**BEFORE THE PUBLIC UTILITIES COMMISSION OF THE**

**STATE OF CALIFORNIA**

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|---|---|
| Application of Pacific Gas and Electric Company (U39E) in Compliance with Ordering Paragraph 37, Resolution E-4906. | Application 18-10-008 |
| And Related Actions. | Application 18-10-009<br>Application 18-10-010 |

# JOINT INVESTOR OWNED UTILITIES' SUPPLEMENTAL FILING OF 2019 TEST YEAR INSTALLATION REPORT PURSUANT TO ORDERING PARAGRAPH 37 OF RESOLUTION E-4906


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**Dated: November 18, 2019**

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Pursuant to Resolution E-4906 (Resolution), Southern California Edison (SCE), Pacific Gas and Electric Company (PG&E) and San Diego Gas & Electric Company (SDG&E), referred to collectively as the Investor Owned Utilities or IOUs, are required to make a supplemental filing in the above-consolidated proceeding that includes a report showing the results of a test pilot of interval meter and data logger installations (Test Year Installation Report). Although Ordering Paragraph 37 of the Resolution directed the IOUs to provide a supplemental filing by October 19, 2018, the IOUs in a July 15, 2019 letter to Executive Director Stebbins, requested an extension of time to comply with the Supplemental Filing deadline. On September 3, 2019, Executive Director Stebbins partially granted the IOUs' extension request and directed the IOUs to submit the Test Year Installation Report by November 18, 2019.

On behalf of the IOUs, SCE is filing the attached Test Year Installation Report prepared by Nexant, Inc.[1] Nexant has included several recommendations in its Test Year Installation

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[1] Pursuant to Rule 1.8(d), representatives for PG&E and SDG&E have authorized SCE to sign and submit this Supplemental Filing on their behalf.

Report. These recommendations do not necessarily reflect the views held by the IOUs, however, the IOUs look forward to considering these recommendations and providing feedback on the report at the public workshop currently scheduled for December 5, 2019.

Respectfully submitted,

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# Appendix A

REPORT

# California Demand Response Prohibited Resources Verification Administrator Metering Pilot Report

November 18, 2019

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# 1 Executive Summary

The following report summarizes the activities, outcomes, and recommendations of a field study carried out by Nexant, Inc., under contract with Southern California Edison Company (SCE), and in partnership with Pacific Gas and Electric Company (PG&E) and San Diego Gas and Electric Company (SDG&E). The study piloted two different types of data collection devices toward the end of developing the public record on the utility and strengths and weaknesses of the use of interval meters and data loggers in monitoring the operation of customer-owned fossil-fueled generation.

Utility customers in California that participate in demand response (DR) programs, pilots, and market products have been prohibited from using certain fossil-fueled generators (DR Prohibited Resources, or PRs) to produce reductions in load served by the utility when dispatched for DR events. The Prohibition went into effect on January 1, 2019. SCE, PG&E, and SDG&E have engaged Nexant to serve as a third-party Verification Administrator (VA) to carry out a DR PR Verification Plan that was approved with modification by the California Public Utilities Commission (CPUC) on June 21, 2018, in Resolution E-4906. The Verification Plan, as modified, provided for a Metering Pilot to be conducted in 2019 for the purposes of gathering data and field experience to develop the record and inform recommendations on which data collection technology is best suited for the future inclusion in the Verification Plan.

Currently, the Verification Plan leverages information sources related to the timing of customer use of PRs already in existence when the Prohibition when into effect. The Verification Plan provides for an annual audit of a random sample of investor-owned utility (IOU) DR program and Demand Response Auction Mechanism (DRAM) product participants. When a DR program or product participant that owns a PR and has agreed that they will not use it to produce DR load reductions is selected for audit, the Verification Plan relies on customer-maintained operating manifests to verify that they do not use their PR(s) to produce load impacts. Operators of fossil-fueled generators are required by California law to maintain such manifests. The Verification Plan could alternatively require the installation of data collection equipment that monitors and records data pertaining the timing and use of PRs. The data recorded by electronic monitoring equipment would be more difficult to falsify than a customer-maintained operating manifest and may be more suitable as information that can be reliably used for audit purposes.

The Metering Pilot was fielded in the spring of 2019 and resulted in the installation of data loggers and interval meters at 38 customer premises located throughout California. The 38 installations meet a CPUC mandate for the Metering Pilot to include 10% of the eligible population of DR participants, which as of April 2019 was comprised of 345 service accounts or premises. The devices were placed in the field prior to the dispatch of any summer DR program events and the devices were removed the first week of October 2019. Installations included customers located in the service territory of all three IOUs involved in the study, and included customers participating in SCE's Agricultural Pumping-Interruptible program and the statewide Base Interruptible and Capacity Bidding programs. Many Metering Pilot participants had more than one PR located on site – installation protocol for the pilot provided for installing data collection devices on all PRs found on site. A total of 58 data collection devices were deployed in order to monitor a total of 56 PRs encountered by the field technicians and electricians.

All PRs monitored by the Metering Pilot can be classified into one of two use cases: back-up generators (BUGs) and fuel cells. The BUGs monitored by this Metering Pilot were nearly never operational and under load during the study. The fuel cells were constantly operational, as would be expected of a baseload-serving power resource. Three PRs were found to be operating during DR events this summer. Two of those PRs are fuel cells that were monitored with interval meters. The data collected by the interval meters conclusively shows that the fuel cell operation observed during the DR event hours was not for the purposes of producing DR load reductions and was no different than non-event days. The third PR that was found to be operating and serving load during DR event hours is found to be in violation of the Prohibition. The timing of PR use relative to the timing of the DR event and relative to normal non-event day PR clearly indicates the use of the PR to produce load reductions. The CPUC and the affected IOU will be notified under separate confidential cover of this observed Prohibition violation.

Nexant puts forward the following recommendations for stakeholder consideration to amend the Verification Plan. These recommendations are made by Nexant as the DR PR Verification Administrator and do not necessarily reflect the views of SCE, PG&E, or SDG&E.

**The Verification Plan should be amended to require that a random sample of DR participants with PRs be selected for monitoring each year.** This random audit approach mimics the same encouragement mechanism used by the existing Verification Plan’s audit mechanisms to develop and encourage compliance.

**Interval meters should be the default monitoring equipment, but data loggers should be used in cases where the installation of interval meters is not possible.** We recommend that shutdowns for installation/removal or coordination with the IOU be enforced to facilitate installation interval metering if necessary. Such shutdowns are an inconvenience, but interval meters are the only way to know for sure if any PRs that are typically used in any manner, including baseload serving PRs, are being used to produce DR.

**Electronic interval data records of PR operation and load service recorded internally by PRs selected for audit should be used in lieu of installing external data collection devices.** Fuel cells were the most problematic installations encountered during the Metering Pilot – fuel cells were also the PR type that were found to consistently be equipped with on-board metering. This built-in data source should be leveraged in the efficient use of IOU and customer resources.

**All PRs at sampled customer premises should be monitored.** It will be critical in the event of an annual random sample to work to ensure all PRs at a given site are monitored. Not being able to monitor just one of multiple PRs makes it impossible to rule out use of PRs for DR load reductions.

**Attestation forms should be amended to provide a field for the customer to provide a point of contact that is knowledgeable of their PRs’ operations** and that can be directly contacted in the case of audit. This point of contact may be different than the individual that is responsible for signing and submitting the attestation.

## 2 Introduction

This report presents the outcomes, findings, and recommendations of the 2019 DR PR Metering Pilot, conducted by Nexant. We are under contract with SCE to serve as a third-party VA in 2019 and 2020. Nexant's VA contract with SCE is subject to a co-funding agreement between SCE, PG&E, and SDG&E, which joins these three California IOUs as common stakeholders in Nexant's work on this project.

Nexant's current role as third-party VA is in connection with CPUC directives concerning the use of certain fossil-fueled power generation resources on the premises of participants of DR programs, pilots, and market products. CPUC Decision (D.) 16-09-056 directed the IOUs to prohibit the use of certain generation resources to produce load reductions during DR events. These generation resources, dubbed Prohibited Resources in the context of DR program participation, are characterized as the following:

Distributed generation technologies, in either topping-cycle combined heat and power (CHP) or non-CHP configurations fueled by any of the following:

- Diesel;
- Natural gas;
- Gasoline;
- Propane; or
- Liquefied petroleum gas.

The following types of distributed generation technologies are exempted from the foregoing list:

- Pressure reduction turbines;
- Waste heat-to-power bottoming-cycle CHP; and
- Storage and storage coupled with renewable generation that meets the relevant greenhouse gas emissions standards adopted for the Self-Generation Incentive Program (SGIP).

This prohibition of the use of fossil-fueled distributed generation to produce DR load impacts, which we refer to in this report as the Prohibition, was made effective January 1, 2019, and is applicable to all participants of the following DR programs, pilots, and market products:

- Agricultural Pumping-Interruptible (AP-I) program;
- Base Interruptible Program (BIP);
- Capacity Bidding Program (CBP);
- DR pilots, which in 2019 are comprised of PG&E's Excess Supply Pilot (XSP) and Supply Side Pilot 2 (SSP2); and
- DRAM products.

All nonresidential participants of these affected programs, pilots, and market products are required to attest, in writing, to compliance with the Prohibition. Existing participants of affected programs were required to submit attestations to their program administrators – either the IOUs, their third-party aggregator, or DRAM Demand Response Provider (DRP) – by January 2, 2019. After January 2, 2019, all new nonresidential program participants were required to submit their attestations at the time of enrollment.

CPUC D.16-09-056 also directed the IOUs to develop an audit verification mechanism to be used to evaluate whether DR participants were in fact complying with the Prohibition. The IOUs engaged Nexant to develop a DR PR Verification Plan, which was served at the CPUC on June 1, 2017, and presented for discussion in a public workshop on August 23, 2017. The DR Verification Plan was approved by the CPUC, with modifications, in Resolution E-4906 (Res. E-4906) on June 21, 2018.

The DR PR Verification Plan provides a verification framework for all nonresidential participants of DR programs and market products affected by the Prohibition. The plan is designed to be carried out annually by a third-party VA and proscribes different verification activities depending on the disposition of PRs at DR participants' premises. The Prohibition contemplates three distinct cases of PR disposition at a customer premise, which are described as "Scenarios" in DR participants' attestations. All written attestations require the participant to indicate PR disposition at their premise as compliant with one (and only one) of three scenarios:

- Scenario 1: I do not have a Prohibited Resource on site;
- Scenario 2: I have a Prohibited Resource on site and I will not use the resource to reduce load during any DR event;
- Scenario 3: I do have a Prohibited Resource on site and I may have to run the resource(s) to reduce load during DR events for safety reasons, health reasons, or operational reasons. My Prohibited Resource(s) has or have a total nameplate capacity of _____ kW. I understand that this value will be used as the Default Adjustment Value (DAV) to adjust DR incentives/charge for my account.

The Verification Plan provides for a multi-tiered approach that leverages customer contact and existing sources of information to efficiently verify and encourage compliance with the Prohibition. The Verification Plan stopped short of specifying, creating, and maintaining new sources of information that can be used to verify compliance. Namely, the Plan does not require customers who attest to Scenario 2 to install or permit to be installed data collection devices that measure and store data indicating the timing of the operation of their PR(s).

CPUC Res. E-4906 instead ordered the IOUs to file Applications on October 19, 2018, to develop a public record on the various costs and functionalities of different data collection devices that could be used to verify Scenario 2 compliance. In addition, Res. E-4906 also directs the IOUs to conduct a Metering Pilot in 2019, where the purpose of the pilot is to test the installation of two distinct types of data collection devices – interval meters and data loggers – on PRs. Nexant has been working to field the 2019 Metering Pilot since March 2019, and this report summarizes our work, findings, and recommendations.

# 3 Summary of the 2019 Metering Pilot

The goal of the 2019 Metering Pilot, as described in Res. E-4906, is to test the installation of data loggers and interval meters in 10% of the population of Scenario 2-attesting DR program participants. The IOUs have further articulated the following goals for the 2019 Metering Pilot:

- Determine the relative value of data provided by data loggers and interval meters in assessing whether a customer used a PR to reduce load during a DR event;
- Measure the effectiveness of data logging and interval metering equipment;
- Evaluate the customer experience of accommodating the installation and removal of a data logger or interval meter and preferences for equipment type;
- Assess realistic costs for installing and retrieving data loggers and interval meters; and
- Develop recommendations to scale up measurement equipment installation to all affected participants, projecting what a long-term Verification Plan budget would look like with data logging or interval metering.

