Portland General Electric Company
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September 23, 2022

Via Electronic Filing

Public Utility Commission of Oregon
Attention: Filing Center
P.O. Box 1088
Salem, OR 97308-1088

Re: **UM 2141 – In the Matter of Portland General Electric Company, Flexible Load Plan Update**

Dear Filing Center:

Portland General Electric Company (PGE) submits this Flexible Load Multi-Year Plan, September 2022 Update for docketing. This filing is a mid-cycle update to PGE's Flexible Load MYP. The filing is made in response to Order 22-023 which approved in part PGE's 2021 Multi-Year Plan (MYP). Order 22-023 invited PGE to provide an update to the 2021 MYP to address gaps identified by Staff regarding product development.

With this filing PGE proposes funding for a single-family water heater pilot and updates the Commission and Stakeholders on the progress of existing flexible load efforts. Further, the filing informs the Commission and Stakeholders of next steps and new concepts PGE intends to pursue through the next Multi-Year Plan in 2023. This filing also demonstrates additional evolution of PGE cost effectiveness calculator as outlined in the 2021 MYP and most recently through PGE's Distribution System Plan in UM 2197. This update filing only requests funding for a single-family water heater pilot through 2023. No other funding requests are being made and no other practices changes are being requested at this time.

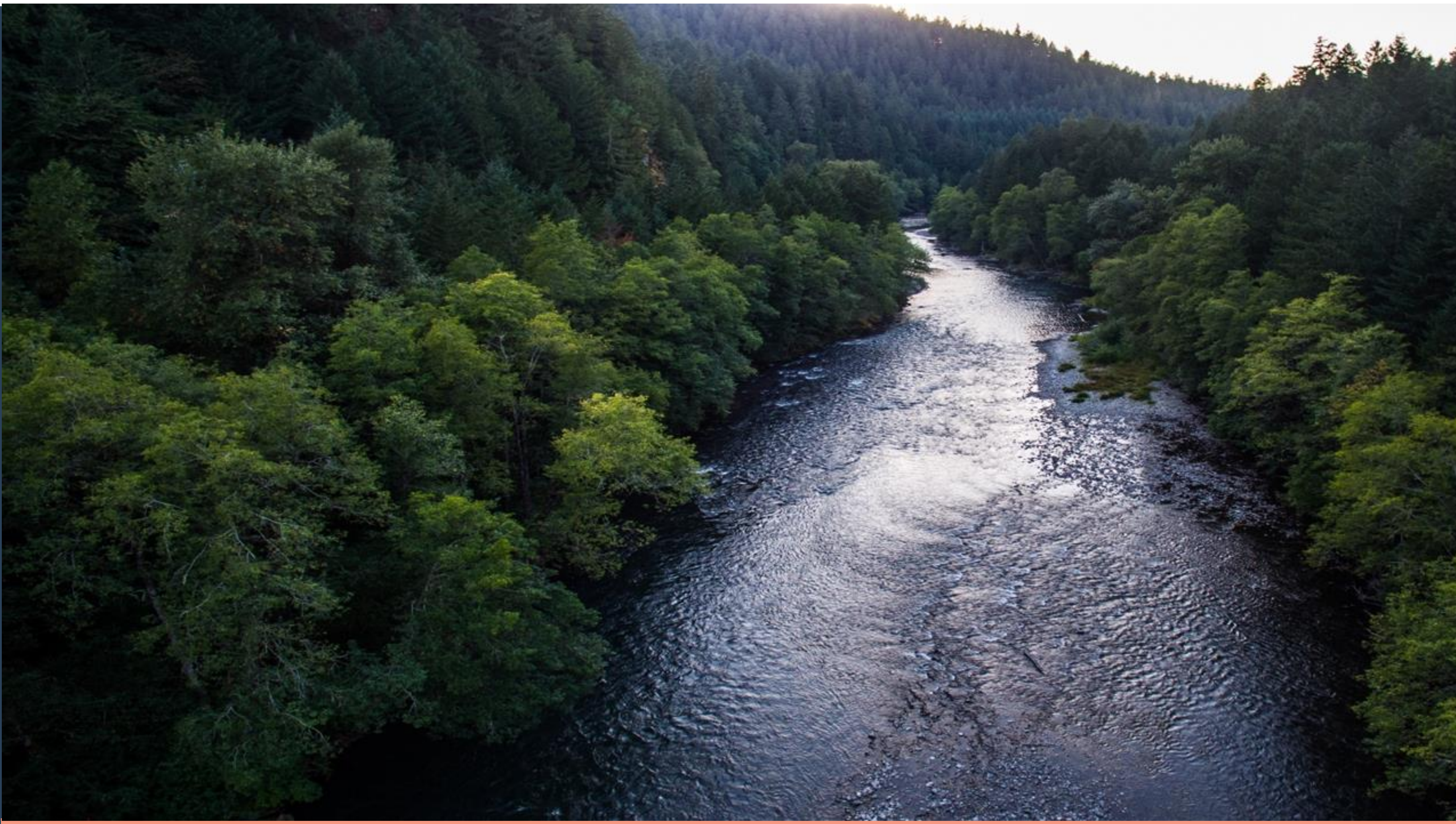
PGE is requesting Commission consideration of this update by November 11, 2022. Please feel free to reach out to me at Jason.Klotz@pgn.com.

Sincerely,

Jason Salmi Klotz
Manager Regulatory Affairs, Strategy and Engagement

JK/dm
Enclosure

CC: Nick Sayen and Kacia Brockman



Flexible Load Multi-Year Plan
September 2022 Update

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Abbreviations

AC............Alternative Current
API............Application Programming Interface
BPA............Bonneville Power Administration
C&I............Commercial and Industrial
CAISO.......California Independent System Operator
CE.............Cost Effectiveness
CEP...........Community Energy Project
CUB...........Citizens' Utility Board
DC.............Direct Current
DER(S).......Distributed Energy Resource(s)
DERMS......Distributed Energy Resource Management System
DLC...........Direct Load Control
DPSST.......Oregon Department of Public Safety Standards Training
DR.............Demand Response
DRAG........Demand Response Advisory Group
DRMS........Demand Response Management System
DRRC.........Demand Response Review Committee
DSG...........Dispatchable Standby Generation
DSP...........Distribution System Plan
DTIM..........Discounted Total Investment
EE.............Energy Efficiency
EIM............Energy Imbalance Market
EO.............Executive Order
EPRI...........Electric Power Research Institute
EV.............Electric Vehicle
ERWH........Electric Resistance Water Heater
EVSE..........Electric Vehicle Service Equipment
FLASH.......Flexible Load Advisory Stakeholder Group
GHG..........Greenhouse Gas
HB.............Oregon House Bill
HPWH........Heat Pump Water Heater
HVAC........Heating, Ventilation, and Air Conditioning
IRA............Inflation Reduction Act
IRP............Integrated Resource Plan
ISO............Independent System Operator
KPI............Key Performance Indicator
kV.............Kilovolt
kW............Kilowatt
kWh..........Kilowatt-hour
LOLP.........Loss of Load Probability
LTE...........Long Term Evolution (wireless broadband standard)
MFWH......Multi-family Water Heater Pilot
MVP..........Minimum Viable Product
MW..........Megawatt
MWa.........Average Megawatt
MYP..........Flexible Load Multi-Year Plan
NEEA........Northwest Energy Efficiency Alliance
NREL.........National Renewable Energy Laboratory
NWEC.......Northwest Energy Coalition
OEM..........Original Equipment Manufacturer
OPUC........Oregon Public Utility Commission
PIM...........Program Implementation Manual
PTR...........Peak Time Rebates
PW...........Present Worth
RS.............EIM Resource Sufficiency
RSE...........Resource Sufficiency Evaluation
SAM..........Serviceable Addressable Market
SEM..........Energy Trust's Strategic Energy Management program
SOM..........Serviceable Obtainable Market
SSPC.........Salem Smart Power Center
SWH..........Single Family Water Heater
TAM..........Total Addressable Market
Testbed....Smart Grid Testbed
T&D..........Transmission and Distribution
TE Plan......Transportation Electrification Plan
TOD..........Time of Day, f/k/a Time of Use, or TOU
TRC...........Total Resource Cost Test
UCM..........Universal Communications Module
UM............Utility Miscellaneous (OPUC Docket)
VPP...........Virtual Power Plant

Key Terms and Concepts

Demand Response (DR) – "Changes in [energy] usage by end-use customers from their normal consumption patterns in response to changes in the price of [energy] over time, or to incentive payments designed to induce lower [energy] use at times of high wholesale market prices or when system reliability is jeopardized."[1]

Flexible Load (a/k/a Flex Load) –is a dynamic form of DR capable of providing valuable grid balancing services. Grid balancing services are necessary for integrating high levels of renewable or variable energy resources. To supply grid balancing services, these demand-side resources must be available to grid operators throughout the day and capable of supplying several different types of energy products beyond peak load shifting.

Resilience – The ability to anticipate, adapt to, withstand, and quickly recover from disruptive events.

Reliability – The availability of service during normal operations and routine events.

[1] FERC National Assessment and Action Plan on Demand Response, https://www.ferc.gov/industries/electric/indus-act/demand-response/dr-potential.asp

Chapter 1 Overview

1.1 Strategic Context for Flexible Loads

In the last year, much has transpired relative to Flexible Load and its value to the electric system. Our region has experienced a once-in-40-year ice storm, a multi-day heat dome event, considerable energy market volatility, and several wildfire events. In the Oregon Legislature, Oregon House Bill (HB) 2021 set accelerated decarbonization targets for the state and Portland General Electric (PGE or Company). In this broader context, Flexible Load has become more critical than ever, both for operating the grid and for giving customers the tools they need to manage their bills, contribute to decarbonization efforts, and become more resilient.

We envision a future where customers can easily participate in an optimized energy system, and how their contribution not only enables their individual goals but also the region's broader climate and reliability goals. If we are to meet the challenges of a clean energy future, it is imperative that customers participate in this journey at scale, adopting Flexible Load programs and technologies at an unprecedented pace.

Today, 22% of PGE's customers participate in a Flexible Load program of some kind.[2] Our Distribution System Plan (DSP) begins our journey of human-centered planning that promotes distribution energy resource (DER) adoption such as Flexible Loads that maximizes grid benefits and furthers decarbonization. Our Flexible Loads will be a critical part of our non-wires solutions (NWS) and virtual power plant (VPP). PGE uses our distribution system planning process to forecast the technical potential for existing and new Demand Response as well as exploring a range of solutions, such as custom-engineered microgrids at customer locations that can provide resilience to the customer and Flexible Load to the utility. In our DSP Part 2, filed in August of 2022, analysis shows the potential for more than 600MW of Flexible Load and Distributed Energy Resources from buildings, vehicles, and customer-sited batteries available within PGE's service territory by 2030.[3] This represents a 600 percent increase over our current portfolio. PGE estimates technology adoption and customer participation at this level – alongside other significant DER contributions such as customer solar – to be a critical part of not only our DSP, but also our Clean Energy Plan, required as part of HB 2021.

PGE continues focusing on delivering the customer experience necessary to help customers overcome critical barriers to participation in Flexible Load programs. As we

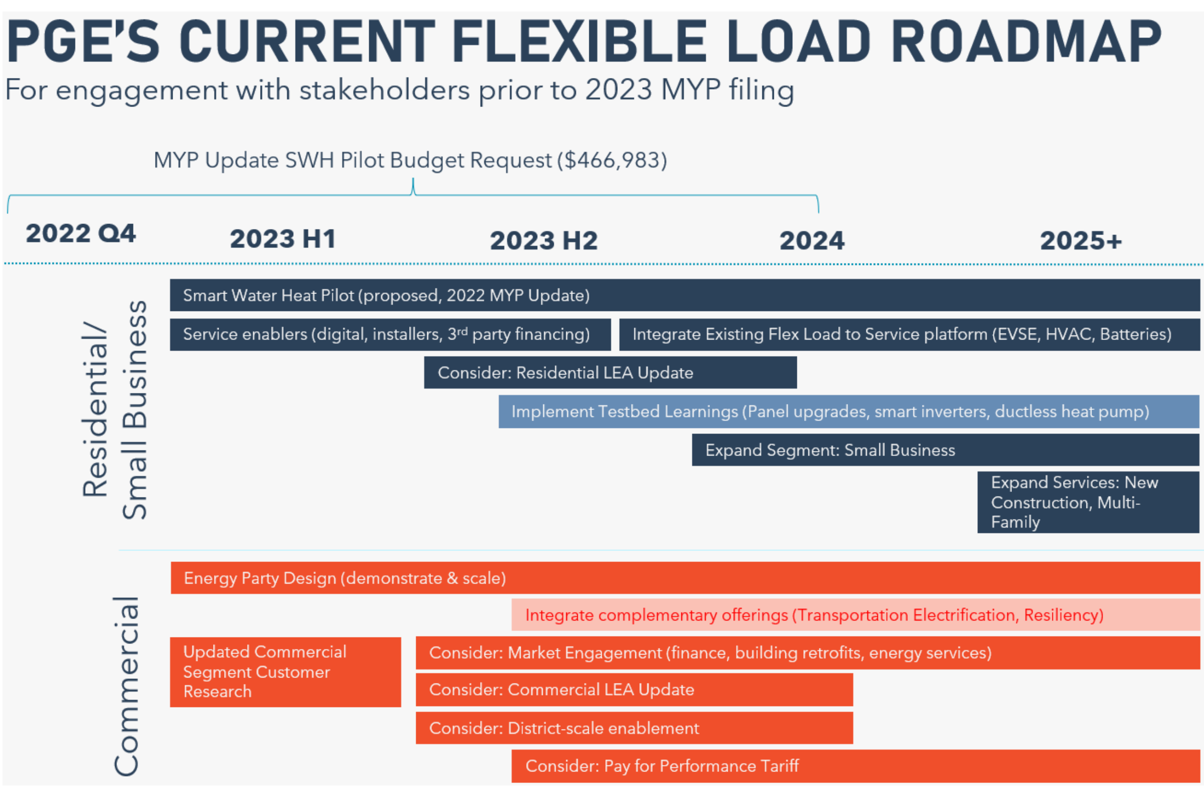
[2] PGE. *Factsheet: Transforming the Energy Future*. Retrieved from: https://downloads.ctfassets.net/416ywc1laqmd/7ERmw4jBAO1Nw2US20LWbL/f0d4b4708d19aa3782368dd0208cda1d/About_PGE_FINAL.pdf.

[3] PGE. *DSP Part 2*. Tables 14, 16-19; 2022. Retrieved from: https://downloads.ctfassets.net/416ywc1laqmd/2Fr2nVc4FKONetiVZ8aLWM/b209013acfedf1125ceb7ba2940bac71/DSP_Part_2_-_Full_report.pdf.

develop the capabilities to integrate Flexible Loads into our VPP or utilize them for NWS, providing grid operators with better information regarding how changing customer loads will interact with these devices under a wide range of conditions becomes increasingly important. Our market research indicates that customers are looking to PGE for ways to efficiently understand their energy options and that they trust PGE to provide affordable and appropriate recommendations to meet their needs. Customers have expressed interest in energy affordability, sustainability, peace of mind offerings, and ease of integration services such as installation, financing, and on-bill payment. We recognize that without integrated experiences that facilitate customer awareness, education, and adoption of Flexible Loads, it will not be possible for us to meet our 2030 and 2040 clean energy goals. To achieve meaningful engagement, we worked across other PGE engagement efforts such as the DSP Partnership Workshops where we focused on unpacking the technical aspects of Flexible Loads into more relevant and translatable topics and content.

PGE is revising our Flexible Load roadmap with the above acceleration and concepts in mind. Below is a high level roadmap, which we share here for the first time, and which reflects our current thinking regarding how the Company will expand its Flexible Load services and tariffs, as well as how we will engage new technologies and market opportunities to meet customer needs and our clean energy goals. We look forward to engaging with stakeholders as we continue to develop and revise this roadmap over the next year, which we will file with the 2023 Flexible Load Multi-year Plan filing (MYP).

Figure 1 – PGE's Current Flexible Load Roadmap



The timing of our stakeholder engagement on the above roadmap and the 2023 MYP filing will align with the outcomes of other guiding filings such as the CEP, the Integrated Resource Plan (IRP), and the DSP; all of which are scheduled to be filed with the Oregon Public Utility Commission (OPUC, or the Commission) in the coming year. Our goal moving forward is to ensure these filings are synchronized, coordinated, and ideally consolidated such that their timing, analysis, and conclusions make it is easy for stakeholders to understand PGE's strategy and approach for meeting our targets. In addition to the above OPUC filings, PGE expects the recently passed Inflation Reduction Act (IRA)[4] will impact our Flexible Load activity. We look forward to uncovering opportunities to extend and augment our roadmap to take advantage of this opportunity.

1.1 Purpose of the Filing

This document is a mid-cycle update to PGE's Flexible Load MYP requesting five quarters (Q4 2022-23) budget ($466,893) for a Smart Water Heating pilot (SWH), which brings the Flexible Load Portfolio budget (2022-23) to $22,987,168.

The SWH pilot reflects a stage-gated approach, with learnings focused on improving cost-effectiveness, the delivery of capacity, and exploration of grid benefits before accelerating scaling. Touchpoints for the activity include quarterly stakeholder engagement, the annual deferral and report, and biannual MYP filings. Chapter 2 lays out the proposal's supporting analyses and the guiding stakeholder input Staff requested in their response to PGE's November 2021 MYP[5].

PGE also requests the following changes for the Time of Day (TOD) activity: move the requirement to provide a comprehensive evaluation report from December 2022 to July of 2023; move the $95,000 evaluation budget in 2022 to 2023 evaluation budget, increasing the latter to $190,000 (note this is a reallocation within the 2022-23 budget, no net change to budget for that period). See Section 3.3.3.6 for supporting details.

PGE requests Commission consideration of this request by November 11, 2022 to allow time to file applicable tariffs and begin new pilot activity with the new year.

1.2 Regulatory Context

The purpose of ongoing MYP reporting is to provide the Commission a two-year view of PGE's Flexible Load acquisition activity and proposed spending. The MYP includes quarterly reporting and engagement processes with Commission Staff and stakeholders, yearly reports, and updates. These activities are in service to PGE's 2019 IRP goals for 2025 and are filed under Docket No. 2141.

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[4] 117th Congress. (2022). *House Resolution 5376, passed August 7, 2022*. Retrieved here: https://www.congress.gov/bill/117th-congress/house-bill/5376.

[5] OPUC. *Staff Recommendation: Portland General Electric Request Approval of Flexible Load Multi-Year Plan*; 2021. Retrieved from: https://edocs.puc.state.or.us/efdocs/HAU/um2141hau18348.pdf.

PGE's November 2021 MYP[6] requested Commission approval for $35M in funding for current and proposed Flexible Load activities:

- Two-year (2022-23) portfolio budget ($30.7M) for current pilot and program activities
- One-year (2022) budget ($2.13M) for development activities
- Initial Smart Grid Testbed (hereinafter Testbed) cost recovery of $2.26M
- A proposed cost recovery mechanism moving from individual deferrals to a holistic supplemental mechanism with a balancing account
- Agreement to receive an update to the MYP in the second half of 2022 to allow PGE time to shift to meet the goals outlined in new Commission and legislative policy

The Commission adopted the following recommendations from OPUC Staff:

- Approve two-year (2022-23) portfolio budget ($24.46M), including $2.26M in Testbed cost recovery
- Do not approve the two-year (2022-23) budget ($5.64M) for the Multi-family Water Heater pilot operating under Schedule 4, instead directing that this activity continue to be funded under Utility Miscellaneous (UM) 1827 until Commission approved pilot expansion
- Do not approve two-year (2022-23) budget ($2.85M) for the Energy Partner Smart Thermostat pilot operating under Schedule 25, instead directing that this activity continue to be funded under UM 1514 until Commission approved pilot redesign and extension
- Do not approve one-year (2022) budget ($2.13M) for development activities
- Do not approve PGE's proposed cost recovery mechanism
- Consolidate deferral authorizations for the portfolio, excepting the Multi-family Water Heater pilot and the Energy Partner Smart Thermostat pilot budgets, to continue to be funded via UM 1827 and UM 1514 budgets, respectively.

In their recommendation, Staff noted that the declined proposals "could be reconsidered if supported by additional details from the Company and significant stakeholder input."[7]

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[6] PGE. *Flexible Load Multi-Year Plan;* 2021. Retrieved from: https://edocs.puc.state.or.us/efdocs/HAD/um2141had16243.pdf.

[7] Ibid, page 3.

1.3 Summary of PGE's Existing Flexible Load Portfolio

The proposed pilot budget and program budgets are summarized in Table 1, below:

Table 1 – Total Portfolio Requested Budget

Pilot/Program	2022	2023	Total
Pilot Budget Total	**$1,500**	**$465,393**	**$466,893**
Smart Water Heater (SWH)	$1,500	$465,393	$466,893
Program Budget Total	**$9,568,061**	**$10,627,879**	**$20,195,940**
Residential - Flex Peak Time Rebate (PTR)	$2,736,500	$2,711,500	$5,448,000
Residential - Flex Time of Day (TOD)	$581,300	$749,000	$1,330,300
Residential - Smart Thermostats	$2,833,548	$3,176,000	$6,009,548
Commercial - Energy Partner Sch 26	$3,416,713	$3,991,379	$7,408,092
Smart Grid Testbed Phase II	**$1,197,070**	**$1,067,565**	**$2,264,635**
Grand Total[8, 9]	**$10,766,631**	**$12,160,837**	**$22,927,468**

In Table 2, below, we provide a summary of the forecasted megawatt (MW) capacity of our existing Flexible Load portfolio. Note that we have separated out maturing pilots and program activity from that of pilots in design transition. More detail on these activities can be found in Chapter 3.

[8] Note that the Energy Partner Smart Thermostat (Sch 25) and Multi-family Water Heater activities are not included in the Portfolio Requested Budget in line with staff's excepting of those pilots from the consolidated portfolio deferral authorization (see Section 1.2). PGE will provide more detail on the progress of those two pilots in design transition when we deliver the Flexible Load Portfolio annual report at the close of the year.

[9] Note that the Residential Battery Storage and Residential Smart Charging pilots are related activities funded separately from Flexible Load and therefore are not reflected in the Flexible Load Portfolio budget.

Table 2 – Summary of the Flexible Load Portfolio's Forecasted MW Capacity

Category of Activity	Season	2022	2023	2024
Maturing Pilots and Program Activity[10]	Summer	87.6	95.9	102.8
	Winter	57.5	61.9	65.0
Pilots in Design Transition	Summer	7.7	8.4	10.7
	Winter	10.7	11.1	13.1
Demand Response Portfolio[11,12]	**Summer**	**95.3**	**104.3**	**113.5**
	Winter	**68.2**	**73.0**	**78.1**

1.4 Summary of Elements in the Filing

This filing provides a brief overview of the existing Flexible Load portfolio, described in detail with the November 2021 MYP, but is chiefly focused on a Smart Water Heating pilot proposal and funding request. This filing also provides an overview of activities supporting and related to Flexible Load, as well as Flexible Load concepts under consideration for development.

- **Chapter 1** includes an overview of the filing, PGE's strategic approach to the development of Flexible Load, and a listing of Activity Briefs.
- **Chapter 2** details the proposed Smart Water Heating pilot.
- **Chapter 3** reviews PGE's existing portfolio of Flexible Load activities, including Testbed demonstrations and maturating pilots and program activities.
- **Chapter 4** describes activities related to and supporting Flexible Load, including products and concepts in the Resiliency and Transportation Electrification sectors.
- **Chapter 5** lays out PGE's approach to evaluating the cost effectiveness of our Flexible Load portfolio.
- **Chapter 6** includes next steps and detail on PGE's ongoing stakeholder engagement for Flexible Load
- **Appendices** provide a regulatory reference, budgets for proposed and existing Flexible Load activities, and also forecasted capacity.

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[10] Does not include Time of Day Combined Summer and Winter Forecasted MW Capacity of 2.6MW (2023) and 5.7 MW (2024).

[11] Ibid.

[12] Forecasted MW Capacities reflect growth in the *existing* pilots and programs, with the exception of Time of Day's combined Summer and Winter forecast of 2.6MW (2023) and 5.7MW (2024); it does *not* include forecasts from: the proposed SWH pilot; related activities found in Chapter 4; and future programmatic additions to the portfolio.

1.5 Activity Briefs

PGE's program evolution approach for Flexible Load follows our established Product Lifecycle Management process[13]. The scale of the activity grows as the maturity of the product, program, or service moves through this evolution. PGE is moving each of our initial IRP Demand Response (DR) pilots through this process in pursuit of each becoming a mature program offering.

As products move through this development pipeline, the probability that they will scale into full market deployment increases. Products with little chance to scale should fall out of the pipeline quickly. Products that do not advance in the pipeline are not failures; rather they are opportunities to capture and incorporate lessons learned to inform future efforts. Currently, PGE is using the Testbed to test many of these new products, technologies, and engagement methodologies, which would not be considered cost effective and/or to gain the necessary learnings required to scale.

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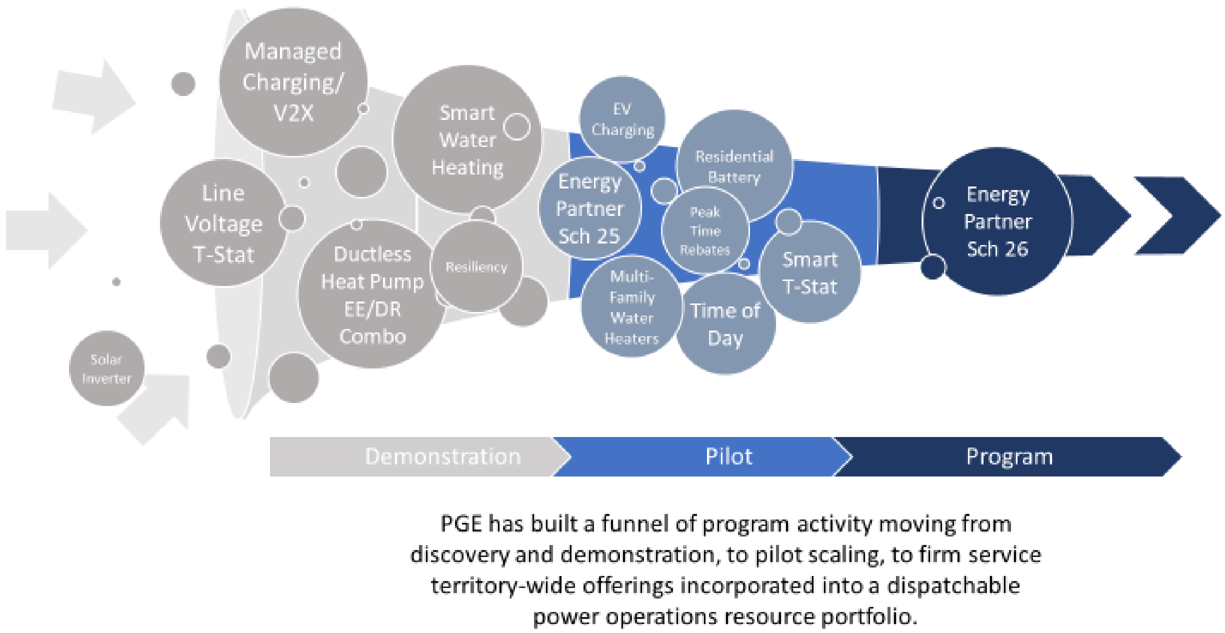
[13] Details on PGE's Product Lifecycle Management process in PGE. *Flexible Load Multi-Year Plan;* 2021. Pages 26-8. Retrieved from: https://edocs.puc.state.or.us/efdocs/HAD/um2141had16243.pdf, as well PGE. *Flexible Load Plan;* 2020. Pages 36-4. Retrieved from: https://apps.puc.state.or.us/edockets/edocs.asp?FileType=HAA&FileName=haa125814.pdf&DocketID=22696&numSequence=1.

Figure 2 – Flexible Load Program Evolution



PGE's Flexible Load activities are briefly described below. For more detail, please refer to Chapter 3:

Demonstrations[14] (see Section 3.1 for detail):

- Flexible Feeder – coordinated project with Energy Trust to field test and document the use and value of distributed energy resources as an operational grid asset.
- Telematics-based Charge Management – explore the use of on-board telematics to optimize the timing of charging around grid considerations and better understand how managed charging can mitigate the negative impacts of high Electric Vehicle (EV) adoption and turn them into an operational asset.
- Solar Smart Inverters – explore various issues and opportunities presented as distributed solar is integrated into the grid, including assessing the readiness of Distributed Energy Resource Management System (DERMS) platforms and integrations.

Maturing Pilots and Programs (see Section 3.3 for detail):

[14] PGE. *Schedule 13 Residential Testbed Pilot: Second Revision of Sheet No. 13-1; Issued August 25, 2020.* Retrieved from: https://assets.ctfassets.net/416ywc1laqmd/1FXchtG1UCoqK74YIOWBoF/6e547fc22cc37b6a0bda163bd761185f/Sched_013.pdf

- **Energy Partner (Schedule 26)**[15] – is focused on large customers via custom load curtailment plans with monthly incentive payments during Winter and Summer seasons, and event-based incentives for shifting their energy consumption during seasonal Peak Time Events. Energy Partner Schedule 26 provides firm capacity and is evolving to provide intra-hour grid services to support resiliency and renewables integration now that the Tariff update to Schedule 26 was approved by the Commission[16].
- **Peak Time Rebates (Schedule 7)**[17] – relies on individual customer participation to reduce electrical demand during Peak Time Events by shifting energy consumption to non-peak periods or through conservation.
- **Time of Day (Schedule 7)**[18] – this pricing plan gives customers more control over their electric bills and offers opportunities to save money by shifting energy use away from peak hours when power costs more and renewable resources are less plentiful. Aligning on-peak hours with capacity constraints encourages customers to shift usage during energy peaks, reduces need for construction of new power plants and supports a reliable grid.
- **Smart Thermostat (Schedule 5)**[19] – aims to enroll and operate connected residential thermostats to control electric heating and cooling load, providing PGE with firm capacity. To participate in the program, PGE customers must have a qualified heating, ventilation, or air conditioning (HVAC) system (ducted heat pump, electric forced-air furnace, or central air conditioner).

