Portland General Electric Company
121 SW Salmon Street • 1WTC0306 • Portland, OR 97204
portlandgeneral.com

November 3, 2021

Via Electronic Filing

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

Re: UM 2141 Flexible Load Multi-Year Plan 2022-2023

Dear Filing Center:

Portland General Electric Company (PGE) submits this Flexible Load Multi-Year Plan (MYP) pursuant to Public Utility Commission of Oregon (OPUC or Commission) acceptance of PGE's 2020 Flexible Load Plan through Order 21-158 which in part accepted PGE's proposal to file a Flexible Load Multi-Year Pan.

Our inaugural Flexible Load Multi-Year Plan is our first effort in multi-year holistic transparent planning, budgeting and reporting for flexible load. As we noted in the 2020 Flexible Load Plan, PGE views this activity as best practice and is committed to continuing the practice through regular submittals of flexible load multi-year plans. PGE is additionally committed to updating our multi-year plans and providing annual reporting and quarterly insight meetings.

This Flexible Load Multi-Year Plan proposes activity to continue growth of our current flexible load portfolio through 2023 to reach 103MW. PGE is requesting $35M through 2023 to continue our current flexible load activities such as multi-family water heaters, peak-time rebates and PGE's Smart Grid Testbed and to advance new product concepts meant to accelerate flexible load development and MW acquisitions through 2023. PGE is proposing modest sums of funding to launch our product concepts such as a Home Energy Bundle which we anticipate will increase acquisitions of energy efficiency, self-generation and flexible load. If approved PGE will continue to report to stakeholders and the Commission Staff on our progress and product structure before submitting an update to this Multi-Year Plan in August 2022. The update will include greater detail regarding our product concepts supported by more firm insights through the finalization of PGE's Distributed Energy Resource Potential Study, and an evolved cost effectiveness study to be found in our Distribution System Plan Part II also to be submitted in August 2022.

Lastly, the Flexible Load Multi-Year Plan proposes a new cost recovery mechanism similar in nature to how energy efficiency is funded. As discussed in the Flexible Load Plan, PGE sees benefits in moving away from current deferrals for cost recovery and moving to a supplemental schedule that better represents risk.

Please direct any question regarding this filing to Jason R. Salmi Klotz at 503-464-7085 or Andy Macklin at 503-464-8129. Please direct all formal correspondence and requests to the following e-mail address pge.opc.filings@pgn.com

Sincerely,

/s/ Nidhi Thakar

Nidhi Thakar
Director, Resource and Regulatory Strategy and Engagement
503-464-7627 (office) • 301-704-2512 (cell)

NT/jsk
Enclosure

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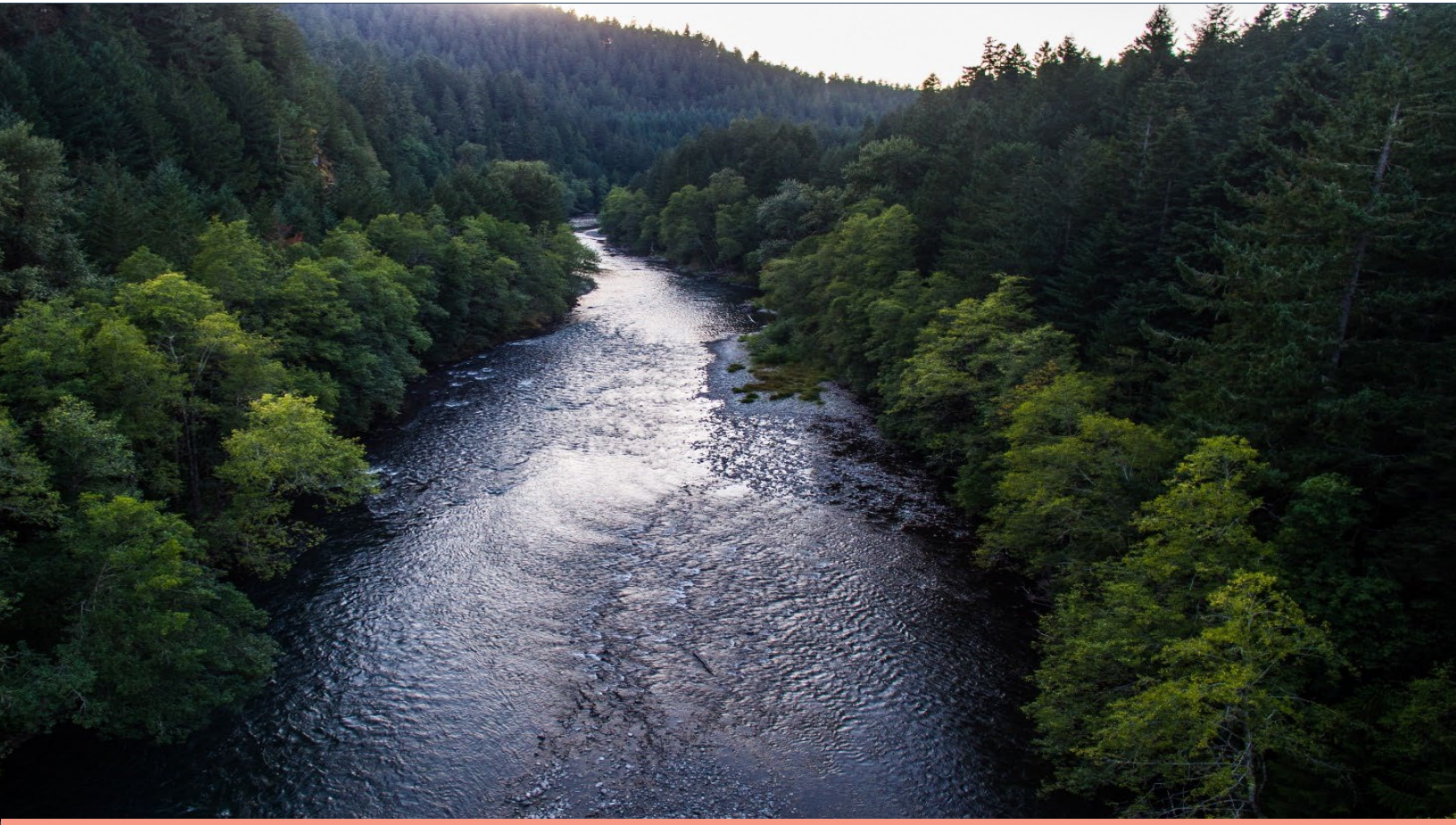

Flexible Load Multi-Year Plan
November 2021

PGE

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Table of Contents

Figures, Charts, Tables

Acronyms

AER .....Automated Emissions Reduction
AMI .....Advanced Metering Infrastructure
ADMS .....Advanced Distribution Management System
AMI .....Advanced Metering Infrastructure
aMW .....Average Megawatt
AWEC.....Alliance of Western Energy Consumers
BCA .....Benefit Cost Analysis
BTM .....Behind-the-Meter
BYOT .....Bring Your Own Thermostat
C&I.....Commercial and Industrial
CAISO .....California Independent System Operator
CBO.....Community-Based Organization
CE .....Cost Effectiveness
CEP .....Community Energy Project
CNBI .....Customer Needs-Based Innovation
CRO .....Contingency Reserve Obligation
CUB .....Citizens' Utility Board
DEI .....Diversity, Equity, and Inclusion
DER(S) .....Distributed Energy Resource(s)
DERDMS ..Distributed Energy Resource Data Management System
DERMS .....Distributed Energy Resource Management System
DHP .....Ductless Heat Pump
DOE.....Department of Energy
DR .....Demand Response
DRAG .....Demand Response Advisory Group
DRMS.....Demand Response Management System
DRRC.....Demand Response Review Committee
DSG .....Dispatchable Standby Generation
DSM.....Demand Side Management
DSP .....Distribution System Planning
EE ..... Energy Efficiency
ELCC..... Electric Load Carrying Capacity
EPRI..... Electric Power Research Institute
EV ..... Electric Vehicle
EVSE ..... Electric Vehicle Service Equipment
GHG..... Greenhouse Gas
HB ..... Oregon House Bill
HVAC..... Heating, Ventilation, and Air Conditioning
Hz ..... Hertz
IOC..... Integrated Operations Center
IRP ..... Integrated Resource Plan
ISO ..... Independent System Operator
kW..... Kilowatt
LEA..... Line Extension Allowance
LTE ..... Long Term Evolution (wireless broadband standard)
MFD ..... Multi-family Dwelling
Mid-C..... Mid-Columbia Electricity Index
MW ..... Megawatt
MWh ..... Megawatt Hour
MYP..... Flexible Load Multi-Year Plan
NEEA ..... Northwest Energy Efficiency Alliance
NEM ..... Net Energy Metering
NERC ..... North American Electric Reliability Corporation
NESP ..... National Energy Screening Project
NPS ..... Net Promoter Score
NREL ..... National Renewable Energy Laboratory
NSL..... Net System Load
NWA ..... Non-Wires Alternative
NWPCC ... Northwest Power and Conservation Council
ODOE..... Oregon Department of Energy
OEM..... Original Equipment Manufacturer
OIT ..... Oregon Institute of Technology
OPUC..... Oregon Public Utility Commission

OSI.....Open Systems International, Inc.
OSU.....Oregon State University
PLM.....Product Lifecycle Management
PNNL.....Pacific Northwest National Laboratory
PSU.....Portland State University
PTR.....Peak Time Rebates
PV.....Photovoltaic
R&D.....Research and Development
RFP.....Request for Proposal
RIM.....Rate Impact Measure Test
ROW.....Right of Way
RTF.....Regional Technical Forum
SALMON.SmartGrid Advanced Load Management and Optimized Neighborhood
SFWH.....Single Family Water Heater
TE.....Transportation Electrification
TOD.....Time of Day
TOU.....Time of Use
TRC.....Total Resource Cost Test
TSO.....Transmission System Operator
T-Stat.....Thermostat
U of O.....University of Oregon
UM.....Utility Miscellaneous (OPUC Docket)
V2G.....Vehicle to Grid
VPP.....Virtual Power Plant
WSU.....Washington State University

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 – Flexible 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.

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

Executive Summary

PGE presents our first Flexible Load Multi-Year Plan (Multi-Year Plan, MYP, or Plan). The Multi-Year Plan is a demonstration of our adoption of best practices for planning, reporting and transparency. The intent of the Plan is to provide a two-year look of Flexible Load savings acquisition activity and proposed spending. The Multi-Year Plan includes a quarterly reporting and engagement process with the Oregon Public Utility Commission (Commission) Staff and stakeholders, yearly reports, and updates. In this first iteration, the Multi-Year Plan also includes updates to our evolving cost effectiveness methodology and a proposal for a new cost recovery mechanism, shifting from the deferral process of the past to a mechanism which mirrors energy efficiency (EE), our other demand-side management (DSM) investment.

Since the Commission's approval of PGE's Flexible Load Plan,[2] the legislature has passed several new bills and the Commission has advanced policy on distribution resource and system planning. These changes have required a swift shift for PGE. This shift is apparent and notable in the Multi-Year Plan. The reader will see that our mature activity such as Peak Time Rebate (PTR), Smart Thermostats, Energy Partner, and Multi-Family Water Heaters continue to evolve toward full-fledged stable programs capable of resource replacement and Power Operations' dispatch.

However, with the passage of HB 2021[3] and the evolution seen in Docket UM 2005[4], PGE pilot activity has rapidly shifted. As noted in the Flexible Load Plan, where PGE stated our intent to begin bundling offers and moving into the early replacement and new construction markets, our pilot work, as demonstrated herein, is evolving into these strategies. PGE is also, through bundling and new market entry, exploring program structures that accelerate electrification and decarbonization through the rapid deployment and utilization of distributed energy resources (DERS) as Flexible Load. At the time of writing the Multi-Year Plan, PGE was in full shift, exploring new structures and approaches for Flexible Load resource development.

The reader will see within this Plan five new offerings in development, each keeping to the bundled and new market strategy first outlined in the Flexible Load Plan.[5] Our funding request to initiate these activities is modest for 2022 and contains no request

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[2] Oregon Public Utility Commission Docket UM 2141, available at https://apps.puc.state.or.us/edockets/docket.asp?DocketID=22696.

[3] Oregon House Bill 2021, available at: https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2021.

[4] Oregon Public Utility Commission Docket UM 2005, available at https://apps.puc.state.or.us/edockets/docket.asp?DocketID=21850.

[5] It is acknowledged that EE is the precursor to flexibility and envisioned that EE measures be paired with FLP offerings. It is PGE's desire to incentivize controllable end-use EE measures and, if measures are cost-effective but not controllable, that we seek to understand how best to enable said controllability.

to fund 2023 activity. Thus, to shift to customer and community solutions that accelerate Flexible Load development, DER deployment, EE and decarbonization, PGE is only requesting 2022 funding for offerings in development. When we file proposals with the Commission to seek approval of these offerings, we will file updated budget forecasts which detail the cost to develop, implement, and scale these offerings. Alternatively, for any offerings to be filed after Q3 of 2022, we will, in coordination with our Distribution System Planning (DSP) Phase II filing (expected in August 2022) update the Multi-Year Plan to reflect more robust planning for pilot work in development.

Prior to filing the Multi-Year Plan 2022 update, we will hold quarterly updates with Staff and workshops with stakeholders to ensure that offerings in development are properly vetted prior to submittal of a proposal for Commission approval. This approach allows PGE to complete our shift, while giving the Commission review of the pace and size of this activity.

The Multi-Year Plan requests:

- **Approval for two years (2022/2023) of funding ($30.7M) for current pilot/program activities**:
    1. Smart Thermostats
    2. Time of Day
    3. Peak Time Rebates
    4. Multi-Family Water Heaters
    5. Energy Partner
- **Approval for one year (2022) of funding ($2.13M) for development activities**:
    1. Home Energy Bundle
    2. Community Microgrids
    3. Single Family Water Heater
    4. Residential New Construction Bundle
    5. Commercial Resiliency Solution
- **Approval for initial Testbed cost recovery of ($2.26M)** as outlined in PGE's Smart Grid Testbed Phase II Proposal[6]
- Approval of our cost recovery mechanism, moving from the current individual deferral mechanisms to a holistic supplemental mechanism with a balancing account.

[6] Filing available at https://edocs.puc.state.or.us/efdocs/HAD/um1976had145212.pdf. PGE's Smart Grid Testbed Phase II Proposal requests release of $2.857M for initiation work on three of seven projects (Distributed PV/Smart Inverters, Managed Charging/V2G, and Flexible Feeder). With the release of requested US DOE grant money, the Flexible Feeder project will be accelerated and enhanced. PGE is not requesting the Testbed's additional $600K in 2024 budgeted funding as such a funding request is beyond the scope of this multi-year filing. The 2022 Multi-Year Plan update will incorporate this funding request.

- Agreement to receive an update to the Multi-Year Plan in the second half of 2022, which will give PGE time to shift to meet the goals outlined in new Commission and legislative policy.

As shown in Table 1 below, the projected total cost of PGE's 2022/2023 Flexible Load activity is $35M. We are asking for approval to recover $35M over two years through the proposed cost recovery supplemental mechanism. The total cost number includes planned activity in the Smart Grid Testbed Phase II currently before the Commission.[7] It is important to note that under the Testbed Phase II proposal, the Testbed will request additional funding from the Commission as activity matures and budgets are developed and agreed to at the Demand Response Review Committee (DRRC). This approached is outlined in the Testbed Phase II Proposal. Our product concepts and pilot activity are shifting to meet new policy. Detail is provided in Chapter 4. This also means that we do not–at present–have full clarity of the funding needed in 2023 to successfully launch the activity. We will provide greater detail in our August 2022 Multi-Year Plan update.

As shown in Table 2 below, the total projected megawatt savings from PGE's currently approved DR activities through 2023 is approximately 103MW Summer and 67MW Winter. These projected savings do not account for new pilots and programs, new sources of DR, modifications to existing programs, load growth, or new approaches to customer awareness and adoption. As such, these savings are subject to modification in 2022, when PGE will better understand the additional savings potential available through our current product development and pilot activities. These savings will be informed by adjustments and clarification of market potential from our DER Potential Study, which is being finalized with the DSP Phase II filing in August of 2022. PGE continues to aggressively pursue the 2019 Integrated Resource Plan (IRP) Flexible Load MW savings goals of 211MW Summer and 141MW Winter as approved by the Commission in Order 20-152.[8]

Additionally, PGE is making some modifications to current activities to include a greater spectrum of Flexible Load; Energy Partner is the first activity to include these changes. Table 2 only shows savings from our current mature activity as it continues its progression to program status, like our Energy Partner program. PGE will be adjusting these activities to acquire additional savings and inform new products such as Single-Family Water Heaters. The savings figures in Table 2 do not account for potential savings from pilot activity. We will update our savings predictions through the Multi-Year Plan 2022 Update and will keep stakeholders and Commission Staff abreast of our progress through stakeholder meetings and the Demand Response Advisory Group (DRAG).

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[7] See link in footnote 6, above.

[8] Order 20-152, LC 73 Commission Adopted a Demand Response MW goal of 211MW summer and 141MW winter by 2025. Available at https://apps.puc.state.or.us/orders/2020ords/20-152.pdf.

Table 1 – Flexible Load Budget

Programs/Pilots/ Projects	2022	2023	Total
Product Development	$2,130,000	-	$2,130,000
Program Management	$15,083,803	$15,611,770	$30,695,572
Smart Grid Testbed	$1,197,070	$1,067,565	$2,264,635
Total	**$18,410,873**	**$16,679,335**	**$35,090,207**

Table 2 – Flexible Load Savings (MW)

Season	2021	2022	2023
Summer	79.8	92.6	103.4
Winter	51.4	60.4	66.8

The activity scores a 0.95 on the Total Resource Cost (TRC) test using our cost effectiveness methodology, which excludes the Value of Service Lost. It should be noted that this cost effectiveness methodology is using the 2019 IRP avoided resource cost established as a simple-cycle gas turbine. PGE recognizes that this input must and will change with the passage of HB 2021[9] and our upcoming Integrated Resource Plan (IRP). Additionally, our cost effectiveness methodology is in flux as we attempt to include and quantify the decarbonization and community-based planning and investment policy goals espoused by the Commission and Legislature. Many questions are raised with these necessary perspectives, including whether they are part of cost benefit analysis, cost effectiveness methodology, or some hybrid analysis. This discussion will be raised and addressed as part of our DSP Phase II filing, which has a more holistic scope than the MYP.

Lastly, PGE has included additional information in the MYP to inform readers of the full scope of our work. This includes a review of our Smart Grid Testbed work, our plans for the development of a measure database, the funding and coordination activity ongoing and planning with other entities in the region and nationally. PGE is presently working with the Energy Trust of Oregon (Energy Trust) to respond to and develop a coordinated planning process as outlined in HB 3141[10]. Both entities view HB 3141 as a critical mechanism to leverage the expertise and infrastructure of both PGE and the Energy Trust. Both entities envision an expanded role for the Energy Trust as we coordinate our measure development and deployment approaches. Only by close coordination can we maximize the PGE customer investment of $100M/year investment in EE in combination with the investments requested here in PGE's first

[9] Oregon House Bill 2021 available at: https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2021.
[10] Oregon House Bill 3141 available at: https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB3141.

Multi-Year Plan. PGE will work with Commission Staff to provide updates on our HB 3141 coordination process.

Filing Roadmap

The Multi-Year Plan, beginning with this 2021 filing, is an adoption and delivery of planning and budgeting best practices utilized by the more mature and long-standing EE practices employed nationally. As this is our first Multi-Year Plan and, given the recent changes in policy and law from the legislature and the Commission, we will provide an update in 2022 in concert with our DSP Phase II filing expected in August 2022. We will provide an update for several reasons.

First, our DER Study will be finalized with our DSP Phase II filing. This bottom-up study of PGE's service territory, programs, and cost effectiveness is a key component to long-term system and distribution system and DER resource planning, including Flexible Load. The draft DER study has already been shared with the Commission, Staff, stakeholders, and the public. This study shows a significant role for Flexible Load, but also a reduction in the assessed potential, technical and achievable and economic potential megawatts available. We have included a review of the relevant portion of that study in the opening sections of this Multi-Year Plan.

Additionally, as stated in the Flexible Load Plan, PGE is undertaking efforts to update our cost effectiveness methodology. The Testbed and our programs' residential participation rate of 22% indicates our innovative approaches to customer engagement and participation hold significant promise. This has led our program development team to begin identifying new customer approaches for accelerating adoption of Flexible Load. That update will be closer to final by the time we submit our DSP Phase II filing in 2022. As cost effectiveness is a major component in planning and developing Flexible Load pilots and programs, this Multi-Year Plan's cost effectiveness is based on an incremental update to–but not yet final–cost effectiveness methodology. Having a more evolved approach to cost effectiveness will also inform the Multi-Year Plan 2022 update.

PGE looks forward to the Commission's review of this, our first, Multi-Year Plan and receiving feedback from the Commission, Staff, and stakeholders on how to evolve this planning document to better serve the purposes and interests of ratepayers and customers.

Chapter 1 gives the reader a review of the some of the important Flexible Load findings from our recent draft DER Study. It provides total portfolio costs by activity. It reviews how PGE plans for Flexible Load development, revisiting some of the additional costs PGE carries for being a prime mover of Flexible Load development within the region. It also reviews emerging market channels identified by PGE in the Flexible Load Plan and, lastly, provides a portfolio-level cost effectiveness score.

Chapter 2 is a review of what it means to have a portfolio level approach to Flexible Load developments and reviews our coordination efforts. This chapter also outlines our proposed reporting requirements.

Chapter 3 is a review of the Smart Grid Testbed work, our Phase II proposal, and our demonstration work from both Phase I and proposed work for Phase II.

Chapter 4 is a review of all the activity we intend to scale, whether initially conducted as a pilot within our product development group or as a more mature activity working through the development cycle to program status.

Chapter 5 reviews the other related pilot and program activities which provide Flexible Load service, but which are, at present, not funded through Flexible Load development; these include our demand response enabled home charging pilot and our residential energy storage pilot.