Res. E-4906 also set some specific guidelines and limitations for implementing the 2019 Metering Pilot. Ordering Paragraph (OP) 36 requires interval meters and data loggers to be installed in equal numbers of Scenario 2 customers. OP 51 stipulates that Scenario 2 customers participating in DR pilots are exempt from the Metering Pilot.

## 3.1 Metering Pilot Design Requirements

The Metering Pilot is situated within the broader context of the population of all participants of DR programs affected by the Prohibition. To review, the Prohibition took effect in January 2019 for customers participating in the following programs, pilots, and market products: SCE's AP-I program, the statewide BIP and CBP, PG&E's XSP and Supply Side Pilot 2, and statewide DRAM products.

While the Prohibition is applicable to residential and nonresidential participants of these affected programs, pilots, and products, the enforcement mechanism differs between the two customer classes. Nonresidential participants are required to attest to the disposition of any PRs on site and may be audited, but residential participants are simply required to agree upon enrollment that they will not use a PR to reduce load during events. Therefore, the universe of participants from which Metering Pilot participation was selected begins with the group of all nonresidential AP-I, BIP, CBP, XSP, SSP2, and DRAM participants; however, the following specific groups of DR participants have been excluded from participating in the Metering Pilot:

- DR pilot (XSP and SSP2) participants;
- SCE customers participating in CBP through a Load Capacity Requirement (LCR) contract; and
- DRAM product participants;[1]

As of April 2019, there were 3,023 nonresidential participants of affected DR programs (that were not participating in a DR pilot, an LCR contract, or DRAM) reported to Nexant by the IOUs. “Participant” in the context of the Metering Pilot is defined as a unique service account (SA) enrolled in a DR program.

These customers can be classified by the PR disposition Scenario to which they attested: Scenario 1, Scenario 2, or Scenario 3. Table 3-1 tabulates SAs by IOU and attestation Scenario. A majority, 55.3%, of attestations come from SCE participants, while 38.2% are from PG&E participants, and 6.4% are from SDG&E participants. A large majority of attestations, 87.4%, are Scenario 1, 11.4% are Scenario 2, and 1.2% are Scenario 3. An SA can only attest to a single attestation Scenario.

Table 3-1: Summary of DR PR Attestations, Current April 2019
Excludes Residential, DR Pilot, LCR Contract, and DRAM Participants

| IOU | Scenario 1 Service Accounts | Scenario 2 Service Accounts | Scenario 3 Service Accounts | Total Service Accounts |
|---|---|---|---|---|
| SCE | 1,498 | 145 | 30 | 1,673 |
| PG&E | 988 | 162 | 6 | 1,156 |
| SDG&E | 155 | 38 | 1 | 194 |
| **Total** | **2,641** | **345** | **37** | **3,023** |

Res. E-4906 directs the IOUs to conduct the Metering Pilot using the Scenario 2 participants as the study subjects. Specifically, the IOUs were directed to recruit 10% of the Scenario 2 attesting DR participants into the pilot. The 10% sampling directive implies a study size of 35 participants, to be selected from a possible group of 345 participants, as shown in Table 3-2 on the following page. While DR program enrollment and participation in the Metering Pilot occurs at the SA level, recruitment into the Metering Pilot requires communication at the customer level. Table 3-2 shows that while 345 SAs were eligible for the pilot, they are covered by only 124 unique IOU customers, reflecting the fact that many IOU customers have multiple SAs enrolled in DR programs.

[1] While these three groups of customers were excluded from the Metering Pilot, they were not excluded from the 2019 Verification Administrator audit.

Table 3-2: Summary of DR PR Attestations Eligible for the Metering Pilot, Current April 2019
Excludes Residential, DR Pilot, LCR Contract, and DRAM Participants

| IOU | Scenario 2 Customers | Scenario 2 Service Accounts |
|---|---|---|
| SCE | 82 | 145 |
| PG&E | 38 | 162 |
| SDG&E | 4 | 38 |
| **Total** | **124** | **345** |
| **10% Sample Size Target** | | **35** |

There were no regulatory directives pertaining to Metering Pilot participation by DR program or by IOU; however, Res. 3-4906, in OP 36, does direct the IOUs to include participants that belong to three specific use case scenarios pertaining to PR usage and DR load reduction capabilities:

- Use Case 1: Participant does not have other on-site load that can be used to reduce load during DR events;
- Use Case 2: Participant uses their PR for baseload generation; and
- Use Case 3: Participant's PR is not connected to the IOU's distribution system.

Finally, Res. E-4906 also requires that the Metering Pilot make use of two different data recording device types: data loggers and interval meters. In the context of collecting data pertaining to electricity usage, data loggers record data that indicates each instance (date and time) that an electric load source is turned on and when (date and time) that the electric load source is turned off. Loggers do not record the amount of power – watts (W) or kilowatts (kW) – drawn by the electric load source. Interval meters record data that indicates the amount of power (W or kW) drawn by an electric load source for all intervals during the period of time the interval meter is monitoring the load. Common recording intervals used by interval meters are 5-minute, 15-minute, and 1-hour. Res. E-4906 requires that half of the Metering Pilot installations use data loggers and that the other half of installations use interval meters.

## 3.2 Metering Pilot Field Operations

Nexant contracted with field services provider Mad Dash, Inc. (MDI) to place the metering pilot equipment in the field. MDI procured metering pilot equipment, contacted customers, screened customers for participation, scheduled installation and retrieval appointments, trained and dispatched field staff, reported installation and retrieval disposition, installed and removed metering pilot equipment, and provided metering pilot data to Nexant.

MDI's project guidelines included the following parameters:

- Data collection window: Data loggers and interval meters are to be installed to collect data from May 1, 2019, through September 27, 2019.
- Log/meter all PRs on site: All on-site PRs are to be logged or metered.
- Logger/meter installations consistent within site: At any given Metering Pilot participant's site, all data recording devices deployed are to be of the same type (i.e., all data loggers or all interval meters).
- 50% split by loggers/meters: Half of all sites are to be installed with data loggers and half are to be installed with interval meters.
- Minimum six sites installed per use case: Screen for and install equipment at the site of at least six participants per Resolution-specified Use Case.
- Even distribution of installations among IOUs: A soft guideline was in place for MDI to seek to evenly distribute pilot installations by IOU, that is, to achieve a 33%/33%/33% balance among installed sites within the service territories of the three IOUs – SCE, PG&E, and SDG&E.

Some, but not all, of the above objectives were met. First, not all equipment installations were completed by May 1, 2019. Approximately 68% of all installations were completed by May 1, 2019, and 95% of all installations were completed by May 15, 2019. The last installation was completed May 23, 2019. All devices placed into the field by MDI for this pilot were recording data during all AP-I, BIP, and CBP events called during the summer of 2019; the first DR event of 2019 called by any IOU after April 1, 2019, for either AP-I, BIP, or CBP occurred on June 10, 2019.

Second, not all PRs on site were successfully logged or metered. In the case of three fuel cells, access to the fuel cells' disconnect was prevented due to the presence of an IOU seal. These installations would have required a joint MDI/IOU staff visit to complete.

Third, there was an implicit goal to complete each installation as per the dispatch plan, where each scheduled site visit was designated by MDI schedulers in advance as a data logger installation site or an interval meter installation site. There were a number of sites where the interval meter installation was not possible, and the site was converted by the installer to a data logger site. MDI was able to manage electrician/technician dispatches overall to bring the pilot into compliance with the 50%/50% requirement by device type, but this outcome has implications for Nexant's recommendations provided later in this report. We will also discuss the failed installations and the installations where interval meters were not possible to install in greater detail in the next section of this report.

Finally, the soft requirement that the installations be distributed on a 33%/33%/33% basis across the three IOUs was not met; however, the IOU installation distribution that was achieved reflects the fact that filling the Use Case 1 quota favored AP-I customers, and SCE is the only IOU that offers AP-I.

### 3.2.1 Metering Pilot Installation Outcomes

Nexant provided MDI with the contact information, service location, and relevant customer characteristics – DR program enrollment, PR attestation information, IOU account executive contact information (if available and applicable) – for all 345 Scenario 2 SAs eligible for the Metering Pilot. MDI communicated with customer points of contact representing 61 SAs. MDI initiated customer contact by sending an introductory letter to the customer that explained the mandate and goals of the pilot, as well as the pilot's context within the Prohibition of using fossil-fueled generation to produce load reductions for DR events.[2] The letters provided an IOU point of contact for verifying the authenticity of the pilot. MDI's schedulers followed up on the introduction letter by telephone or email to screen customers for current business operations (i.e., the customer is still in business), current DR program participation, accurate PR information (i.e., the customer does in fact have PR(s)), and disposition with respect to the three mandated pilot Use Cases.

MDI successfully scheduled installation appointments and installed metering equipment at the service locations of 38 SAs out of a total of 61 SAs contacted. Contact and/or installation was not successful or completed for 23 of the 61 SAs contacted:

- Five SAs did not respond to MDI's communications;
- Three SAs refused to participate;
- Four SAs did not participate due to onerous security requirements for on-site visits;
- Eight SAs stated to MDI that they had no PRs on site;
- One SA had a failed installation due to an inoperable generator; and
- Two SAs were held as alternate installation sites to be scheduled if needed to meet quotas.

Table 3-3 shows that exactly half (19) of the Metering Pilot sites were installed with data loggers and exactly half (19) were installed with interval meters. Due to the varying number of PRs and the varying PR installation configurations among sites, a total of 26 loggers and 32 interval meters were installed, for a total of 58 data recording devices installed by MDI at the 38 Metering Pilot sites.

Table 3-3: Percentage of Metering Pilot Installations with Data Loggers and Interval Meters

| Device Type | Number of Devices Installed | Number of Sites Installed | % of Sites Installed by Device Type |
|---|---|---|---|
| Data logger | 26 | 19 | 50% |
| Interval meter | 32 | 19 | 50% |
| **Total** | **58** | **38** | |

[2] In some cases, rather than MDI, the IOU sent the introduction letter to the customer; and in other cases, the customer's DR program aggregator sent the introduction letter to the customer.

Table 3-4 presents the distribution of pilot installations across the IOUs. The distribution of all Scenario 2 customers is close to the 45%/45%/10% split between SCE, PG&E, and SDG&E typically observed in customer enrollments across statewide DR programs. However, Nexant sought to distribute metering pilot installations closer to an equal allocation among IOUs. The actual site installation distribution was 50%/32%/18%, which diverges from the sought-after 33%/33%/33% allocation since SCE AP-I installations were favored so as to help meet the installation quota for Use Case 1 (no discretionary on-site load that can be used for DR load reductions). AP-I is not a statewide DR program and SCE is the only IOU that offers it.

Table 3-4: Distribution of Metering Pilot Installations across IOUs

| IOU | Number of Devices Installed | Number of Sites Installed | % of Sites Installed by IOU | % of All Scenario 2 Sites by IOU |
|---|---|---|---|---|
| SCE | 24 | 19 | 50% | 42% |
| PG&E | 18 | 12 | 32% | 47% |
| SDG&E | 16 | 7 | 18% | 11% |
| **Total** | **58** | **38** | | |

The distribution of Metering Pilot site installations by DR program is shown in Table 3-5, which also shows the effect of ensuring that customers that meet Use Case 1 were included in the program – AP-I customers were targeted as likely candidates for that Use Case. Exactly half of installed sites were CBP participating sites, 32% of installed sites participate in BIP, and 18% of installed sites participate in AP-I. There is no dual-enrollment among these three DR programs.

Table 3-5: Distribution of Metering Pilot Installations across DR Programs

| DR Program | Number of Devices Installed | Number of Sites Installed | % of Sites Installed by Program | % of All Scenario 2 Sites by Program |
|---|---|---|---|---|
| AP-I | 7 | 7 | 18% | 3% |
| BIP | 16 | 12 | 32% | 36% |
| CBP | 35 | 19 | 50% | 61% |
| **Total** | **58** | **38** | | |

MDI met the quota of a minimum of six sites installed with data recording equipment in each of the three Use Cases. Table 3-6 tabulates the number of sites and devices installed that meet the three Use Cases. Note that some installed sites do not meet any of the three Use Cases, and some sites meet more than one Use Case, so the number of sites in Table 3-6 will not sum to 38, nor will the number of devices in Table 3-6 sum to 58.