Pilots in Design Transition (see Section 3.4 for detail):

- **Energy Partner Smart Thermostat (Schedule 25)**[20] – The Schedule 25 Smart Thermostat pilot was launched on December 1, 2017 to complement Schedule 26. The pilot design includes customer recruitment and provides

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[15] PGE. *Schedule 26: Nonresidential Demand Response Program; Third Revision of Sheet No. 26-1; Issued Apr 7, 2022.* Retrieved from: https://assets.ctfassets.net/416ywc1laqmd/58Ec9RPWBJIL6E6UHYE2of/eea2ef3802918261a60ad6634bdbe6c4/Sched_026.pdf

[16] OPUC. *Staff Recommendation: Portland General Electric Revises Nonresidential Demand Response Program in Schedule 26 to Better Accommodate Non-emitting Resources such as Battery Energy Storage (Advice No. 22-06, authorizing revisions to Schedule 26); May 23, 2022 OPUC Public Meeting.* Retrieved from: https://edocs.puc.state.or.us/efdocs/HAU/adv1386hau102016.pdf

[17] PGE. *Schedule 7: Residential Service; Nineteenth Revision of Sheet No. 7-1; Issued April 29, 2022.* Retrieved from: https://assets.ctfassets.net/416ywc1laqmd/6RgTNk5RU1bldl0LdPpIY9/798481eb9f1171e4ec8ce5ce648bc47f/Sched_007.pdf

[18] Ibid.

[19] PGE. *Schedule 5 Residential Direct Load Control Pilot; Fifth Revision of sheet No. 5-1; Issued March 30, 2022.* Retrieved from: https://assets.ctfassets.net/416ywc1laqmd/2gb1sPf39HCBeDIhZVlqHU/89abc46abd35acc4fcc5f9a5a4f1491a/Sched_005.pdf

[20] PGE. *Schedule 25: Nonresidential Direct Load Control Pilot; Issued May 19, 2022.* Retrieved from: https://assets.ctfassets.net/416ywc1laqmd/73BLFixIOfSbxFltfJMsv8/bc66cdbaf996558beb35fd712dad3464/Sched_025.pdf

installation of qualified smart thermostats for a small copay or to bring their own qualified thermostats. Schedule 25 creates an opportunity for small and medium sized businesses (SMB) to participate in DR without an impact to their business operations. The advent of Schedule 25 created additional opportunity for customers who lack adequate process-based load and/or the operational ability to curtail load via Schedule 26.

- **Multi-family Water Heaters (Schedule 4)**[21] – enables electric water heater operation for demand flexibility. This program provides capacity and has the potential to offer intra-hour grid services to support reliability and renewables integration.

Table 3, below, is PGE's roadmap of proposed and ongoing Flexible Load activities. Table 3 does *not* include yet-to-be-proposed programs and approaches for Flexible Load acquisition. PGE will provide an updated long-term roadmap as part of its 2023 regular filing.

[21] PGE. *Schedule 4: Multifamily Residential Demand Response Water Heater Pilot; Issued December 15, 2020*. Retrieved from: https://assets.ctfassets.net/416ywc1laqmd/7FbRaBNOdq9GNmmWalI921/e2477bd226ac7e07854a016a9cf03475/Sched_004.pdf

Table 3 – Summary Roadmap of PGE's Flexible Load and Related Activities

Activity	2022	2023		2024	
	H2	H1	H2	H1	H2
Proposed Pilots					
Smart Water Heating	Develop proposal, submit with	Run internal beta, perform review	Minimum Viable Product (MVP) launch with Oregon code requirement	Assess pilot performance	Assess pilot performance
Maturing Pilots and Program Activity					
Energy Partner (Schedule 26)	Expanded offerings	Integration and alignment of Energy Partner with additional energy service offerings to Commercial and Industrial (C&I) customers Continued growth		Aggregate Energy Partner assets into Virtual Power Plant (VPP) Full integration of Energy Partner DR into Power Operations resource portfolio	
Peak Time Rebates	Evaluation Report	Seasonal participation	Evaluation Report	Seasonal participation	Evaluation Report
Time of Day	Implement customer focused tools and build awareness and educate utilizing customer outreach plan	Increased enrollment growth	Increased enrollment growth Behavioral Analysis tool	Increased enrollment growth	Increased enrollment growth
Smart Thermostat	Execute channel recommendation Evaluation Report	Introduce post-event communications	Evaluation Report	File for pilot-to-program consideration or additional extension Begin channel transition	Evaluation Report
Pilots in Design Transition					
Energy Partner (Schedule 25)	Updated design implementation Pilot SMB outreach strategy w/Energy Trust	Integration and alignment of Energy Partner with additional energy service offerings to C&I customers Continued growth		Aggregate Energy Partner assets into VPP Full integration of Energy Partner DR into Power Operations resource portfolio	
Multi-family Water Heater	Complete installations of current pipeline of retrofit devices	Complete final evaluation for pilot from current period Update CTA-2045[22] rebate incentive due to OR code change	File for pilot-to-program consideration or additional extension	Expand CTA installations	Cease installations of any retrofit switches (only install CTA comms)
Related Activities					
Smart Battery	Compliance Evaluation Report	Updated pilot structure implemented	Comprehensive Mid-Pilot Evaluation		Compliance Evaluation Report
EV Charging	Implement trade ally network Add telematics incentive, panel upgrade rebate, trade ally network	Assess pilot performance	Assess pilot performance	Assess pilot performance	Close pilot

1.6 Evolving Approach to Customer Engagement

The following sections describe new steps PGE is taking with our customers to help accelerate Flexible Load adoption in service to our Clean Energy goals. As stated above, without new approaches to customer engagement, rapid acceleration of customer participation will not be possible.

1.6.1 Consumer Flexible Load Engagement Journey

PGE's market research and customer conversations have underscored a need for PGE to provide improved energy information and complete energy journeys for residential and small business customers to make individual decisions about their service options.

We understand the need for the utility to play a strong role in identifying additional means to lower costs as well as help customers overcome technical challenges to adopting efficiency products[23] and, increasingly, grid-enabled products. PGE identifies customer needs through market research, interviews, surveys, and feedback from demonstration and pilot activities. These help us understand the diversity of customer needs and identify barriers associated with customers' experiences in achieving their goals. We build on this understanding of customer needs through stakeholder engagement and workshops. In exploring what is required to provide a holistic customer journey for Flexible Load adoption, PGE has identified the following customer priorities:

- Awareness and education for customers related to programs and rates that can help them better achieve their individual goals
- Accurate information on products that support the grid and how to use them
- Rebates/incentives and offering on-bill financing at the time of purchase
- Seamless enrollment into applicable Flexible Load programs
- Additional affordability resources available to customers for whom energy is the greatest burden
- Coordination of purchase, installation, and maintenance services
- Seamless enrollment into applicable Flexible Load programs
- Pathways for market partners to participate in offers and delivery
- Solutions for overcoming related hurdles such as the cost of electrical panel replacements (shared hurdle with Transportation Electrification), and
- Awareness and education of complimentary offerings such as EV Charging and TOD rates.

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[22] ANSI/CTA-2045 specifies a modular communications interface to facilitate communications with residential devices for applications such as energy management.

[23] NEEA. *Energy Efficiency Financing: Barriers and Opportunities in the Small Utility Market Report #E16-298*; 2016. Retrieved from: https://neea.org/resources/energy-efficiency-financing-barriers-and-opportunities-in-the-small-utility-market

A holistic customer experience means our customers can find the information and/or service they need via their preferred channel at the time that is right for them. In considering our residential and small business customers' current engagement pathways with PGE, we have concluded that an integrated digital experience is necessary to help them complete the full energy journey from awareness to education to adoption and even through implementation and support. Without tackling the complexity of Flexible Load adoption in an end-to-end manner, PGE will find it more challenging to meet our decarbonization targets.

With this in mind, PGE is working to enhance our current digital customer channel for a more seamless Flexible Load adoption experience. The development of a streamlined customer experience begins with ensuring customers have the right information to understand their bill and their energy usage. Features such as enhanced rate comparison tools, load disaggregation, and improved user interfaces are important components of customer awareness and education that will help customers understand where there may be opportunities to engage programs that meet their needs.

Once a customer has chosen a device (e.g., thermostat, water heater, or EV charger) and/or a rate that meets their need, it is important that PGE provide tools necessary to overcome other acquisition barriers for adoption as part of the seamless experience. These include integration of applicable rebates, options for financing, the convenience of on-bill repayment, and integration with installers. As PGE implements this improved customer journey(s), we plan to seek to recover on this capital investment in our digital toolset through a future rate case filing(s). We are also seeking to identify advantageous financing terms and rates that can be provided to customers by a third-party lender, and plan to file a tariff for customer financing options.

1.6.2 Updates for Commercial Customers

PGE will continue to be responsive to a growing group of commercial customers and project developers who are approaching the Company for support regarding the use of electric modalities for key building/facility systems such as space and water conditioning in helping them achieve their decarbonization goals.

In the past, PGE has focused on interconnection when addressing customer requests for increased electric service. PGE now sees a growing customer need for support in the early phases of projects regarding electric utilization including how customers can be most effective in their electricity usage through system choices, providing more efficient usage and grid services that would benefit both that customer and ratepayers generally. This extension of education and usage-design assistance will complement PGE's current pursuit of energy efficiency and Flexible Load and is an opportunity to lower acquisition costs.

This design engagement is part of utility core services employed to address the greater need for customer understanding of building system impacts and alignment to Flexible Load offerings supporting both customer and utility decarbonization goals. We believe this engagement will:

- Directly support the objectives of Executive Order (EO) 20-04[24] by increasing the adoption of electric grid interactive building systems for space heating cooling and domestic water heat.
- Help customers understand the implications of building system choices, and how these work towards the decarbonization targets established in HB 2021.
- Create efficiencies by integrating new projects with existing, related programs (EV charging, building energy management, resiliency) in the design phase when integration is most cost effective.
- Integrate with the Energy Trust early design process for commercial customers through lead sharing and collaborative processes.

Additional exploration is also underway as part of the continuous effort to align commercial customer needs with HB 2021 goals and Flexible Load needs, including:

- Analysis of the Commercial Line Extension Allowance in Sch. 300. This work is investigating whether PGE should propose changes to the Commercial Allowance to better reflect the system value and benefit to all ratepayers provided by the adoption of Flexible Load enabled systems.
- The potential for a more concise program offering for the growing number of commercial customers who are considering on-site storage, on-site generation, and grid-integrated building systems as part of a single development or campus.

Updates on this work will also be shared during Demand Response Advisory Group (DRAG[25]) engagements and could potentially lead to proposed tariff revisions prior to the next MYP filing.

1.6.3 Transportation Electrification

According to the Oregon Department of Environmental Quality[26] (DEQ), at the end of 2021 there were approximately 30,000 light duty EVs in PGE's service area. PGE's DSP forecasts that number to grow to 134K vehicles (including medium and heavy duty) by the end of 2025, and up to 300K by 2030. PGE forecasts an increase in the associated charging load from 12-13 average megawatt (MWa) in 2022 to 82-135 MWa by 2030.[27] We have included these load growth projections into our Corporate

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[24] Oregon Governor Kate Brown. *Executive Order 20-04: Directing State Agencies to Take Actions to Reduce and Regulate Greenhouse Gas Emissions*; 2020. Retrieved from: https://www.oregon.gov/gov/Documents/executive_orders/eo_20-04.pdf.

[25] 2022 DRAG meeting dates are January 19, April 15, June 10, and July 25.

[26] Using vehicle registrations from the Oregon Department of Motor Vehicles.

[27] PGE. *Transportation Electrification Plan*; Draft expected to be filing November 2022.

load forecast process, as well as both the IRP and DSP to ensure we have sufficient energy and capacity resources to meet our customer's charging needs. Additionally, by 2030 we are forecasting 5-10 MW of Flexible Load potential from residentially-owned EVs enrolled in our existing smart charging pilots.[28] As we continue to see greater fleet adoption, we expect this Flexible Load potential from EVs to increase for example if fleet smart charging becomes more widely demonstrable and accepted.[29]

PGE's inaugural Transportation Electrification Plan (TE Plan), accepted in 2020, laid out our roadmap to support customers' transition to electric fuel, including programs that "maximize grid benefits and minimize costs" by "integrat[ing] connected charging infrastructure into programs".[30]

To date, PGE has deployed EV charging pilots for the residential, business and fleet sectors, and our upcoming TE Plan is expected to add a Multi-family Charging pilot to the TE portfolio. Each pilot requires participants' EV charging infrastructure be DR-ready, and the residential pilot already includes those chargers in Smart Charge DR events. More detail on the Residential Smart Charge pilot is found in Section 4.2.

1.6.4 CAISO Integration

1.6.4.1 Background

Since joining the Energy Imbalance Market (EIM) in 2017, PGE has provided the California Independent System Operator's (CAISO) load forecasting team with notice of when PGE intends to call on DR resources on a day-ahead basis. In the current process, PGE Operations provides CAISO with specific event hours and the expected MW values. PGE then follows up with CAISO to provide detailed verification information based on our internal baseline verification protocols as per the retail tariff. In response, PGE is informed by CAISO that these MW have been deducted from PGE's load forecast, thus lowering the target in the resource sufficiency capacity test.

At the Q2 2021 EIM Joint Quarterly meeting, CAISO provided information that indicated the previous information provided by CAISO regarding the treatment of DR has been incorrect. The Independent System Operator (ISO) load forecast was not being modified to reflect the DR resources because the total capacity of these resources was less than 5% of PGE's hourly load. This raised significant concerns with

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[28] PGE. *Schedule 8 Residential EV Charging Pilot: Second Revision of Sheet No. 8-1; Issued July 14, 2022.* Retrieved from: https://assets.ctfassets.net/416ywc1laqmd/2CrkwfPNPaDoM1tiVX68k0/6e29d4c934d17d55f7911aebba73606d/Sched_008.pdf and PGE. *Schedule 7: Residential Service; Nineteenth Revision of Sheet No. 7-1; Issued April 29, 2022.* Retrieved from: https://assets.ctfassets.net/416ywc1laqmd/6RgTNk5RU1bldl0LdPplY9/798481eb9f1171e4ec8ce5ce648bc47f/Sched_007.pdf residential TOD rates.

[29] For example, PGE is launching a school bus vehicle-to-grid R&D demonstration project, and if these and similar emerging efforts show promise, we will include in our future forecast updates.

[30] PGE. *2020 Transportation Electrification Plan.* Page 12. Retrieved from: https://apps.puc.state.or.us/edockets/docket.asp?DocketID=20573

PGE Power Operations and Balancing Authority staff, especially as PGE recorded new all-time peak load records as recently as last summer.

Demand response is a critical, and growing, component of PGE's portfolio, especially in light of increasingly volatile and expensive forward capacity markets. If PGE is unable to capture the value of this capacity through the EIM Resource Sufficiency (RS) tests, PGE will be forced to procure expensive capacity in the bilateral market *and* call on Demand Response programs.

1.6.4.2 Near Term Fix

PGE has collaborated with CAISO and Stakeholders in the Resource Sufficiency Evaluation (RSE) Enhancements[31] initiative to address the inclusion of Demand Response in the EIM Resource Sufficiency test. These efforts will allow for CAISO to incorporate Demand Response in the RSE's capacity test to account for Demand Response not currently modeled in the real-time market. This enhancement is currently in production and being utilized. Essentially, PGE is now able to "hard code" an expected amount of Demand Response going into each hour. In addition, CAISO's department of market monitoring will monitor each EIM Entity's utilization of this tool to prevent any one entity from leaning on the market.

1.6.4.3 Long Term Solution

For PGE, the most desirable long-term solution for our DR programs is to register them as a participating resource with CAISO. The New Resource Integration team at PGE is currently navigating the process to register DR as a participating resource and more effectively integrate the benefit of DR in the real-time EIM. This is a complex process that does not have precedent in the EIM, and we are working through the following challenges:

- Model DR as a distributed load in the PGE network model
- Produce a 'plan' for base scheduling
- Provide a calculated real-time value to CAISO which can be used to adjust the PGE Balancing Authority Areas (BAA) load profile
- Provide after-the-fact metering for settlement and determine any customer allocation algorithms
- Identify a solution for baselines, as CAISO does not accept the baseline methodology currently utilized by PGE's programs

PGE's goal is to complete registration of our DR programs with the CAISO as a participating resource by the end of 2022.

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[31] See California Independent System Operator site for more detail. Retrieved from: http://www.caiso.com

1.7 Stakeholder Partnerships

To be responsive to OPUC and stakeholder feedback with regards to "how incentives would interact with Energy Trust's existing incentives" and whether proposals "engage in functions that appear to duplicate Energy Trust program offerings such as incentives for customers and homebuilders, trade ally management, and project development assistance", PGE seeks to articulate opportunities for joint investment and coordinated activity within its 2023 utility-specific action plan (HB 3141[32]).

Per HB 3141 (2021) Section 9, the Energy Trust is directed "With public utilities, [to] jointly develop public utility-specific budgets, action plans and agreements that detail the entity's public utility-specific planned activities, resources, and technologies pursuant to ORS 757.054 and 757.612 (3)(b)(B), including coordinated activities that require joint investment and deployment. Each action plan must reflect stakeholder feedback gathered through a public process managed by the entity and the relevant public utility as overseen by the commission."[33] This process is now formalized in the four steps provided below, in the template that follows, and is now referred to as the HB 3141 Budget Coordination Memo.

A new HB 3141 Budget and Action Plan Process follows four main steps:

- Step 1: Market Assessment (Apr-May)
- Step 2: Action Planning (Jun-Nov)
- Step 3: Budget + Utility-Specific Action Planning (Jul-Nov)
- Step 4: Final Plans + Tariff Filing (Oct-Dec)

Within this new construct is the expressed intent to put forth both an Energy Trust 'comprehensive' action plan and 'utility-specific' action plan, inclusive of identified joint investment opportunities and coordinated activities (not solely a function of IRP goals) which will "largely benefit only the customers of that funder utility."[34]

Given that the market landscape and customer expectations have changed with respect to climate, technology, and equity, PGE and Energy Trust have an opportunity to enhance our partnership and reimagine how we jointly deploy energy efficiency and renewable energy funding. Energy efficiency has an increasingly important role to play in PGE's decarbonization journey by aligning efficiency to greenhouse gas emissions reductions and pairing flexibility with energy savings.

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[32] 81st Oregon Legislative Assembly (2021). *House Bill 3141, passed September 25, 2021.* Retrieved from: https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB3141.
[33] Ibid.
[34] Ibid.

To inform this opportunity we can look to the following principles from the American Council for an Energy-Efficient Economy[35]:

- The purpose of utility energy efficiency programs is evolving as modern policy expectations—such as environmental protection, equity, and economic development—have begun rising to the forefront in many states
- A climate-forward efficiency approach that elevates equitable greenhouse gas (GHG) mitigation and adaptation as drivers is needed to align energy savings with periods of high carbon intensity on the grid; unlock the benefits of electrification; better integrate with demand flexibility; maintain a reliable, secure, and low-cost electricity system; expand equity and reach; and animate local markets
- Emerging approaches generally fall into two categories: those that redefine the range of offerings that could qualify as energy efficiency, and those that modify how we measure the success of those offerings
- Cost declines for renewables have changed grid dynamics, putting a premium on demand flexibility, and unlocking vehicle and building electrification as core climate solutions
- Continued inequality, pandemic-induced recession, and historic disinvestment in communities of color demand that our attention focus on ensuring equitable decarbonization.

Additionally, with the Energy Trust, we seek to align to Northwest Energy Efficiency Alliance's (NEEA) long-term strategy and assessment that business-as-usual is less viable over time. We agree that crafting a portfolio of work for the region will require a coalition to fund core energy efficiency, load flexibility and decarbonization research and market transformation. We assert that NEEA's core funding includes connectivity that contributes to energy efficiency (EE), as long as EE leads, which is echoed in the Seattle City Light Electrification Assessment as "The more aggressive the electrification initiative, the greater the need for flexibility to meet changing demand and to manage the electrical grid."[36]

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[35] American Council for an Energy-Efficient Economy. *The Need for Climate-Forward Efficiency: Early Experience and Principles for Evolution*; 2021. Retrieved from: https://www.aceee.org/research-report/u2106. American Council for an Energy-Efficient Economy. *A Roadmap for Climate-Forward Efficiency.* 2022. Retrieved from: https://www.aceee.org/research-report/research-report/u2202

[36] Electric Power Research Institute. *Seattle City Light Electrification Assessment: 2022 Technical Report*. 2022. Retrieved from: https://powerlines.seattle.gov/wp-content/uploads/sites/17/2022/01/Seattle-City-Light-Electrification-Assessment.pdf

Chapter 2 Pilot Proposal

In this MYP update, PGE proposes a single-family water heating demand response pilot referred to as the Smart Water Heating pilot. Implementation details and strategies to achieve cost-effectiveness are detailed in this section. Early-stage concepts and related activities are discussed in Chapter 4.

2.1 Smart Water Heating Pilot Proposal

PGE proposes to scale water heating Flexible Load as a reliable resource in single family homes through a program that builds on the learnings from PGE Schedule 3 (Residential Demand Response Water Heater pilot with Bonneville Power Administration (BPA) and the Pacific Northwest National Laboratory (PNNL)), PGE Schedule 4 (Multi-family residential Demand Response Water Heater pilot), and the Smart Grid Phase I. The SWH pilot aims to increase access to Flexible Load technology and maximize the flexibility of water heating demand response.

There are several reasons why this is the right time and place for PGE to put forward the SWH pilot. Firstly, water heaters are a near-ubiquitous appliance found in single family residences regardless of socioeconomic circumstance.

Secondly, the water heater market is undergoing transformation as a result of the policy landscape (HB 2062[37], HR 7962[38]) which is driving increased access to grid-enabled water heaters along with water heater technology improvements and advancements in Flexible Load communications protocols.

Thirdly, our market research (see section 2.1.3, below) indicates that residential customers want to be more sustainable, that PGE offers clean energy options that meet customers' needs, and that PGE customers would turn to PGE for resources about water heater purchase and installation. With this pilot, PGE can both address barriers to connecting water heaters to the grid and meet customer desires in a way that no other entity can: we develop Flexible Load resources to further reduce carbon emissions by using smart, grid-connected technologies and programs that customers trust and offer peace of mind.

Lastly, smart water heating is key means by which PGE will meet the decarbonization goals set by the passage of HB 2021 [39]. In order to meet these goals PGE must continue

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[37] 81st Oregon Legislative Assembly Regular Session. (2021). *House Bill 2062, s.2.16*. Retrieved from: https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2062.

[38] 117th Congress. (2022). *House Resolution 7962, introduced June 7, 2022*. Retrieved from: https://www.congress.gov/bill/117th-congress/house-bill/7962.

[39] 81st Oregon Legislative Assembly Regular Session. (2021). *House Bill 2021.* Retrieved from: https://olis.oregonlegislature.gov/liz/2021R1/Downloads/MeasureDocument/HB2021/Enrolled.

to invest and gain customer participation in Flexible Load programs as part of a diverse resource portfolio providing affordable and reliable electricity delivery.

It is important to note that while HB 2062[40] requires newly-manufactured water heaters be grid-*enabled*, PGE will not derive grid benefits from those water heaters until they are grid-*connected*. To facilitate this PGE must focus on reducing barriers to universal communications module (UCM) technology adoption and installation to make Flexible Load participation easy and more rewarding for customers. PGE is uniquely positioned to influence the direction of this market transformation through early partnerships with regional stakeholders such as the Energy Trust and NEEA, accelerating more cost-effective approaches to UCM installation such as embedding them into water heaters during manufacture.

PGE has designed this SWH pilot to reduce barriers for single family homeowners to acquire a grid-enabled water heater, connect it to the grid, and participate as Flexible Load. The pilot focuses on delivering a seamless enrollment experience, answering the identified research questions detailed in 2.1.1, below, and implementing strategies that will improve cost-effectiveness during the pilot period. The pilot's design and implementation feature a concerted push to improve cost effectiveness across a mix of 20[41] variables (see the footnote or 5.2.6 for details) working toward economies of scale both in terms of cost and capacity. The primary data from the SWH pilot will empower PGE to provide increasingly accurate estimates of cost-effectiveness for water heaters as a scaled, Flexible Load resource in single family residences.

In order to reduce cost risk associated with the proposed SWH pilot, PGE is also proposing a phased or "stage gated" approach to the pilot. Each stage gate is an opportunity to review progress and adjust or pause our approach based on early learnings from the implementation of strategies targeted at achieving cost effectiveness. Section 2.1.8 below discusses the Stage Gate approach in more detail.

2.1.1 Learning Objectives and Research Questions

PGE has identified the following learning objectives and related research questions that will be explored during the pilot period. Key performance indicators (KPIs) laid

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[40] 81st Oregon Legislative Assembly Regular Session. (2021). *House Bill 2062, s.2.16*. Retrieved from: https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2062.

[41] Cost of capacity, increase in winter events, increase in summer events, decrease in the cost of connectivity hardware and data costs by 20%, decrease in non-monetary incentives by 20%, increase in fleet connectivity, further decreases in UCM hardware and connectivity, review accounting treatment of pilot costs, review options to reduce administrative costs, update the cost of energy to reflect higher peak pricing, include health benefits, add load-up events, add load-following events, add frequency response events, increase the number of water heaters with flat administrative costs, increase capacity delivered per water heater through optimization and automation, add the value of ancillary services, review options to streamline operations costs, review options to reduce the incentive amount per UCM as the market matures.

out in Section 2.1.12, below, are designed to meet the following objectives and answer the underlying research questions.

Table 4 – Smart Water Heating Learning Objective I, Underlying Research Questions

Learning Objective I Identify how to cost-effectively reduce barriers for participants and installers while providing a valuable customer experience and delivering grid-benefits.
Research Question I.A Which of the 20 variables[42] listed in Table 35 and Table 36 impact cost-effectiveness the most? • What scenario(s) will enable a cost-effective pilot? • Which variables should be prioritized in order to achieve cost-effectiveness as early as possible? • How does each variable perform over the duration of the pilot period? • Data points that would be used to answer this question include: o Flexible Load Adoption KPIs (Table 12) o Event Performance KPIs (Table 13) o Participant Experience KPIs (Table 14)
Research Question I.B What are the overall barriers to sustaining Flexible Load benefits in the pilot period, and which may persist after the pilot transitions to a program? • What are the specific barriers to meeting customer needs? • What are the addressable barriers for water heater installers and/or builders/verifiers? • Data points that would be used to answer this question include: o Qualitative input o Participant Experience KPIs (Table 14)
Research Question I.C How responsive are water heater installers and builders/verifiers (Market Partners) to requests to join the SWH installer network? • What incentives are effective? • Do market partners remain in the network over time? • Data points that would be used to answer this question include: o Qualitative input

[42] See Section 5.2.6 for more detail about these 20 variables: Cost of capacity, increase in winter events, increase in summer events, decrease in the cost of connectivity hardware and data costs by 20%, decrease in non-monetary incentives by 20%, increase in fleet connectivity, further decreases in UCM hardware and connectivity, review accounting treatment of pilot costs, review options to reduce administrative costs, update the cost of energy to reflect higher peak pricing, include health benefits, add load-up events, add load-following events, add frequency response events, increase the number of water heaters with flat administrative costs, increase capacity delivered per water heater through optimization and automation, add the value of ancillary services, review options to streamline operations costs, review options to reduce the incentive amount per UCM as the market matures.

Learning Objective I Identify how to cost-effectively reduce barriers for participants and installers while providing a valuable customer experience and delivering grid-benefits.
◦ Participant Experience KPIs (Table 14)
<u>Research Question I.D</u> What unique challenges do Market Partners encounter when trying to incorporate SWH activities into their typical water heater installation process (e.g., UCM installation, data collection, or customer education)? • Data points that would be used to answer this question include: ◦ Qualitative input ◦ Participant Experience KPIs (Table 14)
<u>Research Question I.E</u> What is the most efficient way for PGE to establish, maintain, and distribute UCMs to Smart Water Heating network installers? • Data points that would be used to answer this question include: ◦ Qualitative input ◦ Flexible Load Adoption KPIs (Table 12)
<u>Research Question I.F</u> Will customers opt-out of participating in the pilot at a consistent rate over time? • Data points that would be used to answer this question include: ◦ Participant Experience KPIs (Table 14)
<u>Research Question I.G</u> What incentive amounts are effective in encouraging participants to connect to the grid while also addressing the water heater first cost barrier, and participation in the Virtual Power Plant (VPP)? • Data points that would be used to answer this question include: • Participant Experience KPIs (Table 14)
<u>Research Question I.H</u> How can PGE facilitate inclusive participation of income-qualified customers in the SWH pilot? • Data points that would be used to answer this question include: ◦ Qualitative input ◦ Participant Experience KPIs (Table 14)

Table 5 - Smart Water Heating Learning Objective II, Underlying Research Questions

Learning Objective II Dispatch load-shifting events to single family Ecoport[43] water heaters to make capacity available to the grid more reliably and at an increased scale.
Research Question II.A How do frequent load-shifting events affect participation in the program? • Data points that would be used to answer this question include: o Qualitative input o Participant Experience KPIs (Table 14)
Research Question II.B Are the load-shifting capacity values for Electric Resistance Water Heaters (ERWH) and Heat Pump Water Heaters (HPWH) consistent as we scale in the single-family setting? • Data points that would be used to answer this question include: o Event Performance KPIs (Table 13)
Research Question II.C Are there incremental costs or challenges in leveraging an existing integration between UCM and Demand Response Management System (DRMS)? • Data points that would be used to answer this question include: o Qualitative input
Research Question II.D How can Smart Water Heating leverage learnings about the interaction between behavioral load-shifting events and direct load-shifting events to be more inclusive of customers participating in Peak Time Rebates? • Data points that would be used to answer this question include: o Qualitative input o Event Performance KPIs (Table 13) o Participant Experience KPIs (Table 14)

[43] "*EcoPort is the brand name associated with CTA-2045 certified products. CTA-2045 is a technical standard promulgated and published by the Consumer Technology Association (R7.8 Modular Communication Interface for Energy Management Subcommittee.).*

EcoPort Is the brand name for technology that has been certified compliant with the CTA 2045 technical specification. Compliance means that a product has been submitted to the EcoPort certification program (operated by the OpenADR Alliance, which also operates a certification for the separate OpenADR standard, IEC 62746-10-1.)"