Chapter 6 is an information-only chapter informing stakeholders of our intent to build a DER database similar to EE measure databases utilized by the Regional Technical Forum, the Energy Trust, the California Energy Commission, and the California Public Utilities Commission. We wrote about this work in the Flexible Load Plan and of the value it would bring to the region. We are not requesting funding for this activity in the Multi-Year Plan.

Chapter 7 gives the reader further insight into our work to evolve cost effectiveness for Flexible Load and DER development. Additional insights will come in the DSP Phase II filing in August 2022.

Chapter 8 is PGE's cost recovery proposal. As discussed in the Flexible Load Plan, PGE sees benefits in moving away from current deferrals for cost recovery and moving to a system similar to how EE is funded, using a supplemental schedule that better represents risk.

Appendix A provides a reference table to relevant regulation.

Appendix B is PGE's plan to transition Schedule 26 Energy Partner from pilot to program.

Appendix C houses a more detailed budget for Commission review.

Chapter 1 Introduction

1.1 Planning Environment

With the passage of HB 2021 by Oregon's 81st Legislative Session, PGE must decarbonize our electric system by 2040. The legislation carries with it significant policy changes. Local engagement and local energy infrastructure investment was a major theme of the Bill. PGE views Flexible Load as a major component in meeting the mandates and intent of the HB 2021 as Flexible Load development is inherently a non-emitting local customer resource capable of providing benefits to the customer, the community, and the electric system.

The Commission, through Docket UM 2005 "Investigation Into Distribution System Planning", has also emphasized community-based, customer-centric planning. Our UM 2005 Distribution System Planning (DSP) activity has only recently begun the long-term earnest work of system planning, distributed energy resource (DER) potential identification, and community engagement. This work is already affecting our Flexible Load work, and the effects of this work are evident in this Multi-Year Plan (MYP). The Distribution Resource Planning (DRP) team has engaged in cost-effectiveness modeling work discussed in the Flexible Load Plan to begin adjustments to our cost effectiveness methodology and perspective. This modelling will identify new values and incorporate new policy influencing the energy resource development landscape.

Additionally, the DRP team has issued a draft DER and Flexible Load Potential study (a foundational component of our DSP work), which provides a more granular, bottom-up approach to Flexible Load potential modeling. PGE expects Flexible Load development to evolve in step with our evolved DSP and DER capabilities, which will adjust as the aperture of our cost effectiveness perspective widens to meet the policies, community needs, and environmental challenges of our time.

At the time of writing the Flexible Load Plan (UM 2141)[11] in 2020, PGE was developing a portfolio of Flexible Load to meet the acknowledged demand response (DR)/Flexible Load resource acquisition goals laid out in the 2016 and 2019 Integrated Resource Plans (IRP). The 2016 IRP DR goals of 77/69MW accelerated to a 211/141MW goal in the 2019 IRP.

With the Investigation into Distribution System Planning (UM 2005)[12], PGE has begun to develop more granular and detailed Flexible Load planning capabilities. As part of

[11] Oregon Public Utility Commission Docket UM 2141 available at https://apps.puc.state.or.us/edockets/DocketNoLayout.asp?DocketID=22696.
[12] Oregon Public Utility Commission Docket UM 2005 available at https://apps.puc.state.or.us/edockets/docket.asp?DocketID=21850.

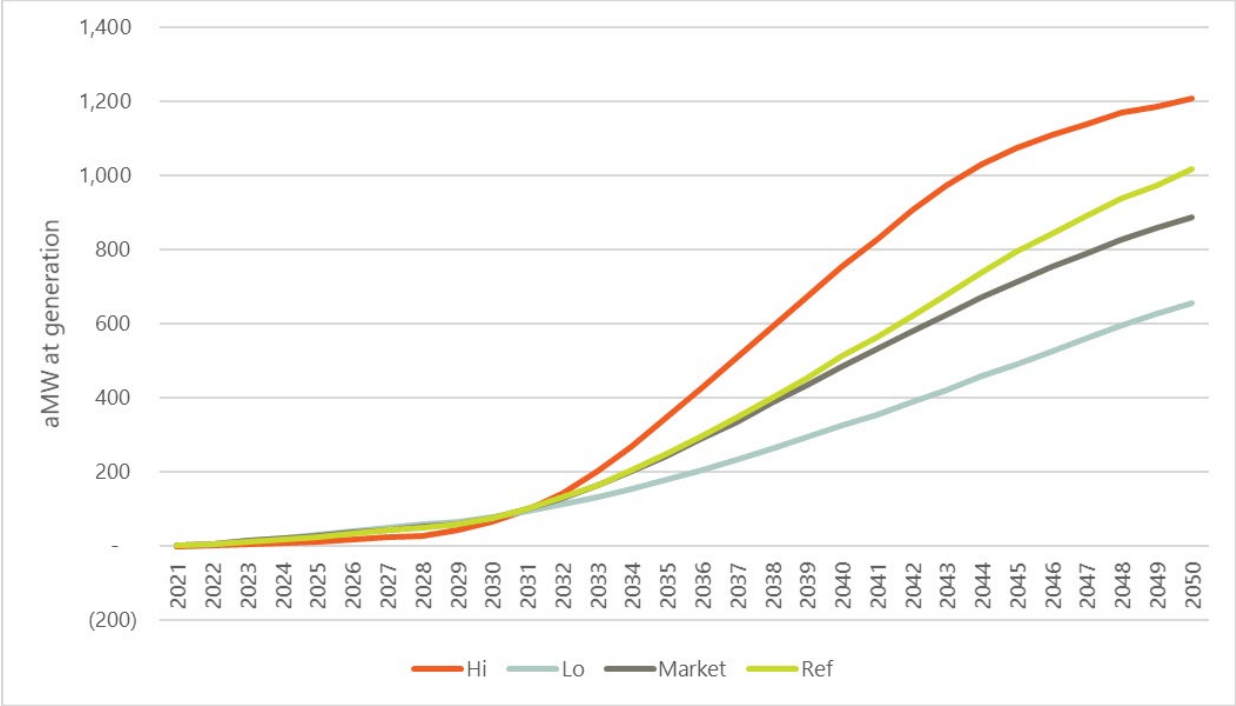
this activity, PGE conducted work to inform our technical, achievable, and economic Flexible Load potential. This work – once completed – would inform and feed the modeling and planning activity within the DSP and the IRP.

The outputs of the first draft of our DER and Flexible Load potential modeling work are presented here for several reasons. First, we are submitting the Flexible Load Multi-Year Plan alongside the October 2021 DSP Part I filing because of the interrelatedness with the DSP's DER planning and cost effectiveness work, which will have evolutionary impacts to our Flexible Load resource development perspectives, and therefore that activity. Second, sharing this early work is a way for PGE to show how the DSP will affect Flexible Load resource potential identification and planning. We are also sharing the shifts we are seeing both in scope and importance of the resource. Lastly, we share this information to inform our stakeholders of how our planning activity will adjust to new policies and markets, which are forcing our program teams to similarly adjust our approach to program development.

Flexible Loads are set to have a dramatic impact on PGE's system and its customers. Chart 1, below, shows the expected energy impacts (in aMW at generation) through 2050 under the different Flexible Load adoption scenarios.[13]

[13] PGE DER and Flexible Load Potential – Phase 1, available at https://portlandgeneral.com/about/who-we-are/resource-planning/distribution-system-planning.

Chart 1 – Expected Energy Impacts of DER Adoption

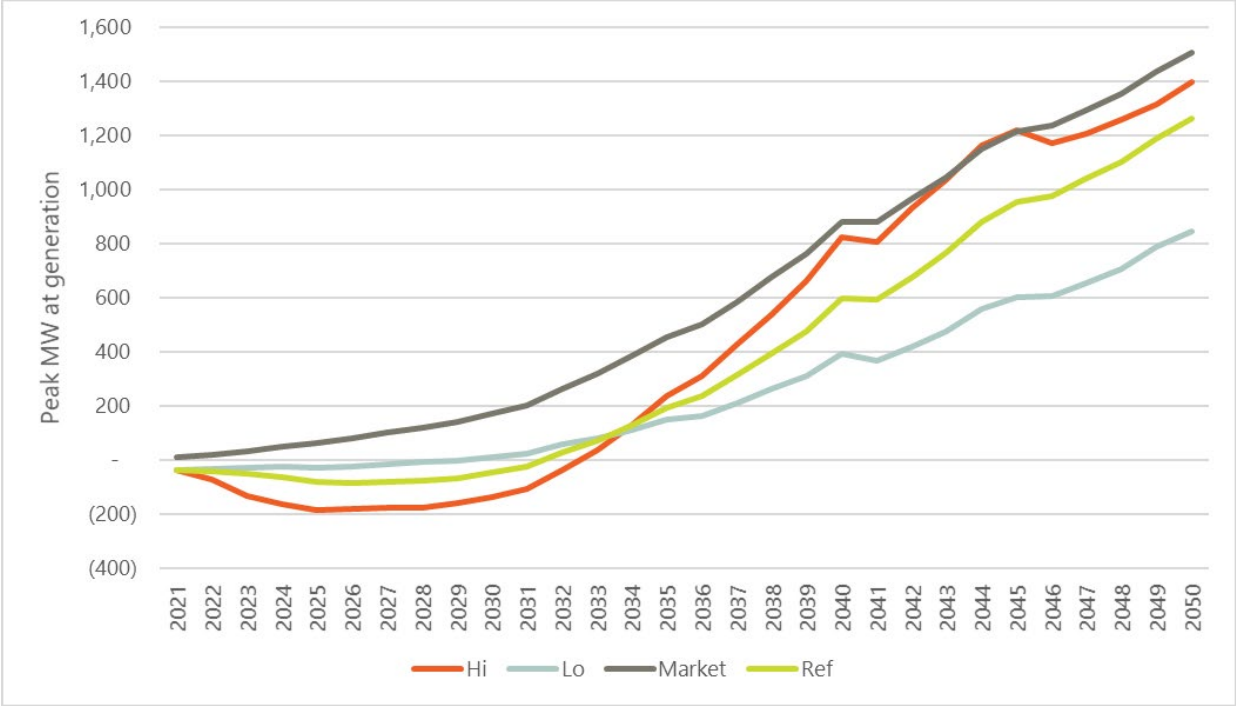


Even after accounting for increased solar adoption, PGE's load is set to increase by over 1,000 aMW in the reference case adoption scenario, driven primarily by transportation electrification, and, to a much lesser extent, naturally-occurring building electrification. The Market Scenario in Chart 1 provides an idea of what we expect to see absent programmatic activity.

The increase in load points to the need for flexible resources to manage peaks and mitigate upgrade costs across PGE's system. The critical role that Flexible Loads play can clearly be seen when looking at peak impacts. Chart 2, below, shows the average net demand impacts under each scenario, where peak is defined as the average over time of event dispatch in both summer and winter[14].

[14] This analysis is based on PGE's 2019 loss-of-load-probability modeling and is therefore not a replacement for a full effective load carrying capacity (ELCC) analysis for expected capacity contributions of these resources in future IRPs.

Chart 2 – Electrification: Flexible Load Peak Load Impacts



Here we see that PGE's continued development of its Flexible Load portfolio leads to a net decrease in peak loads attributable to DER growth in the early years, even when accounting for transportation electrification. However, in outer years, the impact of electrification overtakes Flexible Load adoption. When comparing the reference to the market case, these programs continue to play an important role in mitigating peak impacts.

In the Market Scenario, there are no Flexible Loads or dynamic rates, and changes in peak load are driven almost entirely by electrification.[15] This leads to steady, and eventually large, long-term increases to system peak load. In the programmatic scenarios (Hi, Lo, and Ref), these programs and rates help to reduce peak load to such an extent that their effect is greater than total additions from electrification in the early years of the planning period.

In aggregate, the DER and Flexible Load Potential - Phase I study identifies approximately 135 MW Summer and 108 MW Winter economically-achievable DR[16] (including behind-the-meter storage) in 2025, and 169 MW Summer and 134 MW Winter DR in 2027. These numbers are a departure and a reduction from our 2019 IRP action plan of 211MW/141MW Summer/Winter by 2025. However, these updated numbers, provided by our recent PGE DER study conducted by Cadeo, reflect

[15] There is some reduction in peak load from behind-the-meter solar, but note that storage here is un-managed, so is only used for backup and is also significantly less prevalent in the market scenario absent programmatic incentives.

[16] Economically Achievable activities are those that demonstrate a TRC ≥ 1 under PGE's current cost effectiveness methodology.

changes that have occurred since the 2019 IRP study conducted by Navigant (now Guidehouse). Those changes with the largest impact are: Flexible Load potential more closely aligned to PGE customer base and building stock; updates to reflect current program design and customer participation rates; and evaluation results from recent Flexible Load pilot activity. The 2019 IRP DER study had to make a number of assumptions about future programs and program performance and relied more heavily on benchmarked data from other jurisdictions. Additionally, Cadeo's forecast tracks more closely to the results we are experiencing in the field today and does not adjust for advances in program design for enhanced customer program adoption nor the implications of decarbonization policy acceleration in the region.[17]

The forecast shows PGE's portfolio to be dominated by Peak Time Rebate (PTR), Energy Partner, and the thermostat programs in the near term (as it is today). By 2050, Cadeo's models show 495 MW of summer DR, dominated by electric vehicle (EV) time of use (TOU) due to near-universal adoption of light duty EVs in the residential sector. Additionally, tech-enabled TOU becomes a bigger portion of the portfolio. Chart 3, below, lays out the composition of the forecasted DR in more detail:

Chart 3 – Forecast of Demand Response (Summer)[18]

[17] Note that although the reference case DR/Flexible Load forecast is lower than the reference case in the 2019 IRP study, final determination of the amount of DR/Flexible Load in terms of the IRP action plan has not yet been determined. That determination necessarily requires full IRP analysis, and commensurate Commission acknowledgement, of PGE's action plan. PGE plans to conduct analysis, in response to OPUC direction, of non-cost-effective DR potential in the next IRP to determine if additional demand-side resources would be selected into the preferred portfolio based on other system needs not currently reflected in PGE's cost-effectiveness methodology.

[18] PGE DER and Flexible Load Potential – Phase 1, available at Distribution System Planning | PGE (portlandgeneral.com).

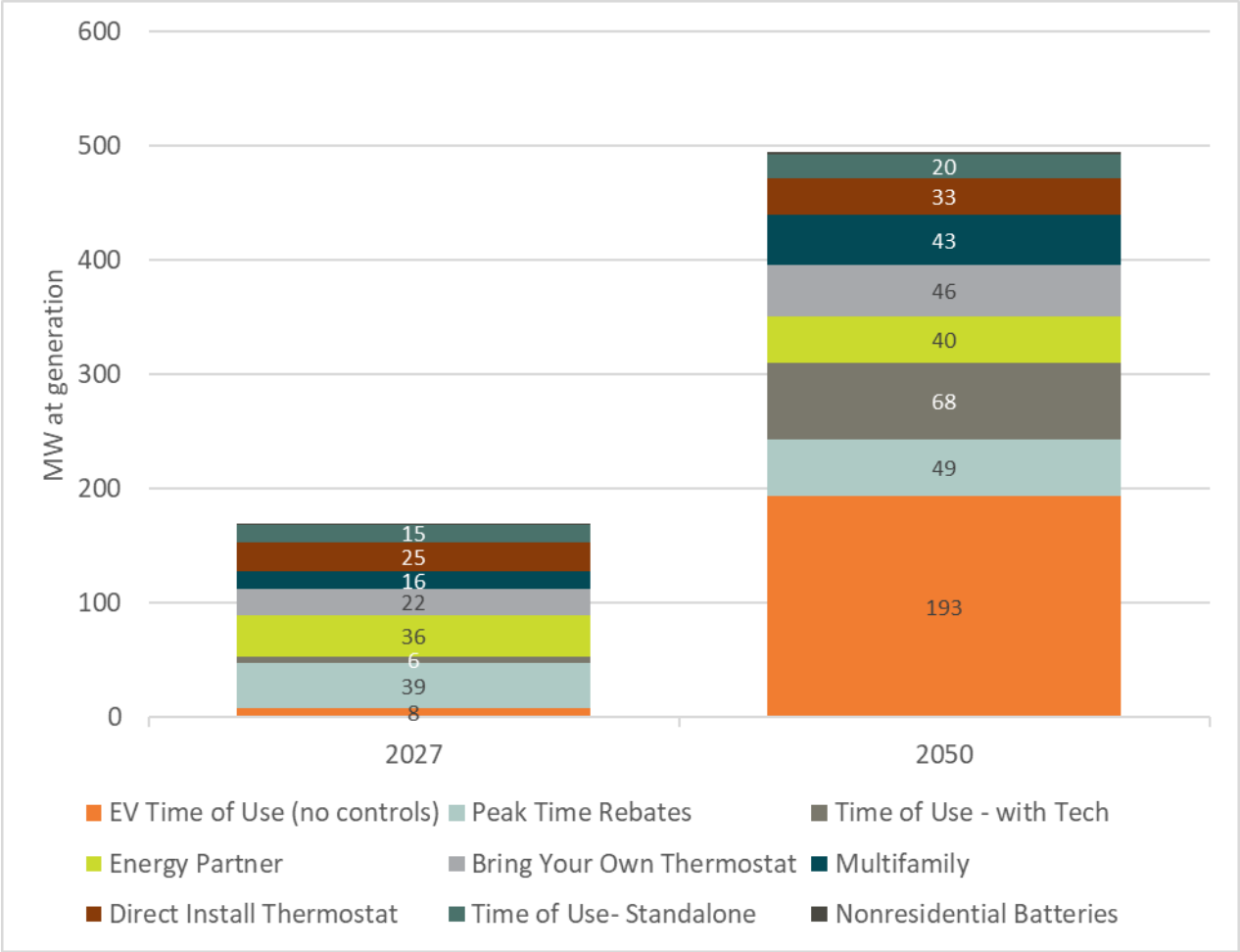


Chart 4, below, illustrates Cadeo's forecast of DR in the winter season. As in previous studies, the model results show slightly lower DR in the winter season due to lower levels of electric heating-relative to cooling-in both residential and commercial sectors. In 2027, we forecast 134 MW of economically-achievable winter DR, comprised of a mix of multi-family, thermostats, and the Energy Partner program (as shown in the Flex 1.0 evaluation, PTR and TOU rates have lower per-unit impacts in winter). In 2050, Cadeo forecasts 344 MW of DR. As in summer, EV TOU dominates due to its low level of seasonality, high impacts on peak, and high level of adoption.

Chart 4 – Forecast of Demand Response (Winter)

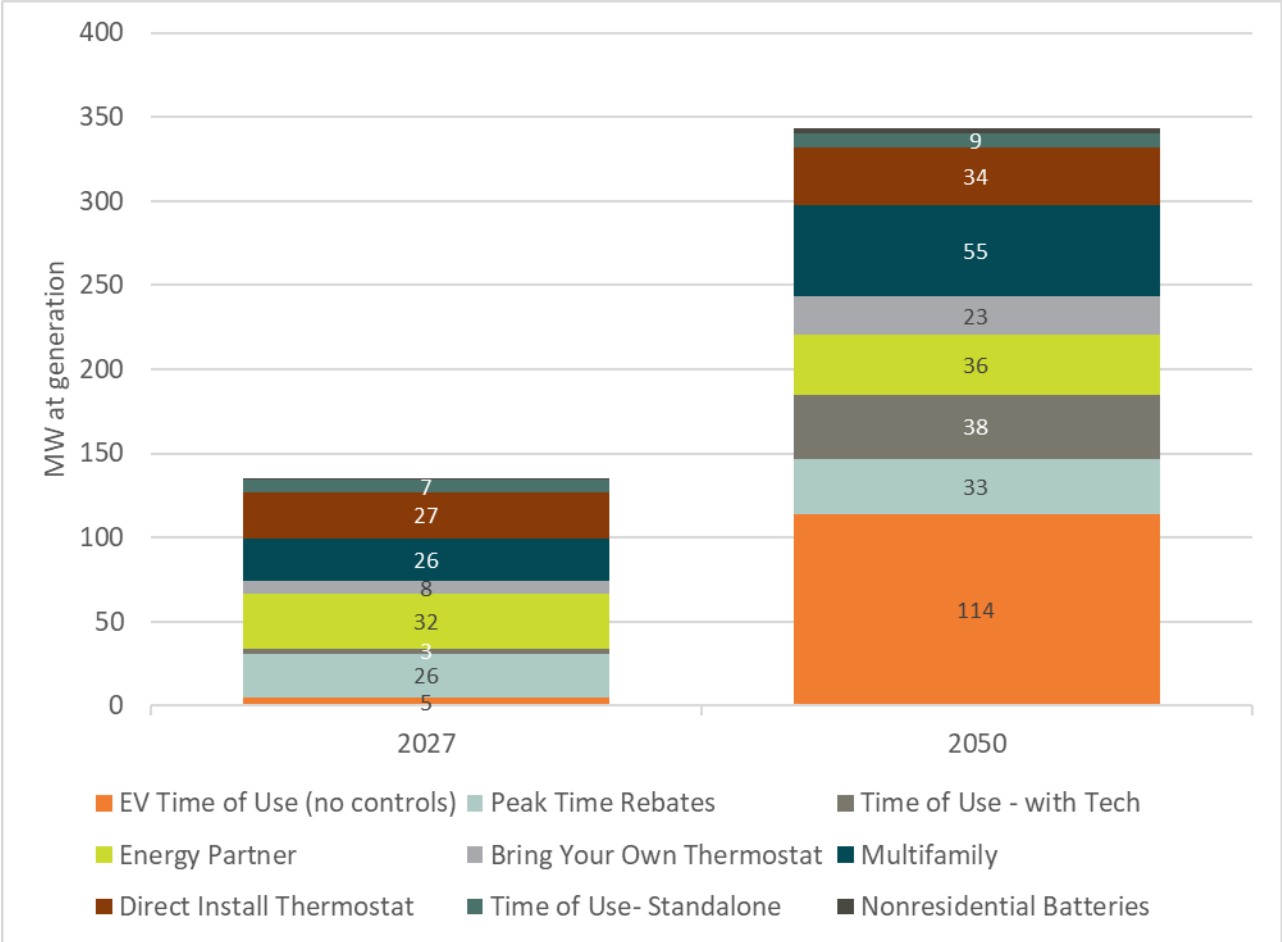


Table 3, below, provides a breakdown of expected MW impacts across different scenarios for both economic and achievable potential. In most scenarios, most of the DR is economic in terms of total MW. Those measures that are not cost-effective remain relatively low in adoption regardless, even out to 2050. The range of potential impacts is broad, reflecting the still high level of uncertainty around adoption of these measures, with ranges of approximately +/- 50% relative to the reference case forecast.

