



*Pacific Gas and
Electric Company*[®]

Emerging Markets & Technology Demand Response Projects 2017 Q1 Semiannual Report

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I. Summary

Pacific Gas and Electric Company (PG&E) submits this semiannual report as directed in *Decision Adopting Demand Response Activities and Budgets for 2012 through 2014*, D.12-04-045, Ordering Paragraph (OP) 59 and continued per D.14-05-025 approving 2015-16 Bridge Funding.

PG&E's Demand Response Emerging Technologies (DRET) program continues to explore new technologies and applications that have the potential to enable or enhance demand response (DR) capabilities and can include hardware, software, design tools, strategies, and services. Examples of some of the types of enabling technologies that have been investigated are advanced energy management control systems (EMCS), direct load controls, and advanced heating, ventilation, and air conditioning (HVAC) controls.

PG&E's DR Portfolio Strategy centers around addressing both customer and grid needs today and in the future, taking into account Rule 24, and the enablement of DR integration into the ISO wholesale markets. In addition, PG&E acknowledges the rapid development of "smart" devices, storage, and other technologies that are seeing increasing customer adoption across sectors, and have the potential to help customers better perform on DR programs.

PG&E, Southern California Edison Company (SCE) and San Diego Gas & Electric Company (SDG&E), collectively referred to as the Investor Owned Utilities (IOUs), share updates on individual projects, including project status and findings, at monthly DRET conference calls as well as via participation in the Emerging Technologies Coordinating Council (ETCC) quarterly meetings.

II. Projects Completed in Q3 & Q4 2016

A. *Field Test of Two-way Load Control Receivers in Connection with PG&E's SmartAC™ Program*

1. Overview

PG&E's SmartAC™ program is a central air conditioning (AC) direct load control program. The program enables customers to participate in DR events via remote control of their ACs and is available to residential customers. An AC load control receiver (LCR) device is installed at the outside unit (condenser) for split or packaged AC systems. The LCR is a switch that limits the AC compressor's run time upon receiving a DR signal. There are approximately 150,000 residential customers currently participating in the program.

The existing communication with LCRs is conducted via one-way paging, provided by two separate commercial carriers for redundancy. PG&E is not able to receive real-time or near real-time data about the status of individual devices and the ACs controlled during an event. The program team relies upon several proxies, including the Real Time Monitoring System, to ensure that LCRs are functioning as expected.

Due to technological advances and the degradation in the program resource value due to lack of paging coverage, PG&E assessed the feasibility and cost to transition to a two-way communication technology platform.

PG&E released a Request for Quotation (RFQ) for this project in Q2 of 2014 and received responses from multiple vendors. This resulted in laboratory testing of eleven device models from six vendors which used a variety of communication platforms. These initial laboratory efforts gauged market maturity levels through assessing if the devices met PG&E's technical requirements. The results indicated that no single device model could meet the technical requirements of which the primary objective was to provide real-time visibility during load control events. Upon receiving feedback from PG&E, several of the device manufacturers indicated an ability to improve the device functionality to meet PG&E's requirements by the second quarter of 2015. These efforts narrowed the pool of vendors down to four different models representing three different communication protocols and manufacturers: Zigbee, Direct to Grid and Cellular. An internal review identified Zigbee and Direct to Grid as more viable options based on leveraging the AMI network. PG&E conducted additional laboratory testing to verify the improved functionality in the second half of 2015. Ultimately, 3 models covering the two technology types (ZigBee and Direct to Grid), developed by two different manufacturers (Cooper and Energate) were selected to be placed into the field for additional testing.

In the spring of 2016, one hundred of each of the three selected models were installed at SmartAC program participant homes. Participants were identified based on their AC usage and load shapes, geographical location and history of event participation. Participants experienced eleven demand response events over the course of the season.

Two different technology types (ZigBee and Direct to Grid), developed by two different manufacturers (Cooper and Energate) were selected of many that were tested, to be placed into the field for additional testing.