OpenADR Alliance. *EcoPort Supplemental Information.* Retrieved September 22, 2022 from: https://www.openadr.org/ecoport-supplemental

Table 6 - Smart Water Heating Learning Objective III, Underlying Research Questions

Learning Objective III Identify how calling additional types of demand response events beyond load shifting (e.g., load-up, load following, etc.) on single family water heaters can support further grid benefits (e.g., relieving capacity congestion) that can be operationalized at scale.
<u>Research Question III.A</u> Can SWH successfully operationalize the additional types of Flexible Load events which the Testbed identifies as most valuable for water heaters? • Data points that would be used to answer this question include: o Event Performance KPIs (Table 13) o Participant Experience KPIs (Table 14)
<u>Research Question III.B</u> Can SWH implement these additional types of demand response events at scale? Data points that would be used to answer this question include: • Event Performance KPIs (Table 13) • Participant Experience KPIs (Table 14)

2.1.2 Background

NEEA, The Energy Trust, many Northwest utilities, and water heating supply chain actors began investing in advancing water heating technology with a focus on energy efficiency in 2008. As a result, HPWHs now have a significantly higher market share than a decade ago, and in that time wireless communication technology has advanced rapidly. During that same time, aided by advances in two-way wireless communication, utility industry and manufacturer interest in water heaters as batteries (i.e. capacity resources) was beginning to grow[44]. In 2013, the Consumer Technology Association (f/k/a Consumer Electronics Association) released the ANSI/CEA-2045 standard, comprised of both a physical form factor and communications protocol for demand response, for application to many appliances including electric water heaters[45]. The CTA, manufacturers, and utility industry partners continued to develop the standard, which is now called CTA-2045 or Ecoport. PGE had joined Electric Power

[44] St. John, Jeff. GreenTech Media. *The Water Heater as Grid Battery, Version 2.0; 2013.* Retrieved from: https://www.greentechmedia.com/articles/read/the-water-heater-as-grid-battery-version-2-0.

[45] Electric Power Research Institute. *Introduction to the ANSI/CEA-2045 Standard*; 2014. Retrieved from: https://www.epri.com/research/products/000000003002004020.

Research Institute (EPRI) and CTA's field test of Ecoport technology[46] in 2013[47], and in 2018 began a research-based demonstration in partnership with BPA and other Northwest utilities. This was called the CTA-2045 Water Heater Demonstration (Schedule 3)[48], focused on understanding the potential for CTA-2045 as a standard for both the physical port that a UCM would be plugged into on the water heater, and the communications protocol which allows remote management and dispatch of DR commands to a water heater via the UCM. The demonstration also tested a combination of one-way radio with Wi-Fi backhaul to dispatch commands to and gather data from water heaters, as well as proposed several paths to market transformation.

The CTA-2045 demonstration delivered the following learnings, which informed the design of this pilot:

- Established capacity expectations for water heating Flexible Load
- Confirmed that CTA-2045 UCMs and event communications protocols were successfully implemented
- Produced evidence that Wi-Fi should be avoided due to the challenges related to reliability and availability
- Identified barriers to strategic market transformation

Ultimately, the CTA-2045 demonstration set the stage for regional actors such as BPA, NEEA, the Northwest Energy Coalition (NWEC), and PGE to advocate for adoption of the CTA-2045 standard (now called Ecoport) for water heaters across the region. This culminated with the passage of HB 2062[49], which requires all new electric water heaters manufactured for sale in Oregon to be equipped with an Ecoport (or equivalent) by July 1, 2023. This will accelerate market adoption of grid-enabled water heaters across our service territory.

The SWH pilot also builds upon lessons learned from PGE's Multi-family Water Heater (MFWH) pilot launched in 2018 (Schedule 4)[50] which focuses on ERWHs in multi-family

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[46] Thomas, Chuck and Seal, Brian. Electric Power Research Institute. *ICT Informational Webcast CEA-2045; 2015*. Retrieved from: https://smartgrid.epri.com/doc/ICT Informational Webcast CEA-2045 09APR2015.pdf.

[47] Tweed, Katherine. GreenTech Media. *Can One Project Redefine Power Delivery?; 2013.* Retrieved here: https://www.greentechmedia.com/articles/read/can-one-demo-project-redefine-power-delivery.

[48] PGE, *Schedule 3: Residential Demand Response Water Heater Pilot; Second Revision of Sheet No. 3-1; Issued August 16, 2018*. Retrieved from: https:/assets.ctfassets.net/416ywc1laqmd/6rUSjxANzOOyqHkj8MClhY/8f8b4f13068a2b238e9ab320240c553d/Sched_003.pdf.

[49] 81st Oregon Legislative Assembly Regular Session. (2021). *House Bill 2062, s.2.16*. Retrieved from: https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2062.

[50] PGE. *Schedule 4: Multi-family Water Heater Pilot*, *Third Revision of Sheet No. 4-1,Issued December 15, 2020*. Retrieved here: https:/assets.ctfassets.net/416ywc1laqmd/7FbRaBNOdq9GNmmWalI921/e2477bd226ac7e07854a016a9cf03475/Sched_004.pdf

complexes with 25 or more units. Learnings from MFWH that greatly informed the design of the SWH pilot include:

- Experience with different water heating Flexible Load dispatch strategies.
- Data to inform development of robust capacity expectations for electric resistance water heater Flexible Load at different times of day.
- Field test results from six different communications devices installed on water heaters to facilitate managing a water heater's power consumption remotely.
- Confirmation of the Schedule 3 Demonstration finding that Wi-Fi is unreliable
- Evidence that cellular Long-Term Evolution (LTE, a wireless broadband standard) communications are more reliable than Wi-Fi.
- Integrations between multiple devices' (retrofit switches and UCMs) Application Programming Interface (API) and the selected DRMS were completed for ERWH assets, and those devices were installed on water heaters to facilitate remote management of the water heaters' power consumption as well as a centralized database.
- Recommendations for effective program design, such as ways to streamline the installation process, the identification of information needed for repeated customer communication, key questions, and process for troubleshooting in the field.

In addition to this foundation, PGE has continued to build our knowledge of water heaters as a Flexible Load resource via demonstrations in the Schedule 13 Testbed. In 2020, the Testbed began a HPWH Flexible Load demonstration in single family homes. The team selected three different communication protocols (Wi-Fi, cellular LTE, and two-way radio frequency mesh network) to test the differences between each modes' uptime, latency, load-shifting potential, and customer experience. This uncovered issues and opportunities related to each mode of communication, as well as additional costs and benefits that would be key to developing a cost-effective and scalable program. Findings that informed this pilot include[51]:

- Identified a contractor-based delivery method for the installation and commissioning of UCMs, which may prove cost effective and scalable.
- There is a need for more education about Flexible Load and distributed energy resources amongst single family homeowners to increase understanding of why they are important to utility operation.
- Cellular-connected UCMs were more reliable than Wi-Fi connected UCMs.
- Mesh-connected UCMs required an additional antenna, resulting in higher hardware costs-and more of a negative impact on cost effectiveness-than cellular-connected UCMs. While the cellular method of communication does

[51] *PGE. Smart Grid Testbed Phase II Proposal (2021)*. Retrieved from: https://apps.puc.state.or.us/edockets/edocs.asp?FileType=HAD&FileName=um1976had145212.pdf&DocketID=21662&numSequence=17

not offer mesh network's ability to "piggyback" other smart devices, cellular-connected UCM's reliability and relative cost-effectiveness make it our preferred method of communication for water heating.

In addition to findings specific to water heaters, the Testbed also found that in the context of Peak Time Rebates, an opt-out enrollment design led to higher rates of participation. PGE will apply this finding to help drive higher participation in SWH.

The Testbed also tested five different Customer Value Propositions (CVP) for Flexible Load program adoption. SWH plans to use the conversion data for each CVP to inform customer messaging on the pilot. SWH will continue benefitting from the Testbed's findings, particularly in the context of learning about Flexible Load event use cases for water heaters beyond load-shifting. Additionally, SWH will be able to leverage API integrations between Flexible Load devices and the DERMS established by Schedule 4 and Schedule 13, which will help reduce pilot start-up costs.

Within the last four years, with the support of market actors such as NEEA, the general water heating market has progressed such that:

- HPWH are reliable and available
- Oregon's new standard[52] for water heaters sold in the state will soon require both ERWHs and HPWHs to be equipped with Ecoport technology essential to connect UCMs
- Ecoport-equipped water heaters have mechanisms on-board and do not need supplemental technology to proactively avoid cold water experiences during load-shifting events
- Cellular LTE UCMs are available

However, barriers still remain:

- 50% of Americans cannot afford a $1,000 emergency[53], which is an issue for water heaters, as PGE estimates that as of June 2022, ERWH and HPWH first costs average $1,400 and $3,100, respectively
- Cellular UCMs are not widely available nor are they a retail product (utility programs have typically provided them to participants)

Again, while significantly more water heater models will be grid-*enabled*, PGE will not derive grid benefits from those water heaters unless they are grid-*connected*. We must deliver an easy and rewarding Flexible Load participation experience for customers that overcomes the barriers to grid-connection. The SWH pilot seeks to

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[52] 81st Oregon Legislative Assembly Regular Session. (2021). *House Bill 2062, s.2.16*. Retrieved from: https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2062.

[53] Velasques, Francisco. CNBC. *Over Half of Americans Have Less Than 3 Months Worth of Emergency Savings; 2021*. Retrieved from: https://www.cnbc.com/2021/07/28/51percent-of-americans-have-less-than-3-months-worth-of-emergency-savings.html.

leverage the learnings from and build on the accomplishments of Schedule 3, Schedule 4, and Schedule 13 to address the remaining barriers and enact this change.

2.1.3 Stakeholder Feedback

We are compelled by our current market research, which indicates that many residential customers have a desire to be more sustainable and that 60% of PGE customers feel PGE offers clean energy options that meet their needs. This market research also indicates that 86% of PGE customers would turn to us for resources about water heater purchase and installation. The SWH pilot can both address barriers to connecting water heaters to the grid and meet customer desires in a way that leverages PGE's unique role in the energy ecosystem developing Flexible Load resources.

In addition to the market research mentioned above, PGE engaged with more than a dozen external stakeholders since September 2021 to inform the design of this pilot. Representation includes industry organizations, organizations providing support to low-income customers, specific communities and individuals, and also customer and community discussions led by PGE's Market Insights team.[54]

This pilot was designed with broad and specific input from many populations, specifically individuals with low-income experiences. Feedback directly incorporated into pilot design follows:

- Cellular LTE communication mode is a more equitable method than Wi-Fi and enables more customers to be first adopters.
- An opt-out design eases entry into pilots and programs by reducing the time it takes individuals to engage. PGE will seek to improve upon this as more is learned from pilot implementation (see customer communications, below, for detail).
- Technology options will include both heat pump and electric resistance to avoid "single–solutioning" which creates barriers that can limit participation in Flexible Load programs and reducing greenhouse gas emissions.
- Stakeholders encouraged PGE to allow customers with existing gas water heaters to participate if they select a qualifying appliance, while noting that HPWH may be the most advantageous option for customers.
- Incentive support for low- and moderate-income customers to be first adopters of efficient technologies like HPWH and Flexible Load programs, as

[54] External stakeholders include DRAG, FLASH, Citizen's Utility Board (CUB), Community Energy Project (CEP), Distribution System Plan (DSP) Partners Monthly Workshop, UA 290, Plumbing and Mechanical Contractors Association, Energy Trust, Northwest Energy Efficiency Alliance (NEEA), PGE's ABLE Disabilities Business Resource Group , Washington Co. Community Action Partner, Renewable NW, Natural Resources Defense Council (NRDC), NW Energy Conservation (NWEC), New Buildings Institute (NBI).

well as resources to proactively guide customers to energy efficient technology options when appropriate.

- Customer communications and educational materials will be provided in multiple languages beginning with Spanish.
- Customer communications need to include phone, text, email options, and we need to better understand ways for customers to control how and when they want to participate in events.

During pilot implementation, PGE anticipates capturing more feedback to help us further refine our understanding of the market and improve upon how we address cost barriers, rising costs, and customer wants and needs. PGE has engaged with a Community Action Partner organization and a Community-Based Organization through the Distribution System Planning (DSP) workshops regarding SWH income qualified incentives. PGE will convene an income qualified incentive workshop to deepen the dialogue and solicit further feedback.

Throughout its life cycle, from design to implementation, stakeholder input will continue to be an important piece of shaping the pilot.

Drawing closer to and during implementation, PGE especially values continued, active collaboration with NEEA and Energy Trust. Our organizations share similar spaces in the market and working together can achieve more than we would acting in isolation. PGE has already begun conversations with both organizations to discuss opportunities to coordinate activities and how to navigate differences between offerings. Both Energy Trust and NEEA focus on energy efficient technologies, thus when it comes to water heating only HPWHs are eligible for incentives and/or market support. Smart Water Heating meanwhile seeks to connect both HPWHs and ERWHs to our grid. NEEA and Energy Trust have contributed immensely to the market transformation HPWHs have experienced over the last 15 years, PGE aims to support this transformation and continued growth while also acknowledging that not all homes can accommodate a HPWH and – at least for now – there is a significant price differential between ERWH and HPWH which results in not all customers being able to afford HPWHs. To reiterate, most Americans cannot afford a $1,000 emergency[55], and a water heater replacement, on average, is at minimum a $1,400[56] expenditure. We believe that by offering a grid-connection incentive that is proportional to the cost of the type of water heater the customer selects, HPWHs would be less expensive relative to an ERWH even though the Smart Water Heating incentive would also apply to the ERWH (Table 7 and

[55] Velasques, Francisco. CNBC. *Over Half of Americans Have Less Than 3 Months Worth of Emergency Savings; 2021*. Retrieved from: https://www.cnbc.com/2021/07/28/51percent-of-americans-have-less-than-3-months-worth-of-emergency-savings.html.

[56] Estimate as of June 2022 based on 50-gallon tank size and qualitative input from professional installers and original equipment manufacturers.

Table 8, below). Additionally, as we designed the SWH pilot, the IRA was making its way through Congress. Its passage marks the way for significant new HPWH incentives, amongst many other opportunities to move faster toward the clean energy future. As more details emerge about the IRA, we look forward to learning how PGE can help customers access HPWHs more readily and streamline access to those additional incentives.

HPWH market share also has an impact on the Smart Water Heating cost effectiveness score. As proposed in this Plan and with the current cost effectiveness model, SWH can bear a 20% - 25% HPWH market share; any higher than that we begin to see a negative impact on the cost effectiveness score. Given that HPWHs are more efficient than ERWHs, they necessarily have less capacity available for a DR event. The greater the number of HPWHs relative to ERWHs in the SWH pilot, the less capacity for load-shifting events. However, that tolerance could increase if certain conditions come to bear – such as lower operational costs, a national standard for water heating demand response, application of IRA incentives, etc. See 2.1.14 for further discussion on this point. We anticipate the passage of the IRA could potentially have a net positive impact on SWH's cost effectiveness score.

Overall, opportunities for coordination to further define with Energy Trust and NEEA include:

- Cross-training HPWH installers from Energy Trust and NEEA on the Smart Water Heating offering
- Data-gathering and sharing
- Incentive delivery mechanisms and timeline
- Up-stream market transformation efforts
- Water heater and/or UCM manufacturer level engagement

As discussed in Section 1.7, PGE looks forward to detailing how we will collaborate with Energy Trust on Smart Water Heating through the HB 3141 process.

Table 7 – Estimated ERWH and HPWH Relative Costs in the Single-family Replacement Market

	Non-income qualified			Income qualified		
Cost Layer[57]	ERWH	HPWH	HPWH Cost Variance	ERWH	HPWH	HPWH Cost Variance
Est. Average Baseline Cost (includes installation)	$1,400	$3,100	+$1,700	$1,400	$3,100	+$1,700
Energy Trust mid-stream incentive	-	- $500	-	-	-$500	$0
Subtotal after Energy Trust mid-stream incentive	$1,400	$2,600	+$1,200	$1,400	$2,600	+$1,200
Smart Water Heating grid-connection incentive	- $150	- $280	-	-$280	- $775	-
Grand Total after both Energy Trust mid-stream and SWH Incentives	$1,250	$2,320	+$1,070	$1,120	$1,825	+$705

[57] Estimate as of June 2022 based on 50-gallon tank size and qualitative input from professional installers and original equipment manufacturers.

Table 8 – Estimated ERWH and HPWH Relative Costs in the Single-family New Construction Market

	Non-income qualified			Income qualified		
Cost Layer	ERWH	HPWH	HPWH Cost Variance	ERWH	HPWH	HPWH Cost Variance
Est. Average Tank Cost	$600	$1,338	+$738	$600	$1,338	+ $738
Est. Average Energy Trust EPS incentive[58]	-	- $500	-	-	- $550[59]	-
Subtotal after Energy Trust EPS incentive	$600	$838	+$238	$600	$838	+$0
Smart Water Heating grid-connection incentive	-$150	- $280	-	-$280	- $775	-
Grand Total after both Energy Trust EPS incentive and SWH grid-connection incentive	$450	$558	+$108	$320	$13	- $307

2.1.4 Market Sizing

Based on our records of customers in single family residences service territory and the ubiquity of the appliance, PGE estimates there are half a million water heaters in single family residences[60] in our service territory, 50% of which are electric[61]. That leaves 250,000 electric water heaters that could be enrolled in the SWH pilot. PGE will reassess the size of the SWH market on an annual basis.

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[58] EPS incentives are variable and awarded on a whole home basis and are variable in amount. PGE assigned $500 to the HPWH as it contributes to a higher EPS score and is consistent with Energy Trust's mid-stream incentive offering.

Energy Trust of Oregon. *Incentive Overview – 2022 Cash Incentives for Energy Efficient Homes Built in Oregon; 2022.* Retrieved from: https://insider.energytrust.org/wp-content/uploads/Oregon-EPS-Incentive-Grid_CLEAN.pdf

[59] Per Footnote 56, above, EPS incentives are variable and awarded on a whole home basis. PGE assigned an additional $50 the EPS income qualified water incentive as it is a portion of the full $500 incentive, which is additive to the whole home non-income qualified incentive, per form 610L.

Form 610L reference: Energy Trust of Oregon. *Builder Affordable Housing Confirmation, EPS New Construction Form 610 L*; 2022. Retrieved from: https://energytrust.org/wp-content/uploads/2022/03/ENH_FM0610L.pdf

[60] Based on PGE customer records, assuming one water heater per home.

[61] PGE. *2021 Residential Appliance Saturation Survey (RASS).*

Since water heaters have a lifespan of 10-15 years[62], the opportunity to replace a conventional water heater with a grid-connected electric model in any given year is limited. PGE estimates an annual total addressable market (TAM) of 30,000 water heaters, reflecting yearly units installed across new construction and existing home replacements in our service territory, evenly split between DIY and installer installations.

SWH will begin with delivery only through professional installations, as adding a UCM to a water heater transaction in a retail setting for a DIY installation is more disruptive to the typical purchase process and presents risks to obtaining accurate data about the status and location of the installation. Limiting initial deliveries to professional installations results in a serviceable addressable market (SAM) of 15,000. The team will work on developing a DIY delivery pathway post-launch.

To drill down to the serviceable obtainable market (SOM), PGE considered how many electric water heaters could enroll in the SWH pilot via an installer installation and assumed a higher overall rate of long-term participation due to the opt-out design. PGE estimates a SOM of roughly 30% of annual electric installations that will meet pilot enrollment requirements. Currently, NEEA measures the ERWH and HPWH market distribution to be 82.5% / 17.5%, but PGE estimates, based on past trends, that with NEEA and Energy Trust's continued activities and our intervention, including additional incentives for connecting HPWHs to the grid, that the distribution will increase slightly for HPWHs to 20%[63]. As a result of these analyses, we estimate a maximum annual SOM of 5,000 water heaters and expect to ramp up to that target over the course of the pilot. In Sections 2.1.14 and 5.2.6, we discuss how market transformation could create conditions that would allow for new delivery pathways, such as DIY installation, that would allow us to increase the SOM and potentially improve cost effectiveness.

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[62] U.S. Department of Energy, Energy Saver. *Tankless or Demand-Type Water Heaters; 2022*. Retrieved from: https://www.energy.gov/energysaver/tankless-or-demand-type-water-heaters#:~:text=Most%20tankless%20water%20heaters%20have,associated%20with%20storage%20water%20heaters.

[63] The NEEA data is backwards looking (the 2022 report shows OR HPWH sales from 2017-2020). Based on the trajectory and 2020 estimate of 17.5%, we believe that 20% is a reasonable estimate for the state of the world today.

Northwest Energy Efficiency Alliance. *Northwest Heat Pump Water Heater Market Progress Evaluation Report #6; Table 1: Market Share of NW HPWH Installations, By State, Pg. 15;* 2022. Retrieved from: https://neea.org/resources/northwest-heat-pump-water-heater-market-progress-evaluation-report-6

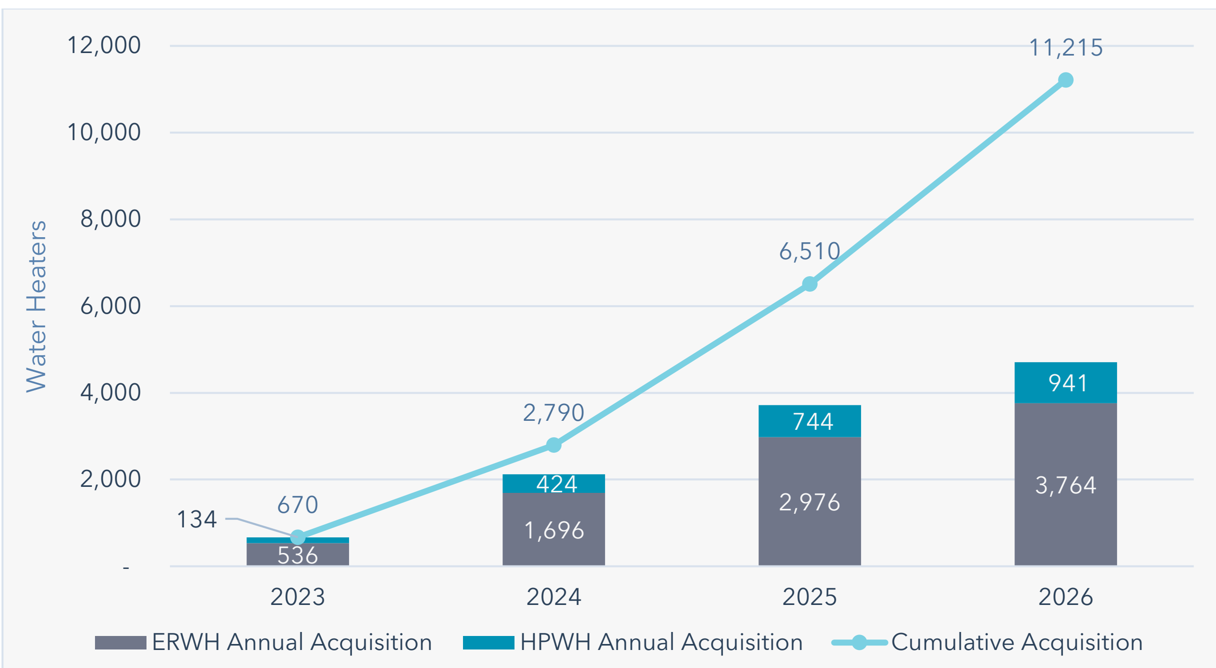
Table 9 – Smart Water Heating Estimated Annual Market Size

	Annual Customers	Electric Resistance	Heat Pump
Total Addressable Market (TAM)	30,000	80%	20%
Serviceable Available Market (SAM)	15,000	80%	20%
Serviceable Obtainable Market (SOM)	5,000	80%	20%

2.1.5 Participation Goals

As shown in Chart 1, below, PGE's aim is to scale toward acquiring 5,000 SWH participants per year, with 80% of those enrollees using an ERWH and 20% a HPWH. By December 31, 2026, PGE's goal is to have at least 11,215 water heaters enrolled in the SWH pilot. PGE will revisit the SOM at regular intervals to assess if revisions are appropriate, as when we have actuals from implementation, after receiving model updates for how external factors (e.g., tax credits) are impacting customer behavior, and after launching new channels such as DIY.

Chart 1 – Smart Water Heating Annual Acquisition Potential, Serviceable Obtainable Market (water heater units per year)



2.1.6 Planning Potential

Based on data from Schedules 3 and 4, PGE estimates ERWHs will deliver 0.30 kilowatts (kW) on average per three-hour load-shifting event in either the winter or summer season. For their part, PGE estimates HPWHs will deliver 0.2 kW and 0.1 kW on average per three-hour event in the winter and summer, respectively, based on data from Schedule 3.

PGE estimates the realization rate for load-shifting events in single family situations to be 74% based on data from both Schedule 3 and Schedule 4. That rate is the result of combining rates of connectivity, water heaters continuously in "override mode", and water heaters not heating during events. To be in "override mode" in this context means that during a load-shifting event, the water heater's onboard sensory mechanism or algorithm has identified that the use of hot water is approaching the point where water coming out of the faucet would be cooler than the set point, and that the water heater needs to leave the event and begin consuming power again to reheat the water in the tank to the set point. Being continuously in "override mode" would mean the end user is using hot water at a rate that the water heater needs to continue reheating. The team only applies the realization rate to the number of water heaters expected to be available to participate in events, assuming that 3% of participants will opt-out, again based on data from Schedule 3.

To forecast expected demand reductions, PGE uses a cost effectiveness model that combines HPWHs' and ERWHs' per event demand reductions, and then applies the realization rate to arrive at an annualized average per event demand reduction (Chart 2, below).

To visualize year-over-year growth, PGE also forecasts expected demand reductions for year-end, when the fleet is at its largest (Chart 3, below). This forecast applies the ERWH and HPWH demand reduction values to the subtotals of each type of water heater in the fleet, and then applies the opt-out rate and realization rate to display this estimation of maximum realization potential.

While the technical potential for demand reductions is higher than either of these estimates, it is unlikely that every single enrolled water heater will participate for an entire event with any frequency, so PGE has chosen not to include those figures.

Chart 2 – Smart Water Heating Estimated Demand Reduction per Event (Annualized Average in kW)

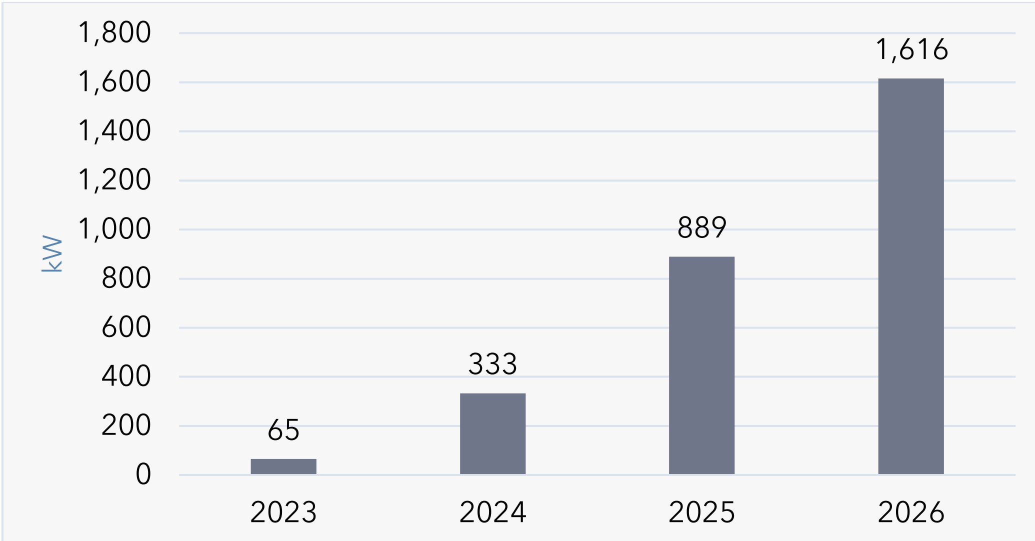
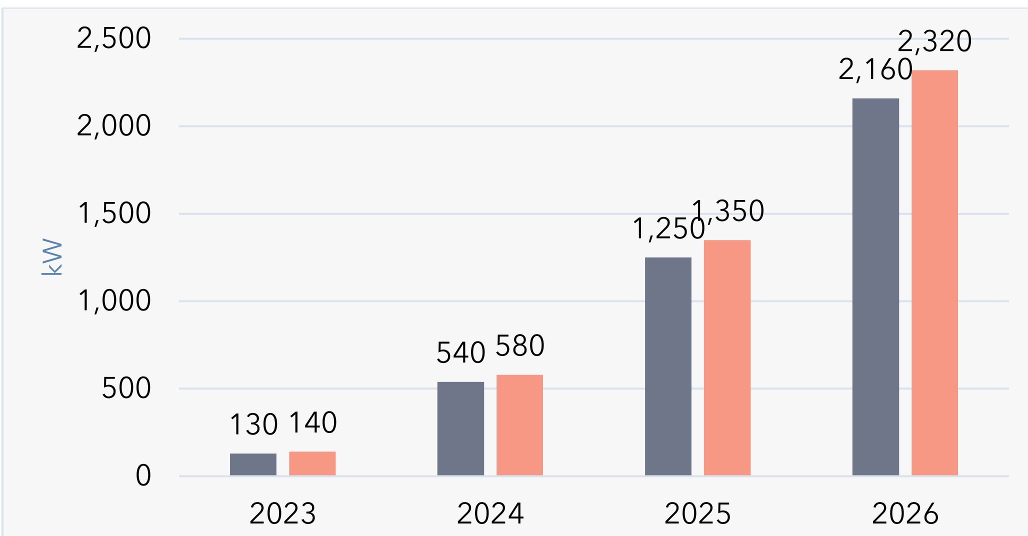


Chart 3 – Smart Water Heating Estimated Seasonal Demand Reduction per Event (by Year End in kW)



2.1.7 Pilot Design and Implementation

PGE proposes the SWH pilot be implemented over four years, starting with a six-month beta test. PGE will provide updates on pilot performance at the quarterly DRAG and Flexible Load Advisory Stakeholder (FLASH) meetings with OPUC Staff and Stakeholders. Each MYP filing and associated update will include a comprehensive overview of pilot progress, particularly in regards for improvements in cost-effectiveness.

PGE plans an opt-out approach to enrollment to avoid the traditional barrier to enrollment that completing paperwork presents. Both the Testbed and MFWH have demonstrated success with an opt-out design.

Enrollment:

- Participants will enroll in SWH by contacting a water heater installer from the SWH installer network for a water heater replacement or moving into a newly constructed home built in partnership with a SWH builder/verifier.
- Customers in existing construction will learn about SWH enrollment at time of installation.
- New construction customers will learn about SWH enrollment upon move-in.
- PGE will automatically enroll customers (replacement and new construction) into the SWH pilot upon the installation of the UCM.
- Installers will place an infographic sticker on the water heater at the time of installation. The sticker will have information about the pilot and how to opt-out of events.
- Installers will provide customers with collateral with key SWH information at the time of installation, either via a leave-behind in new construction or providing directly to the customer in existing construction.
- PGE also plans to send a welcome communication to new enrollees with key SWH details.
- In homes with a known grid-connected water heater where the original enrollee has moved out, the new resident will be automatically enrolled in SWH and PGE will notify them to welcome them to the program.
- If a customer prefers to not participate in Flexible Load events, they can remove their grid-enabled water heater from the event call list. If/when a new resident moves into a home with a known grid-connected water heater, the new resident will be automatically re-enrolled in the pilot. PGE is investigating which modes of communication customers would prefer use for opt-out purposes.