Table 3 – Demand Response Potential by Season and Scenario: 2027, 2050[19]

Scenario	Season	2027		2050	
		All Achievable	Economic Achievable	All Achievable	Economic Achievable
Reference	Summer	207	169	598	495
	Winter	162	134	452	344
Low	Summer	133	117	399	327
	Winter	100	91	310	235
High	Summer	298	261	912	735
	Winter	240	204	703	506

1.2 Reconciling with the 2019 Integrated Resource Plan

Prior to the launch of our DSP and its DER modeling work, PGE had developed our 2019 IRP for Commission acknowledgement. Within the 2019 IRP PGE identified a commitment to continue to invest in DR and Flexible Load, to increase reliance on DR to help balance sources and uses of electricity during peak periods. This includes our 2025 goals of 211 MW during summer months,141 MW during winter months, and 4 MW of customer battery storage. These goals were developed by the IRP Team through our work with Navigant (now Guidehouse Consulting). The scope of the Navigant study focused on the interactive effects and system-level hourly load shapes. The two most significant differences between the Navigant Study and the Cadeo study are that Navigant developed a system level forecast utilizing indicative program parameters informed from other like service territories, building on Brattle's work in PGE's 2016 IRP. In contrast, the Cadeo study, which will inform our next IRP, is informed by PGE's current programs, including planning savings numbers, rates of adoption, etc. Cadeo also utilized PGE customer and building profile information and our current cost-effectiveness methodology (as outlined in UM 2141 PGE's Flexible Load Plan) to identify cost-effective, technical, and achievable potentials.

Though Cadeo found less cost-effective Flexible Load available in the near term, they nonetheless verified a major resource role for Flexible Load as we build to a carbon-free, electric future. Cadeo noted the importance of Flexible Load in meeting the carbon-free future, and also the ability of Flexible Load to provide energy and capacity services to balance system needs and control load growth due to electrification.

This 2021 Flexible Load Multi-Year Plan finds itself betwixt new legislation and planning practices. With the passage of HB 2021, as well as new guidance on distribution system planning and new policy focuses, PGE anticipates changes to Flexible Load commitments and measure development. Our approach to acquisition

[19] Measured in MW at generation.

is already beginning to explore new approaches for accelerating and scaling the portfolio beyond traditional methods in order to meet the needs of policy efforts and customer desires to decarbonize. Our planning assumptions are also likely to change in light of additional greenhouse gas (GHG) reduction commitments and municipalities' additional efforts to address climate change.

1.3 Summary of Elements Found in the Multiyear Plan

This section presents a high-level budget and a review of the elements and stages of Flexible Load development. Individual activity is discussed in the subsequent chapters. PGE also provides a preliminary estimate of the cost-effectiveness of its Flexible Load activity based on the estimated Flexible Load acquisitions and planned portfolio costs.

1.3.1 **Total Portfolio Costs**

The total budget for 2022-23 is estimated to be $35M as shown in Table 4 below. Detail on how this money is employed for each activity can be found in Chapter 4. As stated, PGE is attempting to shift and will have better clarity on activity that defines that shift by the time we update the Multi-Year Plan in August of 2022.

Table 4 – Total Portfolio Requested Budget

Pilot/Program	2022	2023	Total
Pilot Budget Total	$2,130,000	-	$2,130,000
Home Energy Bundle	$350,000	-	$350,000
Community Microgrids	$250,000	-	$250,000
Single Family Water Heater (SFWH)	$1,130,000	-	$1,130,000
Residential New Construction Bundle	$200,000	-	$200,000
Commercial Resiliency Solution	$200,000	-	$200,000
Program Budget Total	$15,083,803	$15,611,770	$30,695,572
Residential - Flex PTR	$3,445,000	$3,445,000	$6,890,000
Residential - Flex TOD	$695,000	$695,000	$1,390,000
Residential - Smart Thermostats	$2,732,250	$2,911,675	$5,643,925
Com - Energy Partner Sch 25	$1,403,162	$1,448,149	$2,851,311
Com - Energy Partner Sch 26	$4,065,259	$4,211,624	$8,276,883
Com - MFWH	$2,743,132	$2,900,322	$5,643,454
Smart Grid Testbed Phase II	$1,197,070	$1,067,565	$2,264,635
Grand Total	**$18,410,873**	**$16,679,335**	**$35,090,207**

Figure 1, below, illustrates the tenets that PGE holds as key to the continued successful development and refinement of our Flexible Load resources:

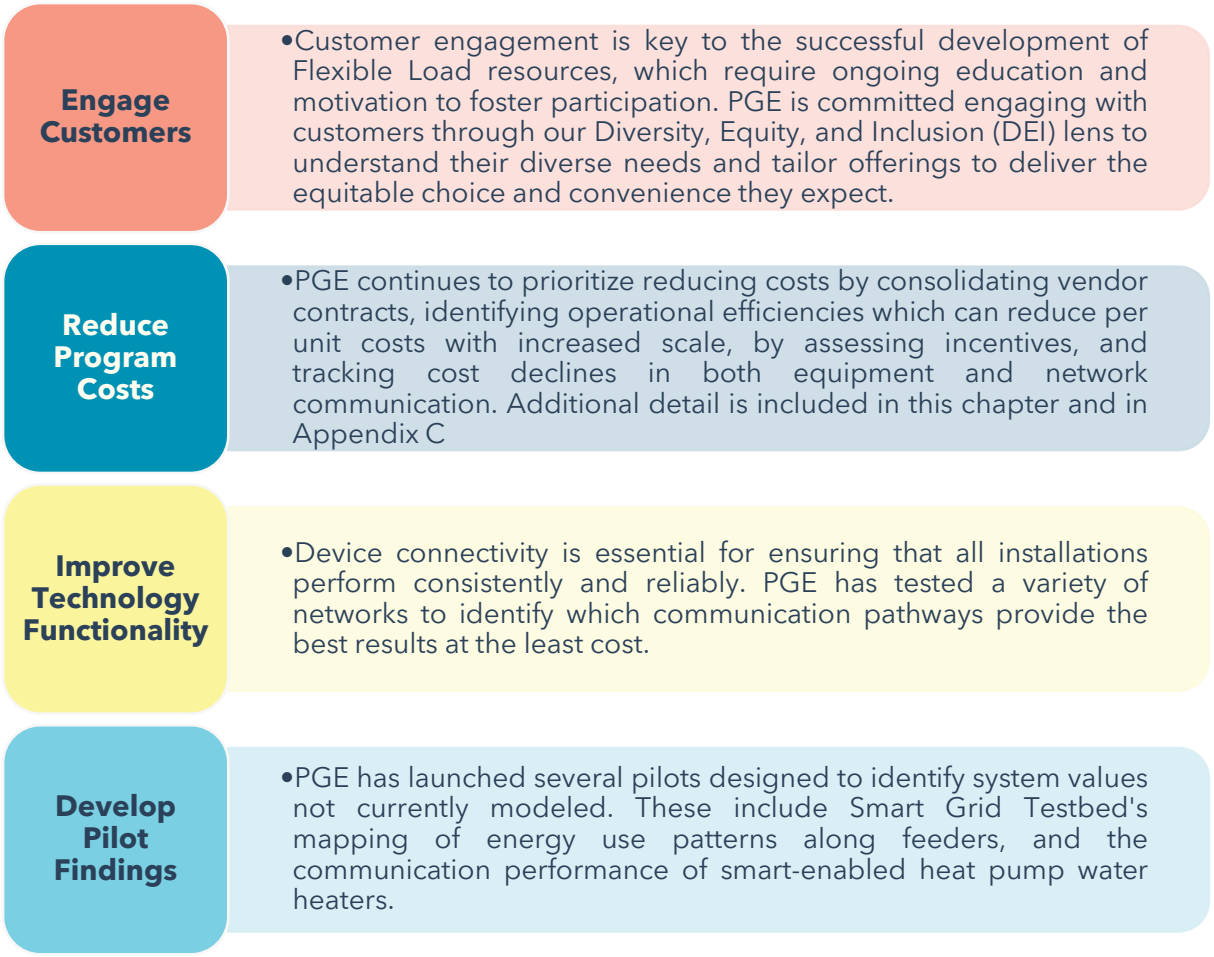


Figure 1 – Tenets for the Development and Refinement of Flexible Load

1.3.2 **Cost Effectiveness**

As discussed in the Flexible Load Plan, PGE intends to evaluate cost-effectiveness at the portfolio and individual measure level. PGE will use the cost-effectiveness of the overall portfolio as our key cost-effectiveness metric. However, we will evaluate the cost-effectiveness of individual measures to help us understand how each contributes to the overall portfolio. As explained in the Flexible Load Plan, we are proposing this approach for the following key reasons:

1. **Flexible Load is a new resource requiring significant investment in rapid, iterative product development.** Rapid iteration means that we create program concepts, prototypes, and demonstrations that allow us to test new technologies and program designs with customers to ensure we are achieving the desired results. Evaluation of these activities allows us to learn from the results and rapidly iterate to improve designs, including overall customer

experience and cost effectiveness. PGE's Smart Grid Testbeds are critical to our efforts to conduct these activities as efficiently as possible prior to scaling to all customers. This rapid iteration process allows PGE to continuously improve the effectiveness of offerings, including overall customer experience and cost effectiveness.

As this rapid iteration process is meant to allow exploration of new technologies, customer engagement methodologies, business models and the like, measures going through this process are not meant to be cost effective. These activities are necessary to understand the details and intricacies of developing a resource that is comprised of disparate technologies, situated in multiple locations, and engaging different customer segments to create a virtual power plant (VPP) capable of providing reliable grid services. Thus, some latitude must be granted when assessing the activity by a single quantitative metric such as cost effectiveness. A portfolio-level cost effectiveness perspective allows PGE to make necessary, but not initially cost-effective, investments and demonstrate to our Commission, our company, and our stakeholders the reasonableness of the totality of the Flexible Load portfolio.

2. **Flexible Load requires significant state and regional investment and collaboration.** PGE is building Flexible Load to an extent not seen elsewhere in the Northwest. The only other distributed energy or demand side management (DSM) resource which has seen similar dedication is energy efficiency (EE). Today, PGE customers invest $100M per year in EE through the Energy Trust of Oregon (Energy Trust), trade allies, regional forums, and other efforts. Energy Trust funding provides for operations, general administration, deployment of infrastructure, and market transformation activities, planning, and evaluations. This significant investment and regional coordination are necessary to assure the acquisition of the Northwest's largest resource.

   However, current Flexible Load investment is one-fifth the size of PGE's EE investment, while the Flexible Load megawatt goal set by the IRP is just as aggressive as the goal set for EE. Further, Flexible Load measure development is not shared by the region, as with EE. Nor does Flexible Load benefit from the decades of regional collaboration and investment, shared learnings, and failures. To mitigate risk and lessen expenditures, we coordinate with the Energy Trust, but this approach is not a replacement for the significant benefits of regional collaboration and infrastructure.

3. **Development of Flexible Load in the Northwest, and therefore for PGE, faces many unknowns.** PGE continues to rapidly iterate device communication protocols, effective customer engagement methods, better

and more firm planning value forecasting, and third-party integration best practices.

Clearly, cost effectiveness for Flexible Load is still evolving. State and Commission policy shifts are creating additional value streams that will help PGE capture more Flexible Load benefits for customers (e.g., social benefits such as community and low-income household investments). PGE is developing new models and methodologies as well as exploring Flexible Load benefits at the local and bulk system level with the goal of supporting rapid iteration and more accurately capturing Flexible Load benefits that better reflect the cost effectiveness of PGE's Flexible Load portfolio. A summary of the portfolio-level cost effectiveness is provided in Table 5 below.

Table 5 – Portfolio-Level Cost Effectiveness

Program	Total Resource Cost Test	Total Resource Cost Test *(excl. value of service lost)*	Rate Impact Measure Test
Residential	0.81	0.93	0.52
Commercial	0.67	0.98	0.50
Total	**0.77**	**0.95**	**0.51**

1.3.3 **Development Cycle**

In the Flexible Load Plan, PGE proposed a three-step evolutionary process for the development of Flexible Load resources. The three steps include:

1. **Demonstrations** – initial, small-scale efforts designed to prove the viability of a technology, hypothesis, or idea, or to answer discrete technical and/or customer-related questions. Demonstrations may involve either the exploration of novel new technologies or ideas, or the application of existing technologies. Demonstrations enable PGE to manage the risks of new ideas and identify any key problems or issues before committing substantial resources and time. Within the Smart Grid Testbed, PGE is conducting numerous demonstrations to explore the capabilities of new products and practices, and identifying if, when, and how these products and practices can be integrated into PGE operations.
2. **Pilots** – limited-scale efforts designed to validate the business case and manage the implementation risks associated with successful demonstrations or other projects that have attained a certain level of readiness, as defined by PGE's Product Lifecycle Management (PLM) process. Pilots test the implementation, customer engagement, marketing approach, customer satisfaction, and acceptance, as well as provide final validation of the business case and demonstrate cost effectiveness or identify a pathway to cost effectiveness. Pilots help PGE, the Commission, and stakeholders assess

whether an offering is ready to become a program and a permanent part of PGE operations. Our goal is to refine our effectiveness at concepting, demonstrating, and designing new programs such that pilot phases become shorter and less expensive, and that pilots are designed to easily scale to programs, incorporating adjustments from learnings. Many of PGE's current activities such as Peak Time Rebates and Smart Thermostats are in pilot phase.

3. **Programs** – the last step in the evolutionary phase wherein activity is cost effective, performance is stable and reliable, and budgets can be forecasted within an acceptable tolerance.

Figure 2, below, shows PGE's program evolution process for Flexible Load. The size of the activity grows as the maturity of the product, program, or service moves through this evolution. PGE is moving each of our initial 2016 IRP DR resource build activities through this process in pursuit of each becoming a mature program offering.

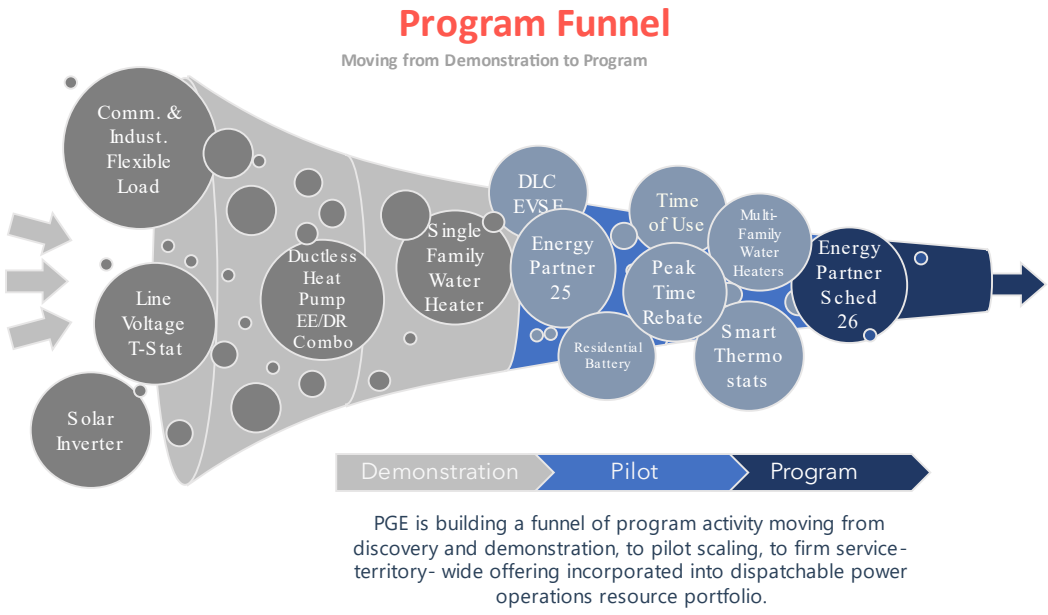


Figure 2 – Flexible Load Program Evolution

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

To support the above product evolution process, products go through PGE's PLM process. Using a modified version of the PLM process described in our Flexible Load Plan, PGE will design, build, and launch the activities outlined in this MYP.

In 2021, we also identified a need to realign on how new opportunities are identified and pursued. Going forward, PGE will engage in Customer Needs-Based Innovation (CNBI), which includes the rapid iteration method discussed above. Figure 3, below, provides a high-level view of PGE's CNBI process.

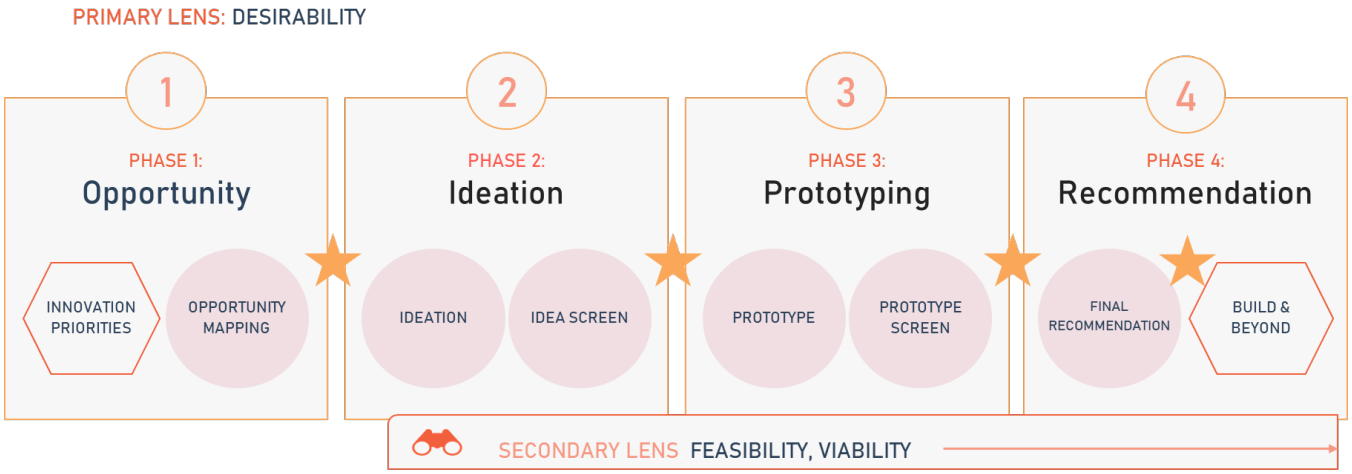


Figure 3 – PGE's Customer Needs-Based Innovation Process

Figure 4, below, shows how the CNBI process feeds into the current PLM process.

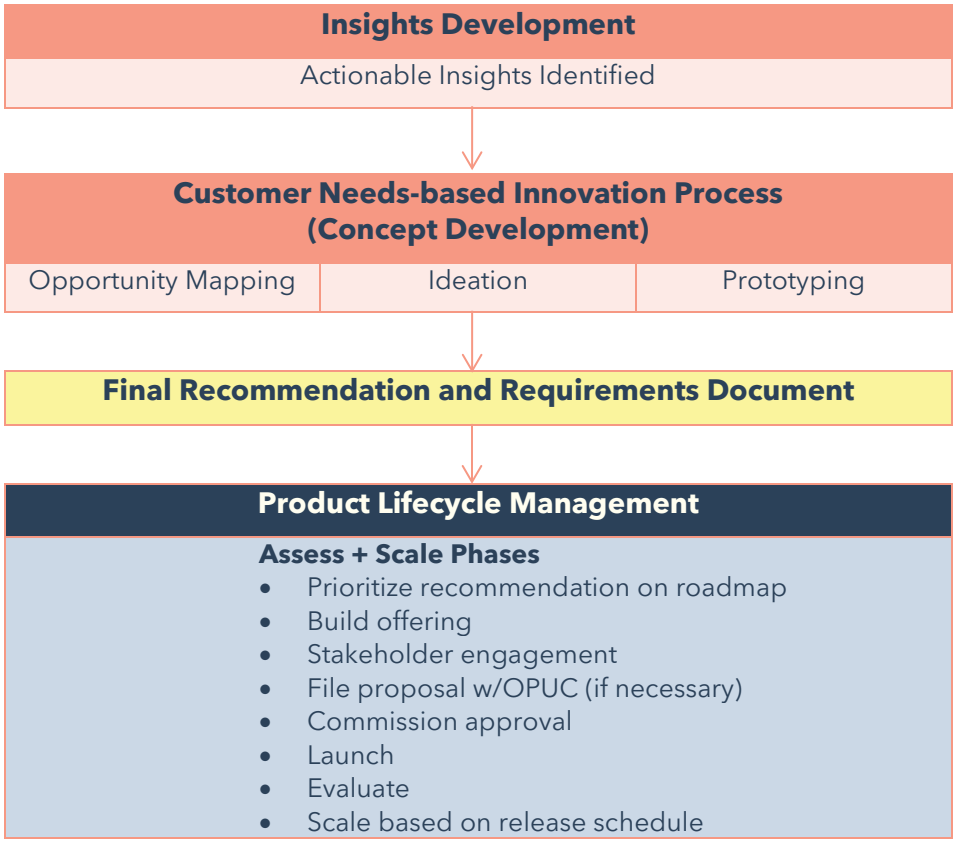


Figure 4 – From Customer Needs to Product Development

Through this new process, PGE will continuously engage with customers to understand their needs, rapidly-design and test concepts that solve those needs, and also create an inclusive and cross-functional approach to executing and launching final programs that deliver the desired customer experience. Through each phase of the process, teams validate hypotheses and sharpen offering criteria before crystallizing a final recommendation that will feed into PGE's current PLM process and be used to construct proposals submitted to the Commission.

