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September 2, 2022

Public Utility Commission of Oregon
Attn: Filing Center
201 High Street, S.E.
P.O. Box 1088
Salem, OR 97308-1088

RE: PGE UM 1856 PGE Draft Storage Potential Evaluation
2022 Annual Energy Storage Update

Pursuant to Public Utility Commission of Oregon (OPUC or Commission) Order No. 18-290, Portland General Electric Company (PGE) submits its fourth annual report on the progress of its energy storage proposal which includes: Baldock, Coffee Creek, Microgrid pilot, Port Westward 2 (PW2), Residential Storage pilot (called the "Smart Battery Pilot"), and the controls for the energy storage systems. During operation of the projects, PGE will submit comprehensive evaluations in the third, sixth, and tenth operating year, along with annual progress updates. The following report details each project and includes progress, challenges, and preliminary learnings, as available.

On August 16, 2022, President Biden signed H.R. 5376, The Inflation Reduction Act of 2022, into law. There are provisions in this law for tax credits related to energy storage and PGE is evaluating how this may affect the projects under UM 1856. At this time the updates below do not take the passing of this law into account.

History of Energy Storage Docket

The Commission opened Docket No. UM 1751 in September 2015 to implement House Bill 2193, which required Oregon electric companies (PGE and PacifiCorp) to submit proposals by January 1, 2018, to procure qualifying energy storage systems with capacity to store at least five megawatt hours of energy. PGE met this requirement and procured 11 MWh of energy storage (Port Westward 2 and a Microgrid site Beaverton Public Safety Center) as of December 31, 2019.

2022 Annual Energy Storage Update

Baldock Mid-Feeder Energy Storage System

This project was planned to develop and build a 2 MW, two-hour energy storage system adjacent to PGE's Baldock Solar facility and will be interconnected to the Canby-Butteville feeder.

PGE issued the Request for Proposal (RFP) for this project in December of 2021, held an optional bidder job walk at the project site in January 2022, and received bids in February 2022. The RFP was issued to eight bidders but only two bids were received. The reasons that some bidders chose not to provide a proposal were mainly due to the relatively small size of the project and supply chain constraints on procuring equipment. Both bids received had costs that exceeded the stipulated cost cap for this project with no clear path to complete this project within the cost recovery limits in the stipulation. Due to these circumstances, PGE is not moving forward with the project at this time, but will review again in the future if cost drivers sufficiently change to allow the project to be completed within the cost cap[1].

Coffee Creek Substation Energy Storage System

This project will develop and build a 17-20 MW, four-hour energy storage system sited and interconnected at PGE's Coffee Creek Substation. The final project rated capacity will be determined based on the proposal pricing received.

PGE issued the RFP for this project in December of 2021, held an optional bidder job walk at the project site in January 2022, and received bids in February 2022. The RFP was issued to eight bidders. Four bids were received and evaluated. PGE is currently negotiating an Engineer, Procure, Construct (EPC) contract with the top scored bidder with the expectation that a contract will be signed by end of Q3 2022. Once the contract is signed, design work and energy storage media procurement will begin and continue into early 2023. Site construction is expected to start in late Q2 2023, with site testing expected in Q1 2024.

Microgrid Projects (Beaverton Public Safety Center and Anderson Readiness Center)

The Microgrid Pilot Project has completed its first microgrid at the Beaverton Public Safety Center (BPSC), commissioned in September of 2020. The second microgrid at the Oregon Military Department's Anderson Readiness Center (ARC) is targeted for completion by December 2022. Both microgrid sites are designed to support community resiliency.

PGE and the City of Beaverton signed an agreement to deploy the 250 kW, four-hour battery and microgrid at BPSC in 2019, with PGE owning and operating the battery. The microgrid is powered by a 300 kW PV solar array and a 1,000 kW standby diesel generator, both owned by the customer.