Event participation:

- Once UCMs are installed, PGE will call "no-notice" load-shifting events on participating water heaters
- Events may be called as frequently as twice daily, every day excluding the following holidays:[64]
    - New Year's Day (January 1)

[64] If a holiday falls on a Saturday, the preceding Friday will be designated the holiday. If a holiday falls on a Sunday, the following Monday will be designated the holiday. Overall, PGE is working toward standardizing event calling parameters across the portfolio and making them more flexible, including weekends in Smart Water Heating is a first step in that direction. We intend to include holidays in the future.

    - Memorial Day (last Monday in May)
    - Independence Day (July 4)
    - Labor Day (first Monday in September)
    - Thanksgiving Day (fourth Thursday in November)
    - Christmas Day (December 25)
- Events will not exceed more than eight hours in a 24-hour period

2.1.8 Incentives

Incentives are key to accelerating adoption of grid-connected devices. It bears repeating that while HB 2062 requires that newly-manufactured water heaters be grid-enabled, PGE will not derive grid benefits from those water heaters unless they are grid-connected. PGE will deliver an incentive to customers to connect their water heater to the grid at the time of installation. This will not only motivate the customer to enroll their water heater as a Flexible Load resource but will also help address the first cost barrier to obtaining a new smart water heater. Over the course of the pilot, PGE will monitor the impact of incentives upon program enrollment and participation and may also be able to reduce them as the market matures. We will also monitor the impact of other market incentives such as those being introduced by the Inflation Reduction Act and look for opportunities to improve cost effectiveness by leveraging those incentives where possible.

Table 10 – Proposed Incentives Offered by Smart Water Heating

Incentive	Value	Est. $ per ERWH	Est. $ per HPWH	Est. % of Fleet	Recipient	Criteria
Installation	Approx. $100 / hour	$50	$50	100%	Smart Water Heating Network installer	UCM is plugged in, powered on, connected to cellular LTE, and relevant data has been submitted to PGE.
Grid Connection (*not* income qualified)	Approx. 10% avg. first cost including installation	$150	$300	80%	Customer	Purchase of a qualified grid-connected water heater. UCM is plugged in and powered on. *Mutually exclusive of income qualified incentive.*
Grid connection (income-qualified)	Approx.. 50% avg. first cost including installation	$280	$775	20%	Customer	Income-qualified criteria aligns with Income-Qualified Bill Discount[65], customer self-identifies; purchase of a qualified grid-connected water heater; UCM is plugged in and powered on. *Mutually exclusive of the non-income qualified incentive.*
Annual non-monetary reward for Flexible Load event participation	Non-monetary, exact reward to be determined during pilot	$20 (max)	$20 (max)	100%	Customer	UCM is not opted out; rewarded as a non-monetary incentive based on device enrollment in SWH.

[65] PGE. *Income-Qualified Bill Discount*. Retrieved from: https://portlandgeneral.com/income-qualified-bill-discount

2.1.9 Schedule

As mentioned above, PGE proposes creating "stage gates" to help manage the progression of the SWH pilot, creating transparency around progress and learnings related to cost effectiveness. These stage gates also provide the opportunity to adjust or pause activity if early learnings are not favorable towards cost effectiveness. The following paragraphs detail implementation milestones around which PGE will stage gate SWH activity. Funding estimates are tied to each milestone, which roll up to the budget presented in section 2.1.13.

Milestone 1: Beta Test

The purpose of the beta test is to identify and address issues with the workflow and customers/installer communications prior to the minimum viable product (MVP) launch.

- Beginning: est. January 1, 2023
- Target market: PGE employees who are also PGE customers living in single family, owner-occupied residences
- SWH installer network for the new construction market (in collaboration with the Energy Trust) and the replacement market
- Cellular LTE UCM equipment and installation furnished by PGE at no cost to the customer

Milestone 2: Minimum Viable Product Launch

Minimum Viable Product launch represents the first time the pilot will be available to the broader single family homeowner market. The launch will incorporate lessons learned from beta and be the foundation from which the team scales and iterates.

- Beginning: est. July 1, 2023
- Target market: Single family homeowners
- Expanded SWH installer network for the new construction market (in collaboration with the Energy Trust) and the replacement market.
- Income-qualified incentives available through SWH installer network.
- Development and initial launch of a specific pathway for income-qualified incentives, in collaboration with organizations serving income-qualified customers.
- Expanded event parameters relative to existing pilots and programs (i.e., including weekends).

Developments slated for 2024 – 2026:

Future iterations of pilot design may include:

- Target market: Expansion into renter-occupied single-family residences as well as DIY installers. Note that the customer journeys for these market

segments require additional research and design work before successful customer experiences can be delivered.
- Operationalization of additional event types to maximize water heating load flexibility, using learnings from Testbed activity.
- Integration of the SWH customer experience with behavioral Flexible Load events (i.e., PTR).
- Changes to processes and/or market partners based on the results of 3rd party evaluations and pilot learnings.

The following table presents a high-level summary of expected learnings over the duration of the pilot, with particular focus on cost-effectiveness.

Table 11 – Smart Water Heating Summary of Expected Learnings

Pilot Phase	Est. Participants (Cumulative)	Est. Expenses (Cumulative)[66]	Expected Learnings	Stage Gate(s)
Beta (H1 2023)	60	$233,447	Preliminary KPI measurements including capacity impacts from DERMS telemetry, rate of connectivity. Assess any changes in customer satisfaction after moderate increase in pilot population. Insights on how to improve pilot design for MVP launch.	N/A
MVP Launch (H2 2023)	670	$466,893	Application of preliminary KPI measurements to cost-effectiveness model assumptions. Confirmation if cost-effectiveness can be improved with initial 6 variables. Insights into how initial installer network expansion process could be improved. Insights into when the installer network needs to be	MYP Filing (08/2023) Deferral (10/2023) Annual Report (12/2023)

[66] This cumulative budget estimate assumes that PGE recognizes the cost of a UCM purchase at the time it is used in the field. In terms of practical implementation, the team plans to issue purchase orders for a volume of UCMs in an amount not to exceed the total for the pilot but at which volumetric price breaks can be secured. The team then plans to receive against those purchase orders in smaller volumes, within the amount of UCMs needed for a single calendar year.

Pilot Phase	Est. Participants (Cumulative)	Est. Expenses (Cumulative)[66]	Expected Learnings	Stage Gate(s)
			expanded to meet installation goals. Identification of essential steps to create efficient processes.	
2024 Implementation	2,790	$1,797,015	Application of updated KPI measurements to cost-effectiveness model assumptions. Assess overall pilot for capacity results (DERMS telemetry) and to identify necessary adjustment s with the objective of improving customer delivered capacity. Results from pilot assessment to inform further refinement of implementation. Use the results from the Testbed demonstration identifying the most valuable water heating Flexible Load events and associated capacity values to inform planning for how SWH will operationalize these to maximize water heating demand response flexibility and assess the impacts on cost effectiveness. Review the conclusion of the HR 7962 rule-making process to assess potential impacts on market transformation and opportunities to improve pilot cost effectiveness.	Deferral (10/2024) Annual Report (12/2024)
2025 Implementation	6,510	$3,887,612	Application of updated KPI measurements to cost-effectiveness model assumptions. Preliminary insights into how the DIY and renter pathways perform relative to installer pathway. If the fleet has sufficient ERWH volume to meet threshold for 3rd party	MYP (08/2025) Deferral (10/2025) Annual Report (12/2025)

Pilot Phase	Est. Participants (Cumulative)	Est. Expenses (Cumulative)[66]	Expected Learnings	Stage Gate(s)
			evaluation per the planned methodology and timeline. If the fleet has adequate HPWH volume to meet threshold for 3rd party evaluation per the planned timeline, or if an alternative methodology is needed as expected. Use preliminary results from the Testbed's field test events of new event types for water heating Flexible Load and how they perform compared to lab results to update plans for operationalization and assess the impacts on cost effectiveness. Potential improvements to cost effectiveness through the incorporation of new water heating use cases pending performance in Testbed field test.	
2026 Implementation	11,215	$6,511,943	Application of updated KPI measurements to cost-effectiveness model assumptions. Using results from the Testbed's field test events for new event types for water heating Flexible Load to revise plans and operationalization of how Smart Water Heating will incorporate these and the impact on cost effectiveness. Comparing the 3rd party evaluation and against KPI measurements and cost-effectiveness model assumptions. Recommendations from 3rd party evaluation to improve pilot performance. Confirmation if pilot performance and cost-effectiveness score support	Transition to Program Operational Tariff Filing (10/2026) Annual Report (12/2026)

Pilot Phase	Est. Participants (Cumulative)	Est. Expenses (Cumulative)[66]	Expected Learnings	Stage Gate(s)
			filing to transition from pilot to program.	

2.1.10 Benefits to Participants

The benefits to customers if the SWH pilot succeeds include:

- Mitigate customer first cost barrier for Ecoport water heaters by providing an incentive to connect the unit to the grid at the time of installation.
- Mitigate energy costs associated with water heating-the second largest energy use in home-by upgrading an ERWH to a HPWH, as they are up to 70% more efficient[67].
- Customers save time and energy by using the Smart Water Heating installer network to locate an installer who can provide them with grid-connected technology and rebates, as well as an experience endorsed by PGE.
- Address customers' desire to be more sustainable (60% of residential PGE customers feel PGE offers clean energy options that meet their needs[68]) with an additional energy efficiency and Flexible Load offerings.
- Reduce carbon emissions through the expansion of DR resources – which help PGE prioritize non-carbon based generation resources – as well as HPWH adoption.
- Amplify existing efforts by community organizations and Community Action Partner agencies to increase income-qualified customer access to sustainable water heating options.

2.1.11 Current Risks and Mitigations

Ecoport water heaters and UCMs are new to the market, which contributes to the need for PGE to enact market interventions to accelerate grid connection. With new markets come new risks; these include:

UCM hardware

- **Risk**: The cellular-connected UCM hardware deployed in the MFWH has demonstrated connectivity below the expectations set by other cellular-connected retrofit DR devices. After investigation, the Original Equipment Manufacturer (OEM) identified a root cause and confirmed it can be fixed.

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[67] United States Environmental Protection Agency, ENERGY STAR. *Choose an ENERGY STAR Heat Pump Water Heater; 2021.* Retrieved here: https://www.energystar.gov/sites/default/files/tools/HPWH_BuyingGuide_May2021.pdf#:~:text=Super%20Energy%20Efficient%3A%20Heat%20pump%20water%20heaters%20make,1%2F3%20the%20cost%20than%20conventional%20electric%20water%20heaters.

[68] PGE Customer Insights team. *2021 Internal customer value proposition and brand index research*.

- **Mitigation**: OEM is designing a second generation UCM, expected no later than Q2 2023.
- **Nature of risk**: Medium, as there could be a delay to the beta test and/or pilot launch if second generation UCM does not perform as expected or does not arrive on schedule.

Timeline alignment

- **Risk**: Oregon code[69] requiring all electric water heaters sold in Oregon be Ecoport-compliant (or equivalent) has been delayed from January 1, 2022 to July 1, 2023.
- **Mitigation**: Begin pilot beta in January 2023 and postpone pilot MVP launch to align with the code adoption date.
- **Nature of risk**: Relatively low, as manufacturers indicate they are prepared to have supply ready by July 1, 2023; further delays to code enactment could delay the pilot launch.

AC vs. DC form factor

- **Risk**: Under Oregon code[70], manufacturers may choose between alternating current (AC) and direct current (DC) form factors for their Ecoport-compliant water heaters (both are accounted for in the Ecoport specification)[71]. There are cellular-connecting AC modules but not DC modules; so far only one major manufacturer is considering a mix of AC and DC form factors on their water heating products.
- **Mitigation**: Monitor the prevalence of the water heater Ecoport form factors; connect with UCM manufacturers to understand if a cellular-connected DC module is technically feasible. Proposed stage-gating of activity will allow PGE to proceed with development of SWH as a Flexible Load, while safeguarding customers from undue financial risk.
- **Nature of Risk**: It is unclear if this will have a significant impact, further market development will inform the nature of the risk.

2.1.12 Key Performance Indicators

PGE has designed the following KPIs to answer the research questions and achieve the learning objectives detailed in Section 2.1.1. The KPIs reflect our best current

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[69] 81st Oregon Legislative Assembly Regular Session. (2021). *House Bill 2062, s.2.16*. Retrieved from: https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2062.

[70] Ibid.

[71] Consumer Technology Association. *Modular Communications Interface for Energy Management (ANSI/CTA-2045-B), s.5; 2021.* Retrieved from: https://shop.cta.tech/collections/standards/products/modular-communications-interface-for-energy-management

understanding; if, in the course of operating the pilot, a KPI needs to be adjusted, PGE will engage with stakeholders via the forums outlined in Section 2.1.15.

Table 12 – Smart Water Heating Flexible Load Adoption KPIs

Metric	Definition	2023	2024	2025	2026
Installation network growth rate	Percentage of installers added to the SWH installer network relative to the preceding year.	100%	100%	0%	0%
DC / AC form factor ratio[72]	Percentage of models using the DC Ecoport form factor to those using AC. Number of DC modules in fleet / Number of AC modules in fleet	11%	11%	11%	11%
Customer decline rate	Percentage of customers that decline a UCM installation relative to those that permit it.	5%	5%	5%	5%
UCM failure rate	Percentage of devices installed as part of the pilot found to be non-functioning in the field.	5%	5%	5%	5%
UCM installation rate	Average UCMs installed by an installer company per year.	82	265	465	589
Total UCM installations	Cumulative UCMs installed on pilot water heaters and associated to PGE's grid.	670	2,790	6,510	11,215

[72] Ibid.

Table 13 – Smart Water Heating Event Performance KPIs

Metric	Definition	Target 2023-2026
Connectivity rate	Percentage of enrolled devices available for communication via the cellular LTE network.	85%
Rate of availability	Percentage of enrolled water heaters meeting all of the following conditions: A) not opted-out, B) actively heating during an event window, and C) not in a state of override for the entire event.	87%
Override rate	Percentage of enrolled water heaters that are in, or go into, override during an event, which indicates that a customer cold water experience was prevented. *Cannot be combined with rate of availability.*	20%
Realization rate	Measured capacity impacts relative to total potential capacity impacts. Total Participating Installations * measured kW / Total installations * planning value kW	70%
Avg. capacity per ERWH – winter	Measured on water heaters participating in events.	0.3 kW
Avg. capacity per ERWH – summer	Measured on water heaters participating in events.	0.3 kW
Avg. capacity per HPWH – winter	Measured on water heaters participating in events.	0.2 kW
Avg. capacity per HPWH - summer	Measured on water heaters participating in events.	0.1 kW

Table 14 – Smart Water Heating Participant Experience KPIs

Metric	Definition	Target 2023-2026
Installation network retention	Percentage of installers who remain in the SWH installer network relative to the total number who have ever been in the network.	80%
Installation network rate of participation	Percentage of installers in the SWH installer network that submit incentive invoices.	90%
Customer concerns	Percentage enrolled customers that submit a concern (excludes those related to water temperature issues)	5%
Customer cold-water concerns	Percentage of enrolled customers that submit a concern related to water temperature issues.	5%
Non-monetary rewards uptake	The ratio of customers activating their seasonal, non-monetary rewards relative to those that do not.	To be set 6 months after market launch
Income qualified incentive uptake	Percentage of enrolled customers who are eligible for and take advantage of the income qualified incentive.	20%
Enrollment churn	If a customer opts-out, then moves out, the new customer will default to participating in the pilot at the same residence. No. of opt-outs that return to participation upon move / No. of total opt-outs	10%
Opt-out rate	Percentage of enrolled customers who opt out of the pilot.	3%
Pause participation rate	Percentage of enrolled customers who request to pause their participation from one or more events during the reporting period.	1%

2.1.13 Budget

The SWH pilot currently projects a maximum budget need of $6,511,944 for the duration of the pilot (Q4 2022 through December 2026) for an estimated fleet of 11,215 grid-connected water heaters delivering up to 2.3 MW of capacity per three-hour load-shifting event. Over the course of the pilot, PGE will actively work to reduce the overall budget through cost management and efficiencies.

PGE recognizes it is not reasonable to request a full budget amount for this pilot at this time given the scale of the projected budget and the need to progress through early phases of the pilot to more confidently project a pathway to cost effectiveness[73]. However, as HB 2062 goes into effect July 2023, it is important that PGE have an offering in place to support customers with grid-enabled water heaters. Absent this activity, there will be a significant number of stranded water heaters, which would represent a lost opportunity as we develop our Flexible Load portfolio to deliver on decarbonization goals.

With the above factors in mind, PGE proposes a staged approach to funding, and only requests budget for Q4 2022 and all of 2023 ($466,893) as of this filing. PGE will request budget for the 2024-25 period with the next MYP filing in August of 2023. This approach affords PGE the opportunity to refine cost estimates based on early pilot learnings, explore additional cost effectiveness measures (discussed below), and reflect the benefits of the market transformation that is underway in the connected-water heating market, which may have a material impact on costs of the pilot.

Table 15 demonstrates PGE's proposed stage-gate approach to budget request, for clarity:

- Budget requested for the current cycle in coral (Q4 2022, 2023)
- Current estimated pilot budget for future years (2024-26) in gray.
- Total percentage of budget constituted by incentives and overall capacity by timeframe is shown below the budget totals.

This juxtaposition demonstrates, at a high level, the Flexible Load that PGE gains for resources used.

[73] See Section 2.1.14, below, for details on cost effectiveness of the SWH pilot.

Table 15 – Smart Water Heating Pilot Budget

Category	Q4 2022	2023	2024	2025	2026	Total
Contract Labor[74]	-	$119,046 [75]	$214,242	$245,133	$250,300	$828,721
DRMS Provider	-	$2,000	$48,000	$17,000	$20,500	$87,500
Evaluation	-	-	-	-	$106,400	$106,400
Recruitment & Customer Outreach	$1,500	$22,997	$86,228	$50,000	$50,000	$210,725
Contracted Services (including warehousing, remediation)	-	$22,848	$10,348	$10,348	$2,500	$46,044
Materials (including UCM hardware and services, marketing)	-	$104,738	$345,593	$640,168	$713,382	$1,803,881
Incentives	-	$193,764	$625,712	$1,127,948	$1,481,249	$3,428,673
Total	**$1,500**	**$465,393**	**$1,330,122**	**$2,090,597**	**$2,624,331**	**$6,511,944**
Incentives as a % of Total Budget	0%	43%	47%	54%	56%	53%
Est. Annualized Average Capacity per Event		0.06 MW	0.33 MW	0.89 MW	1.68 MW	N/A
Est. Annualized Average Demand Reduction per Event - Winter		0.07 MW	0.35 MW	0.92 MW	1.74 MW	N/A
Est. Annualized Average Demand Reduction per Event - Summer		0.06 MW	0.32 MW	0.86 MW	1.62 MW	N/A

2.1.14 Cost-Effectiveness

With the information currently available, the SWH pilot projects a Total Resource Cost (TRC) score below one (1.0) for both the TRC 1 and TRC 2 tests[76, 77]. No single factor reduces the TRC scores below one (1.0); rather, it is a combination of cost-layering from budget estimates, projections of Flexible Load acquisition and performance, and also a reflection of existing cost effectiveness methodology. Although the cost of capacity was updated to reflect a non-emitting resource shown in Table 11, the team

[74] In this context, the term "Contractor Labor" refers to PGE team members who are contracted, rather than full-time employees (FTE). This labor is not contemplated in the 2022 GRC UE 394. Once the pilot becomes cost-effective PGE will shift to programmatic support that could include PGE FTEs if appropriate.
[75] 2023 contract labor estimates is for the last six months of 2023.
[76] Cost effective score is based upon a total analysis period of 15 years (5 years for the pilot and the 10-year useful life of participating water heaters).
[77] The TRC 1 test includes the value of service lost, and the TRC 2 test does not include the value of service lost. This aligns with previous requests from Commission Staff.

did not include any other updates to the cost effectiveness methodology or benefits from aggressive cost management in the scores shown in Table 16, below (budget was detailed in Table 15, above).

Table 16 – Smart Water Heating Cost Effectiveness Scores

Results Summary	Key Assumptions	TRC 1	TRC 2 (excludes Value of Service Lost)
Base Case		0.31	0.37
Low Case	Load Impact: -20% Admin Costs: +20%	0.22	0.25
High Case	Load Impact: +20% Admin Costs: -20%	0.45	0.54

PGE strives to deliver cost-effective programs and recognizes that we must manage SWH to cost-effectiveness before it can be transitioned into a program. With this in mind, PGE has identified 20 variables that can be managed to improve the cost effectiveness of the pilot. Details of the 20 individual variables under consideration to improve cost effectiveness can be found in Section 5.2.6 in Table 35 and Table 36, along with a sensitivity score in Table 33. These 20 variables are the levers we will focus our efforts on to improve the cost effectiveness score.

In addition to the sensitivity analysis in Section 5.2.6, PGE has created two scenarios to show how Smart Water Heating could achieve a cost effectiveness score of greater than one (1.0). Both scenarios rely on a more mature UCM and grid-enabled water heating market in terms of cost, scale, and process, more sophisticated PGE customer program and power operations, and better maximization of water heating Flexible Load, with both load-shifting and ancillary services events. In short, we conclude that market transformation is needed, as initially put forth in the Schedule 3 CTA-2045 Demonstration Report[78].

These scenarios differ from the sensitivity analysis in Section 5.2.6 in that they include changes to variables categorized as 'possibilities' in Table 36, in addition to those categorized as 'opportunities' in Table 35, while the sensitivity analysis includes only those listed as 'opportunities'. Both scenarios cover 2022-31, assuming the pilot transitions to program in 2026. In Scenario 1.0, Smart Water Heating achieves cost effectiveness with a TRC 1 score of 1.17 for the full period, with downward pressure on rates beginning in 2029. In Scenario 2.0, Smart Water Heating achieves cost

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[78] PGE. *Schedule 3 Residential Demand Response Water Heater Pilot; Second Revision of Sheet No. 3-1; Issued August 16, 2018*. Retrieved from: https://assets.ctfassets.net/416ywc1laqmd/6rUSjxANzOOyqHkj8MClhY/8f8b4f13068a2b238e9ab320240c553d/Sched_003.pdf.

effectiveness with a TRC 1 score of 1.07 for the full period, with negative pressure on rates beginning in 2030.

The following tables provide supporting details for these scenarios:

- Table 17 provides detail on the scores and participation information of each scenario.
- Table 18 provides scenario budgets.
- Table 19 provides the key variables that change and the assumptions underpinning those changes.

In both scenarios, we assume that the market for grid-enabled water heaters has transformed to the point where UCMs and incentives do not need to be delivered "downstream" (i.e., directly to the customer), but are rather already installed on the water heater "upstream" (i.e., at the time of manufacture). It is possible that UCMs will be installed at "midstream" (i.e., by distributors and/or retailers), but the "upstream" model is the most efficient way to ensure every single-family water heater has a UCM on it.

This model also assumes that there is a way to identify which UCMs are in PGE's service territory and where they are relative to key grid infrastructure (e.g., feeder), which would allow PGE to maximize the flexibility of water heating load where it is most needed. While HR 7962[79], when passed, will begin the process of creating a national water heating DR standard (which will use AHRI Standard No. 1430[80] and thus Ecoport as the basis for the rule making) these conditions are by no means present today. It will take collaboration and intervention to grow the grid-enabled water heating market to a scale at which "upstream" UCM installation is practical and volumetric pricing for associated data plans can reduce those ongoing costs.

These two scenarios also assume PGE begins offering a DIY pathway to participate in Smart Water Heating. DIY water heater installations represent 50% of installations in the single-family sector, and as such, are critical to increasing the number of water heaters connected to the grid. An "upstream" or "midstream" UCM installation model will help increase the number of water heaters PGE can connect to, but the logistics of knowing which water heater is where in either an "upstream" or "midstream" model are complex, and it will take time to arrange an efficient process. Introducing a DIY pathway also allows the pilot to reduce installer incentive costs, based on the assumption that less time and effort is needed to ensure grid-connection.

Scenario 1 assumes all water heaters are shipped with UCMs installed and that there is a method for obtaining locational information of those UCMs.

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[79] 117th Congress. (2022). *House Resolution 5376, passed August 7, 2022*. Retrieved from: https://www.congress.gov/bill/117th-congress/house-bill/5376.

[80] OpenADR Alliance. *EcoPort Supplemental Information, Relationship to AHRI 1430; 2022.* Retrieved from: https://www.openadr.org/ecoport-supplemental.

Scenario 2 assumes that only some water heaters are shipped pre-installed. In Scenario 2, PGE would therefore need to develop a DIY offering to supply the UCM directly to the customer, including a method that reliably obtains the locational information and results in a connected water heater (i.e., the customer provides key information and completes the installation upon receiving the UCM).

In either scenario, the tolerance for HPWH market share increases as well. The base case for cost effectiveness holds the ratio of ERWH to HPWH as 80/20 and can tolerate a 5% increase to HPWH market share with a 1% decline to the TRC 2 and no impact to the TRC 1. In Scenario 1, we can increase the ratio of ERWH to HPWH to 50/50, bringing the score down from 1.17 to 1.0 on the TRC 1 (Scenario 1.1). In Scenario 2, the ratio can be increased to 60/40, which decreases the score from 1.07 to 1.0 (Scenario 2.1). While increasing the ratio decreases the overall score in both cases, both still achieve cost effectiveness and deliver greater flexibility to support more growth in the HPWH market.

Bringing either of these scenarios to bear will be difficult and not without risk. It will take time and intervention for these learnings and assumptions to bear out, and there will undoubtedly be other changes in the program and marketplace during that time. PGE anticipates that by 2026 we will have the data and experience needed to confirm if and how Smart Water Heating will score a one (1.0) or greater on cost effectiveness, with at several stage-gates, including annual deferral renewals and reports, as well as the 2023 and 2025 MYP filings, to mark progress to this point. We are prepared to meet this challenge and will use the DRAG and FLASH in addition to the stage gates, to provide updates as to our progress and recommendations on how the pilot proceeds. We believe these stage-gates and ongoing stakeholder engagements appropriately manage financial risk and provide a prudent path forward for PGE to develop the Smart Water Heating resource.

Table 17 – Smart Water Heating Cost Effectiveness Scenario Scores and Est. Capacity Impacts for 2022 - 2031

Scenario[81]	TRC 1	TRC 2	ERWH / HPWH Ratio	Est. 2031 Annualized Avg. MW per Event	Est. No. of Participants
1.0	1.17	1.74	80/20	8.73	48,215
1.1	1.0	1.57	50/50	7.27	48,215
2.0	1.07	1.45	80/20	9.01	47,215
2.1	1.0	1.03	60/40	8.01	47,215

[81] Cost effective score is based upon a total analysis period of 18 years (10 years for the pilot and program and the 10-year useful life of participating water heaters).

Table 18 – Smart Water Heating Est. Budget for Cost Effectiveness Scenario Scores for 2022 – 2031

Scenario	2022-26 Budget	% change from Base Case	2027-31 Budget	2022-31 Budget	Incentives as % of Budget
1.0	$5,815,000	- 10.7%	$14,070,000	$19,886,000	78%
1.1	$6,684,000	+ 2.6%	$16,639,570	$23,053,359	81%
2.0	$5,380,000	- 17.4%	$14,647,000	$20,027,000	67%
2.1	$5,380,000	- 17.4%	$14,647,000	$20,027,000	67%

Table 19 – Smart Water Heating Cost Effectiveness Scenario Variable Assumptions

Variable No.[82]	Category	Variable	Scenario 1 Assumptions	Scenario 2 Assumptions
2	Value stream	Transmission and distribution deferral	The value of transmission and distribution deferral is included in the cost effectiveness model.	
3	Value-stream	Load-shifting events	No. of events is maximized at 706 per year.	
4	Value stream	Load-shifting events	Event calling operations have become more sophisticated and optimized, increasing the realization rate of load-shifting events.	
7	Connectivity	Connectivity	Reductions in the cost of LTE data plans to support UCM connectivity by 24% beginning in 2024, and by an additional 65% in 2026 as a result of negotiation, market maturation, and volumetric price breaks.	
18	Value stream	Load-following events	Load-following events for water heaters are quantified in the Testbed and operationalized by SWH as mutually inclusive with load-shifting, implemented with same frequency.	
20	Cost control	Installer incentives	Reduce installer incentives from $50 to $25 when water heaters begin shipping with UCMs already installed, as connecting to the grid will be easier as a result.	

[82] The variable numbering is established in Table 35 and Table 36 in Section 5.2.6.1

Variable No.[82]	Category	Variable	Scenario 1 Assumptions	Scenario 2 Assumptions
5	Cost control	Connectivity	Increases in connectivity, assuming that when water heaters are shipped with UCMs installed, PGE only receives information for those that are connected which reduces the potential for stranded assets.	Increases in connectivity, assuming that the assumptions in Scenario 1 hold for any water heaters shipped with UCMs and that PGE develops a process with installers to quickly, reliably identify if a UCM will connect and remain connected to the LTE network upon installation.
8	Cost control	UCM hardware	UCM hardware costs come down by 44% by 2025, and in 2026 no longer need to be purchased as water heaters are sold with UCM already installed.	UCM hardware costs come down by 44% by 2025, and additional 40% in 2026 as a result of economies of scale and market maturation.
10	Cost control	Staffing	Reductions in staffing as a result of extensive automation, scalable, efficient processes and water heaters being sold with UCMs already installed.	Slightly less reductions in staffing relative to Scenario 1, as not all water heaters will be sold with a UCM as assumed in Scenario 1, so staff will need to facilitate getting UCMs to some customers.
16	Cost control	Fleet size	All electric water heaters are shipped with UCMs already installed by 2026, allowing for a DIY pathway that adds 2,000 units a year	Some electric water heaters are installed with UCMs already installed beginning in 2026, but not all. DIY pathway adds

Variable No.[82]	Category	Variable	Scenario 1 Assumptions	Scenario 2 Assumptions
			beginning that same year.	1,000 units a year beginning in 2026, and 2,000 a year in 2027.
19	Cost control	Tools and services	N/A	Reductions in costs originating from digital tools, licenses, etc. by pushing for achieving efficiencies in operations across the Flexible Load portfolio.
19	Cost control	Tools and services	Reductions in third-party warehousing by taking this responsibility in-house in 2026, and minimal need for warehousing as water heaters now being shipped with UCMs already installed.	Relative increases in the cost of warehousing and shipping to support an increase in DIY installations, as not all water heaters are shipped with UCMs installed.