In the next section, PGE provides a synopsis of each of the Flexible Load products moving through the program funnel and the PLM process. In addition to these categories, PGE provides a summary of market intervention activities that are not intended to be full-scale Flexible Load resource acquisition activities. These activities nonetheless fit within PGE's efforts to acquire Flexible Load.

1.3.4 **Emerging Market Channel Strategies**

1.3.4.1 New Building Construction

PGE will increasingly target new construction markets to encourage Flexible Load -ready, -enabled, and -connected building systems. While relatively small in size, the new construction market offers the opportunity to deploy Flexible Load technologies at a relatively lower cost as equipment does not need to be retrofitted, as would be the case for existing buildings. This approach requires PGE to move some upfront incentives from homeowners and commercial tenants to builders, developers, and contractors. These incentives will be stacked with available EE incentives to overcome the "first cost" barriers in these markets. PGE expects that these actions will drive positive momentum in the existing building market too, since it is often informed by standards implemented in new construction.

1.3.4.2 Marketplace

The PGE Marketplace[20] is an online store that makes the purchase of energy-saving products and services easy by applying rebates instantly during checkout for eligible products.

The PGE Marketplace provides a one-stop e-commerce shop for residential EE products. The Marketplace currently offers smart thermostats, lighting, electric vehicle chargers, smart home products, water efficiency, and air quality products. PGE coordinates with the Energy Trust to provide incentives at point of purchase for smart thermostats and lighting products.

In addition, Marketplace allows eligible customers to seamlessly enroll in DR programs at the point of sale, helping them get the most from their energy. The Smart Thermostat pilot is the first example of this on the Marketplace. As other eligible products are added, customers will be able to sign up for the associated pilot/program(s).

[20] See https://pgemarketplace.com.

PGE launched its Marketplace to provide customers an easy way to engage with their utility as they manage their energy journey. This helps PGE create stronger, more meaningful connections and increases the value that PGE provides to customers. With the Marketplace, PGE's goal is to increase customer engagement through the following actions:

- Enhance the customer experience of enrolling in programs by giving the customer an easy way to apply existing incentives to their purchase
- Increase program enrollment
- Expand offerings to include resiliency products to help customers prepare for unexpected outages

PGE will measure improvement to the customer experience through the PGE program ease of enrollment score and Net Promoter Score (NPS). Future enhancements to the Marketplace will focus on reaching customers and those not currently engaged with PGE beyond basic service.

1.3.4.3 Residential Line Extension Allowance

Effective February 2021, PGE shifted the residential line extension allowance (LEA) from a flat credit for new housing units (homes and apartment) to a two-tiered system that recognizes differences in loads between all-electric heated homes and non-electric heated homes.

PGE recognizes that the residential LEA needs to evolve further:

- Today's LEA can only be used to offset costs of PGE infrastructure. A significant portion of the LEA is not currently utilized because the LEA exceeds the project cost in many instances. PGE advocates for using this unspent LEA to incentivize the purchase of installation of grid-beneficial appliances and/or grid-beneficial new home construction projects.
- Outdated and undersized electric infrastructure adds a significant burden on customers that want to make their homes more energy efficient, Flexible Load-enabled, and resilient. Upgrades to behind-the-meter (BTM) electric infrastructure such as new circuits, electric panel upgrades, and installation of new meter bases should become eligible for the LEA to accommodate customer installation of heat pumps, electric water heaters, Electric Vehicle Service Equipment (EVSE), and batteries.
- Other factors that drive permissible use of the LEA should be established. The commission's decision to exclude electric resistant heat from the higher LEA amount opens a discussion on what factors that should be used to inform LEA eligibility as opposed to basic volumetric-centric billing.

1.3.4.4 Commercial and Industrial Line Extension Allowance

Line extension allowances for business customers are due to be reviewed and modified akin to proposed changes in the residential LEA. BTM electrical

infrastructure for business customers is often outdated, incompatible, and undersized to work with modern energy efficient, grid connected, resilient BTM products.

- The commercial LEA needs to allow to pay for "make-ready" electrical upgrades to BTM infrastructure.
- Excess LEA amounts that are retained ought to be made available to pay for incentives for efficient, grid-connected, or resilient products installed at the customer site.
- Other factors besides solely using the volumetric sale of electricity should be used to determine LEA eligibility and LEA amounts.

1.3.5 **PGE's Virtual Power Plant**

Within a Virtual Power Plant (VPP) bundles of DERs mimic the operational capabilities of a traditional power plant. A VPP should operate as a single dispatchable entity with known parameters such as its generation capacity and ability to ramp up and down.

There is presently no industry consensus definition for a VPP. PGE defines a VPP as a combination of DERs that function together to provide grid services such as generation capacity, regulation, load following, contingency reserves, and frequency response. Based on this definition, a typical VPP might include a combination of solar photovoltaic resources (PV), storage resources (battery or vehicle-to-grid), and Flexible Loads.

As for traditional power plants, building, maintaining, and operating one or more VPPs will require PGE to organize people, implement processes, and define policies. With the establishment of the Integrated Operations Center (IOC), we have laid the foundation of people, processes, tools, and training needed to support a full-fledged VPP operation.

Because the VPP aggregates multiple heterogeneous resources, it is uniquely dependent on technology. VPPs at PGE will be controlled using a "system of systems" that includes the Advanced Distribution Management System (ADMS) and Distributed Energy Resource Management System (DERMS).

At present, PGE programs control distributed energy resources (DERS) through a variety of aggregation platforms. Over the next two to three years, we will increasingly integrate those systems directly into our operations for more streamlined dispatch. Given PGE's goal of operating a carbon-free energy portfolio, our intent is to rely increasingly on VPP resources to provide the flexibility needed to sustain reliable energy delivery at reasonable cost.

In 2022, PGE plans to define a comprehensive VPP operating model. This operating model will serve as our north star for implementing the organization and technology of the future. Among other things, the VPP operating model will drive business requirements for DERMS and other adjacent systems such as the DERDMS described below.

Chapter 2 Flexible Load Portfolio

2.1 Portfolio Approach

This Multi-Year Plan presents a resource acquisition plan and budget at the portfolio level. It is a shift in regulatory practice for PGE's independent management of its Flexible Load efforts, to better align with best practices in the DSM industry, as implemented by various entities throughout the Northwest and the nation.

This framework allows PGE to comprehensively plan its Flexible Load activity over a period of years with a known budget which can be applied to a portfolio of Flexible Load efforts in order to achieve the targets established through PGE's resource planning processes. It also allows PGE to shift resources as the plan meets real-world conditions and dynamics, reallocating budget across years and efforts as appropriate to best acquire the Flexible Load resources identified in the annual goals.

In Order 21-158[21], the OPUC approved PGE's proposal to move to portfolio-level multi-year planning, budgeting, reporting, and stated an openness to receiving a proposal for a new approach to cost recovery. The move represents an improvement over past practices, wherein each activity is separately proposed, approved, reported, and reviewed.

In its Flexible Load Plan, PGE proposed that each pilot or program activity would be assessed for cost-effectiveness at an individual level, and each would also be included in the assessment of portfolio-level cost-effectiveness metric. While PGE would strive for cost-effectiveness within each activity, it would allow some emerging activities to be not cost-effective so long as the Flexible Load portfolio as a whole is cost-effective. Assessing cost-effectiveness at the overall portfolio level will allow PGE to meet the identified goals while still effectively allocating resources to a mix of emerging and well-established activity.

This is similar to how EE activities are evaluated, where components are allowed to be not cost-effective so long as the portfolio is cost-effective as a whole. This recognizes that activities have differing scales of costs and benefits over time. An activity may have higher costs initially when infrastructure and incentive costs are high relative to customer adoption. Over time, however, the costs necessary to continue the activity decrease while adoption increases. A portfolio of activities can be cost-effective if the portfolio includes a mix of activities at various stages.

PGE's proposed portfolio approach to cost-effectiveness includes a proposal that some activities be excluded from the evaluation of portfolio-level cost-effectiveness. This includes activities in PGE's Smart Grid Testbed and Flexible Load demonstration

[21] Oregon Public Utility Commission Order 21-158 available at https://apps.puc.state.or.us/orders/2021ords/21-158.pdf.

projects. Due to the relative novelty of Flexible Load programs in the Northwest, this activity cannot be included in PGE's Flexible Load portfolio at the scale necessary without severely impacting the cost-effectiveness of the portfolio. EE activities in the Northwest rely upon established infrastructure like the Northwest Energy Efficiency Alliance's (NEEA) emerging technologies work and market transformation initiatives to help develop a pipeline of measures for their activities; Flexible Load programs in the Northwest do not yet benefit from similar support.

The small scale of individual demonstration projects is itself a measure to improve the cost-effectiveness of PGE's portfolio over the long term. By limiting the scope of these efforts, PGE controls the costs until it can confidently plan a program at scale. Commission staff also has full transparency and review of all demonstration activity, and the activity will be reported out on a quarterly basis.

Excluding these costs allows PGE to conduct the activities which are necessary to the development of new Flexible Load resources and the achievement of Flexible Load goals. In Order 17-386[22], the OPUC identified the acceleration of PGE's Flexible Load activity as critical to addressing its capacity needs. This acceleration cannot happen without expanding the scope of PGE's current Flexible Load portfolio.

[22] Oregon Public Utility Commission Order 17-386 available at https://apps.puc.state.or.us/orders/2017ords/17-386.pdf.

2.2 Coordination with Other Entities within State and Region

Through the development of this comprehensive Multi-Year Plan, PGE is better enabled to plan coordination activities with other organizations in Oregon and throughout the Northwest. The sections below highlight where PGE plans coordination during the period covered by this Multi-Year Plan.

2.2.1 **Energy Trust of Oregon**

With the passage of HB 3141[23], PGE and the Energy Trust will work more closely to align activity in an effort to save deployment and measure development dollars. The development and submittal of this Flexible Load Multi-Year Plan will inform the collaborative process outlined in the legislation, leading to an EE acquisition plan which demonstrates how the two entities are directly coordinating on deployment, measure development, timeline, and budget. PGE is currently working internally to understand how best to staff the vision outlined in the legislation and how best to work with the Energy Trust on a public stakeholder process resulting in a filing with the Commission.

Chapter 4 of this document describes many pilot and program activities where PGE and the Energy Trust are presently working together. An excellent example of coordinated exploration of deployment approaches is the work we are conducting on residential batteries, detail of which can be found in the pilot write-up below. Another example of PGE and the Energy Trust collaboration at the intersection of EE and Flexible Load is a field test of ductless heat pump (DHP) controls. The field test will explore the potential of this new control technology to provide additional energy savings as well as DR functionality for DHPs. Additional detail can be found in the demonstration write-up inside this document.

2.2.2 **Northwest Energy Efficiency Alliance**

PGE provides funding and support for NEEA work through our funding of the Energy Trust of Oregon. PGE supports NEEA's work when and where possible. Though NEEA's mandate is market transformation for EE, PGE has advocated and let it be known that we feel NEEA should be working on Flexible Load market transformation as well. In support to this position, we have NEEA as an advisor and participant of the Demand Response Review Committee (DRRC)[24] for the PGE Smart Grid Testbed.

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[23] 81st Oregon Legislative Assembly, 2021 House Bill 314, Section 9(1)(e) - With public utilities, 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.

[24] The DRRC was created by the Commission through Order 17-386 where the Commission directed PGE to file a Testbed Proposal and establish the DRRC.

Additionally, we worked closely with NEEA and Bonneville Power Administration in 2016 to test CTA-2045 water heater control.

In 2021 we co-funded NEEA's CTA-2045 Project, in which NEEA, with its selected contractors, plans to develop a CTA-2045-B test harness, test software, and testing methodology. The objective of the project is to extend the open-source CTA-2045 standard into a nationally recognized and adopted certified element on electric water heaters. The goals of this project include the creation of a public-facing qualified products list of approved devices, and will allow manufacturers, test laboratories, and certifiers to provide validation and certification testing of smart grid devices and universal communication module devices that utilize the CTA-2045-B standard. Funding for this project was made possible under the Multi-family Water Heater (MFWH) pilot.

2.2.3 **Regional Technical Forum**

The Regional Technical Forum (RTF) recently added DR to its portfolio of work, assessing the capacity savings of programs possible in the Northwest. PGE will contribute to this important work by sharing information and learnings from its demonstrations, pilots, and programs. PGE is currently developing a measure database for DERs to help inform measure development of Flexible Load and modeling work for our DSP team. We plan to share this work with the regional technical forum.

In an effort to assist the region with Flexible Load development, PGE is partnering with the RTF in our application to the US DOE's Connected Communities Funding Opportunity Announcement. Here the idea is to partner with the regional information-sharing activity of the RTF to help disseminate the learnings of the work outlined in our application to the US DOE. This work includes co-deployment alongside NEEA and the Energy Trust of measures capable of providing both EE and Flexible Load.

2.2.4 **U.S. Department of Energy**

PGE has been awarded a grant through a Funding Opportunity Announcement issued by the US DOE. The project, titled SmartGrid Advanced Load Management and Optimized Neighborhood (SALMON), will demonstrate the value of DERs as a grid resource for bulk system and distribution operations. The SALMON project will spur improved planning for–and increased investment in–load flexibility and efficiency measures across the Pacific Northwest and will ultimately deliver lower costs for ratepayers, all while enabling greater reliance on renewable generation.

Participants include:

- Portland General Electric (PGE)
- The Energy Trust of Oregon (Energy Trust)
- Northwest Energy Efficiency Alliance (NEEA)
- Community Energy Project (CEP)

- National Renewable Energy Laboratory (NREL)
- Open Systems International, Inc. (OSI)

The SALMON project builds on PGE's Smart Grid Testbed (the "Testbed"), a $5.8 million field demonstration project designed to accelerate development and deployment of Flexible Load resources. The project focuses its efforts on the Overlook/Arbor Lodge portion of the Testbed, a historically underserved community in North Portland. In partnership with regional non-profits and community-based organizations (CBOs), the team will build a 1.4 MW Flexible Load resource based in the community, consisting of efficiency measures, connected devices (e.g., thermostats and water heaters), distributed solar with smart inverter capabilities, energy storage, and smart charging.

This community resource will be integrated into PGE's ADMS/DERMS and optimized by NREL to demonstrate a series of bulk services, including energy, capacity, and frequency response, as well as distribution services including capacity relief, power quality, and Volt/Var optimization including conservation voltage reduction. The results of this work will be shared regionally through the existing network of stakeholder groups, spurring a realignment of utility planning and operation.

2.2.5 **Universities and Other Funding**

PGE funds research and development and coordinates work with various organizations. A sampling of 2021 activities follows:

Table 6 – Research and Development with Universities

Partner	Activity
Oregon State University (OSU)	Cascadia Lifelines Program
	Heat Recovery from Carty Plant through Thermochemical Energy Storage
	Microgrid Synchrophasor
	Large-signal PV Inverter Enhanced Grid Model for Rural Area Voltage Stability Analysis and Control
	Pulsed Power DC Microgrid for Remote Area Highway Fast Charging Stations
Portland State University (PSU)	Modeling High-power Electric Vehicle Distribution Impacts
	Modeling Grid-Enabled Residential Loads in Distribution Systems
	Primary Frequency Response Detection and Archiving System
	HD Charging Infrastructure O&M Strategy and Training
Oregon Institute of Technology (OIT)	Investigation on Transient and Steady State Behavior of Microgrids Before, During, and After Islanding in Terms of Frequency and Voltage
	Cold storage applications for grid services and distributed flexibility
Washington State University (WSU)	Power Engineering Energy Innovation Center Data Access
University of Oregon (U of O)	Solar PV Monitoring Data Integrated Health and Energy Levers to Promote Climate Benefits, Community Resilience, and Public Health (I-HELP Community)

2.2.6 **Regional Labs**

PGE does work with various regional energy laboratories. As mentioned above, PNNL sits on the DRRC, and PGE worked with NREL on our Connected Communities grant application to the US DOE. Additionally, NREL is working with PGE's ADMS team to stress test the OSI platform underlying the ADMS system's accuracy and performance. PGE has also been working with NREL on a Boardman Site Hydrogen Production and Biomethanation Feasibility Analysis.

PGE is also partnering with PNNL through a US DOE Solar Energy Technologies Office award to provide data and learnings on advanced prediction of day-ahead net system load (NSL) under high-PV adoption. The project utilizes machine learning techniques developed at the national labs and applied to anonymized PGE customer data to develop statistically determined upper and lower error bounds around NSL forecasts that consider fluctuations in stochastic end use loads. We are also leveraging NEEA's End Use Load Research datasets in this project that PGE has sponsored.

2.3 Reporting Activity

PGE proposes a series of reporting activities to keep the OPUC and stakeholders informed of its portfolio of Flexible Load activities. These include direct engagement as well as public reporting at different intervals and levels of depth.

PGE currently has two advisory committees. The first of these is the DRRC, which provides guidance to the Testbed project and by relation our demonstration activity. PGE has also established a Demand Response Advisory Group (DRAG). This is a quarterly engagement with Commission staff and others as appropriate.

DRAG meetings generally include:

- Key product development updates including concepts in pipeline, recent launches, upcoming filings, evaluations underway, technology challenges, and lessons learned
- Findings from recently completed market research
- Budget and savings review

PGE will provide annual reporting on expenditures and incentives to Commission Staff through a simple spreadsheet tracker. Updates would become a part of the annual report. The more frequent updates are proposed as a recognition of the process change involved with the Multi-Year Plan.

PGE will also provide in-depth annual reporting that will detail the achievements of PGE's Flexible Load programs from the prior year. This will include overall quantities of Flexible Load acquired in relation to the program goals as well as financial details like incentives and expenditures relative to budgets. The table below summarizes the metrics that would be reported and timing for each for the first two years.

Table 7 – 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	

This regular reporting will give the Commission and stakeholders visibility into PGE's work and the costs relative to its accomplishments. It will also obligate PGE to transparently identify any issues and move swiftly towards their resolution.

Finally, PGE will continue the practice of filing a Multi-Year Plan every two years which—similar to this filing—will outline with some detail our activity presently underway and roadmap(s) of additional work which may move to demonstration, pilot, or program over the plan's horizon. PGE plans to file an update to this Flexible Load Multi-Year Plan in August 2022 to bring it into alignment with adjustments made to cost effectiveness methodology, distribution resource potential analysis, and modeling through the DSP Phase II (filing in August 2022). The MYP 2022 Update will also better align our Flexible Load activity with the HB 2021 Clean Energy Plan and our IRP and as well as with the HB 3141 public process and Energy Trust activity coordination.

PGE demonstrates its commitment to transparency through a variety of avenues including quarterly engagement with Staff through the DRAG; stakeholder engagement in the Testbed through the DRRC; the stakeholder process outlined in HB 3141 for EE strategic plans and budget, which will also require PGE to share information about coordinated deployment and measure development; as well as

through written annual updates to the Commission and stakeholders, DSP, and IRP forecasts and planning and the yearly updates we will be filing. However, we recognize that stakeholders may want more engagement from PGE. At PGE we try to balance engagement without overly burdening our stakeholders with calls for meetings and presentations. PGE is therefore open to proposals for additional engagement processes.

Chapter 3 Demonstration Activity

Demonstrations are *not* included in PGE's calculation of overall portfolio cost-effectiveness since they are not intended to be cost-effective. Demonstrations involve expenditures necessary to answer identified research questions and test hypotheses but would not be recurring costs if the demonstration moves forward to the subsequent pilot and program phases. Demonstrations also do not have explicit goals for amounts of Flexible Load to be acquired as they lack the scale to provide significant benefits. They are intentionally kept as small as possible to control costs while still providing a sufficiently broad sample for drawing sound experimental conclusions.

Flexible Load demonstration projects are chosen based on three criteria: identification of market needs, Flexible Load solutions they may provide, and feasibility of activity. Priorities can then be identified based on the size of the potential Flexible Load when delivered at scale, the estimated funding needed for the demonstration project in comparison to the available budget, the timeline necessary for the demonstration project, and other factors.

A demonstration transitions to a pilot when the research questions have been sufficiently answered to validate that the concept is a viable and feasible technology or solution capable of providing Flexible Load to PGE. If the research questions have been answered but indicate that the product is not a viable concept, development may be stopped until there is a need to revisit it (if that's the case).

At times, a demonstration project may answer the original question but raise additional unforeseen questions. This may require additional work as part of the demonstration project, at times with a new experimental design to test the new questions. Once these questions have been answered, a demonstration can move to the pilot stage, where questions involving business models, technology logistics, customer experience, and cost-effectiveness can be tested on an incrementally larger scale.

This Multi-Year Plan includes two categories of demonstration projects. The first are demonstration projects that are already active. The second category includes new projects anticipated to be deployed in the period covered by this Multi-Year Plan and through the Testbed Phase II timeline as proposed in UM 1976, PGE's Testbed Phase II Proposal.[25]

[25] PGE's Testbed Phase II Proposal, UM 1976, October 1, 2021, available at https://edocs.puc.state.or.us/efdocs/HAD/um1976had145212.pdf.

3.1 Ductless Heat Pump Thermostat Demonstration

3.1.1 ***Executive Summary***

PGE has a small-scale demonstration within the Testbed to perform DR on DHPs in single-family homes using a smart thermostat. The goal of the demonstration is to identify the combined value of EE and DR for DHP technology. PGE and the Energy Trust are collaborating to identify customers with DHPs and provide them Flair Puck thermostats at no cost in exchange for participating in the demonstration and allowing PGE and Energy Trust to evaluate the performance.

3.1.2 **Key Customer Needs Addressed, Engagement, and DEI**

For customers without central, ducted heating, ventilation, and air conditioning systems (HVAC), DHPs provide a solution for efficient heating and cooling. The typical controls (an infrared remote) are not as intuitive as the smart thermostats available for central systems, and additional energy savings may be possible. Customers with DHPs have also not historically been able to participate in smart thermostat DR programs. This pilot tests a smart thermostat designed to work with DHPs, providing additional EE and DR functionality.

3.1.3 **Technology Principles**

While extremely efficient in a technical sense, evaluations of DHPs have resulted in marginal cost-effectiveness results. The pilot will test whether DHPs paired with smart thermostats can be cost-effective when looking at the additional energy savings and DR functionality.