The overarching learning to date from the BPSC project is that battery energy storage systems—particularly those designed for microgrid applications—are an effective but "still maturing" technology. Suppliers do a relatively good job of delivering equipment that perform grid services during normal operation. However, supplying power for islanding applications is much more complex and takes more engineering and commissioning effort to make them work properly than originally anticipated.

The agreement to deploy the ARC microgrid has been executed with the Oregon Military Department, consisting of a 500 kW, two-hour battery owned & operated by PGE. PGE issued

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[1] Drivers affecting the cost could be additional entrants into this market segment, alleviation of supply chain constraints, and tax credits and/or grants.

the RFP in February 2021 and in June 2021 PGE awarded the contract. Equipment delivery and design are complete and construction is currently underway.

Pre-Energization Learnings:

Although BPSC has only been operational for a short-time and ARC is still under construction, PGE still gathered quite a few learnings from the process of siting, procuring, and construction. Below are some high-level learnings collected thus far.

Procurement

As noted above, the energy storage and microgrid market is still nascent. Product offerings are constantly changing, evolving, and improving as manufacturers learn from early adopters and technology continues to rapidly improve. Start-ups and prototypes abound, many located overseas and careful research must be conducted to understand which product claims are viable and field-tested and which are based on prototypes or even still in conceptual phase. Few battery energy storage systems are produced domestically and recent supply chain disruptions have exacerbated existing challenges with procurement.

Permitting & Commissioning

Just as energy storage is a relatively new technology for PGE, it is also new for ourmunicipal partners. PGE encountered significant variability in the permitting process of the various projects enabled by UM 1856, but expects this to correct itself as more energy storage projects are built and municipalities become more familiar with the technology.

While the physical construction of the microgrids was straightforward and well-understood, the commissioning did pose challenges to get the microgrids functioning properly. PGE found that the commissioning of a microgrid system with energy storage took approximately four-times the time and effort than simple configuration with only a generator. This may be partially due to the bespoke nature and custom engineering of microgrids and their controls, and the first "real world" application of these specific brands of technology all combined together.

Operational Readiness

PGE pursued maintenance contracts with the suppliers at the time of the purchase contract, and through this process streamlined the expectations for contractors and internal operations.

Interconnection was straightforward and expedient, and PGE found no process gaps.

PGE's Dispatchable Standby Generation (DSG) operations staff was chosen to monitor, dispatch, and respond to trouble-events due to their existing role with large customer generators and the similarities that already existed. The team quickly was familiarized with the microgrid systems and proficiently monitors and responds to trouble events.

Due to the complexities of PGE owning the battery at a behind-the-meter site, revenue metering had to be carefully designed to ensure the varied energy flows are accounted for correctly and the customer is being billed accurately. This involved multiple meters and the involvement of PGE's complex billing team to ensure billing is calculated correctly.

Customer Engagement

For these first two projects, customer engagement has been very detailed and lengthy, and likely not a repeatable process at any type of scale. PGE attributes this to mutual unfamiliarity with the systems and an unprecedented project, and is working on processes to streamline.

System Performance / Use Cases:

PGE has been regularly dispatching BPSC for flexible load services to the bulk power system, including portfolio resource optimization (demand response) and frequency response.

BPSC has participated in three demand response events, providing 880 kWh to PGE's VPP. From a controls perspective, generation capacity or energy portfolio optimization is an uncomplicated and reliable grid-service.

BPSC has spent the majority of time since commissioning programmed to be on standby for contingency reserve and frequency response. Since commissioning BPSC has responded to eleven contingency reserve events and 166 fast frequency events. Fast frequency response in particular has proven to be a exceptionally valuable service.