2.1.15 Reporting

PGE plans to provide regular updates on the progress of the SWH pilot at the quarterly DRAG and FLASH meetings. Annual performance will also be reported in the annual report.

2.1.16 Evaluation Strategy

PGE will implement two evaluation strategies:

The first of these strategies are **impact and process evaluations** by a third party after minimum participant thresholds for statistically significant results are established by PGE's internal evaluation subject matter experts and have been achieved for each water heater technology over a full year of Flexible Load events, including both summer and winter seasons [83] as follows:

- ERWH: minimum 1,500 units participating in events
- HPWH: minimum 1,000 units participating in events

The impact analysis will leverage a comparison group strategy to create a baseline using non-participants against whom to measure participant kW impacts. The process evaluation typically includes materials and process review as well as interview components. PGE forecasts that SWH will meet threshold for impact evaluation for ERWH by the end of 2024 and for HPWH by Q1 2026.

While the timing of the latter presents an obstacle to filing an evaluation prior to August 2026 (and subsequent filing for transition from pilot-to-program in 2027), there is an alternative methodology to obtain statistically significant results for HPWHs if there are fewer than 1,000 units installed by June 1, 2025.

PGE may pursue a third-party evaluation sooner if thresholds are met prior to current forecasts.

The second evaluation strategy is **on-going internal monitoring**, by which the team will measure progress against KPIs on a monthly basis. These insights will inform decisions regarding design iterations.

[83] These minimums must be achieved by June 1, 2025 to obtain sufficient data for both a summer and winter season prior to the pilot's targeted transition to program by the end of 2026. Currently scaling estimates project approximately 4,300 participants by that time, of which 20% or approximately 860 would be HPWH. Applying a 74% realization rate, that leaves approximately 640 HPWHs, which is below the minimum required for evaluation. The team is aware of this gap and confident we can close it by June 1, 2025.

Chapter 3 Existing Portfolio

This chapter of this Multi-Year Plan Update addresses current approved Flexible Load initiatives at various stages of lifecycle and scale. As this is a mid-cycle filing, PGE is not formally reporting on budget actuals and cost effectiveness at this time, rather providing a progress update to the Commission and stakeholders. Formal reporting will be done at the end of the year as required by our current Demand Response and Testbed tariff schedules.

3.1 Demonstration Activity

3.1.1 Smart Grid Testbed Phase II Update

Total Costs (2022-2023)
$2,264,635

The Testbed Phase II Proposal outlines six discrete areas of research: Flexible Feeder, Single Family New Construction, Commercial & Industrial Resiliency, Solar Smart Inverters, Multi-family, and Vehicle-to-Everything. The proposal also included three specific plans outlining the scope, budget and strategy for achieving research objectives related to the Flexible Feeder, Telematics-based Charge Management, and Solar Smart Inverters projects. Since the October 2021 approval by the OPUC, PGE has been actively implementing each of the three plans outlined in the Phase II Proposal[84]. In addition, the Testbed team intends to submit two additional project plans to the Commission for review by the end of calendar year 2022.

As of May 2022, the Telematic-based Managed Charging project is nearing the end of the initiation phase, with a study area and incentive design finalized and approved by the Demand Response Review Committee (DRRC) and scoping underway with the charge management software vendor. Customer recruitment for this effort is expected to begin in Q4 of 2022.

The Solar Smart Inverter project is also well underway. The project team has thus far completed its review of existing solar project data, down-selected smart inverter capabilities included in the demonstration, completed initial discussions with smart inverter OEMs, and begun the process of selecting feeders that will host the research. Customer recruitment for the Smart Inverter demonstration is expected to begin in Q4 of 2022.

The Flexible Feeder project is tied to PGE's Department of Energy Connected Communities award, SmartGrid Advanced Load Management and Optimized

[84] OPUC. *UM 1976 PGE Deferral Of Expenses Associated With Demand Response Testbed Pilot.* Retrieved from: https://apps.puc.state.or.us/edockets/docket.asp?DocketID=21662

Neighborhood project (known as SALMON). The federal contracting process for this project is complete, with funding released to PGE on July 15th. A formal kickoff meeting with DOE staff was held on July 26th. PGE has hired a Sr. Project Manager to support the project and implementation of tasks is underway.

3.2 Pilot-to-Program Activity

PGE does not request the migration of any pilots to programs with this filing.

3.3 Maturing Pilots and Program Activity

Introduction

In this latest filing for the Multi-Year Plan, PGE is providing updates on mature Demand Response pilots: Energy Partner Schedule 26, PTR, and Residential Smart Thermostat. There are also two additional pilots currently undergoing design evolution to improve performance and assess future potential: Multi-family Water Heater and Schedule 25 Commercial and Industrial (C&I) Thermostats.

Overall, PGE is also evolving its approach to manage the portfolio in two very impactful ways: establishment of a Customer Program Operations team and increasing our coordination with PGE's Power Operations team. In 2021, PGE fielded a small operations team, including a manager, program coordinators, and a data analyst, with three objectives:

- Right size the level of work being accomplished with the appropriate skill level and experience.
- Identify operational efficiencies by streamlining process across offers.
- Create better operational resiliency through rigorous process documentation and formal cross-training.

Since inception, we have established a Program Implementation Manual (PIM) for every pilot. PIMs enable coverage for paid time off, unexpected absences, and staff transitions. PIMs are cross-tested and updated annually and form the base level documentation for any new product development. PIMs have also refined and standardized the processes for budget management, vendor management, and metrics tracking. The efficiencies of this model are already returning benefits as Product Specialists have been able to take on more responsibility for managing the program strategy and execution while the Program Operations team focuses on the day-to-day tasks and specialization needed to support our customers.

Our deepened coordination with Power Operations has also yielded some excellent advancements in how we continue to leverage Flexible Loads as a resource. We have accumulated evaluation and performance data into a database that is providing greater accuracy in hour-by-hour forecasts for events given specific temperature ranges. Our coordination with Power Operations has also established portfolio level event calling scenarios, balancing PGE's power needs with the customer experience, the latter being key to maintaining the availability and reliability of this customer-sited resource. Further, this work supports the efforts and benefits previously mentioned above regarding CAISO integration.

In the following sections, PGE provides an overview of maturing pilots and program activity, highlighting any updates from the November 2021 MYP filing. In the following section, we provide a high-level overview of the adjustments to the MFWH and

Schedule 25 pilots, both undergoing design transition. PGE will provide a comprehensive report on maturing pilots and programs at the end of the year.

The following table provides an overview of maturing pilots and program activity, discussed in detail thereunder.

Table 20 – Roadmap of Flexible Load Activities for Maturing Pilots and Programs

Activity	2022	2023		2024	
	H2	H1	H2	H1	H2
Maturing Pilots and Program Activity					
Energy Partner (Schedule 26)	Expanded offerings	Integration and alignment of Energy Partner with additional energy service offerings to C&I customers Continued growth		Aggregate Energy Partner assets into VPP Full integration of Energy Partner DR into Power Operations resource portfolio	
PTR	Evaluation Report	Seasonal participation	Evaluation Report	Seasonal participation	Evaluation Report
TOD	Implement customer focused tools and build awareness and educate utilizing customer outreach plan	Increased enrollment growth	Increased enrollment growth Behavioral Analysis tool	Increased enrollment growth	Increased enrollment growth
Smart Thermostat	Execute channel recommendation Evaluation Report	Introduce post-event communications	Evaluation Report	File for pilot-to-program consideration or additional extension Begin channel transition	Evaluation Report

Table 21 – Demand Response Portfolio Forecasted MW Capacity

Activity	Season	2022	2023	2024
Energy Partner (Schedule 26)[85]	Summer	36.0	39.5	42.0
	Winter	31.3	33.8	35.3
PTR	Summer	18.5	19.9	20.9
	Winter	15.3	16.5	17.3
Smart Thermostat	Summer	33.1	36.5	39.9
	Winter	10.9	11.6	12.4
Subtotal for Maturing Pilots and Program Activity*	Summer	87.6	95.9	102.8
	Winter	57.5	61.9	65.0
Energy Partner (Schedule 25)	Summer	1.5	2.2	4.3
	Winter	1.4	1.8	3.5
Multi-family Water Heater	Summer	6.2	6.2	6.4
	Winter	9.3	9.3	9.6
Subtotal for Pilots in Design Transition	Summer	7.7	8.4	10.7
	Winter	10.7	11.1	13.1
Grand Total of Demand Response Portfolio*	**Summer**	**95.3**	**104.3**	**113.5**
	Winter	**68.2**	**73.0**	**78.1**

**Does not include TOD Combined Summer and Winter Forecasted MW Capacity of 2.6 MW (2023) and 5.7 MW (2024).*

[85] Includes 0.5 MW (2023) & 1.1 MW (2024) forecasted MW Capacity for Energy Partner (Schedule 26) Smart Battery Capacity.

3.3.1 Energy Partner (Schedule 26)

Season	Megawatts Procured by 2023	Total Costs (2022-2023)
Summer	39.5 MW	$ 7,408,092
Winter	33.8 MW	

3.3.1.1 Executive Summary

Energy Partner Schedule 26 is focused on large customers via custom load curtailment plans with monthly incentive payments during Winter and Summer seasons, and event-based incentives for shifting their energy consumption during seasonal Peak Time Events. Energy Partner Schedule 26 provides firm capacity and will evolve to provide intra-hour grid services to support resiliency and renewables integration now that the Tariff update to Schedule 26 was approved by Commission earlier this year.

Delivering impactful business DR programs and the associated Flexible Load is key to meeting PGE's decarbonization goals set in Oregon HB 2021. Energy Partner continues to gain importance in PGE's portfolio via insights on driving adoption, optimizing the DR software platform, and adding new value streams over time, evolving from a solely capacity resource to other use cases such as load following and renewable firming.

The load curtailment portion of Energy Partner Schedule 26 has transitioned from a pilot to program status. The program structure stayed largely the same, while also enabling customers with more sophisticated equipment to provide and be compensated for additional grid services beyond shedding load.

3.3.1.2 Key Customer Needs Addressed, Engagement, and Diversity, Equity, and Inclusion

Energy Partner Schedule 26 is a custom, flexible program designed to provide customers with meaningful financial incentives without significant impact to their operations. The program was originally launched as a pilot in 2015, but faced multiple challenges with customer recruitment and engagement, as well event dispatch. PGE's non-residential DR pilot was relaunched in December of 2017 and is directly administered by PGE with support from our third-party vendor for implementation and third-party DRMS for technology integration via their software platform. Overall, PGE took a more direct and active approach with customers and vendor partners to enable great success and scale than the original pilot design. For example, PGE administration of Schedule 26 also allows for more flexibility in the marketing of the program with other offerings such that it can be bundled with other valuable programs such as EE, renewables, storage, and dispatchable standby generation.

In its current form, Schedule 26 customers can elect to participate in up to 20, 40, or 80 hours of events per season and customize their participation schedule by selecting one or more event windows such as 7-11 am (winter), and 11 am to 4 pm, 4-8 pm, 8-10 pm (summer and winter). Customer compensation opportunities are also more favorable relative to the previous pilot: the same selections as the prior pilot now earn 22% more, and the maximum hour / maximum window option pays 76% more.

The program is operated with sales and engineering staff (provided by our third-party implementer) who work on site with customers to identify opportunities for curtailment, enable manual and auto DR and support ongoing customer needs. Unlike residential DR efforts leveraging a "mass market" approach, business customers require individualized, ongoing focus to ensure their operations are not disrupted by DR events (e.g., nominations may require adjustments, questions may arise as to how to optimize participation during events).

As PGE engages with commercial customers in the design phases of new projects, we expect additional benefits to Energy Partner as project enhancements for Flexible Load enablement are generally more cost effective to implement during construction than as retrofits.

3.3.1.3 Technology Principles

We are currently working with our Power Operations and Balancing Authority teams to incorporate Schedule 26 into Power Operations' dispatch practices, such that Schedule 26 is treated as a resource within the resource portfolio, dispatched based on its operating profile.

Schedule 26 dispatch has transitioned to Power Operations, and dispatch is based on criteria set by Power Operations for grid stability and economic efficiency. The full integration of Energy Partner into Power Operations will require process changes to Power Operations, the program operations group, and the Energy Partner program. Clear and consistent communication to the participants about potential impacts to their operations and managing customer expectations will be integral to the evolution of the product.

Using Schedule 26 as the driver, PGE's Program Operations and IT teams have been working cross-functionally with the Power Operations Team and the Balancing Authority team to develop an integrated approach to Flexible Load dispatch. This will guide the Teams' work as we seek to include additional Flexible Load programs in the resource portfolio, dispatchable to meet economic and operational needs as part of PGE's longer term VPP capability.

3.3.1.4 Coordination

PGE is currently coordinating with the Energy Trust to increase cost effective recruitment and participation in Schedule 26. PGE is coordinating with program delivery staff of the Energy Trust's Strategic Energy Management (SEM) program to market Schedule 26 to existing SEM participants by presenting a program overview and participant case studies during SEM workshop events.

PGE coordinates closely with its implementation vendor to perform program outreach, identify program leads, and offer technical assistance to customers.

3.3.1.5 Market

Market potential is based on estimates from the 2021 "PGE DER and Flexible Load Potential – Phase 1" report prepared by Cadeo. The 2027 economically achievable Energy Partner load is 36 MW; in winter, economically achievable Energy Response DR load is 32 MW. The 2023 target for Schedule 26 is 40.0 MW (Summer) and 34.5 MW (Winter).[86] The target exceeds the Cadeo forecast due to new customer opportunities that have emerged since the report was published.

Figure 3 – Energy Partner (Schedule 26) Market Penetration

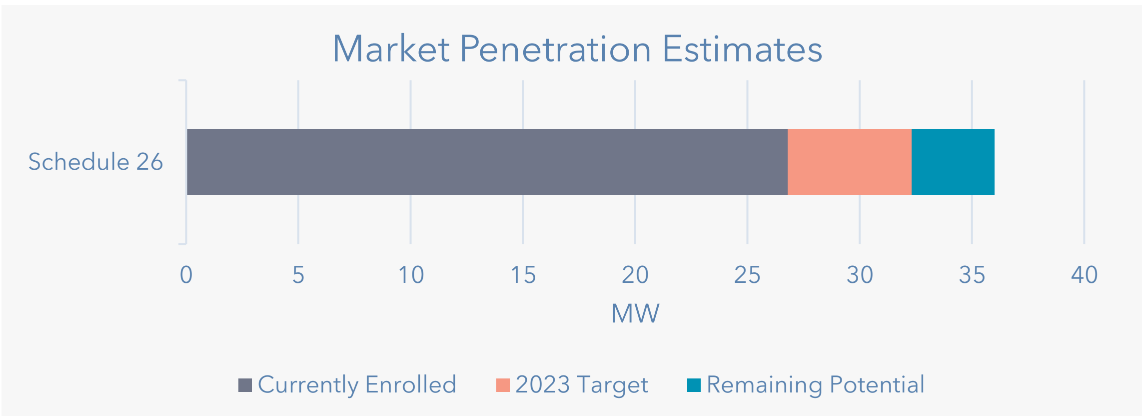

Table – Energy Partner (Schedule 26) Forecasted MW Capacity

Forecast	2022	2023	2024
Summer MW Capacity	36.0	39.5	42.0
Winter MW Capacity	31.3	33.8	35.3

3.3.1.6 *Key Activities, Outcomes, & Measures of Success:*

The Schedule 26 non-residential DR program transitioned from a pilot when the original Flexible Load Multi-Year Plan was approved in 2021. Upcoming program enhancements are expected to bolster several program design elements that accelerate the program's ability to refine and optimize its delivery activities. Specifically, PGE plans for the program's activities to include enhanced incentives, targeted marketing, and dedicated sales and outreach to unmanaged PGE customers. We expect these efforts will be incremental to the program's "business as usual"

[86] Ibid.

operations, meaning that they leverage existing program activities. Furthermore, we expect these incremental efforts to be invaluable in defining optimal program delivery strategies and tactics, identifying customer segment-specific ceilings for program participation, and facilitating acceleration of significant load reduction capacity within the DR portfolio.

Examples of potential incremental program activities evaluated include:

- Incentives: Offering enhanced incentives at a to-be-determined level; and if possible, testing multiple enhanced incentive levels is desirable due to ability to determine "incentive elasticity"
- Marketing: Partnering with Energy Trust SEM staff to message co-benefits of Energy Partner and SEM program participation
- Outreach: Dedicated sales/outreach staff to unmanaged PGE customers
- Product design: Bundling of offerings such as business DR EV charging and Energy Trust's SEM
- New tariff designs that allow the customer to provide differentiated energy services (e.g., contingency reserves, frequency response) throughout the year for a greater number of total hours of the year; or tiered incentive levels tailored to the DR approach (e.g., manual, automated, or advanced).

3.3.1.7 *Timeline of Upcoming Activity*

2022 H2	2023	2024
Expanded offerings	Integration and alignment of Energy Partner with additional energy service offerings to C&I customers Continued growth	Aggregate Energy Partner assets into VPP Full integration of Energy Partner DR into Power Operations resource portfolio

3.3.2 Peak Time Rebates

Season	Megawatts Procured by 2023	Total Costs (2022-2023)
Summer	19.9 MW	$5,448,000
Winter	16.5 MW	

3.3.2.1 Executive Summary

The Peak Time Rebates activity is a cornerstone of PGE's residential Flexible Load portfolio. The pilot relies on individual customer participation to reduce electrical demand during Peak Time Events by shifting energy consumption to non-peak periods or through conservation. As such, it is a behavioral DR pilot. There is no up-front equipment investment making it the ideal platform by which to introduce our residential customers to the concept and value of DR, educate them about the role they can play in supporting a reliable, greener grid for the community, and reward them financially for their efforts in doing so. PTR serves as the gateway to a deeper engagement with PGE's energy-shifting products and services. It is also our first behavior-based DR resource and is proving to be a reliable, consistent resource that will support PGE's Flexible Load acquisition goals.

3.3.2.2 Key Customer Needs Addressed, Engagement, and Diversity, Equity, and Inclusion

Residential customers want to save money on their monthly bill, decarbonize, and provide benefit to the community by helping maintain grid reliability. Many also want to support use of more renewables in their energy mix. PTR provides an equitable way to engage our residential customers in support of those goals as there are no economic barriers to participation.

The PTR pilot provides educational energy saving tips and rewards customers for shifting their energy use during three- to four-hour event periods when energy costs are higher and renewable energy sources are less plentiful. Customers are notified a day prior to the event via text and/or email, based on their preference, and encouraged to shift usage during the event hours the next day. On the day of the event, they may also receive a same-day reminder. After the event, they are notified of the result of their specific effort and, if applicable, their earned incentive. Customers earn $1.00 for every kWh they shift during an event, and the rebate appears as a credit on their next monthly bill. There is no penalty if a customer uses more energy than expected during an event, making PTR a no-risk, "win-only" offering for our customers.

PGE recognizes that every individual customer is unique, and while a customer may be eligible to participate in PTR, it may not be the best option for all. While PTR will remain open to most residential customers, PGE is tailoring its marketing approach to focus on customers with the highest propensity to save energy by making event-based behavioral changes and those who will be most satisfied via their participation.

Low impact (customer unable to shift energy) and less satisfied customers (who use more energy during events and negatively impact cost effectiveness) will be encouraged to migrate from PTR and adopt other Direct Load Control (DLC) offerings for which they may be better suited and will be more satisfying. DLC programs capture larger DR loads and are automated. For some, this presents fewer hurdles to event participation, a more streamlined customer experience, and delivers energy efficiency benefits. Therefore, focusing on transitioning the right customers to DLC may be key to unlocking the full potential resource capability of DR.

3.3.2.3 Technology Principles

The Peak Time Rebates pilot relies on an independent data science firm, focused on the utility sector, to forecast and calculate customer-level load impact and associated rebate earnings. Their team of data scientists also developed five PTR-specific micro-segments that rank customers by forecasted load impact. While the pilot is open to most residential customers, PGE has focused its marketing outreach on customers with higher expected savings. In addition to the measures implemented to benefit DR value, PGE is also continuing to manage costs. PGE leveraged an internal platform (Salesforce Marketing Cloud) for event communication dispatch and post-event data analytics which substantially reduced operational expenses, starting in FY 2021.

Behavior-based programs may not offer power operators as much control and certainty as they would prefer. Thus, integration into power operation dispatch will present novel challenges. PTR has several structural challenges which need to be addressed prior to contemplating integration into Power Operations, but it is PGE's intention to integrate each of our Flexible Load offerings.

3.3.2.4 Market

The vast majority of PGE's residential customer base is eligible to participate in this voluntary pilot. Three years beyond PTR's introduction in 2019, there are more than 125,000 customers currently enrolled, including almost 16,000 customers who were originally auto-enrolled as part of the Testbed project.

While Peak Time Rebates will remain open to most residential customers, PGE has tailored its marketing approach to focus on customers with the highest propensity to save energy through making event-based behavioral changes. We expect pilot growth to slow in the coming years and will continue to focus recruitment efforts on customers who are best suited for PTR, as we grow our portfolio of other customer-facing DR options.

Table 22 – Flex 2.0 Forecasted Enrollment and MW Capacity

Forecast	2022	2023	2024
Enrollment	134,000	140,000	147,000
Summer MW Capacity	18.5	19.9	20.9
Winter MW Capacity	15.3	16.5	17.3

3.3.2.5 Key Outcomes & Measures of Success

The goals for PTR are as follows:

- Design and deploy a large-scale DR pilot that equitably and cost-effectively contributes a substantial DR amount to our IRP goals
- Offer easy-to-engage-in DR offerings that serve as gateways for adoption of other DLC offerings such as Smart Thermostat

In addition, PGE is working to address several challenges associated with the market release of a large behavioral-based offer:

- Continue to address structural challenges to integrate the pilot into Power Operations
- Assure that changes made to the pilot do not jeopardize cost effectiveness
- Continue to improve customer performance through educational and engagement strategies, and
- Test customer value propositions to garner insights into customer engagement and performance.

3.3.2.6 Timeline of Upcoming Activity

2023 H1	2023 H2	2024 H1	2024 H2
Seasonal participation	Evaluation report	Seasonal participation	Evaluation report

3.3.3 Time of Day

Season	Megawatts Procured by 2023	Total Costs (2022-2023)
Combined Summer and Winter	2.6 MW	$ 1,390,000

3.3.3.1 Executive Summary

Residential customers want more choice, information, and control to help them manage their energy use and costs. The Time of Day pricing plan gives customers more control over their electric bills and offers opportunities to save money by shifting energy use away from the peak hours when power costs more and renewable resources are less plentiful.

Time of Day also helps reduce system peak loads and reduce associated carbon footprint and greenhouse gas emissions. Aligning on-peak hours with capacity constraints encourages customers to shift usage during energy peaks, reduces need for construction of new power plants and supports a reliable grid. TOD is one way our customers can partner with PGE and play an active role in grid management to enable a cleaner, greener energy future for all.

TOD has the following benefits:

- Addresses capacity constraints.
    - PGE's IRP calls for the use of DR programs like TOD to help manage system peak loads and to assist with the integration of renewable energy resources.
    - Our Flex 1.0 Time of Use pilot participants achieved a 6% peak load reduction (summer only), and we expect similar DR value from our TOD participants.
- Supports the adoption of enabling technology.
    - Studies from other utilities have found customers on a time varying rate coupled with enabling technology, such as a programmable thermostat, showed substantially greater peak load reductions than those customers who relied on manual processes.[87]
- Accelerates transportation electrification.
    - For EV users who have at least a Level 1 charger, TOD offers 10 hours of off-peak hours to accommodate overnight charging.
- Attracts and engages residential customers.

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[87] Ahmad Faruqui, Brattle Group, 2008.

- When given a choice, PGE customers preferred time-varying programs like TOD to flat-rate plans like Basic Service.[88]

3.3.3.2 Key Customer Needs Addressed, Engagement, and Diversity, Equity, and Inclusion

Dozens of utilities across the country have implemented time varying rates successfully, and a 2020 Brattle Group study that evaluated various offerings found:

- Customers respond to time varying rates by lowering their usage in the peak periods.
- The load drop is higher in the summer months than in the winter months (this is consistent with our Flex 1.0 findings as mentioned above).
- Low- and moderate-income customers respond by almost as much as other customers.
- Customers who would see lower bills without changing their load shape (structural savers) also respond by lowering peak demand.

Our customers want choice and control in their energy options – and they expect PGE to deliver that value. The TOD pricing plan provides the choice customers want and was designed with simplicity and scalability in mind. It is an equitable pricing plan that appeals to a wide variety of customer segments, multi-family, single family, EV owners, and low-to-moderate income customers. To ensure equity, we analyzed how the rate would impact customers across these various segments, specifically who would save and who would not. As shown in the table below, TOD has the potential to benefit a large population of structural savers across all segments as well as additional customer groups who could save assuming a small shift in usage during peak hours.

Table 23 – Time of Day Impact Across Segments

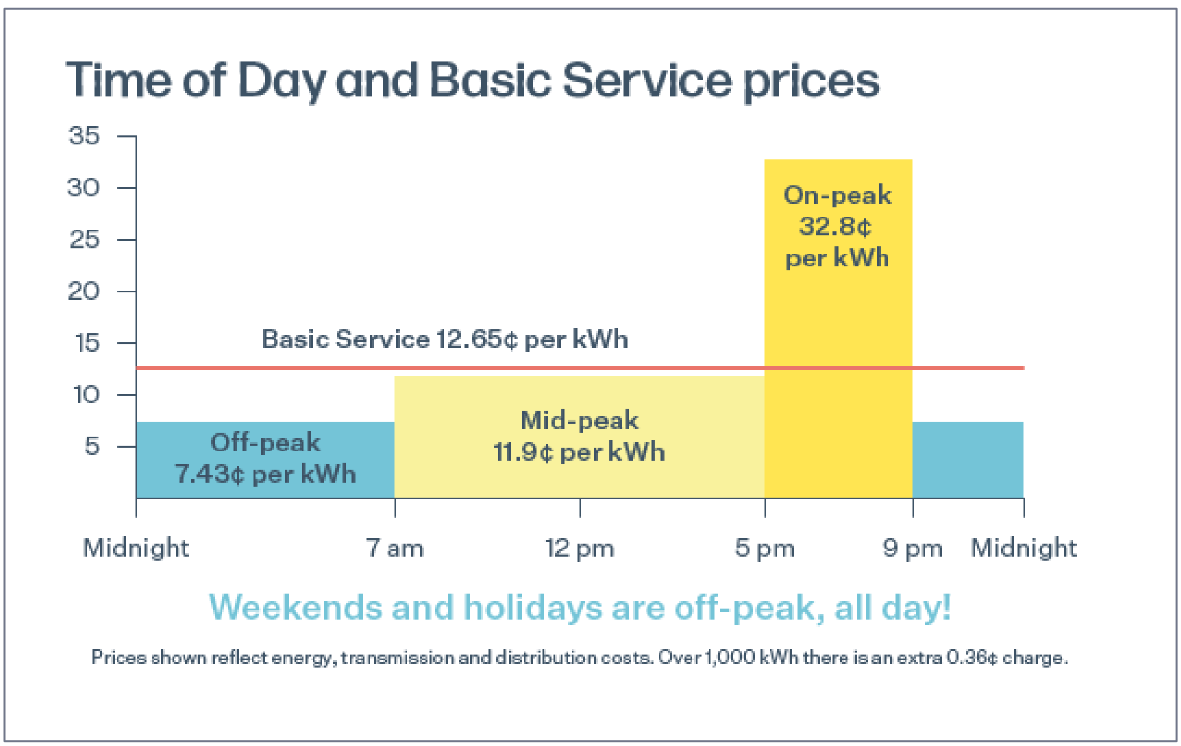
TOD Customer Segment	Pct. Of All Residential Market	Structural Savers	+ 10% Load Shift	Total Post-Shift Savers
All residential	-	45%	10%	56%
Low Income	14%	48%	9%	57%
Non-Low Income	86%	45%	10%	55%
EV Owners	1%	48%	5%	53%
Single Family	63%	42%	11%	53%
Multi-family	32%	50%	8%	58%

[88] PGE. *2015 PGE Pricing Study.*

Additionally, PGE considered industry best practices in designing the rate structure itself with a focus on encouraging behavioral change and associated load impact while delivering a simple and straight-forward tier schedule to support a positive customer experience.

- **Peak/Off-Peak Pricing Ratio:** Off-peak price ratio of 1.5-to-1 is a very mild differential. Ratios of 4-1 or 5-1 are generally high enough to influence customer consumption patterns. The on-peak off-peak ratio of the new Time of Day pricing plan is 4.7-1
- **Peak Period Duration:** Concentrating on-peak prices in a limited set of hours produce more meaningful price differences that better motivate customer response. With TOD, on-peak hours are limited to 5 – 9 p.m. Monday through Friday. Holidays and weekends are all off-peak
- **Peak Period Frequency:** The more peak periods in a rate structure, the more difficult it is to drive behavioral change. While the new TOD pricing plan has three peak periods, only one is more costly than Basic Service. From a customer-facing perspective, this allows us to simplify messaging reinforcing weekday shift from 5 – 9 p.m.
- **Seasonal Differentiation:** Unlike PGE's existing Time of Use offering with two seasons and different pricing and hours for each, the new TOD offering is non-seasonal, designed to shift energy away from 5PM to 9PM through the year. TOD is reported as an annual total rather than a seasonal winter and summer peak shift.

Figure 4 – Time of Day and Basic Service Prices



PGE's TOD was first implemented in the summer of 2021 with significant follow-on focus on technology enablement both of the rate and customer tools. With those pieces in place, the focus has shifted to recruitment. The primary challenge to recruitment lies in making customers aware and educating them about TOD including how it can be beneficial and how they can personally be successful on this rate. TOD is a new concept to many of our customers. Customers are skeptical that time varying rates are designed to benefit the utility not the customer, and that they do require commitment on the part of the customer. To support enrollment, PGE is committed to the ongoing task of building that needed awareness and education for customers.

PGE's initial outreach targeted structural savers who have similar characteristics as our existing Time of Use customers as well as those who participated in the Flex 1.0 pilot and are identified as customers who are most likely to adopt a time-varying rate (high propensity to enroll score). Recruitment materials included personal rate comparison information (12-month comparison of projected spend on TOD vs. actual spend on Basic Service) and highlighted savings opportunities for those structural savers. Post-enrollment support has included a monthly email performance update with personalized savings and usage data as well as savings tips to ensure customers have the information they need to be successful on the plan with full transparency into their potential savings or overspend. An online rate comparison tool is also available for customers on PGE's secure TOD webpage and is accessible to all eligible residential customers.