3.1.4 **Coordination**

PGE and Energy Trust are collaborating to identify customers with DHPs and provide them Flair Puck thermostats at no cost in exchange for participating in the demonstration and allowing PGE and Energy Trust to evaluate the performance.

3.1.5 **Market**

The pilot is limited to the first 500 customers. The Testbed team expected recruitment would meet capacity by end of Q1 2021. However, recruitment was difficult, likely due to COVID concerns. PGE worked with Energy Trust to recruit known DHP rebate recipients. PGE also worked with Cadeo to work with City of Portland's permit database and reached out to those customers as well. PGE and Energy Trust currently have 17 DHPs enrolled in this project.

3.1.6 **Key Outcomes & Measures of Success:**

Identify the combined value of EE and DR for the DHP technology.

3.2 Water Heater Communications Protocol Research and Development

3.2.1 ***Executive Summary***

PGE is leveraging Research and Development (R&D) funding to perform a demonstration project for interconnecting single-family water heaters for DR, and specifically heat pump water heaters. The objective of the research is to test varied communications protocols beyond customer-hosted Wi-Fi, assess the DR potential of heat pump water heaters, test incentive mechanisms, and better understand the options for a future scalable cost-effective single-family water heater program.

Single family water heaters are a top priority for PGE's decarbonization strategy as water heating is typically the second largest energy use in a home, second only to space heating. Testing in the multi-family water heater pilot shows that most customers do not notice when their water heater is being controlled by the utility for grid services, and thus DR activities and grid services can be performed much more frequently than other events that may require more customer involvement or potential discomfort for customers. Additionally, water heaters, like batteries, are able to store and release energy. While the energy cannot be released back on to the grid like batteries, water heaters do demonstrate the ability to take service from the grid in sub-hour and possibly sub-fifteen-minute increments.

3.2.2 **Key Customer Needs Addressed, Engagement, and DEI**

Customers surveys and focus groups consistently convey that customers want to participate in clean and advanced energy programs that provide an environmental benefit and are eager to participate in programs that have either non-existent or relatively low up-front costs for participation. PGE plans to provide this program at no cost to participating customers and may provide a one-time enrollment incentive as well as performance / participation incentives, dependent on the costs to operate the program and the value streams that emerge.

3.2.3 **Technology Principles**

Enabling water heaters for DR purposes in single family settings has not historically been cost-effective for a few primary reasons. Historically water heaters have been DR-enabled by having a licensed electrician install an intelligent switch on a water heater's control panel. In multi-family buildings, economies of scale can be achieved with regards to installation labor, but having contractors spend time travelling between installation sites for specific installation windows with specific customers at least doubles the installation costs. This pilot will test newer communications protocols that do not require installation by a licensed electrician.

The communications protocols PGE seeks to employ for this demonstration are customer-hosted Wi-Fi, cellular LTE, and a mesh radio frequency network. The customer-hosted Wi-Fi will use water heaters with onboard Wi-Fi chips for a "bring

your own appliance" method of enrollment, while the LTE and mesh network controls will rely on water heaters enabled with CTA-2045 (a physical port and communication protocol) and will require a much higher touch effort.

The single-family water heater demonstration project will differ from the multi-family water heater pilot in an important distinction. PGE is committed to EE as the first fuel. To this end, it is important that, where possible, PGE Flexible Load resource building endeavors do not compete with EE procurement. Thus, the single-family water heater demonstration will be working to connect heat pump water heaters, the most efficient electric water heat option. This is also why the endeavor is a demonstration within the Testbed. PGE needs to explore the capabilities of these units to provide load shed.

3.2.4 **Coordination**

PGE and Energy Trust will collaborate to explore a joint incentive structure for heat pump water heaters supporting this key technology. Because heat pump water heaters are so highly efficient, they have a lower potential for DR, and collaboration with EE partners is required to send proper market signals to customers and pursue a cost-effective program.

3.2.5 **Market**

The goal was to enroll 150 water heaters (50 per communication protocol). The demonstration targeted existing homes as well as new construction single family homes.

The total available market for single family housing with electric water heating (both electric resistance and heat pump water heaters) is estimated at 148K households, with an achievable potential of 74,000 households, representing 37 MW (assuming an average capacity across water heater types and sizes of 0.5 kW per water heater). Our literature review estimated load shifting potential of 0.09 kW in the summer and 0.17 kW in the winter for heat pump water heaters.

3.2.6 **Key Outcomes & Measures of Success:**

The goals of the demonstration pilot are to:

- Understand the costs and benefits of various communications protocols for DR of single-family water heaters
- Quantify the potential value of DR in heat pump water heaters
- Understand the complexities, costs, and efficacy of a mesh network using radio frequency communications
- Pilot the use of CTA-2045 communications technology with customers

By gathering the learnings outlined above, in conjunction with the experience of the multi-family water heater DR pilot, PGE will develop a cost-effective and scalable program that correctly values the incentive structure for customers, utilitizes cost-effective communications protocols and dispatch strategy, and employs a streamlined interconnection strategy.

Successfully establishing both the Single-Family Water Heater program and the CTA-2045 standard may allow for water heaters to be DR-enabled by code by 2025.

3.3 Demonstrations Proposed in PGE's Smart Grid Testbed Phase II Proposal

In keeping with the Commission's vision in Order 17-386 PGE uses the Smart Grid Testbed as its Flexible Load laboratory. This means we presently conduct our demonstration activity within the Smart Grid Testbed. The schedule of activity and the activity itself is developed in partnership with the DRRC. The DRRC is the steering committee of stakeholders selected by the Commission to oversee the Smart Grid Testbed. The Committee worked with PGE to develop the activity conducted during Phase I and have similarly worked with PGE to scope the work and budget for a Phase II. The following demonstration projects are planned as part of Phase II of PGE's ongoing Smart Grid Testbed work. Additional detail, including budgets and timelines for these activities can be found within PGE's Smart Grid Testbed Phase II Proposal UM 1976.[26]

3.3.1 **Flexible Feeder Proposal**

As PGE's Flexible Load portfolio expands and its DERMS capabilities mature, there is a growing need to better understand both how DERs can be integrated into distribution operations and the value they provide. In this research area, projects will be developed to explore the values of DERs as an operational asset, by driving high levels of dispatchable load on a single feeder, using targeted incentives for new equipment, controls, storage, distributed solar, and EE. The work will also explore various operational use cases, the development and testing of low-income program design and customer acceptance/participation, document the interplay between dispatch strategies, operational constraints, customer preferences, and incentives, and inform the DSP process related to DER adoption and grid impact/value.

3.3.2 **Solar Inverter**

Integration and control of distributed PV resources through smart inverters (those equipped with the IEEE 1547-2018 standard) can provide insights and support to system operation, distribution planning, and asset valuation. Projects in this area will assess the value of inverter-based controls to deliver distribution operations value (e.g., Volt/VAR support); address hosting capacity issues, including as an alternative to PGE's two-meter solution; and support orchestration of DERs together with distributed solar and storage to minimize grid export. Work in this area may also include rate design (e.g., fixed price) and transactive energy strategies that incentivize self-consumption and/or distribution level load balancing.

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[26] PGE's Smart Grid Testbed Phase II Proposal UM 1976, available at https://edocs.puc.state.or.us/efdocs/HAD/um1976had145212.pdf.

3.3.3 **Multi-family Customer Segment**

Multi-family is a critical customer segment and a key source of Flexible Load potential. Multi-family units are generally heated with electricity via in-unit sources and many buildings also use electricity for water heating. Multi-family is also important from an equity perspective, with higher numbers of low income and other underserved customers occupying this building type. However, multi-family presents significant challenges, with higher turnover rates that make customer enrollment and retention challenging, as well as building design that can impede device communications. Additionally, the split-incentive still exists in the multi-family rental housing market and continues to present participation and engagement challenges.

PGE's Grid Products team has made important advancements in this segment, providing important learnings on the technical viability of in-unit water heating controls as a Flexible Load resource in the multi-family space. As PGE assesses how to scale that effort, this work will focus on new products, bundles, and engagement strategies to increase adoption and participation across a broader range of Flexible Load technologies within the segment. The effort will also test whole building load management strategies and rate design options.

3.3.4 **Single Family New Construction Bundle**

The new construction market presents unique challenges and opportunities for developing a Flexible Load resource. Project developers have the buying power and scale to drive down costs and the ability to incorporate the price premium associated with grid-enabled devices into the overall financing of a new home purchase. However, they also operate in a business with tight margins, and incentives paid to builders in exchange for participation by future tenants who have not themselves opted into the associated Flexible Load program represents risk.

This project area seeks to explore the potential value of connected homes in the new construction market to deliver cost effective Flexible Load. The work will focus on partnering with residential developers to deploy an all-electric, flexible home bundle. In doing so, we hope to explore partnership strategies, pricing structures, and incentive designs that support an increased Flexible Load offering within this market segment. The Testbed team will develop and test the effectiveness of product bundles in driving increased demand amongst new home buyers, as well as test new pricing strategies, incentive tools (e.g., the revised LEA), and rate design options. The overall goal of this effort is to better understand how PGE can partner with developers and buildings to incorporate Flexible Load technology into the design/build process, securing low-cost demand flexibility potential before the customer even occupies the home.

3.3.5 **Commercial and Industrial**

Commercial, industrial (collectively C&I), and municipal customers have a keen focus on operational efficiency, engaging with utilities in EE and self-generation programs

to reduce costs while taking advantage of incentives and other financial inducements. PGE has tapped into this model to a limited extent with its Energy Partner pilot, providing cash incentives for load flexibility.

Now, with the continued decline in the cost of self-generation, the emergence of low-cost energy storage and a newfound focus on resiliency, there is a new opportunity for a combined offering that can bring together these business drivers to deliver customer value and grid benefit. This project area seeks to identify pathways and strategies to achieve higher levels of C&I and municipal site participation in Flexible Load and resiliency programs. The team will explore enhancements to existing programs and the development of new ones with the goal of better understanding and capturing the value of participating in combined measures for EE, Flexible Load, and resiliency. This work will include an evaluation of engagement approaches and how to structure incentives to maximize program and event participation, as well as customer value.

3.3.6 **Non-Wires Alternative**

The projects funded through this work will constitute a significant portfolio of activities, many of them directly addressing or otherwise overlapping with the non-wires alternative (NWA) goals outlined in UM 2005 and being carried out by the DSP team. Where possible and appropriate, the Testbed team will coordinate with DSP on projects that can inform and/or meet the NWA goals of UM 2005, optimizing the lessons, values, and benefits of both activities and also reducing ratepayer burden.

3.3.7 **Vehicle-to-Grid**

Electric vehicle adoption is expected to increase rapidly in the coming years, increasing electricity sales and improving the economic efficiency of grid investments. These efficiency gains, however, could be offset by the need for increased infrastructure investment if charging coincides with peak demand. Identifying effective pathways to manage EV load is essential to controlling system costs and meeting flexibility targets. A series of nimble, responsive demonstration efforts are necessary to keep pace with EV adoption and a rapidly-changing marketplace.

Research in this project area will focus primarily on improving understanding of the technical paths for charge management, their costs, performance, and limitations. The work will evaluate customer acceptance of charge rate/time and location-based price signals as well as demonstrate vehicle-to-grid (V2G) and managed charging use cases (including technical requirements, limitations, and operational considerations of EV original equipment manufacturers (OEMs) and EV service equipment). These efforts will span multiple customer segments including single family, multi-family, commercial, and right-of-way (ROW) charging, and will overlap with numerous other research areas. Research in this area will also explore advanced use cases such as V2G and associated rates structures.

3.3.8 **Cross Cutting Considerations**

In laying out the framework for Phase II of the Smart Grid Testbed, PGE first provided DRRC[27] members with an overarching goal for Phase II.[28] Following the goal discussion, the team outlined ten cross cutting considerations. These considerations are not requirements for every activity, but rather features that Phase II projects should strive to include to help increase the impact on the Flexible Load market. PGE presented ideas for Phase II projects in response to DRRC input and the DRRC provided initial stage-gating feedback.

Cross cutting concepts that should be included in all Phase II project work presented include:

1. Investigation of pricing structures and tariff design
2. Application of the DEI Lens
3. Exploration and accelerated development of joint EE/DR measures, including co-benefits
4. Refinement of program structures (e.g., cost-effectiveness pathways, communications, etc.)
5. Making anonymized program data publicly available
6. Driving market development/market transformation – CTA-2045 (e.g., Trade Ally, Midstream, Workforce)
7. Building out DER Valuation (use cases, Distribution and Transmission Operations)
8. Refine BTM asset modeling/inventory (space heating/cooling, water heating, EV charging)
9. Using open protocols for DER dispatch and control
10. Focusing on the customer (e.g., experience, journey mapping, education)

The team then reviewed key project elements sought by DRRC members during previous planning sessions. These project elements fell into one of four broad categories: Customer, Operations/Dispatch, Planning, and Product Development,

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[27] PGE established the DRRC to engage stakeholders in the effort to meet the aggressive, innovative goals that PGE and the OPUC have adopted for Flexible Load deployment. PGE knows that technology providers, regulators, customers, and advocates must collaborate on new concepts, establish common ground, and avoid unproductive disputes in the pursuit of cutting-edge projects.

The Committee is seated by participating cities, the Citizens' Utility Board (CUB), NWPCC staff, NEEA, the Energy Trust, the Pacific Northwest National Laboratory (PNNL), the Oregon Department of Energy (ODOE), the Alliance of Western Energy Consumers (AWEC), Commission Staff, and other partner organizations. PGE collaborates with these stakeholders to design and implement our Testbed and Flexible Load demonstration projects.

[28] This goal-first approach represented a shift from the Phase I goal of developing Flexible Load resources and exploring customer values to operationalizing flexibility as a grid resource and understanding its use in grid management.

and served as the building blocks for the Phase II project concepts outlined in Table 8, below.

The next point of discussion was the issue of Testbed boundaries. Phase I of the Testbed has a fixed geographic boundary, which is meant to concentrate resources and effort, driving greater awareness in the targeted communities, and achieving higher levels of DER saturation. However, the static boundary created challenges in program implementation, limiting the potential host customer pool for specialized project types and the ability to test the use of DERs to address operational challenges that may not exist in the selected circuits.

To address the issues that static Testbed boundaries posed, the team presented a series of project considerations the DRRC could use to approve projects outside of the existing Testbed boundaries. This approach gives the DRRC greater flexibility in approving projects that would otherwise have limited viability due to 1) the presence (or lack) of specific operational conditions required for project demonstration; 2) the lack of available host customer(s); and/or 3) the project cost. When one or more these conditions are present, the Testbed team proposed allowing the project to move from inside the static Testbed boundary to either an adjacent feeder, a participating Testbed jurisdiction, and in extreme cases, the broader PGE service territory.

The final topic covered was research areas that would guide the Phase II effort. The Testbed team developed specific research areas related to gaps and/or opportunities in PGE's existing Flexible Load product portfolio. These groupings are intentionally broad and interrelated, providing the DRRC with the flexibility needed to allocate resources, constituting a portfolio approach that is both flexible and directed towards high value activities. The team proposed that Phase II projects be organized in one or more of the following areas:

1. New Construction Bundle
2. C&I, Municipal Flexible Load & Resiliency
3. Distributed PV/Smart Inverters
4. Multi-family Bundle
5. Managed Charging/ V2G
6. Flexible Feeder
7. Non-Wires Alternative(s)

These research areas were developed and scoped to ensure maximum coverage of the project areas called for by the DRRC (see Table 8, below). For each area, the team presented a concept overview, expected learnings, estimated budget and participants, potential technologies/strategies that would be explored, and links to the Flexible Load portfolio.

During the presentation, DRRC members engaged the Testbed team, asking questions, challenging assumptions, and redirecting the focus to better align with their understanding and interest in a follow-on Phase II program. Following the

meeting, DRRC members were surveyed to gauge overall thoughts and interest in the proposed work, funding levels, and priority; results indicated broad alignment among DRRC members with the plan as presented. This feedback was further substantiated through follow up phone calls with DRRC members.

Table 8 – DRRC Key Project Elements for Each Proposed Project

Group	Project Elements	Flex Feeder	New Con	C&I/Resi	PV/Smart Inv	Multi Family	V2G
Customer	Behavioral with DLC	X				X	X
	Rate Design	X	X	X	X	X	X
	Transactive Control				X		
	Customer preference/experience	X	X	X	X	X	X
Operations/ Dispatch	Microgrids			X			
	Operationalizing DERs	X	X	X	X	X	X
	Vehicle to Grid						X
	EV Charge Management	X	X	X		X	X
Planning	Electrification/Decarb		X				X
	Multi-family EV Ownership	X				X	X
	Non-Wires Alternatives	X		X	X		X
	Testing DERs Value Streams	X	X	X	X	X	X
	DR/EE Co-benefits	X	X	X		X	
Product Development	New Construction		X				
	New Measure Development	X	X	X	X	X	X
	Product Bundles	X	X	X		X	
	Resiliency		X	X		X	
	Solar Smart Inverters	X	X		X	X	

3.4 Demonstration Roadmap

Activity		Activity	2022 H1	2022 H2	2023 H1	2023 H2	2024 H1	2024 H2
Testbed Phase II*[29]	Requested in Phase II Plan	Flexible Feeder	✓	✓	✓	✓	✓	✓
		Managed Charging	✓	✓	✓	✓	✓	✓
	Anticipated Activities	New Construction Bundle		✓	✓	✓	✓	✓
		Multi-family		✓	✓	✓	✓	✓
		C&I Resiliency			✓	✓	✓	✓

[29] Program/Pilot activities are contingent on OPUC approval.

The activity planned for Testbed Phase II is structured to inform our new offerings or development work, which is described in the subsequent section. As work moves from the Testbed to the appropriate development team, Testbed learnings will inform further design, additional learning objectives, and readiness to scale. Additionally, PGE will work with stakeholders, Staff, and the Commission to understand learnings achieved at each phase and to ensure offerings are scaling at the right pace. The next chapter provides an overview of how PGE is shifting our work using Flexible Load and coordinated EE procurement to advance decarbonization while building an efficient and flexible customer-sited resource capable of providing diverse benefits to all customers and the system.

Chapter 4 Development and Pilot/Program Activity

4.1 Emerging Opportunities

The 2040 goal set forth in HB 2021, increasing support for electrification, and growing clean energy adoption are creating new opportunities and urgency for development of DER with our customers. Specifically, HB 2021 opens the door for PGE to explore and deliver new solutions in the areas of customer energy management (including resiliency and storage), transportation electrification, and clean energy. As such, the development activities detailed in Section 4.2 fall within these portfolios and show that PGE is focusing much of its work and strategy around these three (3) portfolios, with Flexible Load being a key component of each.

Centering on these portfolios will allow PGE to fulfill customer needs while also meeting our Flexible Load goals. These portfolios are critical to ensuring we can manage the ever-increasing balance of renewables on the grid, protect utility assets and infrastructure, and reduce GHG emissions. Moreover, through these portfolios, PGE will engage more closely with our customers to help them more easily integrate key technology and resources into their lives and to efficiently manage their use of electricity. Finally, we believe these portfolios will unlock more Flexible Load potential as we deploy bundled product offers, establish a customer energy services platform, and leverage funding and community engagement partnerships created by recent legislation to increase measure cost-effectiveness and drive overall decarbonization.

4.1.1 **Bundling**

As stated in our Flexible Load Plan, PGE views bundling as a critical strategy for delivering enhanced customer value and experiences resulting in increased adoption of Flexible Load capacity. Through bundled offerings, PGE aims to combine or pair multiple programs, rates, and offerings to create simple and personalized solutions that can be accessed with one-click enrollment.

In deploying this approach, PGE will empower customers to save energy and money based on their sustainability and/or financial goals. Bundled offerings provide customers the opportunity to experience more predictable and stable pricing, as well as insight into their electricity use and how best to manage it. PGE expects bundled offerings to provide customers and the grid the following benefits:

- Personalized and easy digital customer experience
- Reduced and/or predictable energy bills
- More choice and control over energy use and bill
- Increased deployment of smart devices (thermostats, EV chargers, etc.)
- Reduced peak demand

- Reduced GHG emissions stemming from reduced reliance on fossil fuels

Potential adoption barriers may include a lack of customer awareness and education regarding smart devices, the upfront cost of enabling technology, customers' inability to understand each component of a bundle, and potential customer privacy and security concerns. PGE will work with Staff and stakeholders to address these and other potential barriers.

There are numerous policy and regulatory enablers PGE will explore to move forward this market approach, including HB 2021, HB 2842, HB 3141, and currently approved Flexible Load tariffs. As we engage these pathways, PGE will also rely upon strategic partnerships with Energy Trust, Uplight (vendor for the PGE Marketplace), and community-based organizations to assist with program design, funding and incentives, policy issues, and program awareness.

4.1.2 **Customer Energy Services Platform**

PGE is also developing a Customer Energy Services Platform—a one-stop shop for residential and small/medium business customers. PGE's customer research shows that customers are interested in EE and Flexible Load programs, but many are inhibited by the first-cost barrier, making it challenging (or near impossible) for them to cover the initial device purchase and installation costs. Further, available EE and Flexible Load rebates are insufficient to overcome this first-cost barrier. To address this issue, PGE plans to create a service which supports customers through the purchase, installation, and Flexible Load program enrollment journey. PGE will offer customers on-bill financing for specific technology and resources, along with enrollment in relevant Flexible Load offerings. Alternatively, PGE is exploring the ability for customers to lease their device directly from PGE—leaving the ownership, installation, and maintenance of the resource to PGE. We believe the Customer Energy Services Platform will accelerate the acquisition of energy efficient and Flexible Load devices and decarbonization. Again, PGE will continue to engage stakeholders and partners like Energy Trust as we build this platform approach.