2. Collaboration

This project is now complete and was a collaboration with multiple internal groups, including DRET, the Smart AC program team, DR Finance, M&E, PG&E's Applied Technology Services (ATS) lab in San Ramon, and the Smart Grid Test lab.

3. Results/Status

Results of the performance across devices were measured by the current SmartAC program evaluator firm, Nexant. The devices were scored in terms of their technical performance, as well as price, experience with installation, and manufacturer responsiveness. All three devices performed well technically – showing comparable load impacts and ability to communicate critical status information back to the program operations team. PG&E chose the Energate LC2200 for full deployment for the SmartAC program, and intends to begin installing devices later in 2017.

4. Next Steps

Final reporting has been completed by Nexant. PG&E chose the Energate LC2200 for full deployment and intends to install devices in production in 2017 and included this technology in cost and value assumptions underlying the SmartAC application for 2018-2022. As designed, the new platform will run in parallel with the deployed devices that communicate with the existing one-way paging system.

B. Third Party Bring Your Own Thermostat

1. Overview

The intent of this study was to understand how already acquired and installed smart thermostats could be leveraged to provide residential DR resources. The study focused on specific PG&E constrained substation areas and reduced participating residential customer's AC consumption on certain "event" days.

PG&E contracted with three vendors: Nest, EnergyHub and Weatherbug for this study. PG&E did not prescribe program design by setting an incentive level or mandating cobranding, but rather the three vendors and/or their partners conducted recruitment using best practices identified from other markets where each operates.

The primary objectives of this effort were:

1. To assess the ease of launch and deployment of this type of a resource, and

2. To measure load impacts of a third party to provide localized DR for TDSM.

2. Collaboration

This project was a collaboration with multiple internal groups, including the DR Programs team, PG&E's Data Analytics and Governance, DR Finance and M&E.

3. Results/Status

Vendors were contracted, and project scoping was completed in Q2 of 2016. Despite contracting and security clearance delays, which went into early Q3, customer recruitment occurred with sufficient time to call a total of four events before the end of the season and study.

Approximately 600 customers were recruited by the three vendors within eight PG&E substation footprints deemed to have local capacity constraints. Customers were offered varying financial incentives by each vendor in exchange for allowing their thermostat to be temporarily setback on event days.

Vendor recruitment tactics (including incentive amounts) varied, and their efforts resulted in very different numbers of recruited and enrolled customers. Of the three vendors, one was able to recruit approximately ten times the number of participants in less than half the time, compared to the other two. Load impacts for that group were .43kW or ~19%.

4. Next Steps

Final reporting has been completed by Nexant. The measurement and evaluation results served as an input to the calculations for the residential CBP proposal in PG&E's application for 2018-22.

III. Projects Initiated in Q3 & Q4 2016

There were no projects initiated in Q3 or Q4 of 2016.

IV. Projects Continued in Q3 & Q4 2016

A. *Lab Test to Understand Existing Technologies' Ability to meet CAISO Telemetry Requirements for PDR*

1. Overview

CAISO has telemetry requirements for Proxy Demand Resources (PDRs) that are greater than 10MW or provide ancillary services. The ability for Demand Response Providers (DRPs) to meet the telemetry requirements in a cost effective manner could unlock more DR to be bid into the wholesale market and meet the various needs of the grid. In 2015, PG&E commissioned a white paper to explore the landscape of existing technologies that could meet the CAISO requirements.

Two possible solution sets emerged:

1. Use the existing SmartMeter[™] AMI network, owned and operated by Silver Spring Networks (SSN) to communicate along the existing AMI mesh network, “alongside” billing data and, ultimately communicating to a SSN Remote Intelligent Gateway (RIG) which was not yet developed.
2. Enable the SmartMeter's[™] ZigBee radio to communicate with a HAN gateway which can push data to an existing 3rd party RIG.