3.3.3.3 Technology

Customers expect the tools and information they need to make informed choices. Success is highly dependent upon availability of self-service digital customer engagement tools, specifically an online rate comparison and behavior analysis tool that enables customers to assess how small changes in behavior (deferring use of major appliances or lowering heating/cooling) would impact potential savings. Kansas City Power & Light, for example, provided results from their Time of Use pilot (~7,000 customers) and 85% of those customers validated their potential savings/rate comparison information with an online rate comparison tool before going through the enrollment process. Knowing this, PGE set up a TOD community of customers to get direct feedback on time varying rates, customer expectations, and information they would need to make informed decisions. Findings were in line with the other utility studies that showed validation with personalized data was critical to getting customers to enroll.

PGE has designed and implemented a rate comparison tool for customers, currently available on the TOD secure webpage. Early information shows that if customers are directed to the rate comparison through marketing/outreach materials, they utilize it to help inform their enrollment decision. PGE will engage a third party to perform a comprehensive program evaluation including the efficacy of the online rate comparison tool as a means to spur adoption. PGE is currently assessing the best option for delivering a behavioral analysis tool to support continued enrollment and customer experience goals across all programs (not just TOD).

3.3.3.4 Market

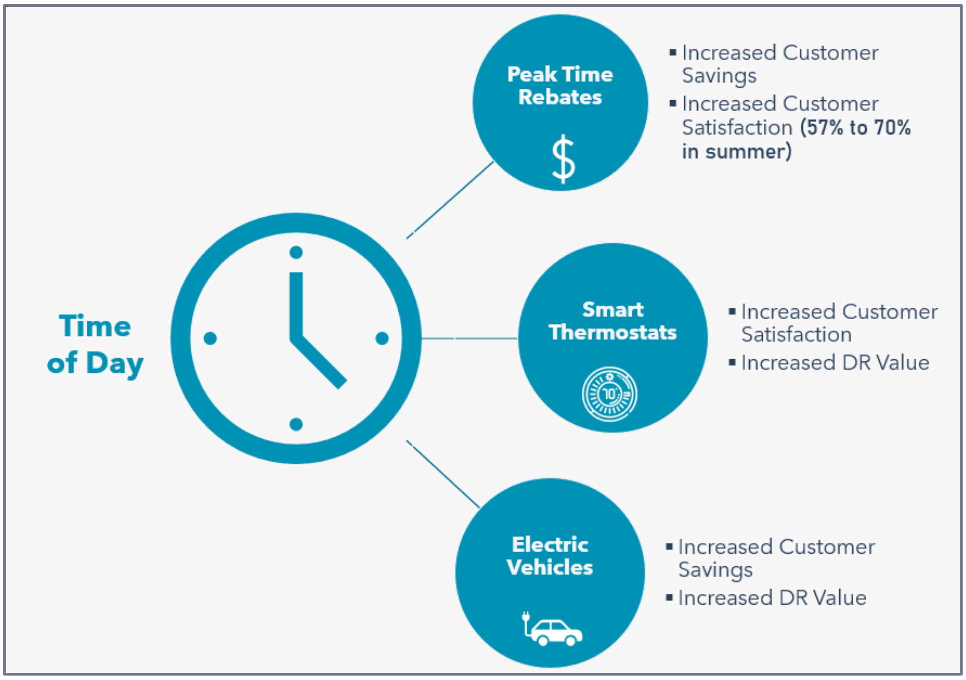
To achieve desired load impact, TOD must benefit a sufficient number of residential customers to encourage adoption. In this instance, customer benefit is measured by the amount a customer *could* save on the new pricing plan vs. the Basic Service.

Our rate modeling analysis forecasts ~46% of our residential customers could save 1% or more of their monthly bill without making any changes to their usage by transitioning from Basic Service to TOD . (These customers are known as structural savers). An additional 10% more could save on TOD by making shifts in usage during peak hours. While the Serviceable Obtainable Market is 355,000 customers (46% of the 772,000 eligible customer residential population), we have focused initial targeted marketing at customers who have the highest savings impact and the greatest likelihood of adopting a time-varying pricing plan.

Enrollment projections assume an adoption rate of 2% in Year 1 which is consistent with similar pricing plan adoption at other utilities and is a conservative estimate based on our own Flex 1.0 pilot adoption. In its recent TOD pilot, Baltimore Gas and Electric achieved a 1.9% adoption rate. (PGE’s Flex 1.0 pilot saw adoption rates ranging as high as 4.5%.) We assume a modest 2% adoption in Year 1 as we educate customers about the value/benefit of a TOD pricing plan, with an uptick in adoption to 3% in Year 2 as customer awareness and receptivity increases. Providing personal rate comparison information coupled with a behavioral analysis tool is expected to accelerate enrollment growth in Year 3 and beyond. Although enrollments are behind schedule at this time due to some delay in outreach activities, the plan is to catch up to the original enrollment targets by the end of 2023 causing minimal impact to the long term MW targets.

Time of Day is a critical component in the company’s overall energy engagement and DR strategy. It is a foundational element that can bind multiple products and services together (Smart Thermostat, EV Charging pilot, and PTR) in a way that delivers a curated experience for a customer. That said, PGE (and the industry) are still learning about the impact of interactions between TOD and other DR programs. We want to ensure the viability of existing products alongside or in combination with TOD while also ensuring that customers have a great experience in their adoption of Time of Day. As TOD adoption scales, PGE is exploring how best to stage or combine offers and will enlist support from a third party evaluator to assess the associated load impacts. PGE will also continue to gather customer feedback, industry best practices, and utilize our outreach channels to deliver a clear customer journey toward this product bundling future.

Figure 5 – How Time of Day Impacts Other PGE Products



Forecasted load impact (summarized below) is based on projections from the DSP. Actual load impact will be assessed as part of our evaluation activities to be completed mid-2023. Near term load impact may suffer as PGE tests the right approaches and combinations of offering and operating TOD alongside other Flexible Load offers as discussed above.

Table 24 – Time of Day Enrollment Targets and MW Capacity

	Actual	Forecast			
Forecast	2021	2022	2023	2024	2025
Enrollment	1,500	7,000	17,000	40,000	53,000
MW Capacity	-	-	2.6	5.7	7.6

3.3.3.5 Key Outcomes & Measures of Success:

- Support PGE's IRP Goals: Help reduce peak load and support decarbonization goals and use of more renewables. Contribute 7.6 MW of capacity value by EOY 2024 to support PGE's residential DR goals
- Deliver an exceptional customer experience that results in high satisfaction and an increase in PGE's Customer Experience Score by 2 points (with introduction of online rate calculation tool)
- Deliver personalized, relevant educational tools and energy savings tips to help customers achieve their maximum savings potential (as defined by TOD micro segments and DR potential ranges),
- Achieve customer satisfaction scores of 80% by EOY3

- Ensure unenrollment remains below 3% annually (exempting those targeted un-enrollments or those who move outside the service territory)
- Create a clear, compelling customer journey that paves the pathway toward adoption of complementary DLC products (specifically Smart Thermostat) for increased DR value
- Build a flexible and extensible program foundation that can enable future Time varying offers.

3.3.3.6 Program Changes

A third party evaluation for the Time of Day rate was originally budgeted for in both 2022 and 2023 to ensure adequate dollars were available to perform a comprehensive report (both process and impact evaluations). PGE was delayed in providing some of the key customer tools necessary for TOD's mass marketing and outreach activities, resulting in lower than planned enrollments. Subsequent to deployment of these tools by June 2022, PGE has moved forward with larger scale outreach and enrollments are increasing as we target planned customer segments and engage all marketing channels. Even with enrollments getting back on track, current enrollments may not reflect the broader TOD target market, as the majority of those enrolled to date are customers who do not have to shift energy away from peak times to save money on their energy bill (underrepresenting other segments such as those on the cusp of saving and those requiring behavior changes to save).

PGE therefore requests that the requirement to provide a comprehensive evaluation report be moved from December 2022 to July of 2023. This would require removal of the $95,000 evaluation budget in 2022 and a commensurate increase in the 2023 evaluation budget to $190,000 (existing 2023 evaluation budget of $95,000 + the $95,000 reallocated from 2022 evaluation budget).

TOD's remaining work in 2022 will solely focus on marketing and outreach, driving enrollment through awareness, education, and personalized marketing. Enrollments have increased with each outreach activity performed. Continuing to inform and educate customers about this new rate is critical over the coming months.

We believe that a full comprehensive evaluation in July 2023, including participant and non-participant surveys and load impact analysis will reflect a more representative population of enrollees and will allow time to obtain the right level of engagement and information about our customers and their behavior.

3.3.3.7 *Timeline of Upcoming Activity*

2023 H1	2023 H2	2024 H1	2024 H2
Increased enrollment growth	Behavior Analysis tool and Increased enrollment growth	Increased enrollment growth	Increased enrollment growth

3.3.4 Smart Thermostat

Season	Megawatts Procured by 2023	Total Costs (2022-2023)
Summer	36.5 MW	$6,009,548
Winter	11.6 MW	

3.3.4.1 Executive Summary

The Direct Load Control Smart Thermostat pilot aims to enroll and operate connected residential thermostats to control electric heating and cooling load, providing PGE with firm capacity. To participate in the program, PGE customers must have a qualifying HVAC system (ducted heat pump, electric forced-air furnace, or central air conditioner).

3.3.4.2 Key Customer Needs Addressed, Engagement, and Diversity, Equity, and Inclusion

By using smart thermostats instead of switches, customers are able to participate in DR programs with minimal disruptions to their comfort compared to traditional switch programs. Smart thermostats are able to pre-condition space prior to DR events and provide a more customer-friendly interface for control of their HVAC system, including the option to opt-out of events. The pilot engages customers throughout the DR season with season start, mid-season encouragement and end of season emails in addition to an enrollment welcome email. The pilot tested pre-event email notifications in summer 2021, and based on positive customer feedback, rolled them out for the entire pilot in summer 2022. All engagement emails remind the customer of the participation rules and what to expect during a DR event. In 2022, the pilot launched a Spanish language program webpage and brochure and will add an explanatory video in Spanish. Customers who do not own a smart thermostat are able to take advantage of incentives and discounts via the PGE Marketplace.

3.3.4.3 Technology Principles

PGE has tested several delivery channels to determine customer acceptance and build the pool of participating customers:

- **Bring Your Own Thermostat –** Customers may enroll online in PGE's DR program by purchasing a new qualifying thermostat via the PGE Marketplace or other retailer, or using an existing qualifying thermostat attached to a qualifying HVAC system. Customers receive up to $25 as an enrollment incentive and $25 for each DR season that they are able participate in (defined as 50% of the DR hours called within a season). Customers are permitted to opt-out of any or all events.

- **Residential Thermostat Direct Installation** (closed to new enrollment as of 6/1/2022) - Customers with a qualifying HVAC-system could participate by having a qualified thermostat, installed, provisioned, and enrolled into PGE's DR platform by a PGE contractor. This channel provided a no cost thermostat for customers with ducted heat pumps or electric forced air furnaces due to the high DR capacity value. Customers with central air conditioners are charged an incremental cost of $50. Customers from this channel are excluded from receiving PGE enrollment or seasonal participation incentives. Due to a low TRC score, dwindling enrollments, and customer confusion between channels, PGE recommended discontinuing the channel as of May 31, 2022, and OPUC approved the tariff update on May 17, 2022.

3.3.4.4 Coordination

Customers can receive energy efficiency incentives for smart thermostats through the Energy Trust. PGE coordinates with the Energy Trust to pass on these incentives to customers through the PGE Marketplace and, until June 2022, the Residential Thermostat Direct Installation channel.

3.3.4.5 Market

This pilot's primary targets are PGE customers with and without existing connected qualifying thermostats that live in single family residences with ducted heat pumps, electric forced air furnaces, or central air conditioners.

Based on the best available information[89], PGE estimates the total number of eligible households is about 322,000 units (total addressable market). This number is increasing due to increasing installations of central air conditioners. The obtainable potential is estimated at 114,500 units, which with our current mix of heating and cooling systems represents approximately 31MW in winter and 92MW in summer. PGE continues to refine these estimations by improving our customer heating and cooling data, analyzing which types of customers are likely to be most successful in the pilot (not override their devices during an event) and implementing efforts that support customer participation.

[89] To determine market size for the pilot, PGE used customer heating and cooling data compiled from a variety of sources including Energy Trust and recent disaggregation work.

Figure 6 – Smart Thermostat Pilot Market Penetration

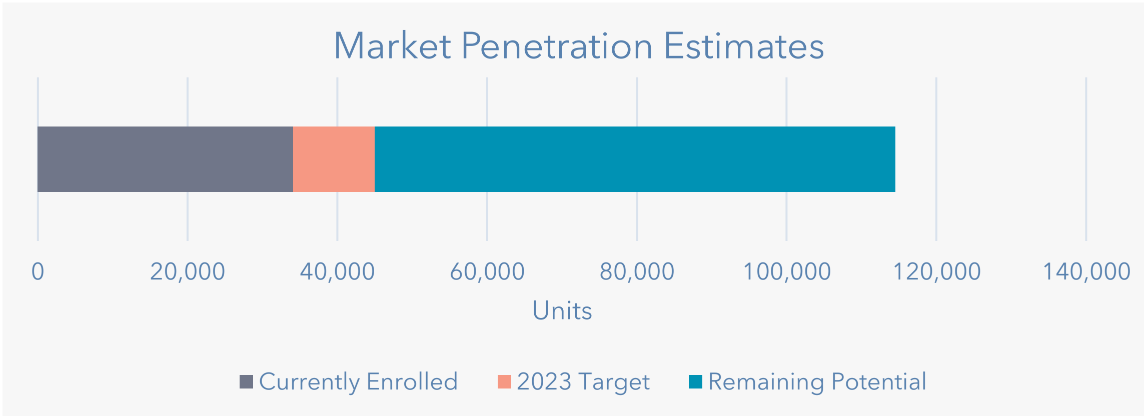


Table 25 – Smart Thermostat Forecasted Enrollment and MW Capacity

Forecast	2022	2023	2024
Cumulative Enrollment	40,897	44,985	49,073
Summer MW Capacity	33.1	36.5	39.9
Winter MW Capacity	10.9	11.6	12.4

3.3.4.6 Key Outcomes & Measures of Success:

- The pilot achieved 34,102 (cumulative) enrolled residential thermostats in 2021 and aims to have a total of 44,985 residential thermostats by 12/31/2023.
- Determine and verify customer acceptance of the above delivery channels.
- Build a minimum of 36.5MW summer cumulative capacity and 11.6MW cumulative winter capacity by 12/31/2023.
- Successfully operationalize and maintain or increase customer satisfaction for both delivery channels.
- Dispatch and control enrolled thermostats and obtain DR capacity at or above planning estimates.
- Minimize customer un-enrollments from the pilot (not event-based overrides) to increase customer retention.
- Minimize event-based overrides to at or below current average rate of 26% in summer and 17% in winter.

3.3.4.7 *Timeline of Upcoming Activity*

2022 H2	2023 H1	2023 H2	2024 H1	2024 H2
Execute channel recommendation Evaluation Report	Introduce post event communications Test dispatch strategies for ancillary services	Evaluation Report	File for pilot to program consideration or additional extension Begin transitioning Direct Install participants to Bring Your Own Thermostat	Evaluation report

3.4 Pilots in Design Transition

The pilots described in this section are undergoing redesign and transition due to lack of cost effectiveness, technology transition, stable performance, and other pilot-to-program considerations.

The following table provides an overview of these activities, discussed in detail thereunder.

Table 26 – Roadmap of Flexible Load Pilots in Design Transition

Activity	2022	2023		2024	
	H2	H1	H2	H1	H2
Pilots in Design Transition					
Energy Partner (Schedule 25)	Updated design implementation Pilot SMB outreach strategy w/Energy Trust	Integration and alignment of Energy Partner with additional energy service offerings to C&I customers Continued growth		Aggregate Energy Partner assets into VPP Full integration of Energy Partner DR into Power Operations resource stack	
Multi-family Water Heater	Complete installations of current pipeline of retrofit devices	Complete final evaluation for pilot from current period Update CTA-2045 rebate incentive due to OR code change	File for pilot-to-program consideration or additional extension	Expand CTA installations	Cease installations of any retrofit switches (only install CTA comms)

3.4.1 Energy Partner Smart Thermostat (Schedule 25)

Season	Megawatts Procured by 2023
Summer	2.2 MW
Winter	1.8 MW

3.4.1.1 Executive Summary

The Schedule 25 Smart Thermostat pilot was launched on December 1, 2017 to complement Schedule 26. The pilot design includes customer recruitment and direct installation of qualified smart thermostats. Schedule 25 created an opportunity for small and medium sized businesses to participate in DR through a turnkey direct load control pilot. The advent of Schedule 25 created additional opportunity for customers who lack adequate process-based load and/or the operational ability to curtail load via Schedule 26.

3.4.1.2 Technology Principles

As Schedule 25 is still a pilot with additional development needs, dispatch of thermostats, while coordinated with Power Operations, is still completed by the Program Operations team.

3.4.1.3 Coordination

PGE is currently in discussions with the Energy Trust to design a coordinated outreach and marketing approach to increase cost effective recruitment and participation in Schedule 25. Schedule 25 can benefit from leveraging Energy Trust's trade ally network and 2022 small to medium sized business (SMB) outreach that will emphasize communities of color. The Diversity, Equity, and Inclusion focus of Energy Trust's SMB initiative adds value to the pilot by performing specific outreach to communities that the pilot has not yet reached in a significant way to date.

PGE coordinates closely with its implementation vendor to perform pilot outreach, identify pilot leads, and offer technical assistance to customers.

3.4.1.4 Market

Market potential is based on estimates from the 2021 "PGE DER and Flexible Load Potential – Phase 1" report prepared by Cadeo. The 2027 economically achievable Energy Partner load is 36MW; in winter, economically achievable Energy Response DR load is 32MW. PGE's recent market potential assessment aligns with Cadeo's findings.

The 2023 target for Schedule 25 is 1.8MW (Summer) and 2.5MW (Winter).

Figure 7 – Energy Partner Pilot Market Penetration

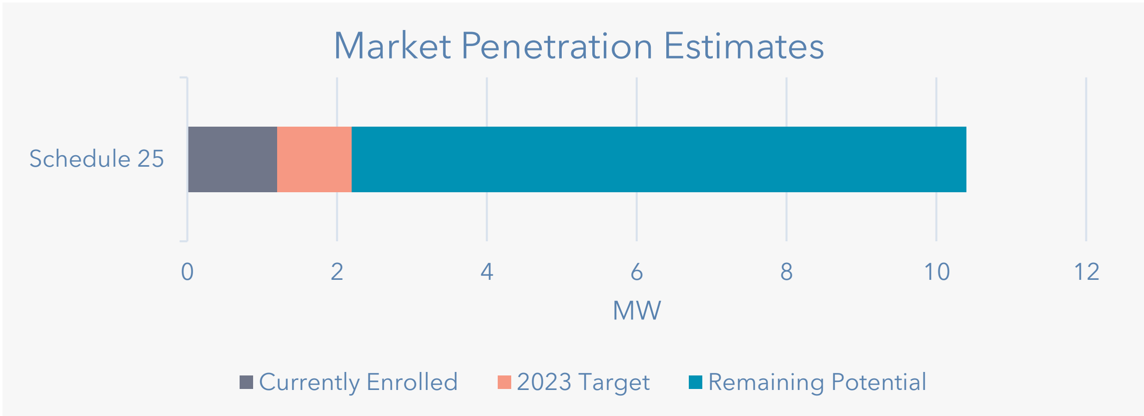


Table 27 – Energy Partner Smart Thermostat (Schedule 25) Forecasted Enrollment and MW Capacity

Forecast	2022	2023	2024
Cumulative Enrollment	2,800	5,400	8,000
Summer MW Capacity	1.5	2.2	4.3
Winter MW Capacity	1.4	1.8	3.5

3.4.1.5 *Key Activities, Outcomes, & Measures of Success:*

Schedule 25 conducted an updated market potential assessment in Winter 2021/2022 to inform the pilot outreach and marketing strategy. The assessment identified business types that are most likely to have qualifying heating and cooling systems and participate in peak time events. The assessment also quantified potential curtailment capacity from each customer. The insights obtained from the assessment will inform the pilot's outreach and marketing strategy going forward, with the expectation that targeting customers with ideal participation characteristics will result in increased DR capacity relative to current participant levels. Additionally, the pilot has undergone a pilot delivery review and redesign to leverage efficiencies via partnerships with Energy Trust and trade allies to reach more potential participants at a lower overall cost. The updated pilot design was launched June 1 following the tariff reauthorization approval by OPUC.

The pilot redesign includes adjustments that are intended to establish a cost effective design that will enable the transition to program:

- Updated basis of seasonal incentive from per thermostat to per site
- Consideration of contractor incentives to participate in trade ally customer recruitment
- Marketing

- A/B testing of the same messaging delivered through different delivery mechanisms
- A/B testing of customer segment-specific messaging
- Outreach/Sales
- Target PGE outreach to small- to medium-sized businesses who have a modeled propensity and capacity to participate
- Partner with HVAC trade allies
- Partner with the Energy Trust on direct outreach to small- to medium-sized businesses owned by communities of color
- Product design
- New pilot delivery models that leverage trade allies and the Energy Trust direct installations
- Customer co-pay introduced per installed thermostat.

3.4.1.6 *Timeline of Upcoming Activity*

2022 H2	2023	2024
Updated design implementation Pilot SMB outreach strategy in partnership with Energy Trust	Integration and alignment of Energy Partner with additional energy service offerings to C&I customers Continued growth	Aggregate Energy Partner assets into VPP Full integration of Energy Partner DR into Power Operations resource stack

3.4.2 Multi-family Water Heater Pilot

Season	Megawatts Procured by 2023
Summer	6.2 MW
Winter	9.3 MW

3.4.2.1 Executive Summary

The Multi-family Water Heater (MFWH) pilot aims to enable and operate electric water heaters for demand flexibility. This program provides capacity as well as intra-hour energy and lays the foundation for PGE's DR programs to offer intra-hour grid services to support reliability and renewables integration.

The approach is relatively novel as it capitalizes on the density of electric water heaters found in multi-family dwellings. Density is necessary for several reasons. First, broadly distributed assets are more expensive per unit installation thus concentrations of units enable water heaters for a fraction of enabling the same number of units across a broader area. Second, because many multi-family units install the water heater within the living space electric resistance water heaters are used. This niche allows PGE to test advanced use cases from water heaters without affecting Energy Trust and the NEEA's efforts to promote adoption of more efficient heat pump water heaters. Third, having a concentration of these units granted PGE an opportunity to begin working with water heaters as a flexible resource sooner than if we had to wait for higher adoption and concentration rates in the field.

Our learnings from this pilot will continue to help inform our approach to single family water heaters. To be clear, PGE supports Energy Trust and NEEA's effort to increase adoption of heat pump water heaters. However, given the importance of water heaters as a cost-effective approach to supplying flexible services, PGE developed the Multi-family Water Heater program to learn about developing a Flexible Load resource from a highly dynamic, ubiquitous appliance.

3.4.2.2 Key Customer Needs Addressed, Engagement, and Diversity, Equity, and Inclusion

This program aims to provide Flexible Load resources in a way that is unobtrusive to the customer. This pilot enables residents of multi-family buildings to participate in energy programs that are often not available due to the limitations of renters to make investments in equipment or building shell improvements.

3.4.2.3 Technology Principles

PGE is operating the MFWH pilot to evaluate the various modes of device connectivity and different OEM solutions as a means to optimize cost effective program implementation and event performance.

Deploying multiple units within a single multi-family site also allows us to see how the water heaters operate in concert to address capacity and delivery constraints. The lessons learned around device installation, device performance and communication will inform development of a single family water heater program.

PGE is actively managing total costs of the program in order to positively affect cost effectiveness. PGE is focusing on a few select cost categories to better manage the overall cost of the pilot while not negatively affecting pilot performance. Installation and hardware costs are the largest controllable cost centers. As stated above, we have seen a significant installed cost decline since the pilot began. Cellular retrofit switches[90] and new cellular, Ecoport Universal Communications Modules[91] (UCMs) eliminate the need for PGE to create local area networks within each building site, requiring less investment from PGE in supporting infrastructure such as Wi-Fi routers and repeaters. This translates to lower operations and maintenance costs. We are also actively managing contractor costs for each install.

Another way to manage to cost effectiveness is to increase utilization of the units, uptime or availability of the units and the total verifiable load drop from the unit. Cellular switches, installed in late 2019 are demonstrating better connectivity, as well as better load drop performance.

This pilot is providing valuable lessons that PGE can leverage for other multi-family programs such as line-voltage thermostats, shared EV chargers, on-site generation, and storage. The lessons learned around technology, communication protocols, and deployment across multiple units within a single site can inform how future Flexible Load programs are delivered. In addition, a successful pilot will help future participation from building owner/managers and tenants. Lessons learned around program incentives and marketing can be applied to future programs. Positive participant experiences with the water heater program will increase participation in future program offerings.

3.4.2.4 Coordination

Many multi-family buildings use electric resistance water heaters and install them within the living space. This niche allows PGE to test advanced use cases from water heaters without affecting Energy Trust and the NEEA's efforts to promote adoption of more efficient heat pump water heaters.

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[90] A retrofit switch in this context is a device with a relay to disrupt power supply to the end point that is hardwired onto a water heater.

[91] See footnote 43, page 23.

OpenADR Alliance. (2022) *EcoPort Supplemental Information.* Retrieved here: https://www.openadr.org/ecoport-supplemental

3.4.2.5 Market

Within the multi-family market, it is estimated that nearly 90% of water heaters are electrically heated and represent 50% of the residential market. This pilot targets the large-scale, non-owner occupied multi-family rental market with approximately 50 units/site. The total number of eligible apartments in large scale multi-family rental housing is 100,000 units. The achievable potential is 50,000 units corresponding to 25MW by 2027.

Figure 8 – Multi-family Water Heater Pilot Market Penetration

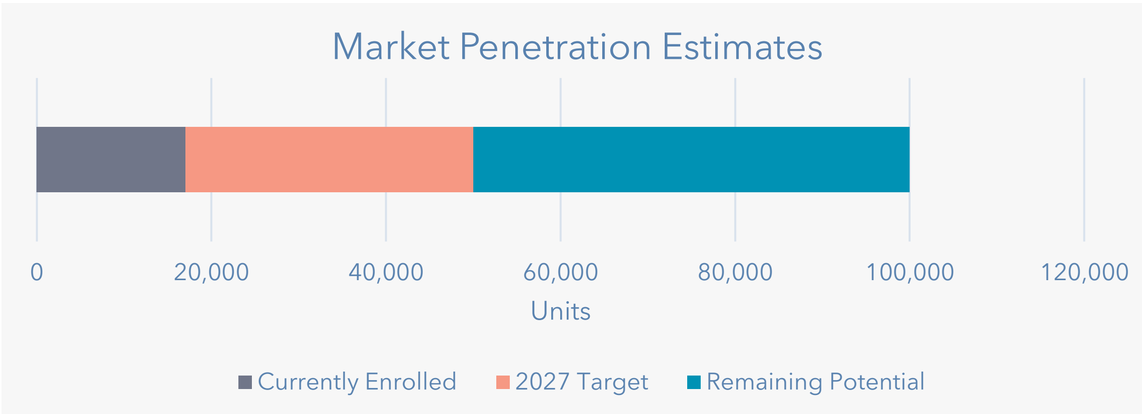


Table 28 – Multi-family Water Heater Forecasted Enrollment and MW Capacity

	2022	2023	2024
Cumulative Enrollment	15,500	15,500	16,000
Summer MW Capacity (.4kw per)	6.2	6.2	6.4
Winter MW Capacity (.6kw per)	9.3	9.3	9.6

3.4.2.6 Key Outcomes & Measures of Success

In 2021, the pilot commenced a major pivot from a focus on existing water heater retrofits (which have enabled PGE to understand the load shifting benefits of this resource but have not proven cost effective) to a focus on installation of new Ecoport[92] water heaters and UCMs, thereby connecting them to PGE's grid to allow for load shifting and greatly reducing costs due to ease of install. The pilot installation strategy was twofold: continue with a modest number of retrofits to honor customer commitments and interest, while working with manufacturers, distributors, and multi-family property management companies to increase adoption of new water heaters. Since that strategy was deployed, the pilot has faced four major challenges: 1)

[92] OpenADR Alliance. *EcoPort Supplemental Information; 2022.* Retrieved from: https://www.openadr.org/ecoport-supplemental

Repeated postponement of the Oregon code requirement for CTA-2045[93]; 2) On-going supply chain issues for both Ecoport water heaters and UCMs; 3) Equipment re-design of the UCM in the existing fleet of Ecoport water heaters; and 4) Tenant appreciation for the program was provided through Chinook Book, a company that ceased operations in Spring 2022. Given these challenges, which have occurred outside of PGE's control, the pilot is, once again, completing an evaluation of the best approach.

Initiatives currently underway include:

- Clean-up of connectivity issues due to firmware issues with cell-enabled retrofit switches and make a decision about Wi-Fi retrofit switches and routers that are repeatedly disconnected.
- Complete retrofit switch pipeline in 2022 and suspend new enrollments.
- Focus on Ecoport water heater pipeline development leveraging third party implementer and coordination with Energy Trust (new construction and retrofit teams).
- Develop a replace on burnout model to ensure all retired electric resistance water heaters are replaced with Ecoport water heaters with established customer base.
- Explore new tenant incentive models that provide more inclusivity, especially with low-income customers.

3.4.2.7 *Timeline of Upcoming Activity*

2022 H2	2023 H1	2023 H2	2024 H1	2024 H2
Complete installations of current pipeline of retrofit devices.	Complete final evaluation for pilot from current period. Update rebate incentive on Ecoport enabled WHs due to code change	File for pilot to program consideration or additional extension	Expand Ecoport installations	Cease installations of any retrofit switches (only install UCMs)

[93] 81st Oregon Legislative Assembly Regular Session. (2021). *House Bill 2062, s.2.16*. Retrieved from: https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2062.