Table 3-6: Metering Pilot Installations by Resolution-Mandated Use Case

| Use Case | Number of Devices Installed | Number of Sites Installed |
|---|---|---|
| Use Case 1: No discretionary ("other") on-site load available to reduce during DR events | 24 | 12 |
| Use Case 2: PR is used for baseload generation | 10 | 9 |
| Use Case 3: PR is not connected to utility distribution system | 31 | 24 |

Due to the necessity of monitoring and adhering to the variety of above-mentioned quota requirements in fielding the Metering Pilot, MDI was not asked to adhere to quota requirements pertaining to industry type of the participating sites. However, the sample of installed Metering Pilot sites tracks reasonably well with respect to the distribution among industry groups seen in the entire Scenario 2 participant population. Table 3-7 presents the distribution of the Metering Pilot sample by industry group and compares it to that of the entire Scenario 2 population. The industry group assignments shown in Table 3-7 are based on the North American Industry Classification System (NAICS) code that the IOUs have associated with their customers' SAs. It should be noted that the oversampling of AP-I customers seen in Table 3-5 is not observable in Table 3-7 because several AP-I participants in the Metering Pilot are coded as "Wholesale, Transport, and other Utilities" rather than "Agriculture, Mining, and Construction."

Table 3-7: Metering Pilot Installations by Industry Group

| Industry Group | Number of Devices Installed | Number of Sites Installed | % of Sites Installed by Industry Group | % of All Scenario 2 Sites by Industry Group |
|---|---|---|---|---|
| Agriculture, Mining, and Construction | 2 | 2 | 5% | 6% |
| Manufacturing | 8 | 7 | 18% | 17% |
| Wholesale, Transport, and Other Utilities | 9 | 8 | 21% | 12% |
| Retail Stores | 31 | 16 | 42% | 32% |
| Offices, Hotels, Finance, Services | 7 | 4 | 11% | 31% |
| Schools | 0 | 0 | 0% | 1% |
| Institutional/Government | 0 | 0 | 0% | 1% |
| Other or Unknown | 1 | 1 | 3% | 1% |
| **Total** | **58** | **38** | | |

Finally, Table 3-8 presents a tabulation of Metering Pilot installations by PR nameplate capacity size groups. A total of 5, or about 9%, of data recording devices were installed on generators with a nameplate capacity of 100 kW or less. The large majority (46, or 81%) of data recording equipment installations were completed on PRs with a nameplate capacity of 100 kW or greater, but less than 500 kW. The largest PR included in the Metering Pilot has a nameplate capacity of 1 MW.

Table 3-8: Metering Pilot Installations by PR Nameplate Capacity

| Number of Devices Installed by PR Nameplate Capacity | Device Type | | Number of Devices Installed |
|---|---|---|---|
| | Data Logger | Interval Meter | |
| < 100 kW | 1 | 4 | 5 |
| 100 kW < X < 500 kW | 29 | 18 | 47 |
| 500 kW < X < 1 MW | 2 | 3 | 5 |
| 1 MW < X < 2MW | 0 | 1 | 1 |
| 2 MW < X < 3 MW | 0 | 0 | 0 |
| > 3 MW | 0 | 0 | 0 |
| **Total** | **32** | **26** | **58** |

### 3.2.2 Metering Pilot Equipment and Installation Approach

The general mandate of the Metering Pilot is to collect data on and gain experience with fielding different types of data recording equipment that monitor when PRs are serving electric load. There are a range of data recording devices that can be used towards that end, of which this pilot tests two distinct types.

The first type of equipment used in this pilot is called a data logger. Data loggers are electronic data recording devices that are commonly used in evaluation, measurement and verification (EM&V) studies of demand side management (DSM) programs such as energy efficiency (EE) programs. EE EM&V studies often need to establish how many hours an electric end use is in operation during a given period of time (i.e., over a year or over a month). As implied by their name, data loggers are, at the most basic level, a data recording device. The kind of data a logger may record depends on what detection device is connected to it. EE EM&V studies sometimes use data loggers to collect temperature data or even ambient lighting data; in these cases, thermometers and light detectors are connected to the data logger. Data loggers can also be connected to current transformers (CTs) that detect the flow of electric current, which is an indicator that an end use is in operation.

Data loggers equipped with CTs can be designed and configured to toll the runtime of an end use, or they can record the date and time that an end use is turned on and subsequently turned off. Data loggers used in this pilot were configured to operate in the latter mode – once they were installed, they detected and recorded the date and time the PR was turned on to operate and serve load, and they subsequently detected and recorded the date and time the PR was turned off and was no longer serving load.[3] This "on/off" data is recorded and stored electronically in the data logger until it is retrieved. Upon retrieval, the data logger was probed by a technician and the stored data was then uploaded to a personal computer (PC).[4] Data loggers do not record the amount of power (kW) served by the PRs; they only record "on/off" data that indicates whether or not the PR is serving load at any given point in time. Data loggers with communications modules that can wirelessly transmit the data stored in its memory are available, but those loggers would require a power source other than an internal battery. The data loggers used in this pilot do not have communications capabilities.

The second type of equipment used in the Metering Pilot is called an interval meter. Interval meters are also electronic measurement and recording devices, but they are more sophisticated than data loggers. They are also commonly used in EM&V studies of DSM programs, but they are more typically deployed in evaluating DR programs than EE programs. Interval meters differ from data loggers in that they measure and electronically record a register of reads showing the amount of power (kW) that an end use is drawing while it is operating over a given period of time. Power is measured and recorded at regular intervals of time (i.e., every five minutes, every 15 minutes, or every hour). In the case of this pilot, the interval meters measured the amount of load being served by a PR at regular intervals of time and stored the data internally until the interval meters were retrieved. Upon retrieval, the interval meters were probed by a technician and the stored data was then uploaded to a PC. The accuracy and design characteristics of any given interval meter results in its designation as "revenue grade" or "non-revenue grade." While no revenue grade interval meters were deployed in this pilot, the interval meters used are accurate to within 0.5% of the power they measure. Also, while the interval meters used in this pilot do not have communications capabilities, like data loggers, interval meters with wireless communications modules exist.[5]

At any given site selected and scheduled for installation, MDI designated the site as either a data logger site or an interval meter site, which means that all monitoring equipment installed at that site will be of one type or the other. There were no sites at which a combination of loggers and interval meters were installed in this pilot. Additionally, an installation objective was for all the PRs on site to be equipped with loggers or interval meters so that it was possible to definitively estimate whether the customer was using

[3] It should be noted that if the PR's engine is simply started for testing purposes and is not placed under load, the CT will not register current and will not show usage. The data loggers record when PRs are both operating (i.e., the engine is running) and serving load.

[4] There are no significant costs associated with software or connecting cables required for downloading data from data loggers onto a PC. A cable is required that costs approximately $20. The software required to download the data is free with purchase of the data loggers and has no licensing fees.

[5] There are no significant costs associated with software or connecting cables required for downloading data from interval meters onto a PC. A Cat5 cab is all that is required for connecting the interval meters to a PC. The software required to download the data is free with purchase of the interval meters and has no licensing fees.

their PR to reduce load during a DR event.[6] This objective was not met in a limited number of cases, which we will discuss below.

### Data Logger Installation

Once the MDI technician or electrician was on site, in the case of installing a data logger on a BUG, it was installed at the BUG's automatic transfer switch (ATS). The ATS automatically detects when power supplied by the utility drops and then switches the site's load to the BUG. The data logger was either installed inside the customer's electrical cabinet (if there was room) or outside the cabinet and within a separate enclosure. In the case of monitoring fuel cells (as opposed to BUGs), the data logger was installed at a fuel cell's disconnect, either inside the cabinet (if there was room) or outside the cabinet and within a separate enclosure. The data logger was connected to a single CT, which detected current on a single phase when the PR was operating and serving load. Either split-core CTs or Rogowski coil CTs were used, depending the case of each PR and how their conductors were configured. The data loggers were battery powered and did not require connection to voltage in the ATS or disconnect. Data loggers typically have enough memory to store data collected over the course of an entire calendar year or summer.

### Interval Meter Installation

Similar to the data logger installation procedure, in the case of installing an interval meter on a BUG, the MDI electrician installed the interval meter at the ATS, either inside the customer's electrical cabinet (if there was room) or outside the cabinet and within a separate enclosure. In the case of installing interval meters on fuel cells, they were installed on the load side of a fuel cell's disconnect. The interval meter was connected to CTs on all three phases to detect current when the PR was operating and serving load. Either split-core CTs or Rogowski coil CTs were used, depending on the case of each PR and how their conductors were configured. The CTs used in this pilot are accurate to within 0.5% of the current they measure. To calculate power (kW), interval meters require an additional set of connections to measure the PR's voltage draw (the same voltage connection also provides power to the interval meter itself). Interval meters typically have enough memory to hold data collected over the course of an entire calendar year or summer.

Table 3-9 presents the make and model of the data loggers, interval meters, and CTs used in this pilot. The table also shows per-unit retail pricing as advertised by the manufacturers. Volume pricing is often made available from these manufacturers for large purchase orders placed by customers such as electric utilities or field services firms like MDI. When we discuss actual pilot costs and projected costs for future similar projects later in this report, we assume pricing available to Nexant that reflects volume discounts.

[6] For example, if a customer has three PRs on site, but we only collected data from two of the PRs, even if we observe no usage of the two monitored PRs during a DR event, it would still be unknown if the unmonitored PR is serving load to produce DR load impacts for the utility.

Table 3-9: Metering Pilot Equipment and Retail Pricing per Unit

| Device | Make | Model | Description | Retail Price per Unit |
|---|---|---|---|---|
| Data logger | Onset | HOBO H22-001 | Multi-channel data logger | $364 |
| Interval meter | eGauge | Core EG4115 | Multi-channel energy meter | $549 |
| Split-core CT | J&D | JSXXFL-XXX-333mV | Split-core CT | $50 |
| Rogowski coil | Accuenergy | RCT16, RCT24, RCT36, or RCT47 | Flexible rope CT | $150 |

### 3.2.3 Prohibited Resources Encountered in the Pilot

As indicated in the previous section, a total of 58 data loggers and interval meters were installed at 38 customer premises. This equipment was deployed in the service of monitoring a total of 53 PRs at the 38 sites. More loggers and interval meters than there are PRs were required in the cases where the PRs involved were BUGs with more than one ATS. While 53 PRs were successfully equipped with data loggers or interval meters, 3 PRs were encountered that were not successfully equipped with data loggers or interval meters, giving a total of 56 PRs encountered by MDI during this pilot. We summarize below some basic information collected by MDI about the PRs that they encountered.

First, all PRs encountered by MDI during the pilot were either baseload-serving generators or BUGs. In the case of baseload-serving generators, they were all fuel cells. The BUGs were largely diesel generators, as seen in a tabulation of fuel type for each PR encountered in the pilot, Table 3-10.

Table 3-10: Metering Pilot PR Fuel Types

| PR Fuel | Count |
|---|---|
| Diesel | 42 |
| Fuel cell | 12 |
| Natural gas/LP | 1 |
| Unknown | 1 |
| **Total** | **56** |

Table 3-11 shows the PR manufacturers encountered by MDI technicians and electricians. PR manufacturer was discernable for most PRs, but year of manufacture was not, as shown in Table 3-12, which tabulates the year of manufacture of the PRs encountered by MDI during the Metering Pilot. Of the 56 PRs encountered by MDI, 13 PRs had built-in logging, where 12 of those 13 were the 12 fuel cells.

