Emerging Markets & Technology Demand Response Projects 2017 Q3 to 2018 Q1 Semiannual Report

March 31st, 2018

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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 and D.16-06-029 adopting Bridge Funding for 2015-16 and 2017 respectively. The Demand Response Emerging Technologies (DRET) Program was also approved in the *Decision Adopting Demand Response Activities and Budgets for 2018 through 2022*, D.17-12-003.

PG&E's 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 on addressing both customer and grid needs today and in the future, and the enablement of DR integration into the ISO wholesale markets, for IOUs and third-party DR providers through Electric Rule 24. 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 act as DR and 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 2018

A. Automated Demand Response (ADR) Assessment of Residential Incentives and Technologies

1. Overview

LBNL has worked with PG&E on demand response (DR) and automated demand response (ADR) programs since 2004. Most recently, LBNL has worked with PG&E to support the ADR program with research and analysis to support customer outreach efforts, technical review of proposed customer projects, and program training and recruiting materials. The purpose of this project was for LBNL to conduct a review of the PG&E's current ADR program design and extract how the lessons learned to date can provide information for further enhancement to the ADR program. The project was constructed around 2 tasks and deliverables:

1) Evaluation of the logic and impact of midstream and upstream ADR device incentives and opportunities they may unlock for residential and SMB markets.

2) Evaluation of a new incentive structure for the ADR Program. For example, offering an incentive based on the incremental cost of the ADR communication technology embedded in the end-use device.

2. Collaboration

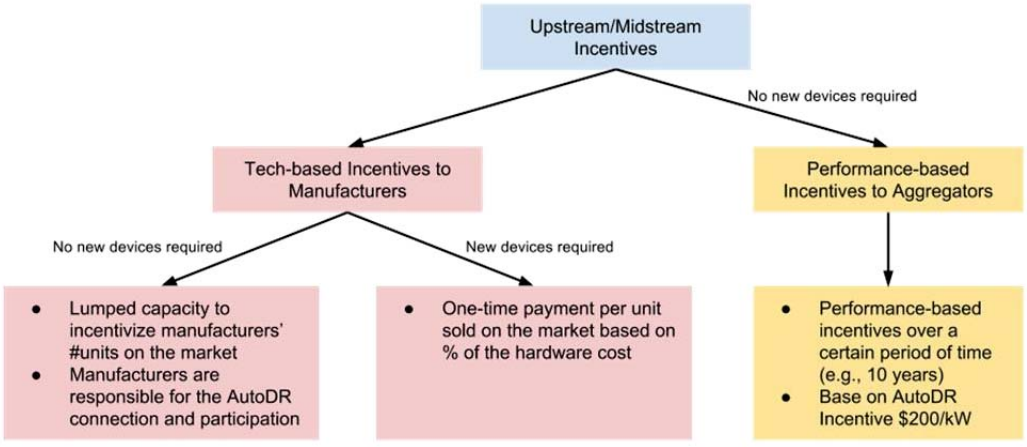
This study partnered internally with the ADR program team and externally with LBNL and PG&E's ADR program implementer.

3. Results/Status

The study was completed in Q4 2017. In the study, LBNL performed the following tasks:

1. Reviewed the effectiveness of documented past efforts to change marketing approaches for similar utility programs.
2. Interviewed a wide range of stakeholders whose work is related to the provision of DR or energy efficiency (EE) in order to determine their interest in supporting such changes.
3. Analyzed the DR load potential from residential and SMB customers using physics based models to determine appropriate conversion factors for developing alternate metrics for ADR incentive.

In this report, LBNL developed a set of concepts that could be considered in potential ADR pilot programs. LBNL proposed several variations of technology- and performance-based incentive options for manufacturers, and aggregators separately, as shown below:



4. Next Steps

PG&E is in the process of reviewing the draft report from LBNL and a public version of the final report will be posted to the ETCC website.

B. Telemetry Field Study

1. Overview

PG&E's DRET program has been exploring the topic of how to meet CAISO's Telemetry requirements[1] for two years. This field study builds directly on two previous studies[2] [3], each indicating that a zigbee to broadband gateway may be able to serve as a scalable solution to provide telemetry for residential demand response. 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.