For the customer case of outage mitigation, the microgrid was able to successfully mitigate the two longer outages experienced by the BPSC during which the microgrid system (batteries, diesel generator and solar power inverters) satisfactorily provided emergency power to the site for the full-duration of the outage. PGE learned that the system response was not fast enough to prevent momentary outages or power flashes, and the site experienced two outages lasting a few seconds that were not prevented by the microgrid. PGE worked with the manufacturer on this issue and collaborated to create a firmware update for the battery system inverters, and in September 2021 the system was re-comissioned, and then again in July 2022 to improve upon identified performance problems.

Port Westward 2 (Generation Kickstart) Energy Storage System

Overview

This project has developed and built a 5 MW, two-hour energy storage system coupled with PGE's Port Westward 2 Generating Station (PW2). By coupling the energy storage system with PW2's reciprocating engines the combined resource becomes enabled to qualify as contingency reserve, even while the engine is not running.

The project design work was completed in November 2020 and the battery energy storage equipment was delivered to the site in December 2020. Construction and controls integration work commenced and continued through August of 2021. The battery was energized and the system testing and commissioning were completed in September 2021, upon when the project was put into service.

System Commissioning

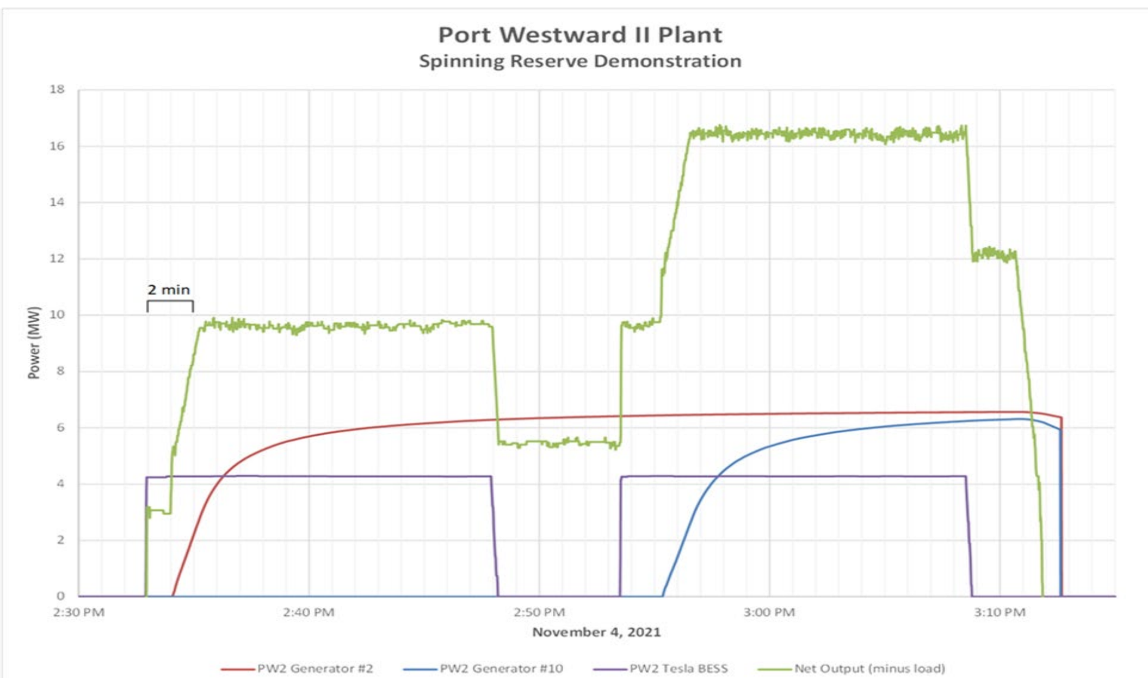
After construction was complete and backfeed power was available to the battery system, the battery manufacturer was able to complete on-site testing and commissioning. Upon completion PGE commissioned the site controller and verified operations from the PGE control center to the site. This included testing dispatches locally from the PGE site controller and again from the PGE control center to the site. Frequency response, generation capacity, frequency regulation, VAr support, and contingency reserves, were all successfully tested and demonstrated.

