Pacific Gas and Electric Company®

Emerging Markets & Technology Demand Response Projects 2023 Q2 – 2023 Q3 Semi-Annual Report

September 30, 2023

Pacific Gas and Electric Company®

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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*, Decision (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, 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 in DR programs and or dynamic rates.

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 Q2 2023 and Q3 2023

A. Voice Automation Technology for Load Management Study

1. Overview

PG&E started to default residential customers to TOU rates in April 2021. Therefore, PG&E continue to expand the existing tools and technologies offered on its website to help customers understand new time varying rates. The objective of this DRET study is to leverage residential voice assistant technology (such as Amazon Alexa) and mobile app to educate residential customers on energy usage and bill forecasts, rates, TOU automation/optimization, and notification of utility events.

Customer engagement through Voice Assistants require the customer to have access to Amazon Alexa via speakers, display, and/or mobile app. Information was collected and processed from PG&E's internal rate engine and Share My Data (SMD) to a third-party system. The customer would then interact with a third-party system (Energy Expert) through their smart speakers, smart display, and mobile devices. The Energy Expert advised the customers to optimize their energy use based on the customer's rate schedule. In addition, the app provided customer notification such as Smart Days and PSPS events.

This study has two phases. Phase 1 of this program targeted 5-10 employees (combination of PG&E employees and friends of PG&E employees). Phase 2 targeted up to 200 customers.

2. Collaboration

The DRET team partnered with the internal customer care Pricing Product and Marketing teams to develop frequently asked questions (FAQs) that relate to TOU and load management. PG&E hired a third party to develop a smart speaker application (a voice automation skill named Energy Expert) for this study.

3. Results/Status

The DRET team completed this study in the first quarter of 2022. Below is a summary of the study:

Research Question	Findings
How do customers perceive Energy Expert?	Participants generally reported that the information they received from the pilot is accurate and useable. Most respondents also rated the information as easy to understand, although some respondents reported challenges understanding the information. Survey respondents found information about power outages to be the most valuable. There were clear differences between PG&E employees and other pilot participants in their ratings of the value of different types of information the pilot provided. Non-PG&E employees were more likely to provide high ratings for almost all information types, with the most notable difference in the value ratings for information about peak and off-peak times.

Research Question	Findings
How do customers interact with Energy Expert?	Survey respondents most often reported using Energy Expert to get information about electricity usage or bills or on-peak and off-peak times; they used both the app and their smart speakers to find information about both topics with roughly equal frequency.
Are customers satisfied with Energy Expert?	A majority of customers (60%) reported that they were "very" or "somewhat" satisfied with their experience accessing information from Energy Expert, whether through the app, a smart speaker, or notifications.
Do customers feel that using Energy Expert changed their knowledge of energy rates and their usage of electricity?	Most of those who accessed the information reported that Energy Expert increased their understanding of their rate plan at least "a little bit." Half of survey respondents reported they had taken some action as a result of the information they received from Energy Expert. Most of these respondents reported the pilot had given them a general increased awareness of their energy use.
What feedback do customers have on the Energy Expert app's usability and features?	Customers expressed a desire for real-time energy usage data or additional data on energy costs. Additionally, some customers suggested opportunities to improve the app design.
Which features of Energy Expert are used most regularly?	About half of participants asked Alexa about electricity costs or their bill; in fact, the 'getElectricityCost' intent was the most popular with 73 unique conversations throughout the analysis period.
Do interactions with certain features diminish over time?	Participants interacted with Alexa the most during the earlier months of the pilot; interactions diminished over time.

Research Question	Findings
Does customer energy usage change following receipt of usage-related notifications?	Customers who received High Price notifications exhibited hourly peak-period load reductions that ranged from 3% to 5%, but the reductions were not statistically significant due to the small sample size available; these impacts were incremental to impacts attributable to their TOU rate. With the available data and scope for this study, it was not possible to measure load impacts associated with Flex Alert notifications. The pilot included two customers who signed up to receive SmartDay notifications; these customers tended to have lower demand on the days with SmartDay notifications versus those without. However, a larger population is needed to draw conclusions regarding the incremental effect of Energy Expert.