4.1.3 **Legislative and Policy Change**

Flexible Load is a requirement of decarbonization and neither PGE nor our customers will reach our sustainability goals without this significant, yet simple, flexible, and cost-effective resource. With the passage of HB 2021, the State is more aligned on decarbonization and the critical energy-related steps that must be taken to achieve a clean energy future for Oregon. In HB 2021, we see an increased emphasis on customer and community-centered planning and benefits. PGE has also seen a growing recognition of the value of customer and community participation and engagement via our Smart Grid Testbed and as part of our outreach conducted for the DSP Part I filing.

Additionally, the passage of HB 2062, which requires electric water heaters manufactured on or after January 1, 2022 to have a modular DR communications port

compliant with CTA-2045 or equivalent, creates more opportunities for PGE to incentivize customers to purchase DR-enabled technology and to enroll in PGE's Flexible Load offerings.[30] HB 3141 requires PGE and Energy Trust to coordinate deployment of measures. Such coordination can leverage the work Energy Trust has undertaken to establish a trade ally network to address the technical complexity of energy efficient smart appliance installation.[31]

To meet the requirements and goals outlined in HB 2021, 2062, 3141, and other recently-enacted legislation, PGE needs to move swiftly and strategically to accelerate customer-sited Flexible Load. We must also leverage key partnerships with the Energy Trust, municipalities, community-based organizations, and other key partners to help customers capture bill savings, overcome the first-cost barrier, gain control over their own energy use, and gain long-term peace of mind regarding Flexible Load appliances and technologies. These combined efforts will help drive us toward a decarbonized system supported by Flexible Loads.

Beyond cost-effectively growing our current offerings, PGE is committed to developing innovative programs that further engage our customers in the clean energy transition and integrate new technological advances necessary to manage the modern electric grid. As such, the below summaries provide high-level information on the offerings PGE will develop over the next two years. PGE plans to submit detailed proposals for Commission review and approval which outline the Flexible Load strategy, market and technology, customer needs and the desired customer experience, results of concept testing, program requirements, program financials, go-to-market plans, and growth strategies. These proposed offerings and target areas will seek to deliver more personalized experiences for customers, contribute to portfolio cost-effectiveness, integrate more renewables and DERs, and influence larger portions of the economy that have significant impacts on the environment (i.e., transportation and building heating).

PGE believes that the identified offerings or areas of opportunity align with recent legislation, center the need for equitable and affordable solutions, and continue to prioritize non-emitting sources of electricity that mitigate the impacts of climate change. And, for the purposes of this MYP, each of the identified opportunities help PGE capture more of the Flexible Load potential available in our territory. Specifically, each of the proposed offerings will focus on increasing equitable access to smart devices and energy savings, increasing the number of behind-the-meter devices deployed in our service territory, and enhancing PGE's ability to manage peak demand and excess renewable generation.

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[30] See generally House Bill 2062, 81st Oregon Legislative Assembly, 2021 Regular Session, available at https://olis.oregonlegislature.gov/liz/2021R1/Downloads/MeasureDocument/HB2062.

[31] See generally House Bill 3141, 81st Oregon Legislative Assembly, 2021 Regular Session, available at https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB3141.

4.2 New Flexible Load Activities

The following briefs summarize product offerings at various stages of development, designed to accelerate Flexible Load acquisition in PGE's service territory. Several of these have been impacted substantially by market or policy factors this year, and so the writing of this first Multi-Year Plan catches us at different levels of maturity and readiness for full funding proposals as described in Table 9, below.

Each brief provides a high-level overview of the proposed offering, including:

- Target customer segment(s)
- Market Size (# of customers, # of deployed technology, etc.)
- Development $
- Expected Flexible Load MW
- Objectives
- Benefits
- Adoption Barriers
- Policy & Regulatory Enablers
- Potential Partners
- Key Tactics
- Key Metrics

The Development dollars ($) provided in each table represent estimated incremental costs for PGE to bring these new proposals forward as filings to the OPUC, including critical market research, vendor engagement, stakeholder engagement, and other preliminary product development work. As development progresses, the Company will need to engage in preliminary technology work, including prototype construction to assist with validation and requirements gathering and foundational work to deliver on key non-functional or technical requirements prior to the launch of many of these offerings.[32] Some offerings will also require that PGE explore integration requirements with our demand response management system (DRMS) providers in advance of a filing to explore concepts, test systems, or prepare for future program launches. These product design and development activities are all necessary to deliver customer-validated, grid-integrated solutions that deliver the necessary experience to customers to ensure program adoption and seamless integration of each of our products or programs. The total anticipated expenses required in 2022 to advance the offerings below to the point of filings are $2.13 million. Single Family Water Heaters makes up a majority of this spend, at $1.13M, as it is the most well understood of the products and program structures.

[32] Information Technology costs associated with program development generally include validation, acquisition, implementation, operational, and improvement costs. For purposes of this request for development dollars, PGE is primarily focused on costs necessary to complete validation, vet vendors and potential solutions, and any preliminary work to prepare for the solution.

Table 9 – Offerings to be Developed (Current Estimated Costs)

Offering	Product Development Stage	Development Funds Requested
Single Family Water Heaters	Final Recommendation & Requirements Development	$1,130,000
Home Energy Bundle	Concept Development	$350,000
Community Microgrids	Concept Development	$250,000
Residential New Construction Bundle	Concept Development	$200,000
Commercial Resiliency Solutions	Concept Development	$200,000
Total		**$2,130,000**

As the Company prepares to file proposals for the above concepts with the OPUC, we will vet offerings with stakeholders prior to filing and also provide the Commission with proposed budgets for each offering and an accounting of any previously spent development dollars. PGE will also provide regular updates to Commission Staff on progress through the quarterly DRAG meeting. This cadence will grant Staff insight into PGE's progress, learnings, successes, and spending forecasts for each new offering.

To that end, PGE is requesting that the Commission approve $2.13 million as development dollars for the Company, allowing PGE to progress with developing the proposed offerings as described in the briefs below. In August of 2022, PGE will file an update to this MYP detailing how the $2.13 million was spent and proposing revised portfolio budgets associated with filings and maturing proposals.

4.2.1 **Single Family Water Heater**

Est. Megawatts Procured by 2024	Est. Connected Water Heaters by 2024	Est. Setup and Implementation Costs	
.65MW Seasonal average	2,200	Setup	$700,000
		Incentives	$430,000

4.2.1.1 Executive Summary

PGE has worked on several fronts to prove water heaters to be a viable, nearly ubiquitous Flexible Load. We have worked with PNNL and BPA to identify the Flexible Load capability of heat pump water heaters. Heat pump water heaters (HPWH) are a highly efficient source for providing hot water in homes, and they can support PGE's decarbonization efforts. HPWH are critical to reducing (and eliminating) carbon emissions from buildings. Moreover, HPWHs store hot water for later use, which

makes them an important resource for load shifting and other Flexible Load purposes that are necessary for balancing grid energy at peak periods or at times when renewable energy is in abundance. We have also worked in multi-family dwellings to prove the ability of smaller electric resistance water heaters to work in concert to provide intra-hour load flexibility. Currently, we are working in the Testbed with CTA 2045 enabled HPWH to test various communication platforms and pathways to control these assets to extract the greatest number of energy services.

PGE now seeks to capture more value from water heaters, through the development and implementation of a Single-Family Water Heater (SFWH) offering. SFWH seeks to enhance PGE's ability to control and operate electric water heaters for demand flexibility. The offering is expected to provide Flexible Load capacity, as well as intra-hour energy shifting, and builds upon the foundation and learnings drawn from the Multi-family Water Heater pilot and other DR pilots and demonstrations.

Through the SFWH offering, PGE will encourage and incentivize customers to upgrade from older, less-efficient water heaters, which can help lower their energy bills and improve their overall energy efficiency. To assist customers with the choice to switch to a more energy-efficient water heater, PGE is proposing to offer rebates on a qualified list of water heating systems.

To further market transformation, PGE will continue working with and support Energy Trust and NEEA efforts to increase the adoption of cost-effective, energy efficient water heaters. These partnerships will allow more customers to experience the benefits of HPWHs, while also allowing PGE to further our understanding of Flexible Load potential of this highly dynamic, ubiquitous appliance in the residential space. Additionally, by incentivizing key channel partners to sell and stock high-efficiency HPWHs, PGE seeks to continue to transform the water heater market for Oregon customers.

4.2.1.2 Target Participants

The SFWH offering will target residential customers in single family dwellings and multi-family dwellings with six-or-fewer units.

4.2.1.3 Engagement Strategy

PGE will leverage its partnership with the Energy Trust as well as the (to be developed) Customer Energy Services Platform to target and enroll customers into the program. Like the Residential Electric Vehicle pilot, SFWH will offer customers a rebate for the installation of a qualifying grid-connected water heater. PGE will also automatically enroll participants in the DR program and reward them for their participation.

4.2.1.4 Market

Annual potential in Year 5 for smart electric water heater installations into single family, owner-occupied homes.

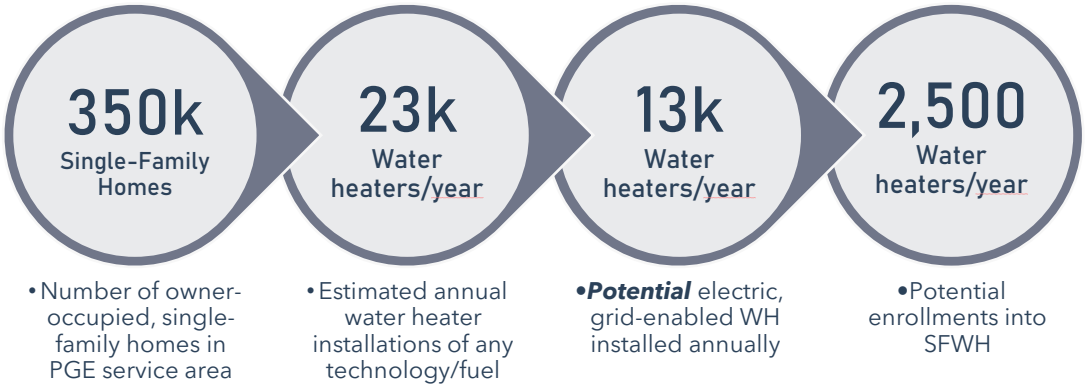


Figure 5 – Annual Potential Market for Smart Water Heaters (owner-occupied SFH)

4.2.1.5 Deployment Strategy

PGE will, as we did with the Energy Trust, utilize three key deployment strategies for water heaters. First is a point of sale, midstream incentives strategy, where we'll work with trade allies on installation and replacement upon failure. This will leverage the current and historical work with the Energy Trust and NEEA. The second approach for retrofits of HPWH and DR-enabled electric resistance water heaters involves collecting sales data where available. This approach was used in the Testbed to identify and engage customers with DR-enabled HPWHs. Identifying DR-enabled electric resistance water heaters already in the field or recently purchased will require a different possible midstream approach to incentives to collect purchase and installation information. Lastly, in conjunction with our new buildings work outlined above, PGE will work with home builders to identify approaches to incent the installation of DR connected water heaters in single family home new construction.

4.2.1.6 Strategy to Scale

PGE will stand on the lessons learned from other DR pilots (e.g., MFWH, Smart Thermostats, and Residential Electric Vehicle) to reduce the time required to scale the SFWH offering. The following items will need to be developed and deployed to successfully scale the offering:

- Seamless and frictionless customer experience
- Supply chain network (installers, manufacturers, distributors, communications vendors, and developers)
- A dynamic qualified products list
- Cost-effective acquisition channels
- A robust marketing funnel that supports customers from awareness through their advocacy and recommendation of the offering
- Diverse list of water heaters integrated with–and controllable by–PGE's DRMS platform

4.2.1.7 Barriers to Scale

PGE has identified several barriers for SFWH. The upfront costs associated with the equipment and installation may deter customers from purchasing a qualified water heater. We plan to leverage our partnership with the Energy Trust and other market actors to help customers find competitive and affordable pricing. We are also examining whether the SFWH offering would be a good candidate to leverage the Customer Energy Services Platform described above.

We also know that the addition of a communication device after the water heater has been installed will be a barrier to recruitment. PGE plans to overcome this issue by providing for and encouraging installation of the communications device when a new water heater is installed. We anticipate trying several methods to address this issue.

There is a lack of awareness around water heaters in general, let alone the new generation of grid-connected water heaters. The pilot will need to include content to educate customers on general water heating issues as well as the benefits of connecting a water heater to the grid.

4.2.1.8 Funding Source and Estimated Costs

PGE plans to keep develop and implementation costs low by leveraging efficiencies and technology already tested in prior DR pilots. PGE estimates the pilot will require funding in the amount of $1,130,000 for research, IT and process development, program resources, DRMS integrations, and incentives/rewards. For this phase of development, PGE will rely on outside sources for items such as initial project management, IT, and web development. If the approach demonstrates viability, PGE will move the work to internal resources, which carry greater costs and permanence.

Table 10 – Single Family Water Heater Estimated Costs

Cost Category	Estimated Cost
Market Research & Focus Groups	$50,000
Digital, IT, & Web Development (including incremental IT development) PGE will use outside contractors to initiate this work until it demonstrates stability at which time the activity will be transferred to PGE internal groups.	$350,000
Market and trade ally engagement, education	$75,000
Project Management Resource short term contractor	$150,000
DRMS Integration	$75,000
Incentives/Rewards	$430,000
Total	**$1,130,000**

4.2.1.9 Timeline of Upcoming Activities

2022 H1	2022 H2	2023	2024
Complete design process Submit SFWH tariff and updated budget for OPUC approval	Expected OPUC approval SFWH soft launched for 90 days, then fully launched in market	ID offering evaluation and improvements Implement applicable changes to the offering	TBD

4.2.1.10 Learning Objectives

- Verify, through field work, that the planned savings number per unit is accurate or needs to be adjusted.
- Verify the grid service benefits used in cost effectiveness and DER planning.
- Identify a next step or evolution for the pilot that can successfully lead to scale and program status.
- Validate the qualified products list developed for the single-family market.
- Determine the most effective strategies for engaging and educating customers around the benefits of efficient Flexible Load-enabled water heaters, and how this approach affects market adoption.
- Identify the type(s) of engagement and training required by water heater installers in order to support the pilot and subsequent scaling efforts.
    - Address misinformation regarding "grid-connected" water heaters.
- Stress test communication devices and their performance within the DRMS platform across all qualifying water heater models.
- Identify required actions to compel customers to retrofit and allow control of their water heater.
- Identify other unique adoption and performance barriers.
- Expand on the work on the MFWH pilot and extrapolate how to operationalize the technology so that it provides uptime of 90+% for the PGE water heater fleet.
- Identify what costs can be reduced prior to maturing to program.
- Demonstrate use of the fleet of Flexible Load-enabled water heaters to demonstrate load following capabilities, as well as frequency response capability.

4.2.1.11 Benefits to Customers and Ratepayers

Benefits to participating customers:

- Lower upfront cost of water heaters for customers
- Access to approved vendors
- Energy Trust, PGE, and trade ally coordination for comprehensive product offering
- Access to affordable maintenance and service
- Increased home value
- Monthly bill adjustment (incentive)

Benefits to ratepayers:

- Dispatchable Flexible Load resource
- Lower power costs, reducing rate pressure
- Non-generating resource development
- Once cost-effective, decreasing rate pressure

Benefits to the system:

- Accelerate acquisition of Flexible Load devices
- Potential locational distribution system benefits

4.2.1.12 Key Outcomes and Success Measurements

The goals for PGE's SFWH offering are as follows:

- Development of a qualified products list
- Engage and train installers on grid enabled water heaters, installation requirements, and their benefits
- Communication devices are reliably communicating with PGE's DRMS platform
- Successfully operationalize and field deploy retrofit devices that allow for controlling legacy water heaters
- Operationalize and field deploy DR-enabled new water heaters that can be controlled via PGE's DRMS platform
- Operationalize communications technology that provides uptime of 90+% for the PGE water heater fleet
- Reduce costs for hardware, installation, maintenance, and operations down to cost-effective levels while scaling up the program during the pilot period
- Successful dispatch of PGE water heater fleet in DR events
- Expansion of operation of PGE water heater fleet from DR to daily load shifting. Demonstration of load following capability

4.2.1.13 Evaluation Strategy

PGE will contract with an independent third-party evaluation firm to assess the implementation mid-pilot and at the end of the pilot period. Evaluation reports will be provided to the PUC once the reports have been written. PGE will provide updates on implementation in the quarterly DRAG meetings.

4.2.2 **Product Concepts**

4.2.2.1 Home Energy Bundle

Target Customers	# of Customers	2022 Development Funds		Expected MW
▪ Residential ▪ Small Business	Potentially 250/year (or 10% of current annual new rooftop solar customers)	Market Research	$25,000	Designed to acquire above cost effective MW, Assessment in progress
		Technology Scoping (prototypes for market testing, billing system changes, web design, and other integration work)	$250,000	
		Product Development	$75,000	
		Total	**$350,000**	

Product Concept Brief

The Home Energy Bundle seeks to create a holistic energy experience for new rooftop solar customers by incentivizing them to make a single, upfront investment in solar plus storage (and potentially EV chargers or new heat pump water heaters). By paying customers a set portion of their anticipated net energy metering (NEM) credits upfront, customers are incented to invest in a battery or other Flexible Load equipment, at the time of their solar purchase, as well as agree to participate in PGE's Flexible Load programs.

The anticipated benefits from a Home Energy Bundle offering are up-front capital and bundling that offset additional investments needed to meet a customer's sustainability and resiliency goals. Additionally, customers will receive incentives for participating in PGE's Flexible Load programs, while non-participating customers and the grid benefit from the additional Flexible Load.

Potential adoption barriers may include confusion between this offering and general NEM offering. There may also be an impact on a customer's payback period for solar installation. PGE will work with Staff and stakeholders to address these and other potential barriers.

PGE believes that HB 2618 and HB 2021 are critical enablers for this offering and will work with stakeholders to leverage these legislations appropriately. PGE will also review and rely upon current NEM legislation and Commission rules to guide the

structure of this offering. Additionally, PGE will pursue strategic partnerships with the Energy Trust, solar installers, Earth Advantage, customer advocacy organizations, and community-based organizations to assist with program design, funding and incentives, policy issues, and program awareness.

This offering will also leverage the learnings and best practices of the Smart Battery pilot, as enabled by UM 1856. The associated battery energy storage with the bundle may use the same DERMS software and qualified products list currently in place for the Smart Battery pilot to keep costs low. The pilot is also working to optimize the dispatch strategies for grid services to ensure that the full value of interconnected residential storage can be realized.

PGE made strides within the AdopDER model (the analytical engine underpinning the Cadeo forecast, developed with PGE, and used to develop the potential estimates referenced in Chapter 1 of this MYP). To depict the interplay of customer co-adoption of DERs and Flexible Loads, we are continuing to improve our planning around bundled DER adoption, both in terms of cost reductions and associated grid benefits, particularly locational distribution system impacts. Toward this end, PGE is leveraging its R&D funding to sponsor an Electric Power Research Institute (EPRI) research project, in collaboration with NREL and LBNL, to study customer preferences, influences, and decision-making for co-adopting solar PV with energy storage and/or EVs. Under this research effort, PGE will work with EPRI to conduct a survey of our customers to develop quantitative models of propensity for co-adoption that reflect our customers' attitudes and perceptions of these products. Outputs of the study will be used to update NREL's tools (in particular, dGen), which are also used in PGE's AdopDER model. PGE will incorporate these learnings and new modeling tools as soon as available and will thus inform future iterations of the Home Energy Bundle product strategy.

As PGE develops this offering and considers implementation, we are considering the following key strategies and tactics to help ensure the success of the offerings:

- Educate customers on the value of solar plus storage in a single investment in electrification
- Combine with a PGE guided in-person, virtual, or DIY Home Energy Evaluation, or Earth Advantage Home Energy Report to reinforce the value of the single, upfront investment
- Align with multi-family, new construction bundles to encourage all-around benefit of all-electric buildings and homes

Key Metrics	▪ # customers accepting offer ▪ # enrolled MW in Flexible Load programs ▪ # managed devices ▪ Customer Experience metrics for specific points in the journey (customer effort score, customer satisfaction, net promoter score)

4.2.2.2 Community Microgrids

Target Customers	# of Customers	2022 Development $			Expected MW
Residential segment	200 units over three years	Across both the Residential and Commercial segments:	Project Management	$75,000	Designed to acquire above cost effective MW, Assessment in progress
Commercial segment	20 units over three years		Product Development	$75,000	
			Grant Writing Assistance	$100,000	
			Total	**$250,000**	

Product Concept Brief

The Community Microgrid offering seeks to incentivize and provide building-level resiliency for buildings that can serve as public hubs during emergency events, while offering Flexible Load in non-emergency times. Additionally, PGE seeks to incentivize and provide building-level resiliency and bill savings for multi-family buildings serving low-income populations, along with Flexible Load for the grid. PGE will also engage in general market research and test how best to structure microgrid offerings designed to support the critical needs of vulnerable communities impacted by grid outages.

PGE is leveraging our R&D funding to partner with University of Oregon's Institute for Health and the Built Environment (part of the College of Design) and PAE Engineers, to study the potential for Flexible Loads and other DERs to contribute to improvements in indoor air quality and provide resilience to public health threats like wildfire smoke and viral/bacterial exposure in buildings (e.g., COVID-19 and related outbreaks). PGE has partnered this research effort with Home Forward, led by the nonprofit Diversifying Energy, in order to determine potential impacts for future building designs geared toward enhancing resiliency and occupant health and comfort. PGE is seeking to partner with the Energy Trust and PNNL in order to answer additional research questions under this project umbrella, such as studying the impact of EE in right-sizing backup battery systems, quantifying new metrics around Flexible Loads, resiliency, and indoor air quality, and leveraging national best practices regarding the overall non-energy benefits inherent to this type of program design.