Table 3-11: Metering Pilot PR Manufacturers

| PR Manufacturer | Count | PR Manufacturer | Count |
|---|---|---|---|
| Bloom Energy | 11 | GM | 1 |
| Caterpillar | 8 | Kohler | 16 |
| Cummins | 1 | Onan | 4 |
| Detroit Diesel | 1 | PRYCO | 1 |
| Generac | 4 | Unknown | 9 |
| Total = 56 | | | |

Table 3-12: Metering Pilot PR Year of Manufacture

| PR Year of Manufacture | Count | PR Year of Manufacture | Count |
|---|---|---|---|
| 1993 | 1 | 2008 | 1 |
| 1995 | 1 | 2014 | 3 |
| 1996 | 1 | 2015 | 3 |
| 2001 | 1 | 2016 | 5 |
| 2002 | 1 | 2017 | 1 |
| 2006 | 1 | Unknown | 35 |
| 2007 | 2 | | |
| Total = 56 | | | |

### *PRs where Interval Meters could not be Installed*

While MDI was able to meet the Resolution mandate for the Metering Pilot to deploy a 50%/50% mix of data loggers and interval meters, it was not without working around site conditions that precluded safe and timely installation of interval meters in some cases. There were five instances of PRs that could not be installed with interval meters, and where data loggers were installed instead. The five instances of reverting to data logger installation can be classified into two general situations:

- Customer would not permit access to ATS without shutting down power to the site: In some cases, customer site safety rules do not even permit opening the ATS cabinet without a shutdown. In others, even if access to the ATS was granted, working with live voltage to connect the eGauge leads was not permitted by the customer without a shutdown. Three sites presented this situation to MDI electricians. In all three cases they were able to install data loggers, which do not require a voltage reference.

- ATS is unsafe for obtaining voltage reference: In the case of two sites, the ATS configuration or condition was such that even with a shutdown, there was not a way to safely establish a voltage reference. In these two cases the MDI electrician successfully installed a data logger.

### PRs where No Installation was Possible

There were no site visits that resulted in a complete "walkaway," where no data logging or interval metering equipment could be installed; however, there were three instances of PRs where MDI electricians or technicians could not install either a data logger or an interval meter on a PR. All three were in the case of fuel cells, where the point of access for connecting CTs and/or voltage leads was located at the fuel cells' disconnect, which, like an ATS, is located inside a cabinet. In the case of two fuel cells, the disconnect was sealed by the utility and could not be unsealed without utility staff present. The only possible place to connect CTs or voltage leads was at the disconnect in the case of these two units, so no installation of any monitoring equipment was possible for those two fuel cells. In the case of one other fuel cell, the design of the switchgear at the disconnect was such that there was no possible safe installation of either CTs or voltage leads.

It should be noted that for the purposes of conclusive monitoring in support of verifying that a customer was complying with the Prohibition, the case of some on-site PRs being able to be monitored while other PRs were not able to be monitored effectively resolves to the case of a "walkaway." For example, if a site has two PRs and one is monitored and one is not, even if the data collected from the monitored PR does not show violations of the Prohibition, it is still unverified that the other PR is not used in violation of the Prohibition.

### Other Equipment-Related Data Collection Barriers

Unrelated to installation barriers are other equipment-related or environment-related barriers that go beyond initial installation and extend all the way to equipment retrieval. Field studies such as this Metering Pilot sometimes experience customers becoming unresponsive to scheduling a retrieval appointment, or perhaps going out of business before the retrieval appointment can be set. Neither of those two cases occurred during the Metering Pilot. Another potential problem is finding that metering or logging equipment is missing at the time of the retrieval appointment. MDI experienced this problem in one case, where an installed logger was found to be missing during the retrieval visit. As of the writing of this report, MDI has requested the customer to locate and return the logger and/or provide their PR's operating manifest documenting its operations this summer, but they have not yet received either of these things from the customer.

## 3.3 Metering Pilot Costs

There are three primary cost centers associated with placing data collection devices such as data loggers and interval meters in the field: the cost of the equipment, the cost to install it, and the cost to retrieve it. We report the costs for these primary cost centers in this section. The actual project costs as incurred by Nexant are not completely captured by reporting on equipment, installation, and retrieval costs. The following costs related to fielding a data collection project such as this Metering Pilot but are not included here:

1. **Developing a participation recruitment list:** Nexant requested all the attestation data for Scenario 2 customers from the IOUs, cleaned and organized it, and prepared it for MDI's use for pilot recruitment. In future data collection efforts like this Metering Pilot, we expect that this work would evolve to require drawing a random sample, with a limited number of alternates in the case of sampled customers closing their utility accounts or ending their DR program enrollment and providing only the random sample and alternates to the field services firm, IOU, or DRP.
2. **Customer contact and appointment scheduling:** Nexant and MDI also used project resources to contact customers to alert them to the pilot, answer questions about the pilot, screen customers for installation, and set appointments to install and retrieve the data collection equipment.
3. **Procuring equipment:** MDI managed the procurement of the equipment needed for the pilot, prepared equipment for installation, and managed equipment inventory.
4. **Training and dispatch of electricians and technicians:** MDI trained all equipment installation and retrieval personnel and dispatched personnel to work sites.
5. **Disposition reporting:** MDI reported on installation and retrieval disposition, as well as various data collected through the installers' site visits: visit duration time; make, model, and year of manufacture of PR; and serial numbers of all data collection devices installed.
6. **Analysis and reporting:** Nexant analyzed the data collected in field and reported on findings related to compliance or non-compliance with the Prohibition.

These costs are not included in the reporting here because these costs may be borne, in a currently unknown combination, between DR program participants, the IOUs and DRPs, or the VA in the future framework for PR monitoring. These excluded costs will also vary significantly depending on whether PR monitoring is a requirement for all affected DR program participants or if PR monitoring will only be required on a sample basis each year.

Table 3-13 presents the costs for equipment, installation, and retrieval as demonstrated by the Metering Pilot. These costs represent those that Nexant would have borne in the case of purchasing the data loggers and interval meters on behalf of the IOUs. In actuality, since the scope of the metering pilot was limited to one year, we leased the data loggers and interval meters from MDI in order to mitigate IOU costs. The total costs for purchasing, installing, and retrieving the equipment used in this pilot is $109,280. Appendix A tabulates these same costs in a format of interest specified by the CPUC in Res. E-4906. The format of interest shows the Metering Pilot's costs segmented by PR nameplate capacity categories.

Table 3-13: Total Metering Pilot Equipment, Installation, and Retrieval Costs Assuming Purchase of all Equipment at Volume Discount

| | Data Loggers | Interval Meters |
|---|---|---|
| Total Equipment Costs | $9,200 | $25,060 |
| Total Installation Costs | $24,250 | $28,750 |
| Total Retrieval Costs | $8,740 | $13,280 |
| Total Sites | 19 | 19 |
| Total PRs | 25 | 28 |
| Total Devices | 26 | 32 |
| Subtotal | $42,190 | $67,090 |
| **Grand Total** | **$109,280** | |

Table 3-14 presents the costs shown above in Table 3-13 on a per-unit basis: per site visited, per PR monitored, and per device installed. The most important metric for planning future PR monitoring frameworks is likely the per-site metric, since expected costs for PR monitoring will either be communicated to the customer on a per-SA basis or the VA may be required to conduct an annual field study and install monitoring equipment on PRs at a sample of customer sites. The average logger installation site cost $2,221 to equip, install, and retrieve. The average interval meter site cost $3,531 to equip, install, and retrieve.

In the case of a future ongoing requirement for annual PR monitoring studies, these costs should be considered representative first-year costs: outer years of annual PR monitoring studies would not require re-purchasing the entire fleet of monitoring equipment.

Table 3-14: Per Unit Metering Pilot Equipment, Installation, and Retrieval Costs Assuming Purchase of all Equipment

| | Data Loggers | Interval Meters |
|---|---|---|
| Cost per Site | $2,221 | $3,531 |
| Cost per PR | $1,688 | $2,396 |
| Cost per Device | $1,623 | $2,097 |

# 4 Metering Pilot Customer Experience

The general objective of the Metering Pilot is to gain real-world experience installing two different types of data collection devices on PRs located on DR participants' premises. Part of the experience gained by conducting the pilot is the view from the customer's perspective.

The primary area of potential difference in customer experience between data logger and interval meter installations on PRs is the duration of the installation appointment. Data loggers involve a simpler installation procedure than interval meters. No electrical connections are required for data loggers; in the case of data loggers, their CTs (whether split-core or rope) are simply placed around the appropriate conductors, connected to the data logger, and the data logger is appropriately secured inside the cabinet.[7] In the case of interval meters, MDI's electricians must don an array of personal protective equipment (PPE) and connect leads from the interval meter so as to obtain a voltage reference, in addition to placing the CTs and the interval meter itself.[8] Therefore, it is expected that data logger installation appointments take less time to complete than interval meter installations.

Table 4-1 presents the average per-site installation and removal time, in minutes, for each type of data collection device. The average data logger installation appointment took 106 minutes to complete, while the average interval meter installation appointment took 176 minutes to complete, approximately 60% longer than the data logger appointments. Since MDI installed approximately 20% more interval meters than data loggers, part of the differential could be due to installing more devices. Retrieval appointment times took less than half the time as installation; on average, both data logger and interval meter removal appointments took less than an hour. However, data logger retrievals were generally completed in about 30 minutes whereas interval meter retrievals were generally completed in 50 minutes.

Table 4-1: Average per Site Installation and Removal Time (Minutes)

| Activity | Data Logger | Interval Meter |
|---|---|---|
| Installation | 106 | 176 |
| Removal | 32 | 51 |

[7] In some instances, data loggers or interval meters may not fit inside the PR's ATS cabinet or disconnect cabinet. In those cases, an enclosure would need to be installed by the installer next to the customer's cabinet. MDI was able to place all data loggers and interval meters inside the customers' cabinets in fielding the Metering Pilot.

[8] In the case of BUGs, the generator is also locked out so that it doesn't power up in the case of a power failure. In the case of fuel cells, unless a shutdown is scheduled, MDI's electrician can only install an interval meter if a safe place can be found to connect the leads without a shutdown. This was not possible in some cases presented by this Metering Pilot and the only viable installation, in the absence of a shutdown, is a data logger.

Nexant also contacted Metering Pilot participants to directly obtain their feedback. Once all equipment installations were complete, we followed up via email and/or telephone to survey the customers that MDI visited for both data logger and interval meter installations in order to find out about their scheduling and installation experience. The purpose of the follow-up contact was to gauge how burdensome the installation process was to customers and to determine if any meaningful differences exist between the installation experience for data loggers and interval meters. The survey additionally served to assure the quality of MDI's work.

Nexant's first attempt at customer contact for the survey was by telephone. If contact could not be made by telephone, we sent a written survey to the customer by email. The survey consisted of the following five questions:

1. Were there any problems with the scheduling or timing of the equipment installation?
2. Were there any problems while the technician was on site doing the installation?
3. Please tell me which aspects of the installation process went well.
4. Please tell me about any aspects of the installation process that you think need improvement.
5. Are there any additional comments you would like to add?

MDI installed data loggers or interval meters at 38 different sites belonging to 22 unique customers. Nexant attempted contact with all 22 customers and received a total of 14 survey responses, five by phone and nine by email, for an overall response rate of 64%. Table 4-2 summarizes the survey response rate by the type of equipment the customer had installed. Most customers experienced the installation of a single type of data collection equipment. One customer with multiple Metering Pilot installation sites experienced both data logger and interval meter installations, and as such their survey responses are tabulated separately. Customers who had data loggers installed had a much higher overall response rate than metered customers and represent almost 80% of the survey responses.

Table 4-2: Survey Response Summary

| Equipment Type | Responses | Response Rate |
|---|---|---|
| Data Loggers | 11 | 79% |
| Interval Meters | 2 | 38% |
| Loggers and Meters | 1 | 100% |
| **Total** | **14** | **64%** |

The lower response rate for interval metering customers can likely be explained by a combination of two factors. First, the installation times for interval metering appointments were significantly longer – interval metering participants' non-response may be a function of greater participation fatigue (associated with more complicated installations and longer installation times) than that of data logger participants.

Second, there were far fewer metering customers to get in touch with; Nexant sought to contact 14 customers that experienced data logger installations and only seven customers that experienced interval metering customers. With relatively fewer interval meter customers to attempt to contact, idiosyncrasies in the ease of making customer contact may have been a factor with the relatively few customers we had to get in touch with. Since the survey was limited in scope, and the data collected was very consistent among respondents, we can succinctly summarize the findings of the survey as follows:

- All but one respondent, 13 out of 14, reported no issues with scheduling data collection equipment installation.
    - One respondent reported that their originally scheduled appointment could not be held by the MDI technician and needed to be rescheduled. They reported that they were not aware of the date of reschedule and that the technician's arrival the next business day surprised them. However, the customer was able to grant access to the technician and the installation proceeded without issue.
- All 14 respondents stated that there were no problems while MDI's electrician or technician was on site doing the installation.
    - Many respondents also commented that the technicians were polite, diligent, and worked quickly.
- When asked if they had any suggestions for improvement to the installation process, three suggestions were made by three separate respondents:
    - Increase the lead time between initial notification and installation;
    - Provide notice at the time of scheduling as to what the access and shutdown requirements are; and
    - One customer expressed concern that the MDI technician did not have proper PPE to work inside live gear.