4. Next Steps

The final report is expected to be uploaded to the ETCC website in the fourth quarter of 2023. The DRET team is exploring different options to continue providing this tool to our residential customers due to the positive results of the study, such as the demonstrated EE saving with TOU customers. PG&E is planning to leverage the IDSM funds to offer this tool to more residential customers moving forward.

B. BTM Battery for Load Management Study

1. Overview

This study evaluated how behind the meter (BTM) residential battery system can be used to provide value to the customers and the grid when the battery is optimizing under different dynamic rates (e.g. TOU and real time pricing (RTP)[1]) and DR events. The study focused on customers with an existing battery.

The objective of this study is to collect data that may informs future load management program designs:

[1] RTP as represented by the CAISO IFM Day Ahead LMP PGAE DLAP price

- Determine how best to leverage battery storage technologies for TOU, DR, RTP, load following, and load shaping;
- Increase number of customers with DER technologies participating in DR programs;
- Reliable load reduction: ability to deliver the amount of load reduction that is promised;
- Meaningful load reduction: identify when and how DERs can provide value to the grid in DR programs;
- Speed of response: measuring the speed of distributed battery storage response;
- Load building capability: the ability to increase minimum load and thus decrease ramping capacity needs and increase hosting capacity;
- How to remove significant barriers for battery storage aggregators and their customers to use DER technologies when participating in DR programs; and
- How to ensure DR programs remain cost effective with these enhancements;

This study collected data, such as customer load performance and effectiveness of different algorithms during 2021 and 2022, to inform optimal program design for aggregators and customers with a BTM battery, which could then inform future DR funding applications.

2. Collaboration

The DRET team collaborated with the internal Distributed Generation and Pricing Products team to implement this study. PG&E hired one consultant to manage the implementation and Evaluation, Measurement and Verification (EM&V) for this DRET study, and another consultant for TOU, DR and RTP signals dispatch.

3. Results/Status

Below are the results of this DRET study:

Research Question	Findings
What are the enrollment rates for existing battery storage customers?	181 customers and 6.5% accepted the offer to enroll in a battery storage study, and 120 customers met technical screening requirements for an overall enrollment rate of 4.5%.

What is the relationship between upfront incentive levels and enrollment rates?	Doubling the upfront incentive amount increases study participation by 1.64x.
What recruitment methods increase enrollment rates? By how much?	Phone calls improved enrollment rates by 3x, but there may be interviewer-specific effects. Push notifications increased enrollment rates by 10x.
What are the enrollment rates for a pay-for-performance incentive structure?	3.8% of customers pay-for-performance incentives (with no upfront incentive) accepted the offer. The overall enrollment rate, after technical screens was 2.4%.
Does the data from PG&E align with the SolarEdge data?	On average, the PG&E data is 10% smaller in magnitude compared to the SolarEdge data when comparing household net loads. The degree to which the two data sources aligned varied by participant, with approximately 40% of participants having almost identical PG&E and SolarEdge data.
How much power do people reserve for backup?	Customers typically committed either 50% or 80% (the maximum) of their battery capacity to the program, on average committing 64%. However, the fleet does not typically discharge below 60% of the overall battery capacity.
What are the typical charge and discharge patterns absent intervention?	On average, batteries start charging from solar when the sun rises and stop when they are fully charged. Charging typically starts at 8 AM and on average charge 4.7 kWh between 8 AM and 2 PM. Batteries typically start discharging at 4 PM, as the sun sets, and on average discharge 2.9 kWh between 4 PM and 9 PM.
How well does a customer's "naturally occurring" battery use align with grid needs? What is the untapped value?	On peak days, there is higher battery discharge for the average customer but there is a larger ramp in customer net load between 4 PM and 9 PM due to higher household load. There is also still a large amount of untapped capacity on peak days – 50% of the battery fleet was not discharged. Without