Chapter 4 Related Activities

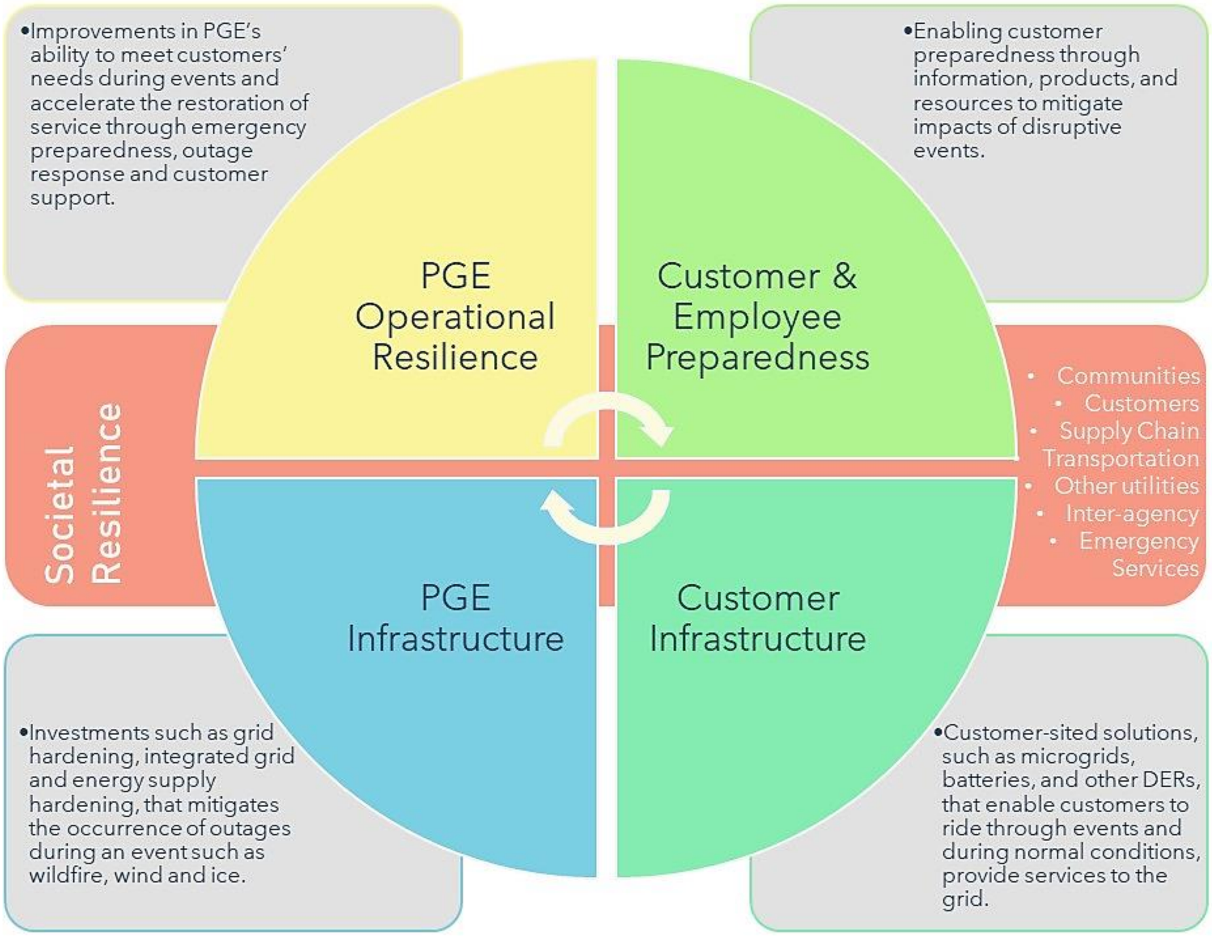
4.1 Resilience Products

PGE and our customers have been impacted by recent disruptive events from wildfires, ice storms, and extreme heat. The Company is looking at resilience from a holistic point of view, with considerations and project work spanning generation, transmission, distribution, and information technology operations. We acknowledge that there are various levels of resilience that customers can pursue, ranging from making an emergency plan, to preparing essential supplies, to incorporating more resilient devices capable of serving as a Flexible Load resource.

This section outlines the spectrum of resilience focus areas considered by PGE. A deeper look at these focus areas can be found in PGE's DSP[94]. The proceeding section will focus on PGE's programmatic efforts around customer preparedness and customer infrastructure, many (though not all) of which contribute to Flexible Load in addition to resilience. These efforts will also account for collaboration with any Energy Trust incentivization of distribution-system connected storage. It is important that these devices are deployed to achieve maximum efficiency and grid connectivity for the benefit of all customers and the energy system.

[94] PGE. *Distribution System Plan Part 2; 2022*, available at: https://downloads.ctfassets.net/416ywc1laqmd/2Fr2nVc4FKONetiVZ8aLWM/b209013acfedf1125ceb7ba2940bac71/DSP_Part_2_-_Full_report.pdf.

Figure 9 – Resilience Focus Areas



4.1.1 Existing Customer Resilience Programs

4.1.1.1 Smart Battery Pilot

PGE launched its five-year Smart Battery pilot in 2020 that seeks to install and connect 525 residential energy storage batteries that will contribute up to four megawatts of energy to PGE's grid. Once installed, these distributed assets create a virtual power plant that is made up of small units that can be operated individually or combined to serve the grid, adding flexibility that supports PGE's transition to a cleaner energy future. In addition, the energy storage batteries provide customers with a backup energy resource they can rely on in the event of a power outage. PGE continues to learn from this pilot and is considering whether a tariff update is warranted to iterate and improve the pilot based on what has been learned thus far. For example, the current structure provides a single incentive level per customer, per month. Based on customer feedback, there is a desire to have more control and customization options for participation. PGE also has observed that the up-front rebates intended to encourage adoption on specific areas of the grid do not appear to be high enough.

Another consideration for energy storage is whether a new participation model is needed to allow customers to dispatch the battery themselves rather than by PGE direct dispatch. This will provide an option to engage with "control keepers," a customer segment who are unwilling to allow utility direct load control of devices. Additionally, PGE has received numerous inquiries from customers that have an energy storage device that is not one of the five qualified products within the pilot. Supply chain constraints and DRMS integration practicalities make a "brand agnostic" approach something PGE believes could benefit customers.

Historical information on this pilot can be found within the UM 1856 Energy Storage Docket. If PGE files any revisions to Schedule 14 it will be within that docket as well, via the existing deferral.

4.1.1.2 Energy Partner

Energy Partner's Schedule 26 is a Demand Response (DR) program providing incentives to large nonresidential customers during seasonal peak time events for reducing their load. The program develops highly customized load curtailment plans that can work with a variety of unique types of businesses. In June 2022, the program received regulatory approval to expand upon the grid services that Energy Partner may provide PGE, as well as support customers' resiliency and clean energy goals by incorporating battery energy storage as a dispatchable resource.

4.1.1.3 Dispatchable Standby Generation

In 1999, the MacLaren Youth Correctional Facility became the first PGE customer to enroll their standby generator in the Dispatchable Standby Generation (DSG) program, a partnership with customers that interconnects generation resources to provide electricity on to PGE's grid when there is a critical need for power in the local region. Since then, the DSG program has grown to 59 sites with a cumulative nameplate generation capacity of 130MW. While not fuel restrictive, the bulk of this capacity has historically consisted of internal combustion diesel generators, and PGE has undertaken a concerted effort to modernize and decarbonize the program.

With the increased commercialization of battery energy storage, as well as PGE's successful integration of customer-sited batteries for grid services as demonstrated by the Beaverton Public Safety Center and Anderson Readiness Center, PGE proposed to build upon those capabilities to expand the DSG program to include battery energy storage greater than 250 kW, receiving approval to do so in June 2022. In addition to contingency reserve and frequency response, customers with battery energy storage may opt to also participate in DR activities, a Flexible Load service not currently possible with fossil-fueled resources.

This program can now provide the same advanced resilience support to enrolled customers as the legacy DSG program, while also supporting customers', PGE's, and Oregon's decarbonization goals.

4.1.1.4 Rooftop Solar

PGE currently has 17,600 customers with solar on their premises, 16,500 residential and 1,100 non-residential, for a total of 154MW. The current solar offerings are net metering, in which the utility purchases excess energy produced by solar panels at retail rates and Solar Payment Option. Solar Payment Option is closed to new applicants and was the precursor to net metering whereby Oregon utilities paid a premium price for excess solar energy to encourage solar adoption. Solar energy is a critical resilience asset when paired with energy storage, extending the duration of back-up power available to a customer during longer outages without needing fossil fuel generators. Customers also are eager to pursue solar for resilience and decarbonization, with new applications for rooftop solar doubling year-over-year from 2020 to 2021, and survey research showing that rooftop and utility-scale solar is customers' preferred renewable energy source[95]. By 2030 solar is expected to contribute 377 MW toward PGE's decarbonization goals[96].

4.1.1.4.1 FUTURE CONSIDERATIONS

As distributed solar becomes a larger part of PGE's generation mix and customers help with the goal of rapid and aggressive decarbonization, solar will need to be managed as a flexible resource in a way that the utility is not doing today. Currently the Smart Battery pilot encourages customers with solar to install battery energy storage, but there will need to be additional and less expensive options for customers to optimize their solar in a way that will support decarbonization across the entire grid and mitigate a "duck curve[97]." Options include either shifting solar production from mid-day production to serve peak usage with energy storage or partnering with customers to encourage shifting their usage to peak solar production.

Additionally, PGE recognizes economically disadvantaged and under-served customers are at risk of being left behind in the clean energy transition. Research confirms that the impacts of climate change (unprecedented heat domes, wildfires, and ice storms) are disproportionately borne by low-income communities and communities of color and are expected to worsen.

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[95] MDC Research. *Green Viewpoints Customer Survey; 2019*.

[96] PGE. *Distribution System Plan Part 2; 2022*; *Section 4.3*. Retrieved from: https://downloads.ctfassets.net/416ywc1laqmd/2Fr2nVc4FKONetiVZ8aLWM/b209013acfedf1125ceb7ba2940bac71/DSP_Part_2_-_Full_report.pdf.

[97] The duck curve is a graph of power production over the course of a day that shows the timing imbalance between peak demand and renewable energy production. Used in utility-scale electricity generation, the term was coined in 2013 by the CAISO.

For additional detail, see NREL. *Ten Years of Analyzing the Duck Chart: How an NREL Discovery in 2008 Is Helping Enable More Solar on the Grid Today; 2018.* Retrieved from: https://www.nrel.gov/news/program/2018/10-years-duck-curve.html#:~:text=In%202013%2C%20CAISO%20produced%20a%20chart%20strikingly%20similar,Curve%20Tells%20us%20about%20Managing%20a%20Green%20Grid%29.

There is a clear need and opportunity for PGE to collaborate with Energy Trust and other industry, government, and community-based organizations to better align energy, decarbonization, and equity goals. Together, we can deliver integrated, equitable solar solutions that satisfy customer needs, achieve mutual resiliency goals, and ensure cleaner energy is inclusive and accessible to all. PGE seeks to build upon and expand work that has already been completed with stakeholders to identify and explore solar offerings or demonstration projects that will advance racial equity and lower our collective carbon footprint.

4.1.2 Proposed Customer Resilience Programs

4.1.2.1 Resilience for Electrically Dependent Individuals (REDI)

PGE recognizes that there is a diversity of customer resilience needs, across the full spectrum of utility / grid integration. Everything from snow-shovels and bottled water to microgrids has the potential to contribute to customer resiliency, and PGE is working to find the balance of serving customer's needs with how or whether all ratepayers fund the initiative.

One such program that was contemplated to provide a resiliency product to a uniquely vulnerable population is Resilience for Electrically Dependent Individuals (REDI). PGE investigated the potential to offer a no-cost portable battery program for select customers who have medical needs served by electrical devices such as CPAP machines, oxygen concentrators, or cardiac devices.

The Resilience Product team researched the needs of this customer segment, engaged with stakeholders, and evaluated similar programs across the United States to create a framework of what this potential product offering could comprise. Our conclusion was that a portable battery with ~1-2 kW of capacity was sufficient to serve the required load (as compared to more costly fixed battery energy storage, such as those devices eligible for the Smart Battery pilot). However, while the cost is significantly lower for a portable battery versus stationary, there is no ability to integrate these devices with PGE's grid to perform grid services, and thus no traditional utility benefits that PGE could use to demonstrate cost-effectiveness. While this program was not deemed to be a good fit for submission within this filing, the Company is reviewing whether this could serve medically vulnerable customers impacted by Public Safety Power Shutoffs and thus be included within the Wildfire Mitigation Plan.

4.1.2.2 Community Microgrid Demonstrations

PGE has several planned and active initiatives that serve to create or enable more resilient customer infrastructure with a focus on critical community facilities. The following descriptions provide examples of the activities PGE is planning or undertaking to enable customers to mitigate the effects of disruptive events and get access to the services they need. Full details of both of the projects outlined below can be found in the DSP Report. [98]

4.1.2.2.1 SALEM SMART POWER CENTER

At PGE's Salem Smart Power Center (SSPC), a 5 MW / 1.25 megawatt-hour battery is nearing the end of its 10-year life. Commissioned in May 2013, it has been showing signs of degradation and only maintains about 60 percent of its original capacity. Over the years, battery technology has advanced, and now most of the center's equipment is not supported; spare parts are unavailable. However, the SSPC remains critical in providing capacity to meet PGE's frequency response obligation.

PGE proposes to repower SSPC to provide support for fast frequency response, generating capacity, DR, contingency reserve, and EV support. In conjunction the re-powered SSPC would provide resilience for the future City of Salem Public Works Operations Center – a critical hub for responding to emergencies such as natural disasters or extended power outages. This proposal would create the first "community microgrid" of its kind in the Northwest. Full details of the proposal, including additional technical details and budget can be found in the DSP.[99]

4.1.2.2.2 DEPARTMENT OF PUBLIC SAFETY STANDARDS AND TRAINING MICROGRID

An additional project that PGE is exploring is to create a microgrid that serves a campus with multiple buildings at the Oregon Department of Public Safety Standards Training (DPSST) campus in Salem. As the State's key operational hub for emergency management, a microgrid at this site could be the solution for a reliable source of electricity during extended power outages.

The DPSST microgrid would use solar and battery storage to partially offset the need for fueled generation on a medium voltage (13.5 kV) system. The solar resource will be generating and providing clean energy even when there is no grid outage. We will propose a generator hookup option in case the battery and solar output is not sufficient for a more extended outage, especially in the winter. In that case, because of the generator, the microgrid will provide greater resiliency to the entire campus. Full details and budget can be found within the DSP. This project would also serve as a proof of concept and learning opportunity for how to structure a funding model that allows for scalable and cost-effective development of similar microgrids, perhaps with a "subscription" to participate in the microgrid.

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[98] PGE. *Distribution System Plan Part 2; 2022*. Retrieved from: https://downloads.ctfassets.net/416ywc1laqmd/2Fr2nVc4FKONetiVZ8aLWM/b209013acfedf1125ceb7ba2940bac71/DSP_Part_2_-_Full_report.pdf.

[99] PGE. *Distribution System Plan Part 2; 2022; Section 4.3*. Retrieved from: https://downloads.ctfassets.net/416ywc1laqmd/2Fr2nVc4FKONetiVZ8aLWM/b209013acfedf1125ceb7ba2940bac71/DSP_Part_2_-_Full_report.pdf.

4.2 Transportation Electrification

PGE has developed a Residential EV Smart Charge pilot to help accelerate Oregon's transition to a clean energy future by focusing on Decarbonization, Electrification, and Reliability. The goals of the pilot are to support the adoption of EVs and Electric Vehicle Service Equipment (EVSE) by offering rebates to lower the total cost of ownership for residential customers. PGE will utilize the pilot learnings to better understand how to leverage EVs and EVSEs to develop a reliable, Flexible Load resource for the grid.

PGE has added vehicle telematics to the pilot, where Smart Charge events can be called on the car rather than through the EVSE. This accommodates customers who own a Tesla and an EV charger that is not eligible for the PGE residential charger rebate.

Overall, this pilot has a goal to have 5,000 customers participating through the duration of the pilot, delivering 2.25 MW Capacity. As of June 23, 2022, there are 752 customers enrolled in the Standard/Income-eligible portion of the pilot and 483 customers enrolled via evPulse for a total of 1,235 customers in the pilot with a current 0.56MW Capacity. The forecasted enrollment and MW capacity follows:

Table 29 – Residential EV Smart Charging Pilot Forecasted Enrollment and MW Capacity

	2022	2023	2024
Enrollment	2,750	3,875	5,000
MW Capacity	1.2	1.7	2.3

As adoption of electric vehicles and PGE customer programs for transportation electrification increases over the coming years, PGE will continue to layer Flexible Load programs into Transportation Electrification. We expect most of those proposals will be made through PGE TE Plans, but the Flexible Load itself will be managed as part of PGE's Flexible Load portfolio.

4.3 Systems of Record for Distributed Energy Resource Data

As the role and significance of Distributed Energy Resources (DERS) grows, PGE must maintain and organize new types of data related to generation, storage, and Flexible Load resources on the distribution grid. The availability of accurate and relevant data will determine how much value can be captured for the grid and for individual customers.

Examples of new or newly significant data include:

- **Nameplate characteristics, electrical and geographic location, configuration settings, and control functions of interconnected DERS:** Systems exist for storing relevant information about traditional, utility-owned resources, but these systems are not designed to manage all required information about new resource types, nor are they designed to manage information about resources owned by customers.
- **Characteristics of buildings and building loads that affect suitability and performance in Flexible Load programs**: Traditional utility systems have limited ability to represent and store information about what lies "behind the meter." Such data has typically been managed as a list of characteristics related to the service point. But emerging applications require richer multi-dimensional data.
- **Information necessary to gain insights from the operation of DERS and customer programs**: Site-level performance data – such as device telemetry – in association with customer insights and external variables like weather and market conditions enables more accurate forecasts and can generate ideas for innovation and improvement. And the benefits of applied data science compound over time as improved program performance drives lower rates and higher incentives for customer participation.

Identifying the system of record (aka the "source of truth") and establishing organizational ownership for key data elements makes it easier to leverage data for business benefit. Making effective use of DER data will enable key functions:

- **Planning and evaluation**: Support more accurate studies through awareness of each DER's capabilities and operational characteristics.
- **Operations**: Support real-time decisions through awareness of DER location, characteristics, and expected impact.

- **Products and Programs**: Streamline program management, reporting, incentive processing, and cost-effectiveness calculations, and help improve program design.
- **Customer Support**: Provide customers with improved information about the programs they participate in and the benefits available to them.
- **Field crews**: Ensure accurate information for maintenance assessment and crew safety.
- **Participation in organized markets**: Enable DERS to participate in the energy imbalance market and provide bulk system services.

In 2022 PGE has contracted with EPRI as part of a collaborative Research and Development effort to ensure that PGE remains abreast of emerging industry practices for managing DER data. Knowledge gained will be applied through various initiatives that implement or change PGE information systems. Primary near- and medium-term implementation efforts include:

- Efforts to further operational integration by automating the dispatch of Flexible Load resources and/or integrating dispatch into the processes and systems used to dispatch other resources.
- Efforts to rationalize and standardize technology implementation across programs through competitive procurement and improvement of the interfaces between systems.
- Efforts such as the Customer 360 Project that directly address the breadth, quality, and availability of data for analysis.

Chapter 5 Cost Effectiveness Approach

This chapter is an update to Cost-Effectiveness section of MYP filed in 2021. Updates are based on latest work and developments in cost- effectiveness analysis of PGE. The company, in alignment with direction from OPUC Staff's comments to PGE's Flexible Load Plan, has begun an effort to update DER cost-effectiveness (CE).[100] In the Multi-Year Plan, PGE outlined several areas in which CE of the Flexible Load portfolio may be improved. These range from demonstrating how Flexible Loads can provide a wider range of grid services, to improved operational efficiencies in program delivery and coordination with PGE System Operations.

PGE is working to expand the current CE methodology to comprehensively and consistently value impacts for the utility, with due consideration for evolving stakeholder and regulatory landscape. As part of this goal, PGE will continue refining and updating its current cost-effectiveness model with new inputs, assumptions and methodologies related to utility system values in order to inform emerging conversations about the impacts of HB 2021 on utility resource planning.

Many jurisdictions are struggling to improve their cost-effectiveness screening techniques to include new benefits that meet evolving needs of utilities, customers, regulators, and partners. Concerns with benefit-cost analysis screening practices are around issues related to existing or standard cost effectiveness methodologies.

In its last Multi-Year Plan filing, PGE noted that to quantify new grid services that Flexible Loads can provide, PGE must invest in updating its tools and capabilities for assessing Flexible Loads and provided latest updates to the following two key areas of work related to improving the cost effectiveness of the Flexible Load portfolio that PGE has undertaken in response to Order 21-158[101] as follows:

- National best practice review of cost-effectiveness methods for DERs.
- Evolving the grid services value capture as outlined in the Flexible Load Plan.

5.1 National Best Practice Review of CE Methods for DERs

PGE is continuing to work on aligning its cost-effectiveness approach with national best practices. As part of this effort PGE sees three main areas where work is needed to reach our planned goals and initiatives. These areas of the cost-effectiveness strategy are Valuation Framework, Business Process, and Regulatory Evolution.

The objective of the Valuation Framework is to refine and update current cost-effectiveness modeling with new inputs, assumptions and methodologies related to

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[100] PGE. *PGE Flexible Load Plan; 2021.* Retrieved from: https://edocs.puc.state.or.us/efdocs/HAD/um2141had16243.pdf.

[101] OPUC. *Order 21-158: Acceptance of Flexible Load Plan; 2021.* Retrieved from: https://apps.puc.state.or.us/orders/2021ords/21-158.pdf.

utility system values and non-energy impacts. As part of this goal, it will be critical to ensure regulators and stakeholders are aligned with the approaches. PGE will also need to provide education to internal teams to support advocacy of new cost-recovery or community-based tariff structures that fairly account for community benefits but also ensure business viability.

Enhanced CE analysis of a program in early stages of development will help PGE to add more clarity to decision-making processes. Establishing a business process around DER CE, data and financial discipline is necessary. Data discipline includes clear documentation and record of all data generated through the program design, implementation, evaluation, and program refresh phases when necessary.

Enhanced CE methodology will enable PGE to make better DER investment decisions and provide the necessary level of details to account for additional costs and benefits compared to current state. The region's goals around decarbonization emphasize the need for higher adoption of DERs and grid modernization. Through improved valuation, we are likely to see better cost-effectiveness and thus better adoption of DERs. This increased adoption will help meet targets set in HB 2021.

PGE's development of robust and transparent valuation methodologies can promote streamlined regulatory approval of DER-related proposals, reducing uncertainty and rework.

5.2 Evolving Grid Services

In the Flexible Load Plan, PGE outlined which grid services our existing Flexible Load products currently are capable of providing, as well as a roadmap of near-term and longer-term services which were deemed suitable.[102] Table 30, below shows the grid services capabilities of PGE's current and planned portfolio at the time of filing the Flexible Load Plan.

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[102] PGE. *Flexible Load Plan; 2020; Section 4.4.1*. Retrieved from: https://edocs.puc.state.or.us/efdocs/HAS/um2141has132229.pdf.

Table 30 – Grid Services Capabilities of Current and Planned Portfolio

Resources							
Grid Service	DLC Daily	DLC Seasonal	Behavioral DR	Res Battery	C&I Battery	EV	Photovoltaic Smart Inverters
Distribution Services							
Volt/Var control				Current	Current		
Frequency response				Current	Current		
Outage Mitigation and Upgrade Deferral	Near-term	Near-term	Near-term	Near-term	Near-term	Near-term	
Transmission Services							
Congestion and Upgrade Deferral	Near-term	Near-term	Near-term	Near-term	Near-term	Near-term	
Generation Services							
Capacity	Current	Current	Current	Current	Current	Current	
Value of Energy	Current	Near-term	Near-term	Current	Current	Current	
Flexibility services							
Contingency Reserves							
Spinning reserves	Current			Current	Current		
Non-spinning reserves	Current	Near-term		Current	Current		
Load following / Energy Imbalance	Longer-term	Longer-term		Near-term	Current		
Regulation				Near-term	Current		
Voltage support	Current				Current		Current
Black start	Current			Current	Current		
Participant Benefits							
Power reliability	Current	Current	Current	Current	Current		
Outage mitigation				Current	Current	Longer-term	Current
TOD charge reduction				Current			
Demand charge reduction					Current		

The following sub-sections provide updates regarding PGE's efforts to further study and evaluate new grid services as identified in the above table.

5.2.1 Distribution Services

While PGE's current residential and C&I battery pilots can provide volt/var control, the largest potential distribution services value is Transmission and Distribution (T&D)

upgrade deferral.[103] Upgrade deferral refers to avoiding or deferring the need for traditional transmission and distribution system upgrades to address capacity constraints triggered by load growth.

In the Flexible Load Plan, we stated that T&D upgrade deferral would apply when the application was tailored to address the specific constraint and the DER characteristics aligned with the identified system need.[104] Today, our Flexible Load dispatch decisions are based on bulk-system criteria such as market price forecasts and system peak load forecasts. However, there is an overlap between bulk system peak time periods and distribution-system peaks, such that even under our current dispatch strategy of our Flexible Load resource there is benefit to the distribution system. For example, during the 2021 summer heat waves, PGE's DR calls provided much needed relief to areas of the grid that were experiencing historical strain due not only to peak loads being higher than ever before, but also to extreme temperatures that shattered previous records for Oregon. The combination of higher loading and higher temperatures in such situations poses additional risk for equipment safety and continued system reliability, making callable demand reductions a very valuable tool in the operations toolkit.

Table 31, below shows the summer 2020 peak loads across PGE's roughly 650 active feeders compared to the IRP loss of load probability (LOLP) heatmap from the 2019 IRP update.[105] During the summer of 2020, PGE called DR events on seven days between hour ending 17 and 21, and 37% of the feeder-level system peaks occurred during the DR event window. With additional coordination of PGE's dispatch of its

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[103] See for example Brattle's *National Potential for Load Flexibility* study, which states that T&D deferral accounts for 12% of load flexibility's value, and that this number will likely grow with greater utility data collection and planning processes.

Brattle. *The National Potential for Load Flexibility: Value and Market Potential through 2030; 2019.* Retrieved from: https://www.brattle.com/wp-content/uploads/2021/05/16639_national_potential_for_load_flexibility_-_final.pdf.

[104] For example, a planned upgrade to address load growth causing a substation transformer to exceed its rated capacity for eight hours may not be avoidable with only three to four hour Flexible Load products. However, an aggregate of distributed resources (for example Flexible Loads, EE, and distributed generation) may combine to provide the necessary relief. This concept is an illustration of the VPP applied to distribution system upgrades. PGE will work together with participants under the DSP (UM 2005) to further establish the conditions that apply to such "non-wire solutions" to address local grid constraints in the lead up to *Distribution System Plan Part 2; 2022*. Retrieved from: https://downloads.ctfassets.net/416ywc1laqmd/2Fr2nVc4FKONetiVZ8aLWM/b209013acfedf1125ceb7ba2940bac71/DSP_Part_2_-_Full_report.pdf.

[105] While not directly comparable, lining up distribution-level peak loads with the IRP LOLP is meant to indicate relative coincidence of bulk-system and distribution-system peaks. The values in the left-hand side of the chart are a simple count of the single-hour MW peaks for each feeder during each month-hour combination, whereas the right-hand side shows relative probabilities that PGE's resources will be less than required to serve load, thereby leading to a loss-of-load event. PGE plans to compile similar metrics for the distribution system under the DSP.

Flexible Load assets to target distribution system relief, this value is likely to increase. Although, it should be noted that despite distribution services representing an additional potential value stream for Flexible Loads, the realization of such value depends not only on the relative system needs and conditions, but also on whether there exists sufficient locational adoption of DERs capable of providing these services.

Table 31 – 2020 Summer Feeder-level Peaks Compared to IRP LOLP

	Summer 2020 Feeder Peak Loads					LOLP Heat Map (PGE 2019 IRP Update)			
Hour Ending	Jun	Jul	Aug	Sep		Jun	Jul	Aug	Sep
1	0	1	0	2		0.00	0.00	0.00	0.00
2	0	0	0	0		0.00	0.00	0.00	0.00
3	0	0	0	0		0.00	0.00	0.00	0.00
4	0	0	0	1		0.00	0.00	0.00	0.00
5	2	0	1	0		0.00	0.00	0.00	0.00
6	3	0	1	0		0.00	0.00	0.00	0.00
7	1	1	1	0		0.00	0.00	0.00	0.00
8	8	4	2	1		0.00	0.00	0.00	0.00
9	3	6	1	5		0.00	0.00	0.00	0.00
10	2	6	0	5		0.00	0.00	0.00	0.00
11	2	5	5	0		0.00	0.00	0.00	0.00
12	0	13	15	7		0.00	0.00	0.02	0.00
13	4	24	8	4		0.00	0.01	0.10	0.01
14	9	28	11	7		0.01	0.03	0.31	0.02
15	7	41	8	13		0.01	0.09	1.05	0.06
16	2	77	18	13		0.02	0.13	0.47	0.16
17	7	88	25	11		0.03	0.26	0.79	0.13
18	1	74	18	8		0.03	0.28	1.22	0.31
19	1	4	3	4		0.05	0.50	2.00	0.51
20	0	3	2	0		0.06	0.77	1.61	0.33
21	1	0	0	0		0.04	0.44	2.47	0.14
22	1	0	0	0		0.01	0.11	0.83	0.13
23	0	1	0	0		0.00	0.00	0.00	0.00
24	0	0	0	0		0.00	0.00	0.00	0.00

PGE plans to improve its modeling of locational grid needs as part of the continuing work carried out under the DSP, which focuses on constraint identification and solutions identification. Our investments in the Integrated Operations Center (IOC) and Advanced Distribution Management System (ADMS) will greatly expand the real-time visibility of distribution system status and enhance our ability to dispatch Flexible Loads for targeted load relief and system balancing.

PGE is currently in the process of reviewing two methods for calculating T&D avoided costs. They are the Present Worth (PW) and Discounted Total Investment (DTIM) methods. PGE utilized the PW method to conduct our locational value analysis for T&D deferral value as part of the evaluation of two Non-Wire Solution pilots under the DSP.

Ultimately, we foresee that one or the other method will be used to calculate T&D avoided cost depending on the specific use cases.[106]

OPUC Staff has previously expressed interest in having PGE analyze cost-effectiveness impacts to Flexible Loads from utilizing the same base avoided costs as Energy Trust.[107] This includes the T&D avoided costs applied to EE under UM 1893.[108] PGE presents results of this sensitivity analysis using Energy Trust's avoided T&D costs in Section 5.2.6 for purposes of illustrating changes to cost-effectiveness in response to OPUC request. PGE notes that this is for illustrative purposes only and does not convey that we recommend using the UM 1893 values to apply to Flexible Loads in lieu of the PW and DTIM methods we are concurrently investigating. For this sensitivity we use Energy Trust's T&D avoided cost values of $9.38/kW-yr. for transmission deferral and $24.39/kW-yr. for distribution deferral.[109]

5.2.2 Generation Services

Traditionally, generation capacity deferral is the largest value for DR or Flexible Loads. This is because unlike EE, DR as typically operated (i.e., for peak load shed only during times of system peak) is largely a capacity resource. However, as PGE continues to expand the range of use cases of its Flexible Load portfolio we expect that both generation capacity value and energy value will need to be applied differently to accurately capture true system value. We provide the following details for each of these generation services and PGEs current thinking:

5.2.2.1 Capacity Value

OPUC Staff has also previously expressed interest in PGE performing sensitivity analysis showing cost-effectiveness of Flexible Load activity using a non-emitting proxy resource.[110] While we maintain that the non-emitting nature of the proxy capacity resource is better viewed as an environmental service value (currently modeled within the energy value, described further below), PGE recognizes that this matter is made more complex with the adoption of HB 2021.