Based on the findings of this paper, a lab study was designed and implemented to explore the technical feasibility of the second solution set: using a Zigbee to broadband gateway communicating to a cloud RIG. The lab study tested two devices: the Rainforest EAGLE and the Universal Devices ISY and used Olivine's CAISO approved RIG.

2. Collaboration

The DRET team worked in collaboration with the PG&E ATS lab, various PG&E DR staff engaged in the Supply Integration Working Group, representatives from CAISO, and the three vendors mentioned earlier (Olivine, Rainforest Automation, and Universal Devices) to conduct this assessment.

3. Results/Status

Lab test findings showed that both devices operated as expected in the lab under various scenarios. Scenarios included testing characteristics about how devices reconnect when a power or internet connection is lost, investigations of security and time synchrony between the various parts.

With respect to meeting CAISOs requirements for polling frequency and accuracy, the lab study showed that both devices could meet the CAISO requirements for one minute and five minute telemetry. Accurate four-second polling, needed for spinning reserve, is unable to be achieved with the architecture tested.

4. Next Steps

A final report describing the lab study and key findings is in nearing completion. The report describes some potential improvements that can be submitted to the CAISO through their BPM change process to reduce barriers to participation in DR.

Based on lab study's demonstration of the device's performance, a field study is being launched in Q1 2017 to further test and demonstrate that the architecture and technical solutions tested in the PG&E lab environment can work at a larger scale and outside of a lab. The field study includes better understanding the costs as well as the challenges of physical deployment and provisioning.

B. Title 24 – Marketing Education and Outreach

1. Overview

Title 24, part 6 requires non-residential buildings be built and commissioned with several components of automated demand response infrastructure. There is a code compliance “industry” that has evolved as a result of past building commissioning requirements and the need to ensure that code required activities are known of by those who need to comply and completed properly.

While energy efficiency has been pro-actively promoted within the compliance industry for many years, automated demand response is relatively new to the industry, and many people in the building and construction industry are not familiar with the state's DR (and integrated demand side management, IDSM) policies, code requirements, or utility DR program offerings available. Anecdotal evidence obtained through standards trainings and demand response program activities indicate that outreach activities designed to increase awareness and understanding of the broader DR policy objectives, code requirements, design strategies, and Auto DR program offerings will improve compliance with the automated demand response systems, and ultimately enable greater participation in DR.

The objective of the project is to educate and inform key market actors who will be impacted by the requirement or can exert an impact throughout the compliance industry. These include equipment

manufacturers and design professionals, installers that implement the designs, acceptance test technicians that verify the proper operation, and building department staff that enforce the requirements.

The project will reach out to each major target audience via trade/industry organizations to identify opportunities and to determine the best approach to disseminate DR-related information within each group.

2. Collaboration

This study is partnering internally with the Energy Efficiency Codes and Standards team, Auto-DR program and PG&E's Pacific Energy Center. Coordination with the Codes and Standards team at SCE is also underway as the findings from this study are expected to be useful statewide.

3. Results/Status

A kickoff meeting was conducted at the beginning of 2016 and the first phase of the assessment was to create an Outreach Plan that identified three to four target audiences and document the proposed communication approach for each. During the first half of 2016, the project team developed informational and educational materials which included a fact sheet, web-site enhancements and presentations targeted at various compliance industry actors.

During the second half of the year, the team presented at over 25 in-person meetings and webinars combined. The in-person meetings provided opportunities for deeper engagement, allowing the project team to understand challenges faced by those in the compliance industry when applying the DR-specific code. For example, while many understand Demand Response as a concept, the study showed that there was a loss in knowledge and understanding about how the building code has any relevance to supporting its enablement.

4. Next Steps

A final report on the efforts conducted and lessons learned is expected for delivery in Q1 of 2017. The findings will be shared with statewide codes and standards teams as well as the CEC to encourage improved quality of communication about demand response.