The primary use case for this site was to leverage non-spinning resources for contingency reserve. To perform this test the Balancing Area Operator (BAO) placed the battery system into "Contingency Reserve" mode and then dispatched a Port Westward 2 reciprocating engine as if it were a contingency reserve dispatch.

This test was successfully performed twice on two separate generators. Figure 1 below is a graphical representation of the contingency reserve test. The purple line represents the battery's power output while the red and blue lines are the two tested generators. The test showed successful deployment of the battery and synchronization with the generators for contingency reserve.

Figure 1 shows both tested generators and the battery idle at around 2:30. Upon receiving a dispatch signal for a simulated contingency reserve event at 2:33 the battery responded immediately to dispatch at full output. This gave Generator 2 (red line) time to start, come up to speed, and synchronize with the grid while ramping up to about 6 MW. After 15 minutes the battery had done its job bridging the start-up time for the generator, and ended the dispatch. Approximately 10 minutes later, the test was repeated on Generator 10 (blue line) with the same successful result.

Figure 1



System Operation

Over the last year the system has been primarily used for fast frequency response and has been very successful in responding to system frequency events. System frequency is monitored locally and if a deviation is detected the site controller immediately dispatches the battery to full output and discharge for three minutes before ramping down. The system has automatically responded to approximately 15 frequency events per month. For the last 12 compliance events randomly selected by the North American Electric Reliability Corporation (NERC) for closer review, the PW2 battery has been instrumental in meeting PGE's fast frequency response compliance needs, providing more than half of the requirement in some cases.

Table 1 below shows the results of 12 fast frequency event responses selected for review by NERC with the proportion of PGE's requirement that was provided by the PW2 battery.

Table 1

Event Time	Delta f (Hz)	Total PGE Obligation (MW)	PW2 Dispatch (MW)	% Provided by PW2
12/6/2021 11:03	-0.056	13.328	3.54	27%
12/11/2021 7:10	-0.031	7.378	4.25	58%
12/19/2021 0:14	-0.037	8.806	4.51	51%
1/7/2022 12:56	-0.044	10.472	4.29	41%
1/11/2022 17:58	-0.091	21.658	4	18%
3/25/2022 1:54	-0.049	11.662	4.1	35%
3/27/2022 18:32	-0.034	8.092	4.2	52%
4/8/2022 23:43	-0.046	10.948	4.3	39%
5/6/2022 13:27	-0.043	10.234	3.9	38%
5/7/2022 0:52	-0.034	8.092	4.5	56%
5/23/2022 7:24	-0.037	8.806	4.3	49%
5/28/2022 22:09	-0.038	9.044	4.5	50%

Residential Storage Pilot

<u>Overview</u>

PGE's Smart Battery Pilot became effective in August 2020, and seeks to integrate up to 525 customer-owned residential storage units as a dispatchable resource providing grid services. During grid outages, the energy storage system provides back-up power to participating residences. In exchange for allowing PGE to operate the battery for grid services, a customer receives $20 or $40 per month. Customers within the Smart Grid Testbed are also eligible for an up-front rebate to encourage the density that will be needed to test locational benefits, and income qualified customers participating in the Energy Trust of Oregon's (ETO) Solar Within Reach program are also eligible for an up-front rebate so that PGE may better understand the needs of a diverse set of customers.

The pilot currently has 100 enrolled batteries with a maximum energy potential of 2 MWh. However, due to dispatch and program limitations PGE is able to access only about 0.5 MWh during a dispatched event. This limitation and PGE's proposed adjustment to unlock additional capacity is outlined further within this document.

