



*Pacific Gas and
Electric Company®*

Emerging Markets & Technology Demand Response Projects 2016 Q3 Semi-Annual Report

September 30, 2016

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I. Summary

Pacific Gas and Electric Company (PG&E) submits this semi-annual 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 Q1 & Q2 2016

There were no projects completed in Q1 or Q2 of 2016.

III. Projects Initiated in Q1 & Q2 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 RIG.
2. Enable the SmartMeter’s™ ZigBee radio to communicate with a HAN gateway which can push data to a 3rd party RIG.

Based on the findings of this paper, a lab study was designed and implemented to explore the technical feasibility of 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

Preliminary lab test findings show that devices behave as expected in the lab under various scenarios. This 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. Analysis of latency and reliability of the two devices is still underway.

4. Next Steps

Based on the lab study findings, a field test may be pursued to prove that the architecture and technical solutions tested in the PG&E lab environment can work at scale in a way that meets CAISO requirements. This includes understanding the costs as well as the challenges of physical deployment and provisioning.

B. Third Party Bring Your Own Thermostat

1. Overview

The intent of this study is to understand how already acquired and installed smart thermostats can be leveraged to provide residential DR resources. The study focuses on PG&E’s constrained substation areas and

will reduce participating residential customer's AC consumption on certain "event" days.

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

The primary objectives of this effort are:

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 is 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. Early Q3 saw the completion of data security clearances and customer recruitment. We successfully recruited close to 600 customers to participate in this pilot and called the first event on 9/7/16.

4. Next Steps:

The recruited pilot participants will be subject to DR events in Q3 and the results will be assessed at that time. We will report out the program findings in the next DRET semi-annual report.

IV. Projects Continued in Q1 & Q2 2016

A. 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, IDSMS) 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.

4. Next Steps

The project team is currently developing informational and educational materials which will be shared in a variety of avenues during the course of the assessment, which is targeted for completion in Q4 2016.

B. 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 it is the only utility non-rate DR program currently available to residential customers. 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 recent technological advances and the degradation in the program resource value due to lack of paging coverage, PG&E is assessing the feasibility and cost to transition to a two-way communication technology platform. Lower cellular communication costs, development of the ZigBee open standard and the evolution of the advanced metering infrastructure, provide potential opportunities for migration to devices and IT systems that are able to provide real time visibility. The multi-year project has involved assessing the feasibility and cost to transition to a two-way communication technology.

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.

As originally conceived, the new platform would run in parallel with the deployed devices that communicate with the existing one-way paging system. No large scale replacement project was intended but rather newly acquired customers and repair candidates would receive the new technology.

PG&E Lab tests conducted throughout 2015 indicated promising technologies exist to improve visibility of direct install devices used for PG&E's SmartAC Program. 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.

In the spring of 2016, one hundred of each of the three 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. They were subjected to eleven demand response events. Results will be measured by the current SmartAC program evaluator firm, Nexant. Installation procedures will be documented and adjustments to cost assumptions will be incorporated into the model. PG&E intends to identify a singular switch model that can be deployed as soon as possible.

2. Collaboration

This project is 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

The results of the field test are not expected until Q3 2016.

4. Next Steps

Final reporting will be completed.

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 must be submitted to and approved by the CAISO. To date, no PDR or RDRR resources have utilized the Type-II methodology in the CAISO market.

The purpose of this project is 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 this project will utilize the residential customers participating in PG&E’s Supply-side Pilot (SSP). If the CAISO approves the proposed statistical sampling methodology, PG&E will work with Olivine, the SSP program implementer and Scheduling Coordinator (SC) to implement the sampling methodology.

After a sampling methodology has been established, the accuracy of the model will be tested by comparing the projected performance of the PDRs using the statistical sampling model to the actual performance of the overall population of the PDRs based on all available interval meter data.

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 is working in partnership with Olivine, the SSP program implementer and SC. This study will be conducted in concert with the SSP. In Phase 2, PG&E will work with SLAC.

3. Results/Status

The scope for this study was developed during Q1 and Q2 of 2015. During the second half of the year, the statistical sampling methodology was developed and iterated in collaboration with the CAISO. PG&E is in the contracting phase with SLAC and this collaboration may extend beyond 2016.

PG&E DR M&E team is in the process of conducting an assessment on the CAISO approved statistical sampling methodology and the result will be provided in the next DRET bi-annual report.

4. Next Steps

The SSP is currently reviewing an application from a residential aggregator that PG&E is considering using as the first trial for statistical sampling. If this and/or subsequent residential aggregators are deemed to be good candidates for statistical sampling, PG&E will work with the CAISO to propose and get CAISO approval for individual sampling plans for each PDR.

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 ¹	\$ 2,499,492
Budget Spent in 2015	\$ 926,675
Budget Spent in 2016 ²	\$473,190
2015 – 2016 Budget Remaining ³	\$1,099,627

¹ 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.

² Through June 30, 2016.

³ As of June 30, 2016. Total budget remaining including \$315,073 added from GRC for employee benefits allocation equals \$1,414,700.