C. Testing Statistical Sampling Methodologies and Alternative Baseline

1. Overview

The CAISO evaluates Proxy Demand Resource (PDR) and Reliability Demand Response Resource (RDRR) wholesale market performance using one of two North American Energy Standards Board (NAESB) measurement and verification standard baseline types (a.k.a. “Type-I” and “Type-II”), with Type-I being the default methodology. Under Type-I, a resource’s performance is based on aggregated interval Revenue Quality Meter Data (RQMD) for all customer locations comprising that resource. However, Type-II is available for resources that do not have interval RQMD available for all locations, which would meet the CAISO’s required timelines. Using Type-II, performance evaluation uses statistical sampling to estimate the performance of the entire resource based on interval RQMD for a subset of the locations in that resource. In order to use the Type-II methodology, a proposal specific to the resource, which demonstrates 10% error at a 90% confidence interval must be submitted to and approved by the CAISO¹.

The purpose of this project was to develop and analyze a Type-II methodology so that all residential customers may be able to participate in CAISO’s wholesale markets. Phase 1 of the project utilized the residential customers participating in PG&E’s Supply-side Pilot (SSP) to develop a proposal for CAISO’s consideration.

Phase 2 of this project will allow PG&E to further validate the CAISO approved statistical sampling methodology. The DRET team is planning to work with the Stanford Linear Acceleration Center (SLAC) to test the existing methodology and DR baselines using the VISDOM tool. The Visualization and Insight System for Demand Operations and Management (VIDSOM) tool developed by Stanford is a platform for gaining insight into utility customer behavior using their observed energy consumption data combined with traditional demographic and psychographic attributes.

2. Collaboration

In Phase 1, PG&E worked in partnership with Olivine, the SSP program implementer and Scheduling Coordinator (SC). This study was conducted in concert with the SSP. In Phase 2, PG&E will work with SLAC.

¹ For more detail on the proposal requirements, see:
<http://www.caiso.com/Documents/RevisedDraftFinalProposal-EnergyStorageDistributedEnergyResources.pdf>

3. Results/Status

In 2016, CAISO approved a sampling plan that was developed for a participant in PG&E's Supply Side Pilot. The approval of the sampling plan was significant, as it was the first Type II baseline proposal to go through a previously unspecified process.

After the sampling methodology was established and approved, the team planned to assess the accuracy of the plan by comparing the projected performance against actual available meter data. The sampling methodology was developed for a participant in the SSP who ultimately proved unable to enroll a sufficient number of kW's to be able to participate in the pilot and therefore the remainder of the assessment could not be pursued.

Meanwhile, PG&E's Measurement and Evaluation team conducted an assessment on the CAISO approved statistical sampling methodology by applying it to the Smart AC program's population and comparing it to the existing methodology, which requires a bigger population than the CAISO approved statistical sampling. Preliminary results indicate that PG&E's approach is more accurate compared to the CAISO approved methodology due to the large population RQMD customers already participating in the SAC Program. PG&E may explore comparing the two methodologies using a control group with only the RQMD population in 2017.

4. Next Steps

PG&E will continue to consider if other residential aggregators are good candidates for statistical sampling for Phase 1, and if so, an assessment of the Type II baseline can be reconsidered. For Phase 2, PG&E is in the contracting phase with SLAC and the contract is waiting for approval from DOE.

V. Budget

The following is a breakdown of the total expenditures for PG&E's 2015 – 2016 DRET budget. These values are based on accruals made each month. Values do not reflect commitments for projects, including those described in this report, which have been scoped and contracted, but not yet executed.

Approved 2015 – 2016 Budget ²	\$ 2,499,492
Budget Spent in 2015	\$ 926,675
Budget Spent in 2016 ³	\$1,032,746
2015 – 2016 Budget Remaining ⁴	\$540,071

² As approved in D.14-05-025, Attachment 2, p. 1. Amount reported does not include employee benefits costs allocation approved in the GRC (D.14-08-032) which equal \$315,073. Total including this value is \$2,814,565.

³ Through December 31, 2016.

⁴ As of December 31, 2016. Total budget remaining including \$315,073 added from GRC for employee benefits allocation equals \$855,144.