Operational Readiness

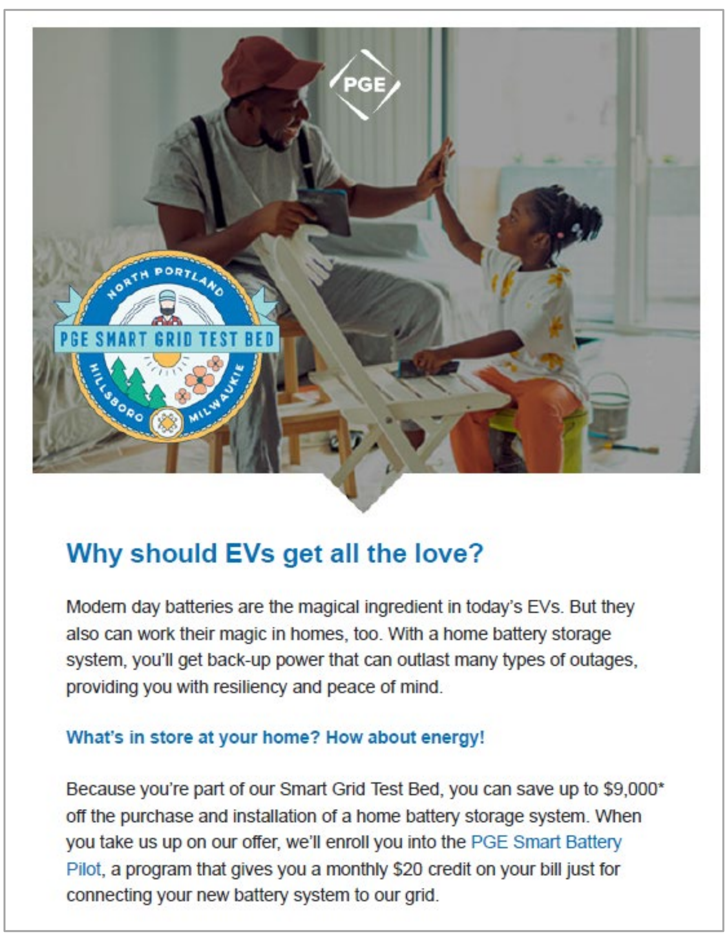
Pilot operations are as mature as is appropriate for a small scale pilot. The team is working to balance implementation cost with efficiency, and thus while some elements are not fully automated, this is a reasonable trade-off at this juncture. Since the previous update filing the day-to-day program management has been transferred from the Product Development group to the Interconnection group. This group handles all new DER applications for PGE and is extremely well-suited to answer customer questions and process the logistics of pilot enrollment. This switch in day-to-day program management shows PGE's long-term commitment to help customer's with batteries interconnect to PGE's system safely and as quickly as possible without the need for multiple handoffs between groups at PGE. Aside from this process enhancement the operations of the Pilot have been functional and smooth, with no major issues.

Customer Recruitment and Outreach

PGE continues to proactively perform outreach to customers, and after significant disruptions due to the Covid-19 pandemic and subsequent supply chain disruptions, is very pleased with recent increases in enrollment.

PGE emailed targeted customers without energy storage to raise awareness of the program options and the benefits of energy storage.

Figure 2 Excerpt of an email sent to Smart Grid Testbed customers without an existing battery.



Feedback from message testing as well as findings from market research made it clear that the monthly pilot rewards are not enough of a financial incentive to purchase a battery if the customer was not already planning on doing so, and uptake on the Smart Grid Test Bed rebates has also been low, and again not enough money to induce a customer to purchase a battery who was not already planning to. This prompted a change in our primary approach of encouraging new customers to purchase a battery, to promoting how the Smart Battery Pilot can optimize their battery once they have it.

Subsequent outreach campaigns focused on customers who already have energy storage but have not yet enrolled in Smart Battery. PGE sent out a regular cadence of emails to customers with links for more information and a direct link to join the Pilot. A post card was also sent to this same audience to reach customers in cases that PGE may not have accurate email information.

Figure 3 Excerpt of email sent to customers with existing battery storage.