	intervention, the batteries tend to discharge earlier than on the net peak load hours or highest price hours.
What are the load impacts of dispatching battery storage?	During a 4-hour discharge event the average impact was 0.7 kW assuming 100% successful dispatch rate. During the first half of the summer there were no impacts from calling charge events. Once charge events were modified customer net usage increased 1.6 kW for a single hour during the charge window.
What did a typical dispatch look like?	SolarEdge discharge events typically had a flat load shed with consistent impacts across the entire event window. Charge events typically concentrated battery charging into a single hour leading to a spike in the customer's net load.
How successful was the battery response when dispatched for an event?	On average 67% of batteries successfully responded when dispatched for an event, but the overall fleet response rate varied over the course of the study. The relatively low response rate can be attributed to two factors. The first is that over the course of the summer some batteries went offline and were no longer able to receive signals. The second reason is that batteries received signals either from Ethernet or from WiFi, and the batteries on the WiFi signal went offline whenever there were WiFi issues.
What are the key drivers of load impacts?	Event duration was the largest driver of impact magnitude due to the SolarEdge event dispatch algorithm, which aim to provide a consistent demand reduction across the event window. Impacts were larger with more advance notice but there wasn't a strong relationship between the two. Weather conditions and event timing had a minimal influence on event impact magnitude.

How did the impacts vary based on the data source used for the evaluation?	When comparing SolarEdge net load impacts to SolarEdge end use impacts, there was on average a very small difference of 0.03 kW.
Are batteries able to respond to price arbitrage regardless of the customer's current rate?	Batteries were able to respond to both TOU rate structures and market day-ahead prices without exposing the customers to any actual changes in their rate. For example, customers on a tiered rate were able to respond to the time of use rate structure without shifting the customer to a TOU rate. Similarly, all participants were able to respond to market conditions without being exposed to day-ahead market prices.
How are the batteries able to respond to a time of use rate structure (TOU-C)?	The batteries responded to a time of use rate structure in one of two ways. The first response was a base setting that could be selected by the customer when they installed the battery. For the customer-selected TOU setting the battery discharged at the beginning of the peak price window. The second type of response was through price arbitrage. When implementing price arbitrage, the battery discharged when the rolling average price was at its peak. As a result, the battery discharged in the middle of the peak price window rather than at the start of the peak price window.
How are batteries able to respond to day-ahead market prices (RTP)?	The battery responded to day-ahead market conditions and discharged during the highest price period of the day, which typically occurred from 6-7 PM during the study period[2].

4. Next Steps

The final report was uploaded to the ETCC website. PG&E will share this report with internal and external stakeholders so that best practices and

[2] Note that batteries responded to market prices in the fall, which had a daily price peak that was slightly earlier on average compared to summer months. In the summer the typical peak occurs between 7 PM and 9 PM.

lessons learned can be used toward further BTM battery storage programs designs.

III. Project Initiated in Q2 2023 and Q3 2023

The DRET program did not initiate new project in Q2 2023 and Q3 2023.

IV. Ongoing DRET Projects

A. Evaluate Third Party Aggregator and Vendor Interest in Residential Digital Rates

1. Overview

The objective of this study is to evaluate third-party (example: integrated demand side management aggregators and smart energy vendors/manufacturers) interest in using residential digital rates to help customers be successful when enrolling in a dynamic rate such as time of use (TOU), electric vehicle (EV) and SmartRate. Below are the proposed scoping topics for this study:

- Defining a digital rate;
- Determining the format of the dynamic rate;
- Scoping information technology (IT) architecture design that can be scaled in the future;
- Documenting third parties' preferences on the channels and different type of rates;
- Testing different channels that can provide digital rates to third parties; and
- Testing the elasticity of different type of rates (dynamic, tier and non-tier, etc.);

2. Collaboration

PG&E's DR Emerging Technology and Data & Energy Platforms (e.g., Share My Data) jointly designed and implemented this Emerging Technology assessment. Internal stakeholders include, but not limited to, the Pricing Products, Customer Programs and IT teams. PG&E hired a consultant to lead the digital rate development.