Nexant contacted MDI with respect to the safety concern cited above and they reiterated that when working with live gear, all MDI electricians are required to wear gloves, face shield, and fire-resistant clothing, even if the generator is locked out.

The survey responses do not reveal any differences in sentiment regarding or experience with the installation of data loggers versus interval meters. The common thread of most respondents' comments centered around communications. Nexant recommends that the attestation forms be amended to provide a field for the customer to provide a point of contact that is knowledgeable of the PRs' operations and that can be directly contacted in the case of audit. This point of contact may be different than the individual that is responsible for signing and submitting the attestation.

# 5 Results of the Metering Pilot

The Resolution-mandated Metering Pilot is a field study that was conducted during the summer of 2019 to assess the ability of data loggers and interval meters to identify if or when customers use a PR to reduce load during a DR event. The Metering Pilot involved 38 customer premises that were equipped with either data loggers or interval meters. Nexant used the data collected by the data loggers and interval meters to answer the following research questions:

1. How do DR participants currently use their PRs? Do they vary in consumption pattern depending on whether the PR is used for baseload, if the customer has no discretionary load shed, or if the PR is not connected to the grid?
2. Are the PRs used during outages of IOU-supplied electric service?
3. Are the PRs used during DR events?
4. If PR(s) is/are used during a DR event, is the participant also delivering load impacts to the IOU, and if so, is there evidence that the PR use was for the purpose of producing the load impacts? That is, are DR load impacts attributable to the customer simply switching load over to their PR(s) instead of actually curtailing operations?

To answer these research questions, we analyzed the quantitative data collected during the Metering Pilot using analytical techniques usually applied in the course of load impact evaluations of commercial and industrial (C&I) DR programs. This section of the report describes the data used by the evaluation team in the course of this work, the statistical modeling used to estimate DR impacts of Metering Pilot participants, and the evaluation team's findings as informed by the analysis. Due to the small number of Metering Pilot participants and the relative size of C&I customers, results are presented in aggregate. Customer-identifiable information is omitted from this report.

## 5.1 Data

This study focuses on collecting and analyzing PR production data. But in order to determine whether DR program participants are switching to PR-sourced load during DR events, the evaluation team also needed to incorporate whole-building interval data, customer characteristics, and program participation data from the IOUs into the analysis. This additional data allows for estimation of DR load impacts which are then compared against PR operations. Below, we review the data made available by the IOUs, the evaluation team's data cleaning process, and any issues that could materially impact the results of the analysis.

### 5.1.1 Customer Characteristics

A full customer list of all metering pilot participants in the SCE, PG&E, and SDG&E service territories were provided by the respective IOUs. While each utility has its own data format, the data generally contained customer IDs, subLAP, dates when accounts were active or inactive, net metering status, and other demographic variables that allow for segmentation of results. Nexant received this dataset for all requested accounts and observed no substantive issues with the data.

### 5.1.2 Data Logger Data

Data loggers measured and recorded current (amps) on circuits connected to PRs. Because only amperage is reported, a designation of whether the PR was operating and serving load or not operating and serving load in any given interval is the only data provided by this data collection method. There were 26 data loggers installed for the Metering Pilot, two of which had unusable data and one was missing when MDI visited the site to retrieve it. Therefore, 23 data loggers yielded usable data. Data loggers were installed during the period April 4, 2019, through May 10, 2019, and were removed between September 30, 2019, and October 4, 2019.

### 5.1.3 Interval Meter Data

Interval meters measured power flow (kW) from PRs in five-minute intervals, providing both the load profile of the generator at any given time in addition to its operational status. There were 32 interval meters installed for the Metering Pilot. One interval meter was incorrectly calibrated, and the data could not be used; therefore 31 interval meters yielded usable data. Interval meters were installed during the period April 15, 2019, through May 23, 2019, and were removed between September 29, 2019, and October 3, 2019.

### 5.1.4 Whole-Building Interval Data and Customer Outage Data

Interval data for every Metering Pilot participant's premise was provided by their respective IOU for the time period January 1, 2017, to September 27, 2019. These roughly 21 months of data were required in order to effectively model customer-specific relationships between seasonal consumption patterns, weather, and DR participation, as discussed further in Section 5.2. Customer consumption patterns observed during the summer of 2018 were especially critical because these patterns provided information about how customers behave during the same time of year as the metering pilot. The vast majority of customers had the full panel of interval data available for analysis. Truncated data was largely accounted for by customers with account openings and closings during this period, but there were some instances where truncated data was due to unavailable interval data from the IOU.

Outage data was also provided by the IOUs, which allowed the evaluation team to assess whether PRs were operating and serving load during service outages and ensure that gaps or changes in consumption due to service outages were flagged in the impact regression analysis. This allowed the evaluation team to avoid incorrectly attributing changes in consumption due to an outage to some other source, such as temperature variation.

### 5.1.5 Event and DR Enrollment Data

To capture which customers were dispatched to deliver load impacts on any given program event day, the IOUs provided a list of DR program events from January 1, 2017, to September 27, 2019. Table 5-1 shows a list of event days during the summer of 2019, as well as the number of metering pilot participants analyzed on that day. Note that CBP has many different dispatch options, including both day-ahead and day-of options. Additionally, CBP aggregators can elect to nominate 0 kW for their participants for any given month while still maintaining the customer's enrolled status in the program. Therefore, not all CBP customers in the analysis were dispatched on any given CBP event day.

For AP-I and BIP, due to the timing of program enrollment and unenrollment, not all customers were necessarily active on the program on every event day in 2019.

Table 5-1: DR Events and Event Participation during Metering Pilot

| Date | DR Events Dispatched | | | Number of Metering Pilot Participants Participating in DR Event | | |
|---|---|---|---|---|---|---|
| | SCE | PG&E | SDG&E | SCE | PG&E | SDG&E |
| 6/10/2019 | | | CBP | 0 | 0 | 2 |
| 6/11/2019 | CBP | | CBP | 2 | 0 | 2 |
| 6/12/2019 | CBP | | CBP | 2 | 0 | 0 |
| 7/23/2019 | CBP | | CBP | 0 | 0 | 2 |
| 7/24/2019 | CBP | CBP | CBP | 0 | 6 | 2 |
| 7/25/2019 | CBP | CBP | CBP | 0 | 0 | 2 |
| 8/5/2019 | CBP | | CBP | 2 | 0 | 0 |
| 8/6/2019 | CBP | | | 2 | 5 | 0 |
| 8/14/2019 | CBP | CBP | CBP | 2 | 5 | 2 |
| 8/15/2019 | CBP | CBP | CBP | 2 | 5 | 0 |
| 8/26/2019 | CBP | | | 2 | 0 | 0 |
| 8/27/2019 | CBP | CBP | CBP | 14 | 0 | 2 |
| 8/28/2019 | CBP | | | 2 | 5 | 2 |
| 9/3/2019 | CBP | | | 2 | 0 | 0 |
| 9/4/2019 | AP-I, BIP, CBP | | BIP, CBP | 2 | 0 | 0 |
| 9/5/2019 | CBP | CBP | CBP | 2 | 0 | 0 |
| 9/6/2019 | CBP | | CBP | 0 | 5 | 0 |
| 9/8/2019 | AP-I, BIP | | | 0 | 8 | 2 |
| 9/9/2019 | CBP | | | 0 | 5 | 2 |
| 9/12/2019 | CBP | | CBP | 0 | 0 | 2 |
| 9/13/2019 | CPP | CBP | CBP | 2 | 0 | 2 |
| 9/24/2019 | | CBP | CBP | 2 | 0 | 0 |
| 9/25/2019 | | CBP | CBP | 0 | 0 | 2 |

### 5.1.6 Weather and System Load

The evaluation team was also provided weather and system load data for each IOU service territory. A mapping of weather stations to customers was provided in each IOU's customer characteristics. We used weather data for the full 21-month range to help select event-like (proxy) days to use for model testing as well as in regression modeling to estimate counterfactual customer loads on event days. We also used system load to help select proxy days for the regression modeling analysis.

## 5.2 Impact Estimation Methods

To assess whether Metering Pilot participants' DR load impacts could be attributed to participants switching from grid power to PR power, the evaluation team first needed to estimate the DR impacts calculated from the whole-building interval usage data. Regression analysis is a fast and reliable way to identify the load impacts associated with three DR programs:

- Capacity Bidding Program (Statewide): Participants are dispatched for economic pricing purposes through an aggregator. Aggregators provide a monthly capacity nomination for each participating customer equal to the amount of load they will shed when dispatched. The program has a variety of event windows for participants to choose from, including day-of and day-ahead event notification options.
- Baseline Interruptible Program (Statewide): An emergency program for large C&I customers, BIP customers are dispatched with a 15-minute or 30-minute notification to reduce their load down to a predetermined Firm Service Level (FSL). The customer must remain at or below this FSL until the event is over.
- Agricultural Pumping-Interruptible Program (SCE only): Agricultural customers are eligible to participate in this emergency program. A switch on agricultural pumping circuits is triggered automatically during program events, shutting off load automatically.

Calculating load impacts relies on estimating what is known as the counterfactual, or reference load. Because evaluators can only observe what the customer did on an event day, we cannot know with 100% confidence what they would have done had they not been called to participate in the event. Instead, evaluators can model the counterfactual using a variety of techniques. The difference between the observed event loads and the modeled counterfactual loads is the program impact.

Historically, load impacts for these three programs have been estimated through annual load impact evaluations conducted in accordance with the California Demand Response Load Impact Protocols.[9] The evaluation team used individual customer regression modeling in this study, which is the analytical approach used in the load impact evaluations for all three of these programs. Individual customer regressions allow evaluators to model every customer's unique consumption patterns as a function of operational patterns (day of week, month), weather (temperature, cooling degree hours), and prior consumption. The goal of regression modeling is to assess what these patterns are on days when no

[9] http://www.calmac.org/events/FinalDecision_AttachementA.pdf

event was called so that the predicted (or reference) load can represent what the customer would have done if the DR event had not been dispatched.

### 5.2.1 Proxy Day Selection and Out-of-Sample Testing

Regression modeling can provide accurate impacts to the extent that the model used captures all the relevant information about an individual customer's consumption patterns. Said another way, if the model does not include a key variable that influences consumption – for example, excluding temperature for a customer that is highly weather sensitive – the model will never be able to accurately predict customer loads. As such, individual customer regression methods rely on extensive testing to ensure that the specification ultimately used to estimate reference load provides an accurate representation of customer consumption. This is generally done by way of what is known as out-of-sample testing, where the following testing procedure is undertaken:

1. First, we select a number of proxy days for each IOU. Proxy days are event-like days where no DR events were actually called; they are selected by identifying event-like non-holiday weekdays where the temperature in the IOU's service territory was similar to that of the event days for that IOU's DR programs. The number of proxy days selected for each IOU was roughly 1.5 times the number of event days, depending on the availability of similar non-event days.
2. Next, for each customer, we identify all hours where they either participated in DR events or experienced an outage. Because these hours are not representative of normal operations, they should not be included in modeling.
3. We then define a set of regression models for each customer to test. For each candidate regression model and for each customer, the relationship between the model variables and the customer's consumption is estimated, excluding the days and hours identified in Steps 1 and 2.
4. We predict each customer's consumption patterns for their applicable proxy days. Since no events were called on these days, any difference between the observed load and the predicted load is attributed to error in the modeling process.
5. We then calculate the error between the predicted load and observed load on the proxy days for each customer and each candidate model. Error is assessed in two ways:[10]
    a. How accurate is the regression model? Across all event hours in the summer, does the model tend to overstate or understate the true load?
    b. How precise is the regression model? By how much does the model tend to vary from the true load across event hours?
6. For each customer, we select the model that yields the lowest bias and the greatest precision as the estimation model.