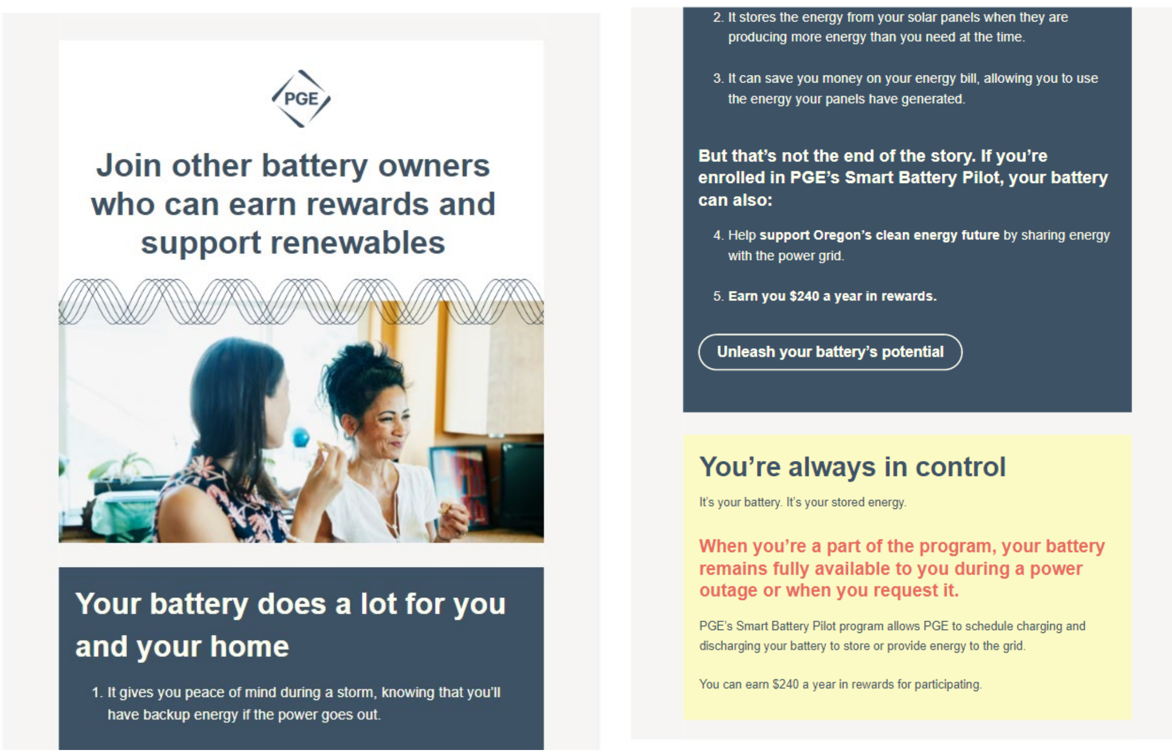
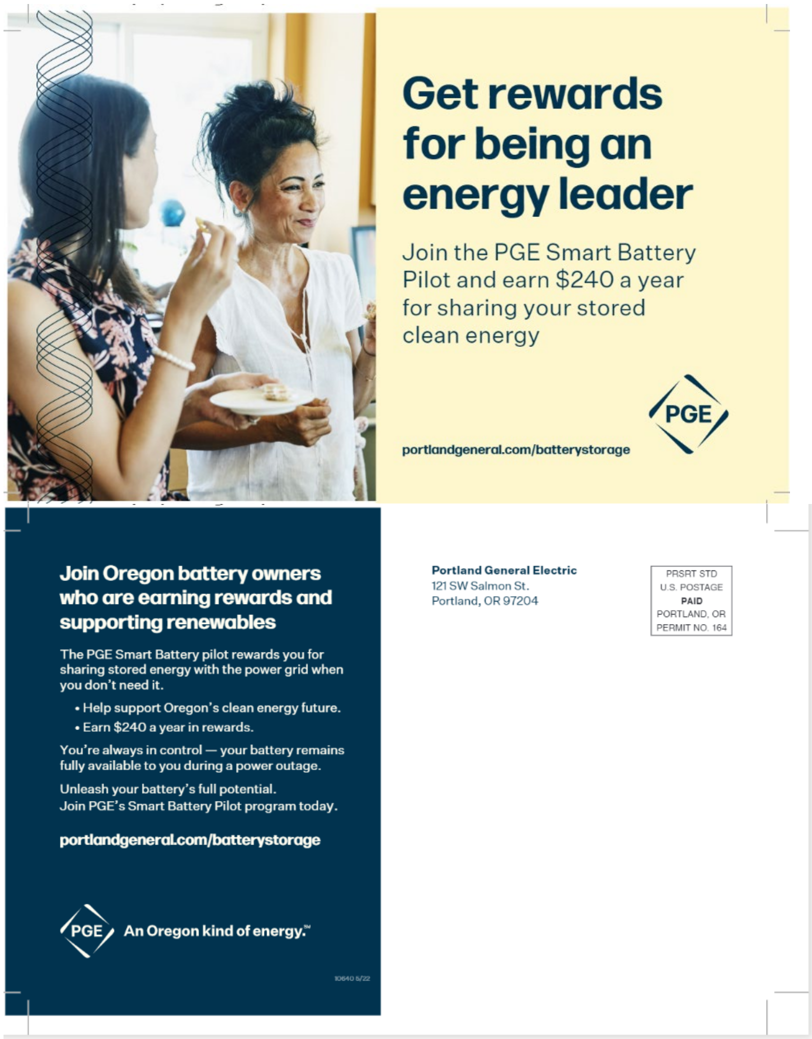