3. Results/Status

CPUC Energy Division Staff suggested that PG&E put this DRET study on hold due other priorities, such as the Reliability Order Instituting Rulemaking (OIR). PG&E delayed the deployment of this DRET study until the end of second quarter 2021 and is restarting the study in the third quarter of 2021.

PG&E hosted three webinars to enroll third parties into the study and three parties submitted a registration form to show interest in participating in the study. PG&E signed a participation agreement with one vendor in the third quarter of 2022 and will started to onboard this vendor in the fourth quarter of 2022.

4. Next Steps

PG&E is working with the vendor to develop a final report by the end of 2023.

B. Smart Electric Panel Lab Test

1. Overview

In recent years, electric panel manufacturers have started to add connected technologies to traditional electric panels. These technologies include integrated or add-on software controls that provide customers with additional information and capabilities beyond a traditional panel.

Below are the objectives of the study:

- Evaluate smart panel installation difficulty
- Evaluate smart panel customer app functions
- Evaluate smart panel utility app functions
- Validate that the smart panel is safe to operate for field demonstrations

2. Collaboration

PG&E's DR Emerging Technology and PG&E's Applied Technology Service (ATS) teams jointly designed and will implement the test cases and procedures for the lab tests.

3. Results/Status

The ATS team installed two smart panels at its San Ramon location. The panels are connected to a load simulator, which may expand to real residential electric loads such as air conditioning, electric vehicles, and water heaters in the future. The team is currently developing test cases for the customer and utility apps.

4. Next Steps

The ATS team started testing the customer and utility apps from last quarter of 2022 to the first quarter of 2023. The DRET team is in the process of reviewing the draft test results, lab results and report will be finalized by the fourth quarter of 2023.

C. Residential load management software platform

1. Overview

Home Energy Management system provides the functions and capabilities for residential customers to manage their energy use by behavior changes and/or automation through different energy end uses. The Study will assess residential customers' receptiveness and ability to perform load management with the support of a load management app, which serves as a home energy management system.

1. What is the effectiveness of emissions reductions messaging in:
    - Reducing household emissions
    - Shifting energy usage to off-peak periods
    - Engaging customers in load management awareness and education
2. What are the incremental load impacts of emissions reductions messaging to existing DR participants.
3. Can new communication protocol (e.g., Matter) be leveraged to automate load management measures.

2. Results/Status

The DRET team have contracted with a third party software company to develop an advanced API to enable the residential load management software platform and app.

3. Next Steps

The DRET team will continue to develop the advanced API with the software company and scopes of work/contract with the residential load management software platform company. Technology automation may be introduced to the software platform company's employees before rolling out to the general public.

V. Budget

2018-2022 DRET Budget (Excluding VCE Pilot)

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 for, but not yet executed.

Approved 2018-2022 Budget	$7,230,000
Budget Spent as of December 31, 2022	$6,651,702
2018-2022 Budget Remaining	$578,298

2023 DRET Budget (Excluding VCE Pilot)

The following is a breakdown of the total expenditures for PG&E's 2023 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 for, but not yet executed.

At the time of filing this report, PG&E has over committed its 2023 DRET budget. In response, PG&E decided to fund shift a portion of ADR funds to the DRET Program in 2023. Because the fund shifting amount will be less than 50% of the ADR budget, it will be reported in the monthly DR ILP report.

Approved 2023 Budget	$1,510,000
Budget Spent as of August 31, 2023	$978,093
Budget Committed as of August 31, 2023 (estimated)	$2,500,000
2023 Budget Remaining (estimated)	$0