To test the solution architecture in the field, PG&E deployed approximately 380 Rainforest EAGLE gateways in customer homes. For participants, the field study involved installing a Rainforest EAGLE gateway in their home for a fixed period of time, and responding to a brief survey to assess the features of the home that serve as predictors of zigbee or broadband communication barriers. Meanwhile, the gateways were auto-provisioned by PG&E, and pre-configured to send data in 5 minutes and 1-minute intervals to Olivine's cloud remote intelligent gateway (RIG).

Data was collected from the sample of 380 customers and analyzed in a fashion consistent with the lab study that was completed in 2016, with the goal to understand if CAISO's requirements for data accuracy and speed are met outside of a lab environment.

2. Collaboration

This study is partnering internally with PG&E's StreamMyData program. External partners include Olivine Inc, BMW of North America, and Rainforest Automation.

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[1] CAISO has telemetry requirements for Proxy Demand Resources (PDRs) that are greater than 10MW or provide ancillary services.
[2] Veregy Consulting for PG&E. *Assessment of Technologies Available to Meet California Independent System Operator (CAISO) Telemetry Requirements for PDR*. May 2016. Available at etcc-ca.com/reports.
[3] Anderson, Robert; Piell, Sam. *CAISO Telemetry Solution Over Broadband Lab Test and Proof of Concept*. May 2017. Available at etcc-ca.com/reports.

The field study's population was enrolled alongside customers who were enrolling in BMW of North America's IChargeForward study[4]. This collaboration made sense, as both studies required the use of a Home Area Network gateway to provide real time SmartMeter data, albeit for different purposes. The key objectives of the study were to:

- Determine suitability for HAN gateway devices to support the CAISO requirements for various products relevant to DR resources in a residential environment.
- Identify challenges in the deployment and customer support related to the use of such devices
- Better understand the costs associated with deployment of such a solution,
- Identify further research questions

3. Results/Status

In this study, over three hundred residential SmartMeters™ meters were placed into an aggregation, each connected to broadband interface via Rainforest Eagle 200 HAN devices. Olivine DER provided device to cloud services, metering and telemetry services, as well as a CAISO-validated Remote Intelligent Gateway (RIG). Three resource possibilities were analyzed, including energy, non-spinning reserves, and spinning-reserves.

The study presents an analysis of HAN telemetry costs, scenarios for the different resource possibilities, and other aggregation challenges not observed in a lab environment. Some obstacles were observed in the application of the HAN in residences. Issues included SmartMeter™ to HAN pairing, ZigBee communications issues, and other customer specific logistics. Another challenge the study addressed in detail is the aggregation of meter measurements, the propagation of measurement error, and the CAISO ±2% error threshold.

The study concludes that while these devices can meet the CAISO telemetry requirements for the 1-minute and the 5-minute options (but not for the 4-second option) the cost of deploying and supporting the telemetry equipment for the purpose of enrolling mass market customers in CAISO demand response markets is unlikely to be supported by available market revenues.

[4] https://www.bmwchargeforward.com/#program-overview.

The study offers several avenues for potential improvements to CAISO direct telemetry rules that could lay the ground work for a more balanced approach to bringing residential aggregation to the market including:

- The CAISO BPM 5-minute case requires a +/- 30 second clock synchronization between the devices. While clock synchronization in itself is not a concern since gateway devices can synchronize with meter time – an option unavailable to pulse devices – this clock alignment results in a 5-minute spike of traffic to the cloud provider. As the number of devices involved becomes very large in the mass market case, there is a clear value in distributing the transactions though time.
- The CAISO BPM considers 3-cases: 4-second, 1-minute, and 5-minute. Due to options with such gateway devices and other needs for this data, it would be helpful to codify other frequencies. For example, if 30-second operational telemetry would be useful to a product, it is presumably acceptable to serve the 1-minute instantaneous requirement. What is less clear is whether one could use 2.5-minute telemetry to serve the 5-minute requirement. This could be helpful to be resilient to an occasional drop of a value, allowing the 5-minute requirement to still be met.