PGE submitted an IRP extension waiver in 2021 to allow us to more fully engage the vision of Oregon's new clean energy law (HB 2021) and encourage a more robust

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[106] For example, the PW method is better for calculating deferral value of a known investment amount over a given and knowable time period (as in a non-wire solution application), whereas the DTIM method is better suited for long-run average avoided cost calculation where exact investment quantities are unknown or data is lacking (as in a more general, service-area wide value).

[107] OPUC. *Staff Report to March 16, 2020 Special Public Meeting, page 14.* Retrieved from: https://edocs.puc.state.or.us/efdocs/HAU/lc73hau163412.pdf

[108] OPUC. *UM 1893: Staff Investigation Of Methodology And Process Of EE Cost-Effectiveness*. Retrieved from: https://apps.puc.state.or.us/edockets/docket.asp?DocketID=20999

[109] OPUC. *Order No. 20-464: Request for Approval of Energy Efficiency Avoided Cost Data to be Used by Energy Trust; Attachment 1; 2020.* Retrieved from: https://apps.puc.state.or.us/orders/2020ords/20-464.pdf

[110] OPUC. *Staff Report to March 16, 2020 Special Public Meeting; page 14.* Retrieved from: https://edocs.puc.state.or.us/efdocs/HAU/lc73hau163412.pdf

public participation process. As part of this process, PGE will update its net cost of capacity for the IRP based on updated market info and will include (as has been the case in previous IRPs) a variety of non-emitting capacity resources. PGE encourages future participation in determining the appropriate method for applying the updated cost of capacity to Flexible Loads as we chart our course to meet HB 2021 goals and add significant renewable resources to our resource mix.

5.2.2.2 Energy Value

In the Flexible Load Plan, we stated, "[f]or emerging Flexible Load such as batteries and electric vehicles, with their greater call frequency, energy may be a more significant benefit stream." To accurately assess the energy value of highly dynamic Flexible Loads (i.e., capable of being dispatched throughout the entire year under a range of market price conditions), PGE will need to develop new tools that integrate DER resource characteristics with market data. We plan to leverage economic co-optimization tools that will simulate how DER will participate in competing value streams such as capacity vs contingency reserve value streams, while under constraints for resource adequacy needs. This will allow for quantification of market wholesale price optimization depending on each DER's unique operational limitations/flexibility, for example by charging batteries during times of relatively low prices and discharging at relatively high prices.

5.2.3 Flexibility Services

In our 2019 IRP, we studied the contribution of all dispatchable resource types to provide system flexibility value.[111] This study, informed by work performed by Blue Marble Analytics, analyzed system-level flexibility value of utility-scale battery storage (2-hr, 4-hr, and 6-hr batteries). The per-unit flexibility value is shown in Table 32.

[111]PGE. *2019 Integrated Resource Plan; Section 6.2.2; 2019*. Retrieved from: https://portlandgeneral.com/about/who-we-are/resource-planning.

Table 32 – Flexibility Values of New Dispatchable Resource Options[112]

Dispatchable Resource	Flexibility Value (2020$/kW-yr)
Solar + Storage	-
2-hour Battery	$23.73
4-hour Battery	$28.10
6-hour Battery	$29.43
Pumped Storage	$25.95
CCCT	$8.40
LMS 100	$8.87
Reciprocating Engines	$9.19
SCCT	$4.82

The flexibility value developed in the IRP represents a combination of grid services, including load following, regulation, spin and non-spin reserves, and renewable integration.

Currently, PGE includes the resulting flexibility $/kW-yr. value from this study only to distributed batteries, reflecting the fact that these products can perform daily dispatch at any hour and have quick response times, as opposed to pre-determined dispatch windows. If the water heater pilot demonstrates ability to respond on a response curve required to achieve these system flexibility services, this will further improve the cost-effectiveness score.

PGE has contracted with Blue Marble again for our upcoming IRP analysis and will be updating the flexibility-adequacy study. Given the influence on HB 2021 on PGE's resource supply mix, PGE will investigate whether future system flexibility needs under the presence of higher variable energy resources lead to appreciably different values for DERs capable of providing these services. Many studies have indicated that future demand for ancillary services will increase as renewable penetration grows.[113]

In addition to modeling potential changes to future demand for ancillary services as the grid evolves toward 100% clean energy sources, it is important to simulate dispatch of aggregated Flexible Loads to quantify the tradeoffs for committing

[112] PGE. *2019 Integrated Resource Plan; Section 6.2.2; 2019*. Retrieved from: https://apps.puc.state.or.us/edockets/docket.asp?DocketID=21929.

[113] Lee et al. ASME Journal of Engineering for Sustainable Buildings and Cities, 1(1). *Providing Grid Services with Heat Pumps: A Review; 2020*. Retrieved from: https://asmedigitalcollection.asme.org/sustainablebuildings/article/1/1/011007/1072202/Providing-Grid-Services-With-Heat-Pumps-A-Review.

resources toward one or another use case. For instance, research has shown that the potential in California for providing operating reserves with thermostatically controlled loads (air conditioners, heat pumps, water heaters, and refrigerators) surpasses the total requirement of the CAISO.[114] PGE plans to evaluate the technical potential and relative economic benefit of utilizing Flexible Loads (other than batteries and which already are attributed the flexibility value) to provide ancillary grid services as part of the work related to building out the VPP.

5.2.4 Environmental Benefits

In the Flexible Load Plan, we stated, "PGE has quantified this value as the cost of carbon in energy prices … [b]ecause many Flexible Load programs have minimal energy impact, the modeled environmental benefit of those programs is also minimal."[115]

PGE is undertaking new analysis within the IRP to comply with requirements of HB 2021 to achieve 80% reduction in GHG emissions by 2030. This will include analysis of how Flexible Loads contribute to relative changes in GHG emissions across different portfolio futures.

In addition, OPUC Staff is interested in the hourly emissions impacts from our IRP analysis. PGE is committed to working with Staff and IRP/DSP participants as we develop the methodologies needed to produce hourly emissions factors from IRP analysis that can then factor into Flexible Load planning. PGE expects that similar to the planned improvements in quantifying energy value associated with wholesale price optimization of DERs, any potential updates to hourly emissions factors will also filter through to increased ability to assign incremental GHG reductions from intra-day load shifting.

5.2.5 Participant Benefits

Potential participant benefits include bill management, reliability and resiliency, and non-energy impacts resulting from participating in a Flexible Load program. In this update, we focus on customer reliability and resiliency.

In DSP Part I filed in 2021, we defined resiliency as one of our five strategic initiatives to realize the grid of the future and help accelerate DER deployment. PGE takes our responsibility as a critical service provider very seriously, and we know our customers have been through a lot in the last couple of years – ranging from COVID disruptions

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[114] H. Hao, et. al. Energy Policy (79). *Potentials and economics of residential thermal loads providing regulation reserve; Page 115-126; 2015.* Retrieved from: https://certs.lbl.gov/publications/potentials-and-economics-residential.html.

[115] PGE. *Flexible Load Plan; 2021; Section 4.3.2.4; page 112.* Available at: https://apps.puc.state.or.us/edockets/edocs.asp?FileType=HAD&FileName=um2141had16243.pdf&DocketID=22696&numSequence=19

to historic wind and ice storms that left many without power for sustained periods, to the extreme heat events during summer 2021.

In response to these events and in efforts to improve the resiliency of our customers to grid outages and extreme events, PGE is investigating new mechanisms to share value between customer and grid for distributed storage. For example, during the 2021 winter ice storms, PGE's residential Smart Battery pilot demonstrated how these resources can provide customer-ride through to minimize loss of service even when the grid is down. Per the terms of the tariff to not dispatch batteries when PGE crews are put on stand-by notice, the batteries were not dispatched during the storm. Balancing customer resilience with utility dispatch of energy storage undoubtedly changes the cost effectiveness calculation, given that during a severe weather event trade-off decisions must be made whether to serve grid- or customer-resilience needs.

PGE is in the process of developing a resilience value for customer resiliency reflecting the value for a customer to be able to meet critical energy needs during an outage and plans to have it finalized by the end of year 2022.

5.2.6 Smart Water Heater Sensitivity Scenarios

Section 2.1.14, above, provides an overview of cost effectiveness for the Smart Water Heating pilot as proposed, as well as two scenarios for how the pilot can achieve a cost effectiveness score of one (1.0) or higher. This section shares more detailed cost-effectiveness results for the SWH pilot as currently designed, as well as potential near-term improvements in the form of a sensitivity analysis.

Table 33, below, shows Benefit Cost ratio for TRC tests, based on the new Avoided Cost of Capacity of $143.29/kW-yr. In addition to the base case, there is a sensitivity for the avoided cost of $24.39/kW-yr for distribution deferral and $9.38/kW-yr for transmission deferral applied to base case. These enhancements to cost effectiveness analysis are described in PGE DSP Part II filing. Scenarios 1 and 2 in section 2.1.14 also include these sensitivities, but have additional, specific assumptions applied as well.

The purpose of Table 33 is to show immediate potential improvements from using the updated cost of capacity value, applying the transmission and distribution deferral, and applying very general assumptions to show how the score could change as a result of a 20% increase or decrease in capacity impacts and administrative costs.

The purpose of both the sensitivity analysis, as well as Table 35 and Table 36, is to show which variables can influence cost effectiveness, but need further work to assign a value or operationalization (note that only two variables in Table 35 are actually applied to the base case to reach the scores shown in Table 33). Thus, the scenarios in Section 2.1.14 reflect a greater degree of uncertainty than the analysis presented here.

The cost effectiveness model uses an annualized average demand reduction of ERWH and HPWH impacts. Table 34 shows the annualized average, as well as a disaggregation of that annualized average into summer and winter season averages. For details about the demand reduction potential expected by the end of each year of the pilot see Section 2.1.6.

Table 33 – Initial Improvements to Cost Effectiveness for Smart Water Heating Pilot

Results Summary	Key Assumptions	TRC1	TRC2 (excludes Value of Service Lost)
Base Case		0.31	0.37
Base Case with Sensitivity		0.38	0.45
Low Case	*Load Impact: -20%* *Admin Costs: +20%*	0.22	0.25
Low Case with Sensitivity		0.26	0.30
High Case	*Load Impact: +20%* *Admin Costs: -20%*	0.45	0.54
High Case with Sensitivity		0.54	0.65

Table 34 – Annualized Load Impacts for Smart Water Heating Pilot per Load-Shift Event

Load Impact (MW)	2023	2024	2025	2026
Annualized Average	0.06	0.33	0.89	1.68
Annualized Average - Winter	0.07	0.35	0.92	1.74
Annualized Average -Summer	0.06	0.32	0.86	1.62

5.2.6.1 Smart Water Heater Sensitivity Analysis

PGE identified an array of variables that, if adjusted and improved, would positively impact cost effectiveness. Through the annual deferral renewal process, Flexible Load multi-year plan filings, and annual reports, PGE will have the opportunity to stage-gate the progression of the pilot to ensure we have an increasingly clear path to achieve a cost effectiveness score of one (1.0) or higher for Smart Water Heating. Most notably, we expect to learn significantly more through an MVP launch in year one, and also from completion of a third-party evaluation.

Of the 20 variables PGE has identified for impacting cost effectiveness, PGE has identified six that are likely to have the greatest, currently quantifiable improvement to the base cost effectiveness scenario; together, these reflect an approximately 20% improvement in cost effectiveness. These six variables are categorized as **opportunities** in Table 35, below, and are described below:

The first two opportunities that can be incorporated, pending cost effectiveness methodology updates, are **avoided cost of generation capacity (Variable 1)** and **T&D avoided costs (Variable 2)**. The team expects to be able to incorporate these values in the 2023 MYP filing following the Commission's acknowledgment of the 2023 IRP. PGE recently submitted our DSP Part II, which proposes several valuation updates in our current cost effectiveness methodology approved for use by the Commission. PGE again could develop a scenario showing how this pilot would score when these valuation updates are incorporated. Further, DSP Part II reviews several potential non-wires solution projects which also show locational values. If our initiation of SWH was targeted to these potential project sites PGE could score this pilot using those location specific values. PGE is confident that SWH cost effectiveness scoring will be adjusted upward as the values which drive the cost effectiveness calculator are adjusted to meet the new planning realities emerging as a result of the state's greenhouse gas reduction goals.

The next two opportunities PGE can pursue are **adding shoulder seasons to winter and summer seasons (Variables 3 and 4, respectively)**. Typically, the existing water heater pilots and demonstrations only call events on weekdays that are not holidays. The team plans to file an operational tariff that increases the flexibility of event parameters to include weekends, as well as create an operational process to ensure events are called regularly both during and outside of the shoulder seasons.

Over the course of the pilot, the team will also be looking at **reduction of connectivity costs (Variable 5)**. Because the water heating market is currently undergoing transformation, there are very few options for UCM hardware and connectivity in the marketplace. In our current budget, these represent 28% of all program costs. Through aggressive management strategies and negotiation, we can identify pathways to significantly lower these costs. Table 35 uses a sensitivity of 20% reduction in costs, although we believe significantly greater savings may be available through aggressive management (e.g., bulk purchases, evaluation of LTE data plans).

Finally, optimizing incentives to balance program costs with participant uptake is an important pilot objective that we plan to address after implementing the pilot for at least one year to gauge the effectiveness of the current incentive levels. **Reducing incentives (Variable 6)** at the initial stage of the pilot could remove an important tool for catalyzing the acceleration of Flexible Load technology adoption. Pilot incentives currently account for 53% of the overall pilot budget and present a real opportunity to manage cost effectiveness over the life of the pilot and ultimately program. Table 35 uses a sensitivity of 20% reduction in incentives, though we believe significantly greater savings may be available through additional management including combining PGE incentives with other incentives that may be in the marketplace (e.g. Inflation Reduction Act).

Table 35 – Opportunities to Improve Smart Water Heating Cost Effectiveness

Variable No.	Category	Variable	Opportunity	Est'd Impact to TRC 1	Est'd Impact to TRC 2	Notes
1	Value stream	Cost of capacity	Update the value of avoiding the cost of constructing generation capacity	5%	6%	Included in Base Case and Base Case Sensitivity
2	Value stream	Transmission and distribution deferral	Add the value of transmission and distribution deferral to the cost effectiveness model	7%	8%	Included in Base Case Sensitivity
3	Value stream	Load-shifting events	Add March and November to winter season at two events per day (116 more events)	2%	2%	Not included in Base Case or Base Case Sensitivity
4	Value stream	Load-shifting events	Add April, May, October to summer season at two events per day (299 more events)	3%	3%	Not included in Base Case or Base Case Sensitivity
5	Cost control	Connectivity	Decrease cost of connectivity hardware and services by 20%	1%	2%	Not included in Base Case or Base Case Sensitivity
6	Cost control	Incentives	Reduce incentives and non-monetary rewards for customers by 20%	6%	0 %	Not included in Base Case or Base Case Sensitivity

PGE has identified fourteen additional variables that require further exploration before PGE can quantify their specific impact on cost effectiveness. These are categorized as **possibilities** in Table 36. These variables may have either unquantified benefits, be outside of PGE's direct sphere of influence or control, be complex to implement, or share a combination of those characteristics. For instance, the process of identifying and quantifying the capacity impacts of which additional types of water heater Flexible Load events (load-up, load-follow, frequency regulation, ancillary services) best support grid performance outcomes (e.g., relieving distribution capacity constraints) will be done in the Testbed in partnership with National Renewable Energy Laboratory (NREL) and the Energy Trust. Pending the Testbed's findings, Smart Water Heating will then need to operationalize those use cases in order to realize their value.

In addition to the variables listed below in Table 36, of particular note is the impact Flexible Load could have on avoided power costs via its use in the CAISO EIM (described in Section 1.6.4). Initial modeling suggests there are significant potential benefits that may result from this activity. Efforts to register our DR resource enable 1) PGE to avoid double-procurement energy in the day ahead market, allowing us to pass the resource sufficiency test, and 2) open the door to more advanced DR programs that could provide intra-hour flexibility. However, as 2022 is the first year PGE is able to use Flexible Load in the CAISO, quantification of those benefits is not currently available for inclusion in our cost effectiveness calculation. We look forward to future analysis and assessment of the incorporation of avoided power costs on Smart Water Heating's cost effectiveness score.

Table 36 – Possibilities to Improve Smart Water Heating Cost Effectiveness

Variable No.	Category	Variable	Possibility
7	Value Stream	Connectivity	Increase the rate of water heater connectivity
8	Cost control	UCM hardware	Decrease the cost of UCM hardware and communications costs
9	Cost control	Accounting	Review option to re-evaluate accounting treatment for pilot costs relative to CE
10	Cost control	Staffing	Review options to reduce administrative burden while maintaining adequate resources for effective implementation
11	Value stream	Cost of energy	Update the avoided cost of energy to reflect higher peak pricing
12	Value stream	Non-energy benefits	Include the value of health benefits
13	Value stream	Additional events	Add load-up events
14	Value stream	Additional events	Add load-following events
15	Value stream	Additional events	Add frequency response events
16	Cost Control	Fleet size	Increase number of water heaters in fleet without additional administrative burden
17	Value stream	Load-shifting events	Increase capacity delivered per water heater through optimization and automation
18	Value stream	Ancillary services	Add the value of ancillary services
19	Cost control	Tools and services	Review options to streamline operations to reduce costs related to warehousing, digital tools, licenses, etc.
20	Cost control	Installer incentives	Review options to reduce the incentive amount per UCM installed as the market matures.

Finally, we believe that updated approaches to cost effectiveness methodology currently being discussed through the DSP may enable SWH to include benefits that are not included in our existing methodology.

5.2.6.2 Conclusion

PGE will continue to aggressively explore cost effectiveness variables throughout the life of the pilot and report to stakeholders on our progress through our quarterly DRAG and FLASH meetings. The team will use a stage-gate approach to moving the pilot forward via multi-year plan, deferral renewal, and annual report filings (see the stage gates laid out in the right-hand column of Table 11). We believe water heat is a critical component of our Flexible Load portfolio, and that its value will continue to appreciate as we are able to recognize and quantify additional use cases, include additional benefits from updated approaches to cost effectiveness, realize the benefits of market and policy transformation, and increasingly leverage Flexible Load with the operations of the utility to offset other costs.

Chapter 6 Next Steps / Stakeholder Engagement

6.1 Tariff filing timeline

No tariff filings are included with this MYP Update. PGE requests Commission consideration of the MYP Update by November 11, 2022 to allow the Company time to file applicable tariffs and begin proposed pilot activity with the new year.

6.2 Reporting

Table 37 – Report Contents and Cadence for First Two Years

Metric	Portfolio Level	Cadence	Program Level	Cadence	Notes
Flexible capacity acquired	✓	Annually	✓	Annually	Totals relative to annual goals
Incentives Provided	✓	Annually	✓	Annually	
Expenditures	✓	Annually	✓	Annually	Relative to budgets
Forecast Annual Portfolio Cost	✓	Annually	✓	Annually	
Total Resource Cost Test	✓	Annually	✓	Annually	Benefit-cost ratio
Utility Cost Test	✓	Annually	✓	Annually	Benefit-cost ratio
Administrative Costs	✓	Annually	✓	Annually	As percent of annual expenditures
Sites/Customers Served	✓	Annually	✓	Annually	Some C&I customers have multiple sites
Schedule 135 Recovery	✓	Annually	✓	Annually	
Goal Setting	✓	Annually	✓	Annually	

6.3 Stakeholder Engagement

Firstly, PGE would like to convey our deep appreciation to UA 290, Citizens' Utility Board (CUB), the Community Energy Project (CEP), Commission Staff, the Energy Trust, members of the Flexible Load Advisory Stakeholder group (FLASH), Natural

Resources Defense Council (NRDC), the New Buildings Institute (NBI), Northwest Energy Coalition (NWEC), Northwest Energy Efficiency Alliance (NEEA), Northwest Power and Conservation Council (NWPCC) staff, participants in the Distribution System Planning Monthly Workshop series, Plumbing and Mechanical Contractors Association, PGE's ABLE Disabilities Business Resource Group, Washington Co. Community Action Partner, Renewable NW, and other partner organizations, whose engagement and contributions have helped shape the SWH proposal put forward in this filing.

PGE will continue to host quarterly DRAG and FLASH meetings with OPUC staff and stakeholders to report on portfolio performance and to engage on development activities.

The Testbed team will continue to engage with the DRRC on a quarterly basis.

Product teams continue to engage with stakeholders via the DSP workshops and individually to discuss development activities.

PGE will next report on performance of the Flexible Load portfolio by end of year 2022.

Appendices

Appendix A Regulatory and Legislative Reference

Table 38 – Regulatory Reference

Reference	Title	Link
EO 20-04	Directing State Agencies to Take Actions to Reduce and Regulate Greenhouse Gas Emissions	https://www.oregon.gov/gov/Documents/executive_orders/eo_20-04.pdf
HB 2021	Relating to clean energy; and prescribing an effective date	https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2021
HB 2062	Relating to energy efficiency standards; and prescribing an effective date.	https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2062
HB 3141	Relating to energy; and prescribing an effective date.	https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB3141
HR 7962	To amend the Energy Policy and Conservation Act to modify the definition of water heater under energy conservation standards, and for other purposes.	https://www.congress.gov/bill/117th-congress/house-bill/7962
LC 73	PGE 2019 Integrated Resource Plan (IRP)	https://apps.puc.state.or.us/edockets/DocketNoLayout.asp?DocketID=21929
Order 19-313	Application for Reauthorization to Defer Expenses Associated with Two Residential Demand Response Pilots	https://apps.puc.state.or.us/orders/2019ords/19-313.pdf
Order 21-158	Flexible Load Plan Acceptance	https://apps.puc.state.or.us/orders/2021ords/21-158.pdf
Order 17-386	2016 IRP Acknowledgement	https://apps.puc.state.or.us/orders/2017ords/17-386.pdf
UE 394	PGE's Request For A General Rate Revision	https://apps.puc.state.or.us/edockets/docket.asp?DocketID=22887
UM 1514	Application for Deferral of Incremental Costs Associated with Automated Demand Response	https://apps.puc.state.or.us/edockets/docket.asp?DocketID=16575
UM 1708	Portland General Electric Demand Response Pilots Expenses Deferral	https://www.oregon.gov/puc/eDockets/Pages/default.aspx
UM 1827	Application for Deferred Accounting of Costs Associated with Demand Response Water Heater Pilot	https://apps.puc.state.or.us/edockets/docket.asp?DocketID=20726
UM 1856	PGE Draft Storage Potential Evaluation	https://apps.puc.state.or.us/edockets/docket.asp?DocketID=20913
UM 1893	Staff Investigation Of Methodology And Process Of EE Cost-Effectiveness	https://apps.puc.state.or.us/edockets/DocketNoLayout.asp?DocketID=20999
UM 1938	Transportation Electrification Plan	https://apps.puc.state.or.us/edockets/DocketNoLayout.asp?DocketID=21371
UM 2005	Distribution System Planning	https://apps.puc.state.or.us/edockets/docket.asp?DocketID=21850
UM 2141	Flexible Load Plan	https://apps.puc.state.or.us/edockets/docket.asp?DocketID=22696

Appendix B Budgets for the Flexible Load Portfolio

Table – Budget Summary by Product Stage

Product Stage	2022	2023	Total
Product Development	$14,497	$452,396	$466,893
Program Management	$9,568,061	$10,627,879	$20,195,940
Smart Grid Testbed	$1,197,070	$1,067,565	$2,264,635
	$10,779,628	**$12,147,840**	**$22,927,468**

Table 39 – Budget Summary by Program/Pilot

Product Stage	Program/Pilot	2022	2023
Product Development	Smart Water Heating (SWH)	$14,497	$452,396
Program Management	Residential - Flex PTR	$2,736,500	$2,711,500
	Residential - Flex TOD	$581,300	$749,000
	Residential - Thermostats	$2,833,548	$3,176,000
	Com - Energy Partner Sch 26	$3,416,713	$3,991,379
Smart Grid Testbed	Phase II	$1,197,070	$1,067,565
		$ 10,779,628	**$ 12,147,840**

Table 40 – Budget Detail: Incremental Contract Labor

Product Stage	Program/Pilot	2022	2023
Product Development	Smart Water Heating (SWH)	-	$119,046
Program Management	Residential - Flex PTR	-	-
	Residential - Flex TOD	-	-
	Residential - Thermostats	-	-
	Com - Energy Partner Sch 26	$16,000	$6,000
Smart Grid Testbed	Phase II	-	-
		$16,000	**$125,046**

Table 41 – Budget Detail: Incremental PGE Labor

Product Stage	Program/Pilot	2022	2023
Product Development	Smart Water Heating (SWH)	-	-
Program Management	Residential - Flex PTR	$65,000	-
	Residential - Flex TOD	-	-
	Residential - Thermostats	$60,548	-
	Com - Energy Partner Sch 26		-
Smart Grid Testbed	Phase II	$357,070	$357,565
		$482,618	**$357,565**

Table 42 – Budget Detail: DRMS Provider

Product Stage	Program/Pilot	2022	2023
Product Development	Smart Water Heating (SWH)	-	$2,000
Program Management	Residential - Flex PTR	-	-
	Residential - Flex TOD	-	-
	Residential - Thermostats	$952,548	$980,000
	Com - Energy Partner Sch 26	$611,050	$653,026
Smart Grid Testbed	Phase II	$300,000	$130,000
		$1,863,598	**$1,765,026**

Table 43 – Budget Detail: Evaluation

Product Stage	Program/Pilot	2022	2023
Product Development	Smart Water Heating (SWH)	-	-
Program Management	Residential - Flex PTR	$150,000	$110,000
	Residential - Flex TOD[116]	$ -	$190,000
	Residential - Thermostats	$300,000	$300,000
	Com - Energy Partner Sch 26	$101,350	$100,000
Smart Grid Testbed	Phase II	-	-
		$551,350	**$ 700,000**

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[116] TOD reallocated some 2022-23 funds from the marketing/outreach budget to the evaluation budget to fund the work needed to address OPUC evaluation requirements. These evaluation requirements are laid out in the following OPUC Staff report:

OPUC. *ADV 1194/Advice No. 20-34: Staff Report; Public meeting January 26, 2021.* Retrieved from: https://edocs.puc.state.or.us/efdocs/HAU/adv1194hau17552.pdf

Table 44 – Budget Detail: Recruitment & Customer Outreach

Product Stage	Program/Pilot	2022	2023
Product Development	Smart Water Heating (SWH)	$11,997	$12,500
Program Management	Residential - Flex PTR	$215,000	$280,000
	Residential - Flex TOD	$ 581,300	$ 559,000
	Residential - Thermostats	$89,452	$150,000
	Com - Energy Partner Sch 26	$14,000	$24,000
Smart Grid Testbed	Phase II	$90,000	$100,000
		$ 1,001,749	**$1,125,500**

Table 45 – Budget Detail: 3rd party Implementer

Product Stage	Program/Pilot	2022	2023
Product Development	Smart Water Heating (SWH)	$2,500	$20,348
Program Management	Residential - Flex PTR	$460,000	$475,000
	Residential - Flex TOD	-	-
	Residential - Thermostats	$36,000	$36,000
	Com - Energy Partner Sch 26	$1,229,000	$1,486,408
Smart Grid Testbed	Phase II	$350,000	$265,000
		$2,077,500	**$2,282,756**

Table 46 – Budget Detail: Direct Installation/Field Labor/Materials

Product Stage	Program/Pilot	2022	2023
Product Development	Smart Water Heating (SWH)	-	$104,738
Program Management	Residential - Flex PTR	-	-
	Residential - Flex TOD	-	-
	Residential - Thermostats	$300,000	$300,000
	Com - Energy Partner Sch 26	$396,400	$467,827
Smart Grid Testbed	Phase II	$50,000	$50,000
		$746,400	**$922,565**

Table 47 – Budget Detail: Incentives

Product Stage	Program/Pilot	2022	2023
Product Development	Smart Water Heating (SWH)	-	$193,764
Program Management	Residential - Flex PTR	$1,846,500	$1,846,500
	Residential - Flex TOD		
	Residential - Thermostats	$1,095,000	$1,410,000
	Com - Energy Partner Sch 26	$1,048,913	$1,254,118
Smart Grid Testbed	Phase II	$50,000	$165,000
		$4,040,413	**$4,869,382**

Appendix C Flexible Load Forecasted MW Capacity

Table 48 – Detail of Flexible Load Portfolio's Forecasted MW Capacity

Program/Pilot	Season	2022	2023	2024
Energy Partner (Sch 26)	Summer	36.0	39.5	42.0
	Winter	31.3	33.8	35.3
Peak Time Rebates	Summer	18.5	19.9	20.9
	Winter	15.3	16.5	17.3
Smart Thermostat	Summer	33.1	36.5	39.9
	Winter	10.9	11.6	12.4
Subtotal of MW Capacity from Maturing Pilots and Program Activity[117]	Summer	87.6	95.9	102.8
	Winter	57.5	61.9	65
Energy Partner (Sch 25)	Summer	1.5	2.2	4.3
	Winter	1.4	1.8	3.5
Multi-family Water Heating	Summer	6.2	6.2	6.4
	Winter	9.3	9.3	9.6
Subtotal of MW Capacity from Pilots in Design Transition	Summer	7.7	8.4	10.7
	Winter	10.7	11.1	13.1
Grand Total MW Capacity from the Demand Response Portfolio[118]	**Summer**	**95.3**	**104.3**	**113.5**
	Winter	**68.2**	**73.0**	**78.1**

Table 49 – Detail of Related Activities' Forecasted MW Capacity

Related Activity	2022	2023	2024
Residential Smart Battery	0.3	1.8	2.4
Residential EV Charging	1.2	1.7	2.3
Total MW Capacity from Related Activities	**1.5**	**2.7**	**3.3**

[117] Does not include Time of Day Combined Summer and Winter Forecasted MW Capacity of 2.6MW (2023) and 5.7MW (2024).
[118] Ibid.