The anticipated benefits from a Community Microgrid offering are:

- Reduced impacts of power outages and minimized disruptions for low-income households and energy-dependent individuals who require uninterrupted power
- Increased resiliency in communities that may be at higher risk of electrical outages

- Increased resiliency (and the ability to island) for critical facilities such as hospitals, wastewater treatment plants, nursing homes, fire stations, and schools
- Additional storage resources add flexibility and capacity and energy services to the VPP

Potential adoption barriers may include:

- Limited customer capital available
- High financial costs and risks
- Federal tax policy (the Investment Tax Credit)

PGE believes that HB 2021 and HB 3141 are critical enablers for this offering and will work with stakeholders to leverage these legislations appropriately. Additionally, PGE will pursue strategic partnerships with the Energy Trust, local governments, private entities, and community-based organizations to assist with program design, funding and incentives, and program awareness. The Beaverton Public Safety Center, Anderson Readiness Center, and other activities enabled by UM 1856 have positioned PGE to fully understand the costs, configuration, dispatch strategies, and staffing needs associated with utility ownership and dispatch of behind-the-customer-meter microgrids.

As PGE develops this offering and implementation approaches, we are considering the following key strategies and tactics to help ensure the success of the offerings:

- Engage with communities and stakeholders early and throughout (inclusive process)
- Identify key partners and funding sources necessary for fast and seamless approval
- Establish a replicable process or program
- Explore resiliency-as-a-service models to address financing concerns
- Ensure robust understanding and valuation of stacked grid services and non-energy benefits (see section 7.2)
- Test support for a "30-by-30" campaign that solicits partners and communities to commit to building 30 microgrids by 2030

Key Metrics	▪ # customers accepting offer ▪ # microgrids constructed ▪ Amount of funding leveraged ▪ # enrolled MW of solar & batteries ▪ MW of available Flexible Load capacity

4.2.2.3 Residential New Construction Bundle

Target Customers	# of Customers	2022 Development $		Expected MW
Builders and Developers constructing homes in PGE's territory	Up to 10 Builders or Developers	Market Research and Focus Groups	$50,000	Designed to acquire above cost effective MW, Assessment in progress
		Technology Scoping	$50,000	
		Project Management	$50,000	
		Product Development	$50,000	
		Total	**$200,000**	

Product Concept Brief

PGE's Residential New Construction Bundle seeks to meet increasing demand within the building industry for electric equipment with an easily-packaged offering that ensures electrification at time of construction is DR-enabled. The offer will apply to single-family homes, townhomes, or duplexes. With this offering, PGE will also incent builders to build solar and EV-ready homes. The offer may include technical or design expertise and assistance, an increased rebate for income-qualified homes, or the establishment of a preferred trade ally network. The New Construction offering will ultimately help PGE's customers meet their sustainability goals and live in clean and efficient homes that provide them with peace of mind.

PGE anticipates the New Construction offering will provide residential customers and the grid the following benefits:

- Increased comfort and health
- Energy bill savings
- Reduced maintenance costs
- Reduced peak demand
- Additional grid services for integration of renewable resources

To successfully move this offer forward, PGE will work with stakeholders to address adoption barriers, which may include:

- Current high cost associated with building electric homes
- Incentive too low
- Lack of builder awareness and education on electric equipment and homes, and how to sell to potential homeowners
- Misaligned with builders' development and build cycle
- Homeowners not aware of PGE's Flexible Load programs

PGE will also leverage key policy and regulatory enablers designed to address some of the above-listed barriers. Specifically, PGE will explore opportunities under HB 2842 and HB 2165, and the Commission's Transportation Electrification Investment Framework to support the New Construction offering. PGE will also bundle the New

Construction offering with current or future program offerings to deliver more value for customers and the system.

Strategic partnerships will be critical to the success of this offering. PGE plans to explore partnerships with the Energy Trust, developers, builders, installers, and community-based organizations to assist with program design, funding and incentives, policy issues, and program awareness.

As PGE develops this offering and considers implementation, we are considering the following key strategies and tactics to help ensure the success of the offerings:

- Identify progressive builders and key partners to help design offering
- Offer customized incentive structures, particularly for multi-family vs. single family homes, or for developers of income eligible homes
- Encourage early engagement by requiring application to be submitted prior to key steps in the pre-design and permitting process

Key Metrics	▪ # devices installed ▪ # participating Builders/Developers ▪ MW of available Flexible Load capacity ▪ Customer Experience metrics for specific points in the journey (customer effort score, customer satisfaction, net promoter score)

4.2.2.4 Commercial Resiliency Solutions

Target Customers	# of Customers	2022 Development $		Expected MW
• Commercial • Industrial • Municipal	50	Market Research and Focus Groups	$50,000	Designed to acquire above cost effective MW, Assessment in progress
		Product Development	$75,000	
		Project Management	$75,000	
		Total	**$200,000**	

Product Concept Brief

With the increase in DER technologies, storage options, and flexible power generation, businesses across industry segments are increasingly looking for ways to mitigate the risk of loss of power due to the impacts of climate change, which presents a significant financial risk to many of our commercial customers. Data centers and manufacturers are particularly vulnerable to significant financial loss from electricity service interruptions, be they in the short or long-term.

PGE's Commercial Resiliency offering will provide our commercial, industrial, and municipal customers access to enhanced resiliency and power quality solutions for a

fee. PGE will own, operate, and maintain a custom-engineered microgrid to meet the customer's specific needs. Costs and benefits will be appropriately allocated between PGE, participating customers, and cost of service customers. During normal operations (or "blue sky" days), PGE will use the microgrid as a Flexible Load resource. Participating customers will have access to the on-site resource during power interruptions. This offering will also bring the added benefits of renewable integration and reduce reliance on fossil fuel generation.

For businesses, the biggest barriers to integrating battery energy storage systems (BESS) are "first cost" and a lack of technology familiarity. Funding a storage system is often cost prohibitive, especially for public entities such as schools and cities. To address these barriers, PGE will explore potential opportunities to work with customers to leverage funding under HB 2021 (small renewables and resiliency) and HB 3141. PGE is also considering an "As a Service" (AaS) model, which allows customers to finance costs over a defined period (5-20 years), effectively shifting a capital expenditure to an operating expenditure as part of an energy service performance contract or shared savings agreement. Applying the AaS approach to BESS offers a unique opportunity for PGE to serve customer needs while also benefiting the distribution and bulk power system.

To successfully move this offer forward, PGE will establish strategic partnerships with the Energy Trust, OEMs, installers, and community-based organizations to assist with program design, funding and incentives, policy issues, and program awareness.

Key Metrics	▪ # customers accepting offer ▪ # enrolled MW of batteries ▪ MW of available Flexible Load capacity ▪ Customer Experience metrics for specific points in the journey (customer effort score, customer satisfaction, net promoter score)

4.3 Current Flexible Load Pilot/Program Activities

This section presents an overview of existing PGE Flexible Load activity. The activities are maturing through the pilot process and are being refined to a point of stability before evolving into full programs.

Table 11 - Program Roadmap

Activity	2022		2023		2024	
	H1	H2	H1	H2	H1	H2
Residential Battery Energy Storage Pilot	Year 2 Recruitment Activities	Compliance Evaluation Report	Final Year of Recruitment	Comprehensive Mid-Pilot Evaluation	Recruitment closed, pilot operations	Compliance Evaluation Report
Energy Partner Pilot	Updated go-to-market delivery implementation (Schedule 25) Tariff reauthorization updates (25 & 26) Pilot SMB outreach strategy in partnership with the Energy Trust (25)	Expanded offerings (26) Updated design implementation (25)	Integration and alignment of Energy Partner with additional energy service offerings to C&I customers Continued growth (25 & 26)		Aggregate Energy Partner assets into VPP Full integration of Energy Partner DR into Power Operations resource stack	
Peak Time Rebate	PTR as part of DR product bundle		Seasonal participation			
Time of Day (TOD)	Introduction of online rate calculator & what-if analysis tool	TOD as part of Flexible Load bundle	Increased enrollment growth			
Multi-family Water Heater Pilot	Change rebate incentive on CTA-2045 enabled WHs due to code change	Ramp up installation of CTA-2045 comms devices on Smart WHs	Complete final evaluation for pilot from current period	File for pilot-to-program consideration, or additional extension	Expand CTA installations	Cease installations of any retrofit switches (only install CTA comms)
Smart Thermostat Pilot	Complete assessment and recommendation of channel delivery strategies File for pilot extension	Execute channel recommendation Evaluation Report		Evaluation Report	File for pilot to program consideration or additional extension	Evaluation Report

4.3.1 **Energy Partner**

Activity	Megawatts Procured by 2023		Total Costs (2022-2023)	Cost-Effectiveness Score[33]
Schedule 25	Summer	1.8 MW	$2.851M	Total Resource Cost (TRC) without Value of Service Lost: 0.48
	Winter	1.1 MW		
Schedule 26	Summer	30.5MW	$8.277M	TRC without Value of Service Lost: 1.20
	Winter	24.4 MW		

4.3.1.1 Executive Summary

Energy Partner is comprised of two distinct participation models:

- Schedule 26 is focused on large customers via custom load curtailment plans, 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 may evolve to provide intra-hour grid services to support resiliency and renewables integration.
- Schedule 25 provides an option for small and medium customers to participate via Smart thermostat installations that curtail HVAC load during peak time events and offer seasonal incentives for 50% or more event hour participation.

Delivering impactful business DR programs and the associated Flexible Load is key to A) delivering upon PGE's IRP commitment, B) supporting Oregon's 50% renewables by 2040 (SB 1547) target, and C) enabling PGE to achieve aggressive carbon reduction goals (carbon emissions reduced by 80% below 1990 levels). Energy Partner continues to help us learn how to drive adoption, optimize the DR software platform, and add 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 seeks to transition from a pilot to program. The program structure intends to stay largely the same, while also enabling customers with more sophisticated equipment to provide and be compensated for additional grid services beyond shedding load. The full pilot-to-program transition plan can be found in Appendix B. While proposed tariff updates are discussed in the transition plan, the request to approve a revised tariff will be filed under a separate docket.

[33] Comprehensive cost-effectiveness table here: Table 20.

For its part, Schedule 25 is also currently undergoing a transformation, leveraging earlier learnings from the first two years of pilot operations, and identifying additional opportunities to increase cost effective customer enrollment.

4.3.1.2 Key Customer Needs Addressed, Engagement, and DEI

Energy Partner Schedule 26 is a custom, flexible offering designed to provide customers with significant financial incentives without significant impact to their operations. PGE's non-residential DR pilot was relaunched in December of 2017 and is directly administered by PGE with support from CLEAResult (for implementation) and Enbala (for technology integration via their software platform). PGE took a more active approach than the prior turnkey DR pilot administered by EnerNOC, as PGE found that third party aggregation fell far short of load goals.

The updated arrangement offered a variety of products and the flexibility to adjust them in the future. The secondary reason for PGE to work directly with customers was portfolio resiliency; as with the loss of EnerNOC in 2017, PGE had to execute new contracts and deploy new technology to current participants, which presented customer retention risk. Directly administering Schedule 26 avoids such adverse operational risks should a third-party implementer exit. 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 select 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 to 11 am (winter) and 11 am to 4 pm, 4 to 8 pm, and 8 to 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 2017 pilot update also featured the addition of dedicated sales representatives and engineering staff (provided by CLEAResult) who can work on-site with customers. 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 or questions may arise as to how to optimize participation during events).

On December 1, 2017, PGE launched the Schedule 25 Smart Thermostat pilot as a complement to 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.

4.3.1.3 Technology Principles

PGE is 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.

As Schedule 26 transitions to Power Operations, this resource must be dispatched 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 the Power Operations and Program Operations teams, as well as to the Energy Partner program. Clear and consistent communication to the participants about potential impacts to their operations and active management of customer expectations will be integral to the evolution of the offering.

Using Schedule 26 as the driver, PGE's Program Operations and IT teams have been working cross-functionally with the Power Operations and Balance Authority teams 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 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.

4.3.1.4 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 and 26. Schedule 25 can benefit from leveraging the Energy Trust's trade ally network and 2022 small-to-medium sized business (SMB) outreach emphasizing communities of color. The DEI focus of the 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. In addition, 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.

For both Schedule 25 and 26, PGE coordinates closely with its implementation vendor to perform pilot outreach, identify pilot leads, and offer technical assistance to customers.

4.3.1.5 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 combined 2023 target for Schedule 25 and 26 is 32.3 MW.

Figure 6, below, provides an estimate of market penetration for PGE's Energy Partner offerings:

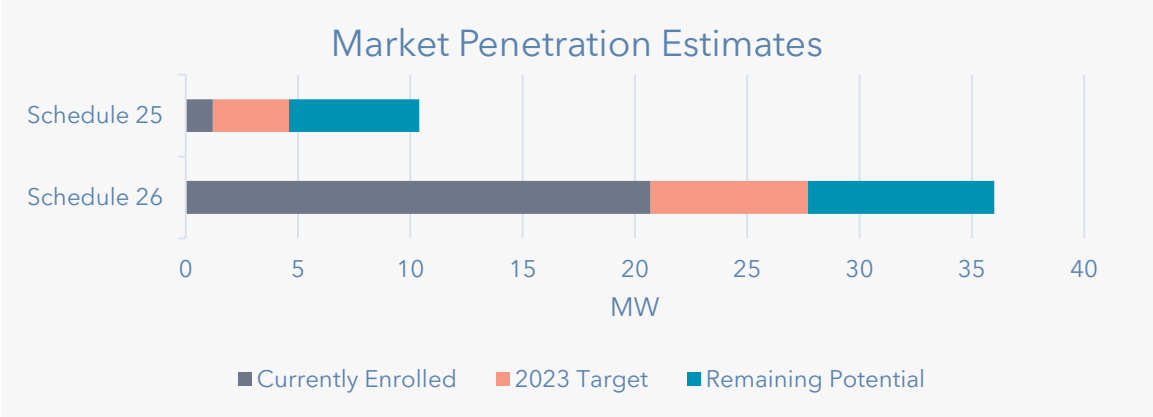


Figure 6 – Energy Partner Pilot Market Penetration

4.3.1.6 Key Activities, Outcomes, & Measures of Success:

The Schedule 26 non-residential DR activity is expected to bolster several design elements that accelerate the ability to refine and optimize its delivery activities. Specifically, PGE plans to include enhanced incentives, targeted marketing, as well as dedicated sales and outreach to unmanaged PGE customers. We expect these efforts will be incremental to "business as usual" operations, meaning that they leverage existing activities. Furthermore, we expect these incremental efforts to be invaluable in defining optimal delivery strategies and tactics, identifying customer segment-specific ceilings for participation, and facilitating acceleration of significant load reduction capacity within the DR portfolio.

Schedule 25 conducted a market potential assessment in Summer 2021 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 also to participate in peak time events. These insights 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 is undergoing a pilot delivery review and redesign to leverage efficiencies via partnerships with the Energy Trust and trade allies and reach more potential participants at a lower overall cost.

Examples of potential incremental activities evaluated can be found in Table 12, below:

Table 12 – Energy Partner: Potential Incremental Activities Evaluated

Incremental Activity	Schedule 26	Schedule 25
Incentives	Offering enhanced incentives at a to-be-determined level If possible, testing multiple enhanced incentive levels is desirable due to ability to determine "incentive elasticity"	Consideration of contractor incentives to participate in trade ally customer recruitment and direct install model
Marketing	Partnering with Energy Trust SEM staff to message co-benefits of Energy Partner and SEM program participation	A/B testing of the same messaging of co-benefits, delivered through different delivery mechanisms A/B testing of customer segment-specific messaging
Sales/Outreach	Dedicated sales/outreach staff to unmanaged PGE customers	Partner with HVAC trade allies Partner with the Energy Trust on direct outreach to SMBs owned by communities of color
Product Design	Bundling of offerings such as business DR EV charging and Energy Trust's Strategic Energy Management 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 Tiered incentive levels tailored to the DR approach (e.g., manual, automated, or advanced)	New pilot delivery models that leverage trade allies and Energy Trust direct installations

4.3.1.7 Timeline of Upcoming Activity

2022 H1	2022 H2	2023	2024
Transition of Schedule 26 to program status with tariff updates Updated go-to-market delivery implementation (Schedule 25) Tariff reauthorization updates (Schedules 25 and 26) Pilot SMB outreach strategy in partnership with Energy Trust	Updated design implementation (Schedule 25)	Integration and alignment of Energy Partner with additional energy service offerings to C&I customers Continued growth (Schedules 25 and 26)	Aggregate Energy Partner assets into VPP Full integration of Energy Partner DR into Power Operations' resource stack

4.3.2 **Flex 2.0: Peak Time Rebate**

Megawatts Procured by 2023		Total Costs (2022-2023)	Cost-Effectiveness Score[34]
Summer	22.4 MW	$6,890,000	TRC without Value of Service Lost: 0.87
Winter	16.8 MW		

4.3.2.1 Executive Summary

Peak Time Rebates 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 considered a behavioral DR piot. 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. 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

[34] Comprehensive cost-effectiveness table here: Table 20.

resource and is proving to be a reliable, consistent resource that will support PGE's Flexible Load acquisition goals.

4.3.2.2 Key Customer Needs Addressed, Engagement, and DEI

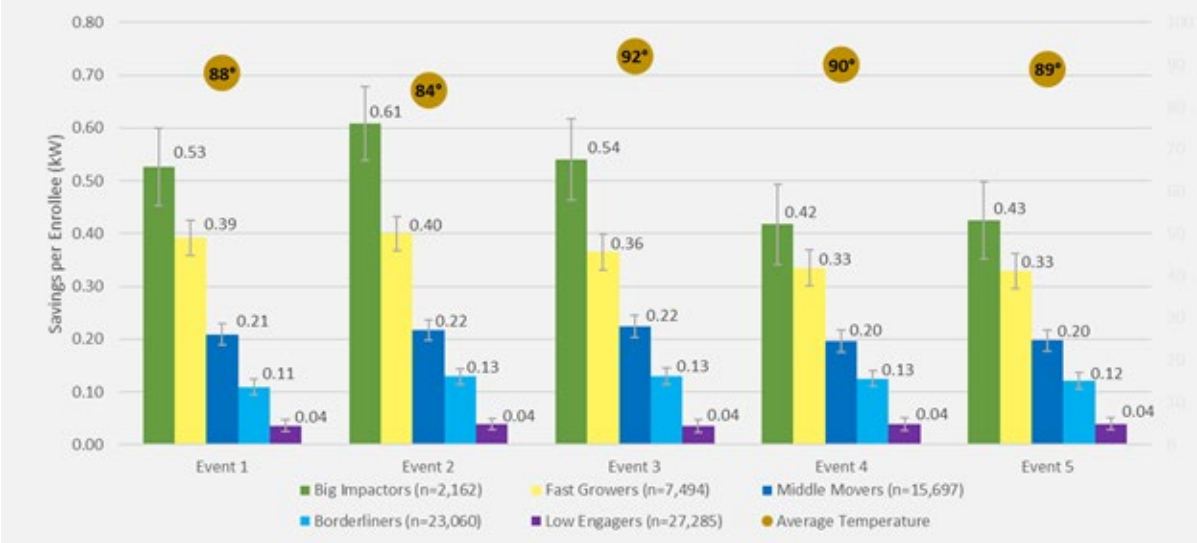
Residential customers want to save money on their monthly bill, decarbonize, and provide benefit to the community by maintaining grid reliability. Many also want to support use of more renewables in their energy mix. PTR provides an equitable way to engage our residential customers in support of those 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 e-mail (based on their preference) and encouraged to shift usage during the event hours the next day. On the day of the event, they receive a same-day reminder, and after the event, 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 should a customer use more than expected energy 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 all 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.

In Summer 2020, impact of the high propensity customer segment was 10-15 times as large as the lowest impact customer group and they were most satisfied in the pilot. For Summer 2020, savings per enrollee averaged between approximately 0.20 kW and 0.61 kW. (See customer segmentation chart below.)

Chart 5 – Peak Time Rebate Savings



Source: Cadmus Summer 2020/Winter 2020/21 Evaluation

By taking an "audience of one" approach, PGE encourages customers who are delivering high-impact and are highly satisfied with the pilot to remain on PTR. Low impact/less satisfied customers (who 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 satisfied. 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, transitioning the right customers to DLC will be key to unlocking the full potential resource capability of DR.

4.3.2.3 Technology Principles

The PTR pilot relies on an independent data science firm (E Source) 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 (referenced above) that rank customers by forecasted load impact. While the pilot is open to all, PGE has focused its marketing outreach on customers with high expected savings. In addition to the measures implemented to benefit DR value, PGE is also continuing to manage costs. PGE has leveraged an internal platform (Salesforce Marketing Cloud) for event communication dispatch and post-event data analytics, which substantially reduced operational expenses in FY 2021.

Behavior-based programs do not offer Power Operators the control and certainty they prefer. Thus, integration into Power Operations' dispatch will present novel challenges. PTR has several structural challenges which need to be addressed prior to contemplating such an integration, but it is PGE's intention to so integrate PTR and other Flexible Load offerings.

4.3.2.4 Market

The vast majority of PGE's residential customer base is eligible to participate in this voluntary pilot. Since its introduction in April 2019, 95,873 customers have chosen to enroll and an additional 16,841 were auto enrolled as part of the Testbed project (enrollment numbers as of 8/3/2021).

While Peak Time Rebates will remain open to all 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 as we learn more about each unique customer, specifically those who are best suited for PTR, and grow our portfolio of other DR options available to customers.

Table 13 – Flex 2.0 Forecasted Enrollment and MW Impact

	2021	2022	2023	2024
Enrollment	127,000	134,000	140,000	147,000
Summer MW Impact	18	21.4	22.4	23.5
Winter MW Impact	15	16.1	16.8	17.6

4.3.2.5 Key Outcomes & Measures of Success:

The goals for PTR are as follows:

- Design and deploy a large-scale DR program 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 program into Power Operations
- Assure that changes made to the program do not jeopardize cost effectiveness
- Continue to improve customer performance through educational and engagement strategies
- Test customer value propositions to garner insights into customer engagement and performance

4.3.2.6 Timeline of Upcoming Activity

2022 H1	2022 H2	2023 H1	2023 H2	2024 H1	2024 H2
PTR as part of DR product bundle		Seasonal participation			

4.3.3 **Time of Day**

Megawatts Procured by 2023		Total Costs (2022-2023)	Cost-Effectiveness Score[35]
Summer	4.8 MW	$ 1,390,000	TRC without Value of Service Lost: 1.36
Winter	2.2 MW		

4.3.3.1 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 is a new option that 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 manage system peak loads and reduces 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. Time of Day 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.