Several future research questions are raised by this study:

- How would a hybrid approach of different device types and cloud architectures or other non-HAN measurement devices perform compared to the existing solution architecture?
- The field study focused on meeting the 1-minute and 5-minute CAISO telemetry requirements. What modifications to SmartMeter™ and/or HAN devices might be necessary to support the 4-second telemetry requirement?
- To support the spinning reserves without 4-second telemetry from the HAN, could 4-second telemetry be mixed with longer frequencies? For example, if a subset of the assets in an aggregation provide frequency response with 4-second telemetry, perhaps 1-minute telemetry would be sufficient for the remaining locations?
- Should further testing and analysis be performed on the accuracy of the 5-minute inferred demand method?
- Could applications of these technologies be utilized for distribution needs in addition – or instead of – CAISO telemetry? While standards for such data at the distribution level have not been established, how could these configurations feed into future standards work or pilot projects?
- How can the findings from this project, focused on residential HAN gateways, help inform the relevant Commercial & Industrial

cases? Studying the differences and similarities in the Commercial & Industrial case could leverage the work of this project and other PG&E projects (e.g., the EPIC-funded HAN project for Commercial customers).

- What opportunities and associated cost savings are there to combine HAN telemetry data and statistical sampling techniques to avoid installing HAN gateway on all locations in an aggregation?
- Should the general consensus of the 2015 DR Integration Working Group that average demand over an interval is more appropriate at lower data collection frequencies than instantaneous demand readings be tested with analysis?

4. Next Steps

The final report is posted to the ETCC website

III. Projects Initiated in Q4 2017 and Q1 2018

A. Automated Demand Response (ADR) Collaborative Stakeholder Process

1. Overview

In 2017, PG&E expanded its ADR Program to residential customers to satisfy the AB 793 requirement. The first eligible residential ADR end use device was Smart Thermostat, which was an Energy Management Technology that should qualify for EE and ADR incentives based on AB 793 guidance. On January 17, 2017, PG&E filed its 2018-2022 Demand Response Application (A.17-01-012). In this Application PG&E proposed to continue to offer ADR Program to residential customers. The 18-22 DR Application was approved December 14th, 2017.

In order for the Residential ADR Program to provide ADR incentive to other residential ADR enabled end use devices (beyond Smart Thermostat), PG&E needs to develop deemed incentive levels for these end-use devices. The ADR incentive of $50 on eligible Smart Thermostat was based on a DRET assessment on Smart Thermostats' load impact done in 2016. This assessment developed the DR load impact for Smart thermostat, which was then used to calculate the ADR incentive, based on the up to $200/kW ADR incentive approved by CPUC.

2. Collaboration

In the Motion of the Settling Parties for Adoption of Settlement on Specified Issues in a PG&E Application 17-01-012, PG&E committed to start a collaborative stakeholder process for the development of the following two items:

1) relevant criteria to determine the order in which the load impact study for the residential ADR-enabled end-use devices identified should be done, as an input to the calculation of their associated ADR incentive

2) the development of a list of On March 15th, PG&E hosted an in person meeting to continue the collaborative stakeholder process. Approximately twelve people attended the in-person meeting.

residential ADR-enabled end-use devices to be considered for eligibility for an ADR incentive.

The collaborative stakeholder process was opened to all stakeholders in the 18-22 DR application service list. All three IOUs and Energy Division staff from CPUC attended the first in person meeting.

Results/Status

On February 5th, PG&E hosted a webinar to kick off the collaborative stakeholder process, approximately twenty people attended the webinar.

3. Next Steps

Based on stakeholders' feedbacks from the webinar and in-person meeting, PG&E developed a list of criteria to prioritize ADR-enabled end uses for inclusion in the ADR residential program. PG&E will collect supporting data on the criteria from a boarder group of stakeholders, including device manufacturers that were not on the 18-22 DR Application service list. The data will then be provided to an independent Measurement and Evaluation consultant to evaluate and prioritize the ADR enabled end uses for ADR incentive based on the quality and quantity of the supporting data. When data of specific ADR enabled end use device is not sufficient, PG&E will leverage the DRET program to assess the load impact of this end use device.

