSUs may not require an upgrade.

PG&E would confront additional perceived responsibility and liability.
Regardless of the PV inverter vendor's responsibility for the absolute PV production data's accuracy, and regardless of the quality of the PV installation, if the absolute PV production data were to be reported via PG&E's own "My Energy" web portal, PG&E would invariably become a first point of contact for customers. Although PG&E would have no ability to affect the quality of absolute PV production data or the performance of the customer's own PV system, customers may perceive that some measure of responsibility or liability accrues to PG&E.

IX. Conclusion

The number and severity of the challenges inherent in the constraints identified in this report lead PG&E to conclude that the use of its advanced metering infrastructure to make absolute PV production data available to CSI participants is not practical at this time.

Among the identified technical constraints, it is notable that even if PG&E were currently prepared to accept absolute PV production data, as of the writing of this report, the PV industry does not have an approved ZigBee inverter protocol; a critical component to making absolute PV production data available to CSI participants via PG&E's SmartMeter AMI as explained in the "Metering" section of this report.

In light of the legal and technical constraints identified in this report, and considering that a market exists in which third party performance monitoring providers currently make absolute PV production data available to customers through web interfaces, it is suggested that the CPUC continue to encourage customers to explore this third party option.

Though the third party option requires that customers manage two separate interfaces to interact with their data – PG&E's "My Energy" web portal for usage data and a third party's website for absolute PV production data – this existing, low-cost solution is preferable to the potentially high-cost approach of using PG&E SmartMeter AMI until such time that all the legal and technical constraints identified in this report, as well as any others not identified here, have been thoroughly investigated and addressed.

Once all constraints have been thoroughly investigated and addressed there may be value in reexamining the feasibility of using PG&E SmartMeter AMI to make absolute PV production data available to CSI participants.

X. About DEKRA

DEKRA holds a leading position in management and industrial testing and certification services. More than 3,900 employees in competence centers of utility, environmental protection, health and safety, real estate and construction, and standards certification provide a range of services for over 70,000 industrial customers.

DEKRA audits to recognized quality management systems, national and international utility and telecommunications standards, and risk standards using comparison tools such as Software Engineering Institute (SEI) and Smart Grid Maturity Model (SGMM) approaches, as well as proprietary DEKRA tools.

- Member of the ANSI-RAB and advisory councils. Observer ANAB Board as the IAAR Chairman.
- QUEST Forum (TL9000) – Oversight Committee participation
- AAQG [AS9100] forum participant
- IACBA [TS16494] forum participant
- CMDCAS forum participant
- IAAR [Independent Association of Accredited Registrars] – Chairmanship President in North America
- EFAC (EU) membership
- IAF [International Accreditation Forum] - Global body-Technical Committee Representative