[10] The evaluation team measured accuracy by assessing the mean percent error and precision by assessing the root mean squared error of each model for each customer. More detail on how these statistics are calculated can be found in Appendix B.

The evaluation team tested a total of 24 different regression models for each customer using the process described above. A full accounting of the different regression specifications and their overall performance is presented in Appendix B. In general, the candidate models included some or all of the regression variables shown in Table 5-2.

Table 5-2: DR Load Impact Estimation Regression Model Variables

| Variable | Definition | Reason for Inclusion |
|---|---|---|
| Month | Categorical variable, representing the change in consumption associated with each month. | This variable captures seasonal consumption changes that are not attributable to weather and is especially important for customers that may operate different schedules in different times of the year (such as agricultural customers). |
| Day of Week | Categorical variable for each day of week, representing change in consumption associated with each day. | This variable captures weekly operating schedules, for example, for a customer that does not operate on weekends or has a reduced schedule on Fridays. |
| Cooling Degree Day (CDD) | CDD, calculated by taking the difference between the average daily temperature and 60°F. If the average temperature is less than 60°F, this value is 0. | This variable captures general consumption changes associated with building cooling loads. Because it is 0 when the temperature is below 60°F, it effectively estimates only changes in load for each degree above the 60°F setpoint. |
| Heating Degree Day (HDD) | HDD, calculated by taking the difference between 60°F and the average daily temperature. If the average temperature is greater than 60°F, this value is 0. | This variable captures general consumption changes associated with building heating loads. Because it is 0 when the temperature is above 60°F, it effectively estimates only changes in load for each degree below the 60°F setpoint. |
| CDD and HDD Squared | The two prior variables, squared. | Because heating and cooling loads may not have a strictly linear relationship with changes in temperature from the 60°F setpoint, adding a squared term in the regression can improve model fit. |
| Cooling Degree Hours (CDH) and Heating Degree Hours (HDH) | CDH and HDH. Same principle as CDD and HDD but done for each hour rather than the average daily temperature. | These variables operate similarly to CDD and HDD, but because they are hourly, they provide additional granularity to the consumption patterns. |

| Variable | Definition | Reason for Inclusion |
|---|---|---|
| CDH and HDH Squared | The two prior variables, squared. | These variables are included for the same reason that we include CDD Squared and HDD Squared. |
| Morning Load | The customer's average hourly consumption between 7:00 am and 12:00 pm. | Including a morning load component calibrates the reference load to more closely match the observed load prior to the event being called and can capture unobserved factors that are influencing that day's operations. Best suited for inclusion for programs that customers do not receive advanced notification.[11] |
| Prior Day Morning Load | The customer's morning load from the prior day. | Including the morning load for the prior day has a similar rationale as the day-of morning load but is more appropriate if the customer had advanced notice of the next day's event. |

Once the best model has been selected for each customer through the out-of-sample testing procedure described above, that model is run again including all non-event days (including the proxy days and excluding any hours of outages) to predict what the customer would have done on the event day. The difference between this reference load and the observed load for each hour on DR event days is the hourly impact attributable to the DR event.

## 5.3 Results

The following section presents high-level results synthesizing PR usage as measured through the data collection devices fielded in this Metering Pilot with DR load impacts as estimated by the evaluation team. Because of the small size of this study, information is reported in aggregate to avoid showing customer-level confidential information. First, we summarize typical operations of Metering Pilot participants on hot non-event days (proxy days) to provide a general sense of how they use their PRs. We then summarize our findings about PR operations during outages and during DR program events, and we conclude with a discussion of the results.

[11] For true, unbiased impact estimation, it's important to factor any program-specific information into the selection of an appropriate regression model. For programs that are called on the day prior to an event, such as some types of CBP, it's generally not appropriate to include a variable that explicitly adjusts the reference load to match the observed load in the morning of the event day because customers have already been notified of the event and may have adjusted their behavior prior to the event start. For example, a customer may start a process earlier than they would have in order to avoid running during the event. Despite this, the evaluation team included this term in the candidate regression specifications because prior CBP load impact evaluations have included this term in their specifications of ex post load impacts.

This is not a concern for emergency programs such as BIP or AP-I, as customers get minimal notice prior to an event.

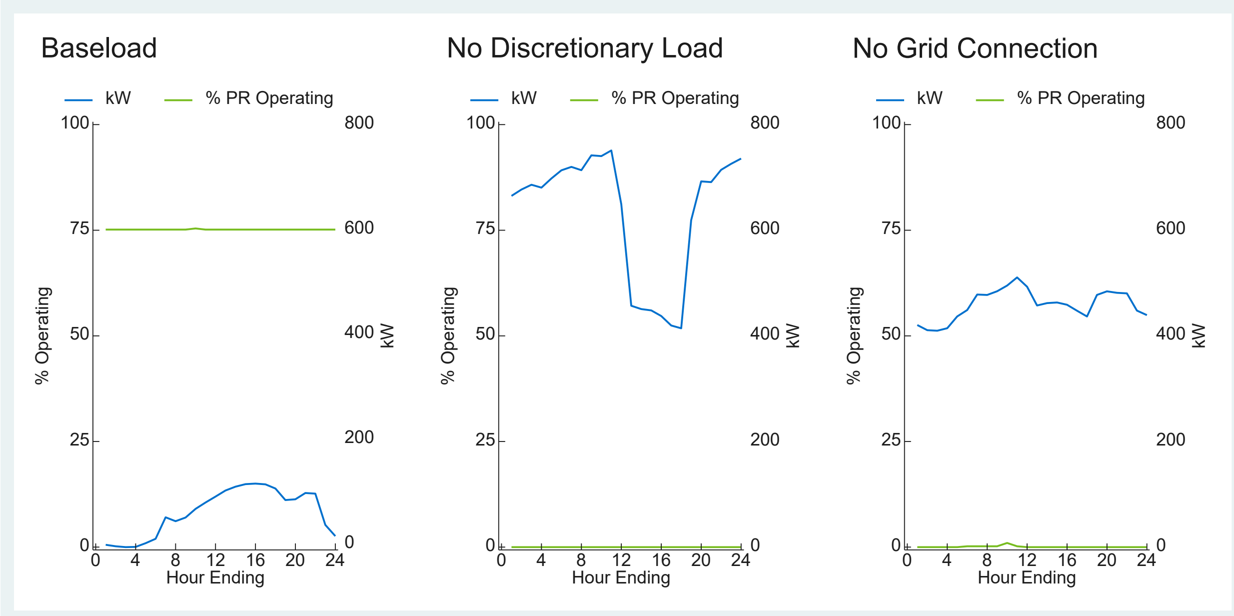
### 5.3.1 Typical PR Operation on Proxy Days

The first research question seeks to characterize how Metering Pilot participants use their PR(s) generally. Does PR operation vary significantly depending on whether the PR serves baseload processes on site, whether the customer has no discretionary load shed available for DR, or whether the PR is not connected to the IOU's grid? The answer is that those use cases do in fact differentiate PR usage patterns among Metering Pilot participants.

Figure 5-1, shows Metering Pilot participant consumption profiles segmented by Use Case, averaged across participants in the Use Case, all programs, all IOUs, and across all available proxy days (blue line). Figure 5-1 also shows the percentage of customers running their PR during those proxy days (green line). While not visible in Figure 5-1, it should be noted that the demand size (kW) of the customers in these three categories varies substantially from customer to customer. The following key findings for typical PR operation on event-like days are summarized as follows:

- Metering Pilot participants who are classified as using their PR to serve baseload (the panel in the figure on the left) source relatively little site load (peaking at around 150 kW) from their IOU, and on proxy days (and in fact nearly always), their PR is consistently producing power for their facility (and potentially for export to the IOU).
    - 75% of Metering Pilot participants classified as having PRs on site to serve baseload show their PR running all day on proxy days. This is not 100% for two reasons. First, there are two customers for whom logging or metering their fuel cell was not possible. If those fuel cells were monitored, they would likely show similar baseload-serving production patterns. Second, the categorization of baseload-serving PRs was customer-reported at the time of installation appointment scheduling, and it seems clear that it is a mischaracterization in the case of one customer (with only diesel-powered generation units on site) to say that their PR(s) serve baseload.
- Metering Pilot participants with no discretionary load for DR (middle panel of Figure 5-1) and participants with PRs unconnected to the grid (right panel of Figure 5-1) generally do not show PR usage at all during proxy days.

Figure 5-1: Average Load and PR Operation on Proxy Days by Use Case




## 5.3.2 Typical PR Operation during IOU Service Outages

The evaluation team also investigated typical PR operations under the specific condition of IOU service outages. The IOUs sent the dates and times of all outages experienced by Metering Pilot participants during the period January 1, 2017, through September 27, 2019. Table 5-3 presents a tabulation of total outage hours experienced by Metering Pilot participants while the data collection equipment was in field during the summer of 2019.

During approximately 59 hours that included the incidence of an outage, there were only 4 hours, 2 each for SCE and SDG&E, where customers were also running their PRs. There are two important notes to add prior to drawing conclusions from Table 5-3. First, the number of outage hours in this table represents the number of hours where an outage happened, not necessarily that the outage happened for the full hour. For example, a 10-minute outage in the hour counts as a full hour in the table below. Second, this table does not distinguish by Use Case – it is the case that for some of the outage hours below, customers were using their PR for baseload generation, and did not specifically turn on their PR in response to the outage. In fact, only two out of the four PR production hours that are coincident with service outages are not associated with baseload-serving PRs.

Table 5-3: Outage Hours during Metering Pilot

| IOU | # of Customer Outage Hours | # of Customer Outage Hours where PR Ran |
|---|---|---|
| SCE | 57 | 2 |
| PG&E | 0 | 0 |
| SDG&E | 2 | 2 |

### 5.3.3 PR Operation during IOU DR Events

Finally, the data collected in the field over the course of the summer of 2019 is also used to determine whether Metering Pilot participants were running their PR(s) during DR events, and if so, whether it should be concluded that any participants were using their PR(s) for load reductions. Table 5-4 shows the overall findings regarding this research question by IOU, program, and Use Case. To protect confidential customer information, we cannot present illustrative or more specific information pertaining to the customers who used their PR(s) during DR event(s). The customer-specific information illustrating how some Metering Pilot participants used their PR(s) on DR event days, and whether it should be concluded that the PR usage was for the purpose of load reduction will be provided to those customers' IOU and the CPUC Energy Division.

Overall, there were a total of 27 customer-event hours of PR operation across all three IOUs that were coincident with DR event hours:

- In the case of PG&E and SDG&E customers who are enrolled in CBP and that had PR usage coincident with DR event hours, these customers' PR baseload production during event hours is as expected given typical PR baseload production or production patterns on proxy days.
- In the case of SCE AP-I customer(s) that used their PR(s) during event hours, their proxy day PR production (in addition to their AP-I load impacts) indicate PR usage during event hours for the purpose of DR load reductions. This finding constitutes the observation of a violation of the Prohibition in the case of this/these AP-I customer(s).

Table 5-4: PR Operations during DR Events

| IOU | Program | # of Customer Event Hours | # of Customer Event Hours where PR Ran | Base Load | No Discretionary Load | No Grid Connection | Evidence of PR Usage for DR? |
|---|---|---|---|---|---|---|---|
| SCE | BIP | 32 | 0 | No | No | No | N/A |
| | CBP | 34 | 0 | No | No | No | N/A |
| | API | 13 | 3 | No | Yes | Yes | Yes |
| PG&E | BIP | 0 | 0 | No | No | No | N/A |
| | CBP | 54 | 2 | Yes | No | No | No |
| SDG&E | BIP | 0 | 0 | No | No | No | N/A |
| | CBP | 22 | 22 | Yes | No | No | No |

### 5.3.4 Discussion

A primary goal of the Metering Pilot is to assess whether data loggers or interval meters can successfully identify PR operations during DR events, and to demonstrate their relative usefulness in determining whether PR operations during DR event hours, when that exists, is for the purpose of generating load impacts for the DR program.

As summarized by the findings above, the evaluation team identified a case of AP-I event hours at SCE where participants(s) electively (i.e., there was no SCE service outage) used their PR(s) during event hours to substitute load from the grid to the PR. In this instance of the coincident AP-I event/PR usage hours, it was clear that the PR usage was in the service of producing DR because the PR was not a baseload-producing PR. This is significant because the site(s) were monitored with data loggers, which revealed that normally on a proxy day the PR(s) are not producing power, but they were producing power during event hours.