B. Res ADR/CBP Request for Information (RFI)

1. Overview

On January 17, 2017, PG&E filed its 2018-2022 Demand Response Application (A.17-01-012). In this Application PG&E proposed continuing its existing Capacity Bidding Program (CBP), a DR program that is currently only open to commercial and industrial customers, and also opening it up to residential customers.

The goal of the RFI is to help uncover and assess best practices, and available commercial solutions to implement an enrollment solution for PG&E's Residential CBP, and an enrollment, dispatch, and rebate solution for PG&E's Residential ADR Program.

2. Collaboration

In the Motion of the Settling Parties for Adoption of Settlement on Specified Issues in a PG&E Application 17-01-012, PG&E committed to conduct a RFI to identify best practices for a streamlined, digital residential CBP customer authorization and enrollment process, that also considers whether and how automated demand response enrollments and CBP enrollments can be coordinated in PG&E's systems.

3. Results/Status

In January 2017, PG&E released the RFI and received 7 responses in February. Most response provided information on the vendor's solution for the following 3 objectives:

- Objective 1 – Digital Enrollment in PG&E's Residential CBP
- Objective 2 – Digital Enrollment, Dispatch, and Rebate Processing for PG&E's Residential ADR Program
- Objective 3 – Coordination between the CBP and the ADR Program for Residential Customers

4. Next Steps

PG&E is in the process of reviewing the RFI's responses and will determine if a RFP will be released in Q2 2018 and if the RFP will include both Res CBP and ADR rebate Process. The subsequent pilot(s) will be funded by the DRET program.

C. Expansion of the Deemed Auto-DR Express/Fast Track Solutions

1. Overview

In the past few years, PG&E and SCE have offered a more streamlined ADR incentive option to SMB customers. PG&E's SMB offering is the Fast Track ADR Program and SCE's SMB offering is the Express ADR Program. There were limited SMB customers enrollments in the Fast Track and Express ADR Program, and the objective of this DRET assessment is to increase automated demand response market penetration of SMB customers by expanding SMB eligible measures, adding additional facility types, and increasing customer and vendor awareness of the program.

2. Collaboration

This study is a joint DRET assessment between PG&E, SCE and SDG&E.

3. Results/Status

Below are tasks that were completed as of March 31st, 2018:

- Interview Past Participants - 16 responses-totaling 583 SAs & 67 MWs in SCE territory
- Analyze Past Participants
- Identify Additional Measures and New Facility Types
- Collect utility Stakeholder Feedback

Below are recommendations based on initial findings:

- Simplify the reservation process
  - FastTrack form based on PG&E FastTrack program
- Increased the eligibility of FastTrack/Express
  - Facilities based on past participants and interviews with vendors
- Make Auto-DR easier for vendor sales staff to discuss during onsite meetings with customers
  - Offline form, incentives and kW listed, uniform across utilities

4. Next Steps

The study will be completed in Q2 2018. The consultant is in the process of drafting the report and a public version of the final report will be posted to the ETCC website when it becomes available.

IV. Projects Continued from 2017 to 2018

A. 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 CAISO[5].

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.

[5] For more detail on the proposal requirements, see: http://www.caiso.com/Documents/RevisedDraftFinalProposal-EnergyStorageDistributedEnergyResources.pdf.

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.

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 kWs 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

In 2018, PG&E starts the Phase 2 study with SLAC. The objective of the Phase 2 work includes the following tasks:

- Identify methodologies that quantify loads accurately for each customer and as a variety of aggregations for supply-side.
- Explore the impact of clustering on the accuracy and bias of the baseline models compare to the existing baseline methodologies for Residential and SMB customers.
- Research machine learning and other methods for load forecasting and calculating Residential and SMB resource availability.

The Phase 2 study is scheduled to be completed by Q4 2018. PG&E will post the final report in the ETCC website when a public version of the report becomes available.

V. Budget

The following is a breakdown of the total expenditures for PG&E's 2018-2022 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 2018-2022 Budget	$7,230,000
Budget Spent in 2018	$61,204
2018-2022 Budget Remaining[6]	$7,168,796

[6] As of February 28th, 2018.