Figure 4 Front and back of postcard sent to customers with existing battery storage



We are measuring interest by engagement with our email campaigns. We saw an average of 57.5% open rates, 13.9% click through rates and 0.01% unsubscribes. These numbers exceed industry standards and show strong interest and engagement in battery storage. Finally, general information about solar and storage and the Smart Battery pilot were included as part of PGE's All Electric Tiny Home promotional activities that launched in the summer of 2022.

<u>Dispatches and Technical Discovery</u>

PGE conducted tests to establish whether fast frequency response (FFR) could be performed with the Smart Battery customer fleet. Multiple tests on PGE's own batteries at the Salem Smart Power Center and Rose City Meter Shop were first conducted prior to testing this functionality with customer devices. PGE conducted the test by utilizing an internal software (GenOnSys) capable of detecting fluctuations in grid frequency and autonomously sending a signal command to Virtual Peaker, that in-turn sends a signal that directs all batteries to perform a discharge at full-power for 5 minutes. The same test was also performed using a second DRMS software that leverages the

IEEE 2030.5 communication protocol[2] called Kitu. As true frequeny events are random and challenging to test, PGE simulated events by sending manual commands through GenOnSys to trigger the dispatch response, and measured the device response time via a local power meter.

The results of this test showed a latency average of 61 seconds when a dispatch signal was triggered by GenOnSys to Virtual Peaker to the device, and 90 seconds when using Kitu as the pathway. A latency of 20 seconds or less is targeted for resources to contribute to NERC compliant frequency response, so PGE looked for ways to reduce the response time. Eliminating the GenOnSys portion of the architecture and dispatching directly from Virtual Peaker and Kitu reduced the latency slightly (depending on the device and software, between 1.4 seconds to 13 seconds), but not enough to reduce to sub-twenty seconds.