Data loggers' usefulness in characterizing PR production that is coincident with DR event hours is limited in the case that PRs may be used regularly, as in the use case of baseload production. In this case, data loggers can only identify operational hours and cannot, for example, show the change in output from hours prior to the event to the event hours. It is technically feasible that PRs used for baseload power production (or even in non-baseload application, but regularly) operate consistently at some fraction of their nameplate capacity during non-DR hours and then operate close to capacity during DR event hours. Interval meters would be able to detect that kind of usage behavior, but the data loggers cannot.

In the case of Metering Pilot participants' usage of PR(s) during DR event hours at PG&E and SCE, the participants' PRs were monitored with interval meters. So, the evaluation team can conclusively rule out the possibility that the PRs were ramped up during event hours to produce load impacts.

We summarize the following strengths and weaknesses of the use of data loggers and interval meters in Table 5-5 below, which are synthesized in Nexant's recommendations in the next section of this report.

Table 5-5: Strengths and Weaknesses of Data Loggers vs. Interval Meters

| Consideration | Data Logger | Interval Meter |
|---|---|---|
| Strengths | ▪ Can nearly always be successfully installed. In the case of fuel cell disconnects, a coordinated visit between field technician and IOU technician may be required if the fuel cell disconnect is under IOU seal.<br>▪ Installations are easy on the customer – fast and simple.<br>▪ Data loggers are inexpensive. | ▪ Can definitively inform an evaluator whether a PR is used differently on DR event days versus non-event days. |
| Weaknesses | ▪ Unless a PR is nearly never used to serve load, data loggers cannot definitively inform an evaluator whether a PR is used differently on DR event days versus non-event days.<br>▪ Ease of installation also means that it is more likely that data loggers "disappear" while in the field. | ▪ Installations are hard on the customer – obtaining a voltage reference may require shutting down electric service for safe installation (or to simply comply with customer access policy).<br>▪ Interval meters are more expensive than data loggers. |

# 6 Recommendations

Nexant offers the following recommendations with respect to the incorporation of data collection devices such as data loggers and interval meters in the DR PR Verification Plan. These recommendations are made by Nexant as the DR PR Verification Administrator and do not necessarily reflect the views of SCE, PG&E, or SDG&E.

The Verification Plan currently does not rely on the deployment of electronic monitoring devices to collect data on PR operations, on either a census or random audit basis. We recommend that the Verification Plan be amended to include an annual audit of Scenario 2 DR participants, whereby data collection devices are installed on a random sample of Scenario 2 participants. This recommendation contrasts with requiring that all Scenario 2 DR participants have data collection devices installed on their PRs:

**Nexant does not recommend that all Scenario 2 DR participants be required to install monitoring equipment at their own expense and to be maintained at their own expense going forward.** In our estimation, the likelihood that the appropriate level of stewardship will occur that is required to keep the fleet of monitoring devices operating as designed is low. We anticipate that requiring customers to install and maintain PR monitoring equipment would be a barrier to program participation. We also anticipate that many customers will not develop the know-how that is required to successfully maintain data collection equipment in proper working order over time.

**We do not recommend that all Scenario 2 DR participants be required to permit their IOU, DRP, or the VA to install monitoring equipment as a condition of participation.** The level of effort for the IOUs, DRPs, or VA to maintain a permanent census fleet of monitoring equipment as customers join the programs/leave the programs would be massive and extremely expensive.

**Nexant recommends that an amended Verification Plan require a random sample of Scenario 2 DR participants to be selected for monitoring each year.** This random audit approach mimics the same encouragement mechanism used by the rest of the Plan's audit mechanisms to develop and encourage compliance. Stakeholders may wish to debate whether the increasing propensity of DR events to be called year-round warrants the necessity of placing monitoring equipment in the field for an entire calendar year, rather than only the traditional DR event season during the summer months. It is important to conduct a true random sample each year – even if a customer is randomly selected for audit one year, they are also eligible for random selection for audit in any subsequent year they are participating in a DR program.

**We recommend that the default monitoring equipment be interval meters, and to use data loggers in cases where the installation of interval meters is not possible.** We recommend that shutdowns for installation/retrieval or coordination with the IOU be enforced to facilitate interval metering installation if necessary. Such shutdowns are inconvenient, but interval meters are the only way to know for sure if any PRs that are typically used in any manner, including baseload serving PRs, are being used to produce DR.

Nexant recommends that interval data recorded internally by the PRs be used in lieu of installing external data collection devices. The most problematic installations encountered during the Metering Pilot were fuel cells – fuel cells were also the PR type that were found to consistently be equipped with on-board metering. This built-in data source should be leveraged in the efficient use of IOU and customer resources.

We recommend all PRs at sampled customer premises be monitored. It will be critical in the event of an annual random sample to work to ensure all PRs at a given site are monitored. Not being able to monitor just one of multiple PRs makes it impossible to rule out use of PRs for DR load reductions.

Finally, as an administrative recommendation, Nexant recommends that the attestation forms be amended to provide a field for the customer to provide a point of contact that is knowledgeable of their PRs' operations and that can be directly contacted in the case of audit. This point of contact may be different than the individual that is responsible for signing and submitting the attestation.

## 6.1 Long Term Data Collection Budget

Under the recommended conditions described above, Nexant has prepared a budget for a proposed random audit of Scenario 2 participants from 2020–2024. While Res. E-4906 requires a sample of 10% of the Scenario 2 customers to be installed with metering devices, we recommend that the number of installations for each year reflects a sample size that is the minimum number of sites that need to be sampled to obtain a 90% confidence level and a 10% margin of error, assuming a compliance rate of 90%. This sampling method mirrors the method used for the other sampling requirements used in the Verification Plan.

The proposed budget makes the following assumptions:

- All existing Scenario 2 customers will be eligible for the Metering Pilot going forward (including DRAM, LCR, and DR Pilots);
- 70% of sites can support interval meter installation and 30% of sites will instead have data logger installation(s);
- All equipment will be purchased in the first year of the budget (2020) and will be re-used in the following years, with an annual equipment replacement rate of 5%;
- There is no increase in annual enrollment over the next five years for Scenario 2 customers; and
- There is no assumed escalation in equipment or labor costs.

It should be noted that the budget does not include costs incurred through contacting customers, scheduling site visits, training installers, and general management. It also does not include VA costs to analyze the collected data and report violations to the appropriate stakeholders. It only includes the equipment and installation costs reported in Section 2.

Table 6-1 reports the annual number of installations, the average cost per installation,[12] and the total annual cost of the pilot based on the assumptions listed above. Each year, the budget estimated for the pilot covers a total of 24 installations, for a budget of $75,309 in the first year when the equipment is purchased and $50,947 in subsequent years. In total, the metering pilot will have 120 installations over the next five years, for a budget of $279,098 from 2020–2024.

Table 6-1: Summary of Five-Year Budget with Proposed Recommendations

| Pilot Year | Average Cost ($/Site) | Number of Sites | Total Cost ($) |
|---|---|---|---|
| 2020 | $3,138 | 24 | $75,309 |
| 2021 | $2,123 | 24 | $50,947 |
| 2022 | $2,123 | 24 | $50,947 |
| 2023 | $2,123 | 24 | $50,947 |
| 2024 | $2,123 | 24 | $50,947 |
| **Total** | – | **120** | **$279,098** |

## 6.2 Cost Allocation

The allocation of costs has not been determined for this report, as the question of how to allocate DRAM participant costs is still an open issue. Per Res. E-4906 OP 35, utilities are not currently required to take on any cost burdens associated with the Verification Plan being borne by DRAM customers. However, the issue of where to allocate the costs incurred by DRAM customers going forward will be addressed in the application proceeding ordered in Res. E-4906. How DRAM participant costs are allocated going forward will significantly affect the total cost incurred by the IOUs, as more than half of the future affected DR participants are anticipated to be DRAM participants.

[12] The average cost has been weighted to account for the number of meters vs. loggers installed, as well as how much equipment is expected to be purchased for the given pilot year.

# Appendix A Metering Pilot Costs by Nameplate Capacity

Table A-1: Installation Costs Assuming Equipment Purchased with Volume Discount – Data Loggers by PR Nameplate Capacity Category

| Data Loggers | Equipment Costs | X<100 kW | 100 kW<X<500 kW | 500 kW< X<1 MW | 1 MW<X<2MW | 2 MW<X<3 MW | X>3 MW | Formula Explanation |
|---|---|---|---|---|---|---|---|---|
| Onset HOBO Logger | **Logger unit** | $ 1,200 | $ 5,400 | $ 900 | $ 300 | $ - | $ - | Columns C, D, E, and F are the number of loggers used multiplied by the $300 retail price. A total of 26 loggers were installed on 25 generators because of multiple ATS in some cases. |
| | **Current transformer (CT)** | $ 250 | $ 950 | $ 150 | $ 50 | $ - | $ - | Columns C, D, E, and F are the number of 400A split core current transformers (CTs) used multiplied by the $50 retail price. Generally 1 CT is installed per ATS monitored. |
| | **Voltage transformer (PT)** | $ - | $ - | $ - | $ - | $ - | $ - | |
| | **Any other equipment needed (please specify)** | $ - | $ - | $ - | $ - | $ - | $ - | |
| | **Cabinetry material** | $ - | $ - | $ - | $ - | $ - | $ - | |
| | **Installation Costs** | **X<100 kW** | **100 kW<X<500 kW** | **500 kW< X<1 MW** | **1 MW<X<2MW** | **2 MW<X<3 MW** | **X>3 MW** | **Formula Explanation** |
| | **Logger unit** | $ 4,600 | $ 15,050 | $ 3,450 | $ 1,150 | $ - | $ - | Columns C, D, E, and F reflect installation costs (labor) of $1,150 for the initial logger installed onsite and and $400 for subsequent loggers installed onsite. Note that installation fees were only charged for 17 rather than 18 loggers in Column D due to the fact that in some cases multiple loggers were used to deal with multiple ATS. |
| | **Associated equipment (i.e. PTs, CTs)** | included | included | included | included | $ - | $ - | |
| | **Cabinet and componentry** | $ - | $ - | $ - | $ - | $ - | $ - | |
| | **Retrieval Costs** | **X<100 kW** | **100 kW<X<500 kW** | **500 kW< X<1 MW** | **1 MW<X<2MW** | **2 MW<X<3 MW** | **X>3 MW** | **Formula Explanation** |
| | **Meter unit** | $ 1,400.00 | $ 4,900.00 | $ 1,050.00 | $ 350.00 | $ - | $ - | Columns C, D, E, and F reflect installation costs (labor) of $350 for the initial logger retrieved and $175 for subsequent loggers retreived. As mentioned above, Column D reflects retreival fees for 17 rather than 18 loggers due to multiple ATS in the case of some PRs. |
| | **Data download** | $ 160.00 | $ 720.00 | $ 120.00 | $ 40.00 | $ - | $ - | Columns C, D, E, and F reflect $40 per logger to download the data. |
| | **Number of PRs** | 4 | 17 | 3 | 1 | 0 | 0 | |