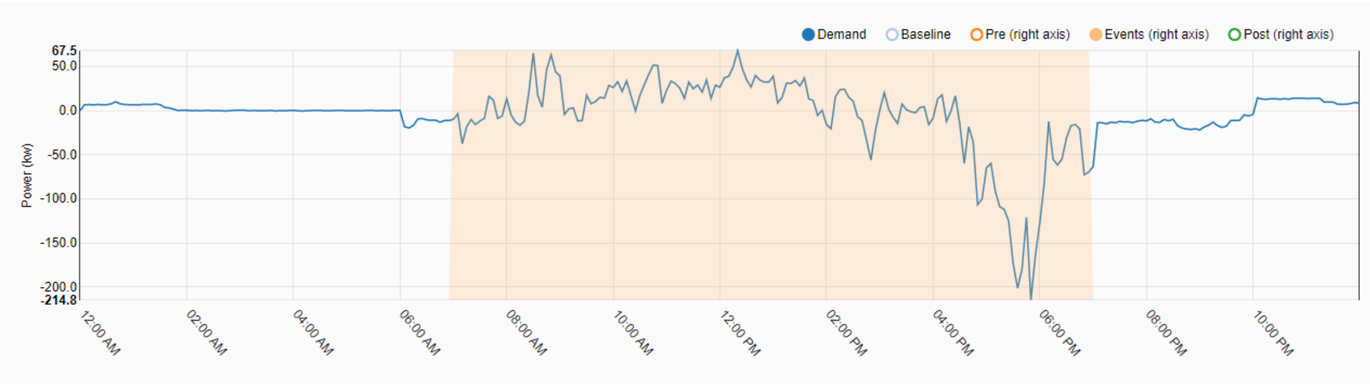
In conjunction with the testing of Fast Frequency Resonose, PGE also pursued the testing of frequency regulation- a use case not originally conceived at the outset of the filing but a functionality of PGE's DRMS software. Testing of the functionality was successfully conducted with a PGE-owned device in August 2021, and later with customer batteries in March 2022. This customer test proved effective, with almost all eligible batteries responding as expected to these signals.

The frequency regulation setting did not interrupt other battery functions, perhaps setting it up for future co-optimization opportunities. Figure 5 shows the Virtual Peaker interface and the frequency settings that will make micro-adjustments when a frequency deviation above or below 60 hertz is detected. Figure 6 shows the charging and discharging activity of the fleet over the duration of the event.

Figure 5

[2] For comparison, Virtual Peaker communicates with devices using OEM cloud based API protocols.

Figure 6



PGE also worked to implement and test the functionality of autonomous demand response as a locational benefit. Demand Response can be performed autonomously with a complete integration of PGE's Genonsys system via PI telemetry feeder head data. PGE is working with internal teams to enable the automatic dispatch of residential batteries for demand response using PGE's hosting aggregator – Virtual peaker. Based on Transformer and feeder loading percentages, PGE will try to dispatch the residential batteries.

Volt-Var Controls: This is a control setting on the battery inverter that can be used to alleviate low voltage thresholds seen on the PGE distribution network. Because voltage is proportional to Load, customers that are farthest from a PGE substation or heavily loaded feeders might see a slight decrease in voltage. Volt-Var controls on the battery inverter allow PGE to control the VARs we can inject back into the PGE grid in order to boost voltage back to nominal values. The OEMs currently in the program do not allow PGE to remotely operate the Volt-Var control settings on the battery inverters. PGE plans to develop a in-house experimental Volt-Var control mechanism by getting real time Var readings from the feeder and dispatching the batteries to help where necessary. Albeit, due to the scale of the batteries currently in the pilot, the impact of this exercise may be negligible. PGE intends, however, to pursue this exercise for experimental purposes.

This concludes PGE's Annual Energy Storage Update for 2022. Next year in addition to filing an Annual Energy Storage Update for 2023, PGE looks forward to filing the mid-term Comprehensive Evaluation for the Residential, Energy Storage Pilot.

Please direct any questions regarding this filing to Chris Pleasant at (503) 464-2555. Please direct all formal correspondence and requests to the following email address pge.opuc.filings@pgn.com

Sincerely,

\s\ Robert Macfarlane

Robert Macfarlane
Manager, Pricing & Tariffs

cc: UM 1856 Service List