## Table A-2: Installation Costs Assuming Equipment Purchased with Volume Discount – Non-revenue Grade Interval Meters by PR Nameplate Capacity Category

| A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|
| Non-revenue Grade Meters | Equipment Costs | X<100 kW | 100 kW<X<500 kW | 500 kW< X<1 MW | 1 MW<X<2MW | 2 MW<X<3 MW | X>3 MW | Formula Explanation |
| eGauge | Meter unit | $ 500 | $ 14,500 | $ 1,000 | $ - | $ - | $ - | Columns C, D, and E are the number of meters used multiplied by the $500 retail price. A total of 32 meters were installed on 28 generators because of multiple ATS in some cases. |
| | Current transformer (CT) | $ 150 | $ 8,550 | $ 300 | $ - | $ - | $ - | Columns C, D, and E are the number of current transformers (CTs) used multiplied by the retail price. The retail price of the CTs used varied: 400A split core CTs cost $50 each and rope CTs cost $150 each. Generally 3 CTs are installed per ATS monitored. |
| | Voltage transformer (PT) | $ - | $ - | $ - | $ - | $ - | $ - | |
| | Any other equipment needed (please specify) | $ - | $ - | $ 60 | $ - | $ - | $ - | Column E is the number of fuses used multiplied by the $60 retail price. |
| | Cabinetry material | $ - | $ - | $ - | $ - | $ - | $ - | |
| | Installation Costs | X<100 kW | 100 kW<X<500 kW | 500 kW< X<1 MW | 1 MW<X<2MW | 2 MW<X<3 MW | X>3 MW | Formula Explanation |
| | Meter unit | $ 1,250 | $ 25,000 | $ 2,500 | $ - | $ - | $ - | Columns C, D, and E reflect installation costs (labor) of $1,250 for the initial meter installed onsite and $500 for subsequent meters installed onsite. Note that installation fees were only charged for 26 rather than 28 meters in Column D due to the fact that in some cases multiple meters were used to deal with multiple ATS. |
| | Associated equipment (i.e. PTs, CTs) | included | included | included | $ - | $ - | $ - | |
| | Cabinet and componentry | $ - | $ - | $ - | $ - | $ - | $ - | |
| | Retrieval Costs | X<100 kW | 100 kW<X<500 kW | 500 kW< X<1 MW | 1 MW<X<2MW | 2 MW<X<3 MW | X>3 MW | Formula Explanation |
| | Meter unit | $ 500.00 | $ 10,500.00 | $ 1,000.00 | $ - | $ - | $ - | Columns C, D, and E reflect installation costs (labor) of $500 for the initial meter retrieved and $250 for subsequent meters retreived. As mentioned above, Column D reflects retreival fees for 26 rather than 28 meters due to multiple ATS in the case of some PRs. |
| | Data download | $ 40.00 | $ 1,160.00 | $ 80.00 | $ - | $ - | $ - | Columns C, D, and E reflect $40 per meter to download the data. |
| | Number of PRs | 1 | 25 | 2 | 0 | 0 | 0 | |

# Appendix B Load Impact Estimation Out-of-Sample Testing

A full list of models tested are summarized in Table B-1. In total, 24 models were tested for each customer. Models 9–16 included the base of models 1–8 with the addition of a morning load $(\beta_{morning} * morningload_{ih})$; and models 17–24 included the base of models 1–8 with the addition of the prior day's morning load $(\beta_{prior} * priormorningload_{ih})$. Models were estimated for each customer $i$ and hour $h$.

Table B-1: Individual Customer Regression Model Specifications

| Model # | Specification |
|---|---|
| 1 | $kW_{ih} = \alpha_{ih} + \left(\sum_{m=1}^{m=12}\sum_{d=1}^{d=7} \beta_{m,d} * I_m * I_d\right) + (\beta_{cdd} * CDD_{ih}) + (\beta_{cddsq} * CDD_{ih}^2) + (\beta_{hdd} * HDD_{ih}) + (\beta_{hddsq} * HDD_{ih}^2) + \varepsilon_{ih}$ |
| 2 | $kW_{ih} = \alpha_{ih} + \left(\sum_{m=1}^{m=12}\sum_{d=1}^{d=7} \beta_{m,d} * I_m * I_d\right) + (\beta_{cdd} * CDD_{ih}) + (\beta_{cddsq} * CDD_{ih}^2) + \varepsilon_{ih}$ |
| 3 | $kW_{ih} = \alpha_{ih} + \left(\sum_{m=1}^{m=12}\sum_{d=1}^{d=7} \beta_{m,d} * I_m * I_d\right) + (\beta_{cdh} * CDH_{ih}) + (\beta_{cdhsq} * CDH_{ih}^2) + \varepsilon_{ih}$ |
| 4 | $kW_{ih} = \alpha_{ih} + \left(\sum_{m=1}^{m=12}\sum_{d=1}^{d=7} \beta_{m,d} * I_m * I_d\right) + (\beta_{cdd} * CDD_{ih}) + (\beta_{cdh} * CDH_{ih}) + (\beta_{hdd} * HDD_{ih}) + (\beta_{hdh} * HDH_{ih}) + \varepsilon_{ih}$ |
| 5 | $kW_{ih} = \alpha_{ih} + \left(\sum_{m=1}^{m=12}\sum_{d=1}^{d=7} \beta_{m,d} * I_m * I_d\right) + \left(\sum_{m=1}^{m=12} \beta_{cdd} * CDD_{ih} * I_m\right) + \left(\sum_{m=1}^{m=12} \beta_{cddsq} * CDD_{ih}^2 * I_m\right) + \left(\sum_{m=1}^{m=12} \beta_{hdd} * HDD_{ih} * I_m\right) + \left(\sum_{m=1}^{m=12} \beta_{hddsq} * HDD_{ih}^2 * I_m\right) + \varepsilon_{ih}$ |
| 6 | $kW_{ih} = \alpha_{ih} + \left(\sum_{m=1}^{m=12}\sum_{d=1}^{d=7} \beta_{m,d} * I_m * I_d\right) + \left(\sum_{m=1}^{m=12} \beta_{cdd} * CDD_{ih} * I_m\right) + \left(\sum_{m=1}^{m=12} \beta_{cddsq} * CDD_{ih}^2 * I_m\right) + \varepsilon_{ih}$ |
| 7 | $kW_{ih} = \alpha_{ih} + \left(\sum_{m=1}^{m=12}\sum_{d=1}^{d=7} \beta_{m,d} * I_m * I_d\right) + \left(\sum_{m=1}^{m=12} \beta_{cdh} * CDH_{ih} * I_m\right) + \left(\sum_{m=1}^{m=12} \beta_{cdhsq} * CDH_{ih}^2 * I_m\right) + \varepsilon_{ih}$ |
| 8 | $kW_{ih} = \alpha_{ih} + \left(\sum_{m=1}^{m=12}\sum_{d=1}^{d=7} \beta_{m,d} * I_m * I_d\right) + \left(\sum_{m=1}^{m=12} \beta_{cdd} * CDD_{ih} * I_m\right) + \left(\sum_{m=1}^{m=12} \beta_{cdh} * CDH_{ih} * I_m\right) + \left(\sum_{m=1}^{m=12} \beta_{hdd} * HDD_{ih} * I_m\right) + \left(\sum_{m=1}^{m=12} \beta_{hdh} * HDH_{ih} * I_m\right) + \varepsilon_{ih}$ |

The best model for each customer was selected according to two metrics: the mean percent error (MPE) and the normalized root mean squared error (CVRMSE). MPE is a measure of model accuracy, while CVRMSE is a measure of model precision. A visual explanation of the difference between model accuracy and precision is shown in Figure B-1. Ideally, a model is both accurate (on average, it is unbiased) and precise (every attempt is accurate).

Figure B-1: Precision versus Accuracy (Lack of Bias)

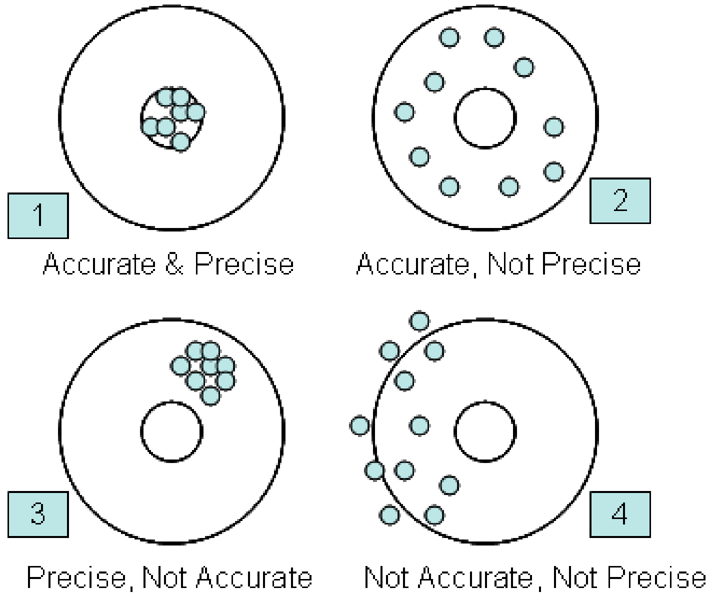


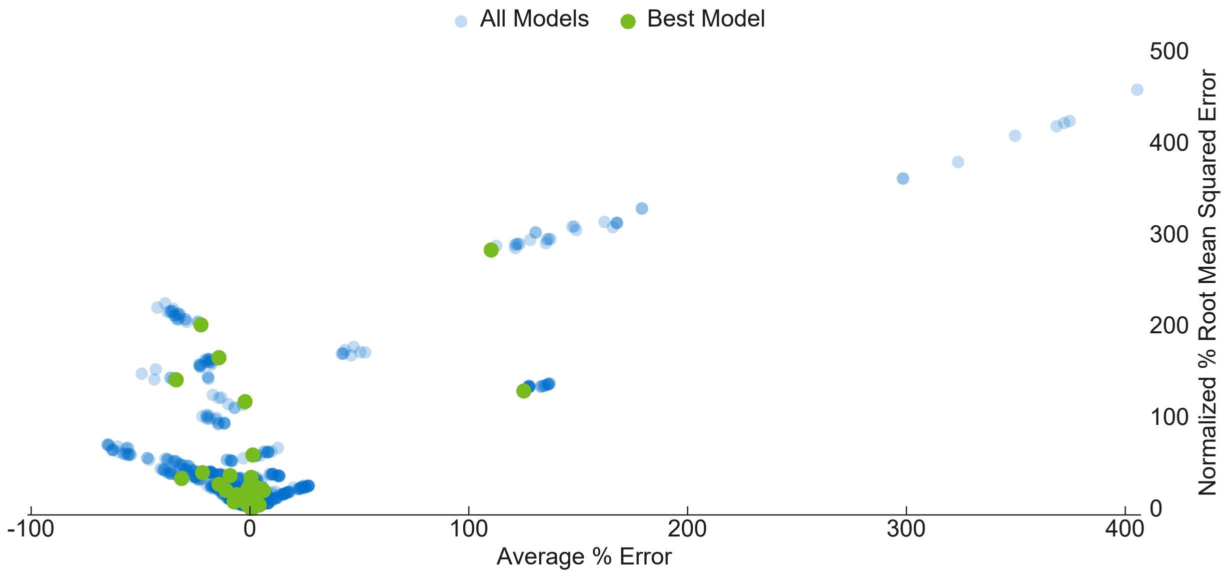

Table B-2 presents the formulas used to calculate each of the accuracy and precision metrics.

Table B-2: Accuracy and Precision Metrics Used to Identify Best Performing Baselines

| Type of Metric | Metric | Description | Mathematical Expression |
|---|---|---|---|
| Accuracy (Bias) | Mean Percent Error (MPE) | Indicates the percentage by which the measurement, on average, over or underestimates the true demand reduction. | $MPE = \frac{\frac{1}{n}\sum_{i=1}^{n}(\hat{y}_i - y_i)}{\bar{y}}$ |
| Precision (Goodness-of-Fit) | CV(RMSE) | This metric normalizes the RMSE by dividing it by the average of the actual demand reduction. | $CV(RMSE) = \frac{RMSE}{\bar{y}}$ |

To identify the best performing models, the evaluation team calculated the MPE and CVRMSE for each customer and model. We first identified the top three models in terms of MPE, and from those, selected the one with the best CVRMSE. A visual summary of the overall performance for each model, as well as the best performing models for all customers and IOUs is shown in Figure B-2.

Figure B-2: Performance of All Models Compared to the Best Model




Some models performed substantially better than others; overall, model 16 was the model selected most often across customers and IOUs, as shown in Table B-3. In general, inclusion of that day's morning load was a helpful variable to improve model performance, as 24 of the 37 best models included it in their final specification.

Table B-3: Best Performing Model Specifications

| Model # | Base Model (1-8) | Base Model w/ Morning Load (9-16) | Base Model w/ Prior Day's Load (17-24) |
|---|---|---|---|
| 1 | 1 | 1 | 0 |
| 2 | 0 | 3 | 0 |
| 3 | 1 | 3 | 1 |
| 4 | 0 | 2 | 1 |
| 5 | 1 | 3 | 2 |
| 6 | 0 | 1 | 3 |
| 7 | 1 | 2 | 0 |
| 8 | 1 | 9 | 1 |