Time of Day:

- **Addresses capacity constraints** – PGE's IRP action plan calls for the use of DR programs like Time of Day 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 Time-of-Day participants.
- **Supports adoption of enabling technology** – studies from other utilities have found customers on a time-varying rate coupled with enabling technology such

[35] Comprehensive cost-effectiveness table here: Table 20.

as a programmable thermostat showed substantially greater peak load reductions than those customers who relied on manual processes.[36]

- **Accelerates transportation electrification** – for EV users who have at least a Level 1 charger, Time of Day offers 10 hours of off-peak hours to accommodate overnight charging.
- **Attracts and engages residential customers** – when given a choice, PGE customers preferred time-varying programs like Time of Day to flat-rate plans like Basic Service.[37]

4.3.3.2 Key Customer Needs Addressed, Engagement, and DEI

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 new Time of Day pricing plan provides the choice customers want and was designed with simplicity and scalability in mind. It is an equitable pricing plan that will appeal to a wide variety of customer segments including 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, Time of Day has the potential to benefit a large population of structural savers across all segments, as well as additional customer groups who could save with a small shift in usage during peak hours.

[36] Ahmad Faruqui, Brattle Group, 2008.
[37] Source: 2015 PGE Pricing Study.

Table 14 – Time of Day Impact Across Segments

TOD Customer Segment	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%

**Percentage of all residential market*

PGE considered industry best practices in designing the rate structure, 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. Key aspects of PGE's TOD rate structure include:

- **Peak/Off-Peak Pricing Ratio** – off-peak price ratio of 1.5-to-1 is a very mild differential. Ratios of 4-to-1 or 5-to-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-to-1.
- **Peak Period Duration** – concentrating on-peak prices in a limited set of hours produces more meaningful price differences that better motivate customer response. With Time of Day, on-peak hours are limited to 5 to 9 pm Monday through Friday. Holidays and weekends are all off-peak.
- **Peak Period Frequency** – the more complicated the price signals, the more difficult it is for a rate structure to drive behavioral change. While the new Time of Day pricing plan has three block periods (or tiers), only one is more costly than Basic Service. From a customer-facing perspective, this allows us to simplify messaging reinforcing weekday shift from 5 to 9 pm.
- **Seasonal Differentiation** – is common practice but more difficult for customers to remember. Unlike PGE's existing Time of Use offering (with two seasons and different pricing and hours for each), the new Time of Day offering is non-seasonal and has consistent rates year-round.

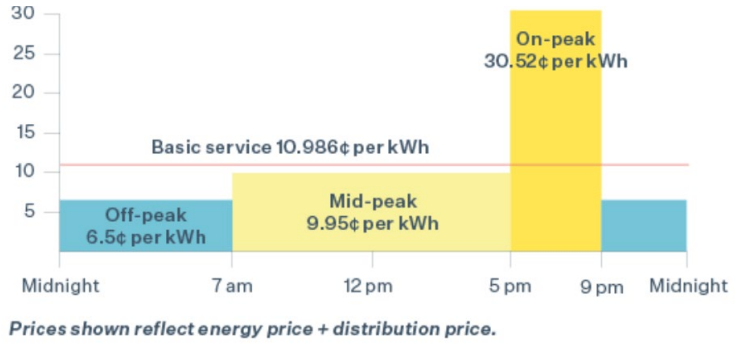


Figure 7 – Time of Day and Basic Service Prices

The challenge lies in educating customers about this new offering. Many customers aren't familiar with, or don't understand, time-varying rates, are skeptical that they are designed to benefit the utility not the customer, and they do require commitment on the part of the customer. To support enrollment, PGE needs to build awareness and educate customers about how this pricing plan could benefit them personally.

Initial marketing outreach will target structural savers who have similar "DNA" to 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 will include personal rate comparison information (12-month comparison of projected spend on Time of Day vs. actual spend on Basic Service) and will highlight savings opportunities for those structural savers. Post-enrollment support will include a monthly email performance update with savings tips and usage data to ensure customers have the information they need to be successful on the plan, with full transparency into their potential savings or overspend. Future state will include an online rate comparison tool accessible to all residential customers to help make this personal rate comparison available at scale.

4.3.3.3 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 tool and "what-if" survey that enables customers to assess how small changes in behavior like deferring use of major appliances or lowering heating/cooling would impact potential savings. PGE is currently evaluating best options for delivering these tools to support enrollment and customer experience goals.

4.3.3.4 Market

To achieve desired load impact, Time of Day 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. 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 Time of Day (these customers are known as structural savers). An additional 10% more could save on Time of Day by making shifts in usage during peak hours. While the Serviceable Obtainable Market is 355,000 customers (46% of the 772,000 customer residential population), we will focus 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 a growth 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 TOU 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 Time of Day pricing plan, with an uptick in adoption to 3% in Year 2 as customer awareness and receptivity increases. Providing an online rate calculator and personal rate comparison information is expected to accelerate enrollment growth in Year 3 and beyond.

Forecasted load impact (summarized below) is based on the Cadeo work. Actual load impact will be assessed as part of our evaluation activities.

Table 15 – Time of Day Forecasted Enrollment and MW Impact

	2021	2022	2023	2024
Enrollment	1,000	17,000	40,000	53,000
Summer MW Impact	0	2.5	4.8	7.9
Winter MW Impact	0	1.2	2.2	3.8

Time of Day is a critical component in the company's overall product engagement and DR strategy. As such it is the "glue" that can bind multiple products and services together (Smart Thermostat, EV Charging pilot, and Peak Time Rebates) in a way that delivers a curated experience for a customer based on known preferences, needs, and eligibility. Enabling a clear customer journey that paves the pathway toward product bundling of this nature will drive customer satisfaction, engagement, and retention while supporting PGE's strategic objectives.

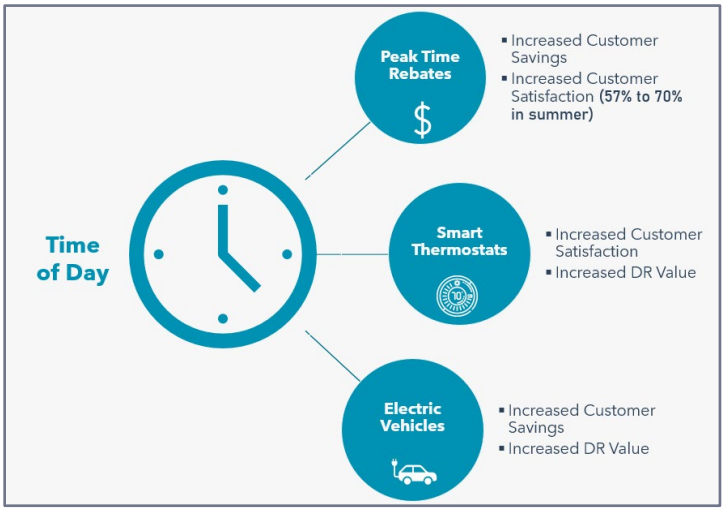


Figure 8 – How Time of Day Impacts Other PGE Products

4.3.3.5 Key Outcomes & Measures of Success:

- Support PGE's IRP Goals: help reduce peak load and support decarbonization goals and use of more renewables, contributing 7.9 MW of DR 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 CES 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 TOU 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 TOU offerings

4.3.3.6 Timeline of Upcoming Activity

2022 H1	2022 H2	2023 H1	2023 H2	2024 H1	2024 H2
Introduction of online rate calculator and "what-if" analysis tool	TOD as part of Flexible Load bundle	Increased enrollment growth	Increased enrollment growth	Increased enrollment growth	Increased enrollment growth

4.3.4 **Multi-family Water Heater Pilot**

Megawatts Procured by 2023		Connected WHs by 2023	Total Costs (2022-2023)	Cost-Effectiveness Score *(current July 2021)*[38]
Summer	5.8 MW	18,000	$5,643,454	TRC without Value of Service Lost: 0.66
Winter	8.7 MW			

4.3.4.1 Executive Summary

The Multi-family Water Heater (MFWH) pilot aims to enable and operate electric water heaters for demand flexibility. This pilot 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 installed, thus higher concentrations of units enable water heaters for a fraction of the cost to enable the same number of units across a broader area. Second, because many multi-family units install the water heater within the living space where electric resistance water heaters are used. This niche allows PGE to test advanced use cases from water heaters without affecting Energy Trust and NEEA efforts to promote adoption of more efficient heat pump water heaters. Third, having a concentration of these units grants 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 help inform our approach to single family water heaters. To be clear, PGE supports Energy Trust and NEEA 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 pilot to learn about developing a Flexible Load resource from this highly-dynamic, ubiquitous appliance.

4.3.4.2 Key Customer Needs Addressed, Engagement, and DEI

This pilot 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 on renters to make investments in equipment or building shell improvements.

4.3.4.3 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.

[38] Comprehensive cost-effectiveness table here: Table 20.

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 pilot 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 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. New mobile-enabled switches negate the need for PGE to create local area networks within each building site. Mobile switches require 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, uptime/availability, and the total verifiable load drop from the units. Recent cell enabled chips, installed in late 2019, are demonstrating better connectivity and better load drop performance.

This pilot is providing valuable lessons that PGE can leverage for other multi-family activities 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 activities are delivered. In addition, a successful pilot will help future participation from building owner/managers and tenants. Lessons learned around incentives and marketing can be applied to future activities. Positive participant experiences with this water heater pilot will increase participation in future offerings.

4.3.4.4 Coordination

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

4.3.4.5 Market

Within the multi-family market, it is estimated that nearly 90% of water heaters are electrically heated, representing 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 in PGE's service territory is 100,000 units. The achievable potential is 50,000 units, which corresponds to 25 MW by 2027.

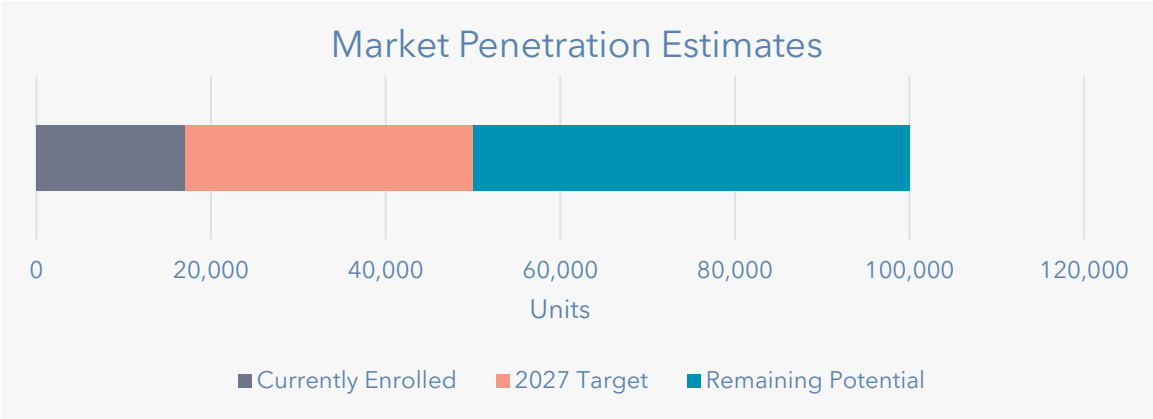


Figure 9 – Multi-family Water Heater Pilot Market Penetration

4.3.4.6 Key Outcomes & Measures of Success

The goals for PGE's Multi-family Water Heaters pilot are as follows:

- Successfully operationalize and field deploy retrofit devices that allow for controlling existing water heaters in PGE's DR platform
- Operationalize and field deploy DR-enabled new water heaters that can be controlled via PGE's DR platform
- Operationalize communications technology that provides uptime of 90+% for the PGE water heater fleet
- Reduce costs for hardware, installation, maintenance, and operations down to cost-effective levels while scaling up the activity during the pilot period
- Test, modify, and prove the business model with MFD property owners and their agents (MFD property managers)
- Successful dispatch of PGE water heater fleet in DR events with an average capacity of .5 KW per water heater during the DR event period
- Expansion of operation of PGE water heater fleet from DR to daily load shifting and demonstration of load following capability

4.3.4.7 Timeline of Upcoming Activity

2022 H1	2022 H2	2023 H1	2023 H2	2024 H1	2024 H2
Change rebate incentive on CTA-2045 enabled WHs due to code change	Ramp up installations of CTA-2045 comms devices on Smart WHs	Complete final evaluation for pilot from current period	File for pilot to program consideration, or additional extension	Expand CTA installations	Cease installations of any retro-fit switches (only install CTA comms)

4.3.5 **Smart Thermostat Pilot**

Megawatts Procured by 2023		Total Costs (2022-2023)	Cost-Effectiveness Score[39]
Summer	34.7 MW	$5,643,925	Combined TRC without Value of Service Lost: 1.09
Winter	9.2 MW		

4.3.5.1 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 pilot, PGE customers must have a qualifying heating, ventilation, or air conditioning (HVAC) system (ducted heat pump, electric forced-air furnace, or central air conditioner).

4.3.5.2 Key Customer Needs Addressed, Engagement, and DEI

By using smart thermostats instead of switches, customers are able to participate in DR offerings 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. All engagement emails remind the customer of the participation rules and what to expect during an event. Customers who do not own a smart thermostat are able to take advantage of incentives and discounts via the PGE Marketplace or receive one professionally installed for free when they sign up for the pilot.

4.3.5.3 Technology Principles

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

Bring Your Own Thermostat – Customers may enroll online in the pilot by purchasing a new qualifying thermostat via the PGE Marketplace or other retailer, or with an existing qualifying thermostat attached to a qualifying HVAC system. Customers receive an enrollment incentive of up to $25 and an additional $25 for each DR season that they participate (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 – Customers with a qualifying HVAC-system can participate by having a qualified thermostat installed, provisioned, and enrolled into PGE's DR platform by a PGE contractor. This channel provides a no

[39] Comprehensive cost-effectiveness table here: Table 20.

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.

4.3.5.4 Coordination

Customers can receive incentives for smart thermostats through the Energy Trust. PGE coordinates with Energy Trust to pass on these incentives to customers through the PGE Marketplace and the Residential Thermostat Direct Installation channel. PGE is also working with the Energy Trust to explore how thermostats and other efficiency measures can be paired to provide longer duration energy optimization.

4.3.5.5 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, PGE estimates the total number of eligible households is about 264,000 units (total addressable market). This number is increasing due to increasing installations of central air conditioners. The achievable potential is estimated at 96,500 units, which with our current mix of heating and cooling systems represents approximately 25 MW in winter and 92 MW 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.

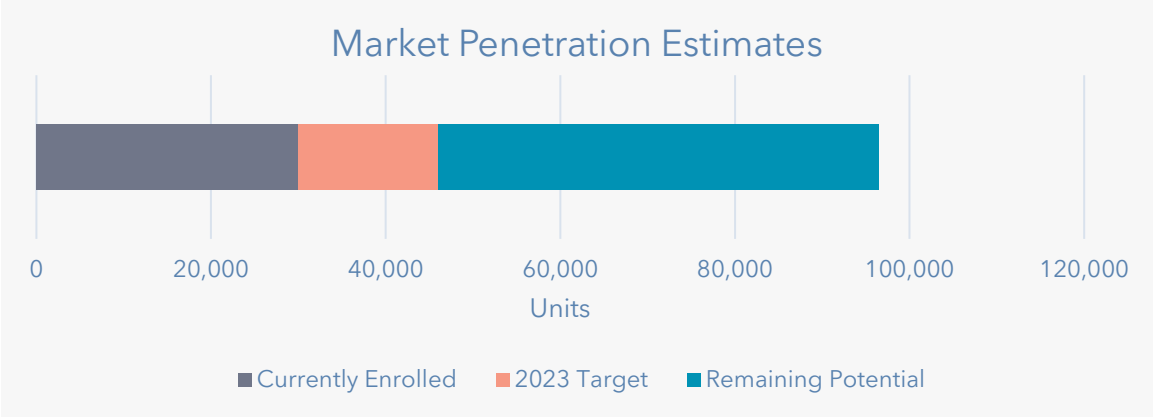


Figure 10 – Smart Thermostat Pilot Market Penetration

4.3.5.6 Key Outcomes & Measures of Success:

- The pilot achieved 31,000 (cumulative) enrolled residential thermostats in 2021, and aims to have a total of 47,000 residential thermostats by 12/31/2023
- Determine and verify customer acceptance of the above delivery channels
- Build a minimum of 39.9 MW summer cumulative capacity and 9.7 MW 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

4.3.5.7 Timeline of Upcoming Activity

2022 H1	2022 H2	2023 H1	2023 H2	2024 H1	2024 H2
Complete assessment and recommendation of channel delivery strategies File for pilot extension	Execute channel recommendation Evaluation Report		Evaluation Report	File for pilot to program consideration, or additional extension	Evaluation report

Chapter 5 Coordinated Activities with Flexible Load Capabilities

5.1 Coordinated Transportation Electrification Activities

The following activities are part of our Transportation Electrification (TE) activities. These pilots and programs have a Flexible Load component. The costs for these activities are approved in sperate dockets and managed through separate accounting. We are providing information here to demonstrate the connected nature of TE to managing load and providing Flexible Load services. Via the Testbed and Clean Fuels program, PGE is working to demonstrate new approaches to and sources of Flexible Load available from the emerging TE market. We will add those to future Multi-Year Plan updates as results are available for reporting.

5.1.1 **Residential Electric Vehicle Pilot**

Megawatts Procured by 2023		Total Costs (2022-2023)	Cost-Effectiveness Score[40]
Summer	0.5 MW	See ADV No. 20-18	Demand Response TRC without Value of Service Lost: 0.85
Winter	0.5 MW		

5.1.1.1 Executive Summary

In March 2020, PGE proposed a Residential EV Charging pilot to encourage customers to deploy connected Level 2 EV Charging infrastructure at their homes. The pilot, which targets single family homes, aims to provide rebates for approximately 3,600 charging stations over a three-year period. Participants will receive a rebate ranging from $500- $1,000 per charger, and EV dealers will receive a $100 mid-stream rebate for referring a qualified successful EV charger installation. Further, the pilot will test the effectiveness of providing grid services–specifically DR using home chargers–by offering customers a $50 annual incentive for participating in grid services events. Within the Multi-Year Plan there is no funding request for this activity.

5.1.1.2 Key Customer Needs Addressed, Engagement, and DEI

Through customer interviews, PGE found that EV buyers exhibit several key needs and wants. Many customers don't know how to navigate the transition from gas-fueled vehicles to EVs. While customers want green affordable transportation[41], they struggle to quantify the benefit of EVs when considering the purchase of a vehicle.

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[40] Comprehensive cost-effectiveness table here: Table 20.

[41] Edmonds, Ellen. (2018, May 8). *1-in-5 U.S Drivers Want an Electric Vehicle*. AAA. Retrieved from https://newsroom.aaa.com/2018/05/1-in-5-us-drivers-want-electric-vehicle/.

Customers want charging that is fast, easy, and convenient enough to compete with traditional fuel. The pilot is designed to address the fact that most homes do not have an available 220 volt / 30-40 amp circuit installed in their garage or driveway to accommodate a Level 2 charger.

Many customers simply lack the information they need to figure out that EVs are affordable, reliable, and can make financial sense for them. Finally, early EV adopters and potential EV buyers indicate that they desire to be perceived as smart and knowledgeable within their community (e.g., friends, family, and co-workers) when transitioning from gas-powered vehicles to EVs.

5.1.1.3 Technology Principles

EV chargers represent an incremental cost[42] for EV buyers to move from fossil fuels to electric. Financing of charger and installation costs are often not addressed by EV manufacturers or dealers during the EV sales process. As a result, customers face many home charging options and often choose the lowest cost option, which is often not connected and has no opportunity for grid integration.

The Residential EV Charging pilot is a Flexible Load pilot. As PGE demonstrated in its TE Plan and again the Residential EV Charging pilot proposal, Time of Use charging is valuable, but a DR component is needed to address grid constraints, local grid integrity and the ability to manage EV charging load directly. This comports with the criteria found in SB 1547, Section 20 where any pilot is expected to improve grid efficiency and operational flexibility including renewable integration. The Residential EV Charging pilot is structured to address this criterion by enabling new chargers to provide grid services such as DR, load shifting, and load following. These tools will support the integration of renewables on the grid.

5.1.1.4 Market

The pilot targets single-family homes and aims to provide rebates for approximately 3,600 charging stations over approximately a three-year period. This includes a mix of customers that will purchase new EVs and connected chargers as well as some customers that may bring their own device.

5.1.1.5 Key Outcomes & Measures of Success:

The Residential EV Charging pilot aims to:

- Encourage EV adoption by reducing the cost and complexity of installing qualified connected charging stations
- Explore and establish mechanisms to realize the value of the delivery of grid services (DR, daily load shifting, and load following) from connected chargers

[42] Agenbroad, Josh (2014, April). *Pulling Back the Veil on EV Charging Station Costs*. Rocky Mountain Power Institute. Retrieved from https://rmi.org/pulling-back-veil-ev-charging-station-costs/.

The pilot will undergo an evaluation to measure the effectiveness of the approach in meeting its objectives, areas for continuous improvements, and energy impacts on PGE's system. The following are some of the high-level learning objectives:

- Track customer participation and satisfaction levels with pilot offerings (grid service events, rebates, dealership assistance, and referrals)
- Understand the level of PGE's influence in customers' decisions to procure an EV and install charging
- Document charging installation successes and challenges
- Document and understand the successes and challenges of managed charging for PGE and customers
- Measure customer load impacts on PGE's system
- Identify pilot implementation successes and challenges, as well as improvement opportunities

The pilot will support Oregon's climate goals, accelerate TE, and encourage efficient grid integration by:

- Reducing customer costs – decreasing costs associated with deploying charging infrastructure at home and at businesses
- Enhancing customer experience – simplifying and standardizing the EV charger buying and installation process
- Enabling efficient grid integration – ensuring that future charging stations deployed in PGE's service territory are connected and participating–or have the ability to participate–in smart charging pilots
- Supporting greater EV adoption in moderate-income and low-income communities – by offering larger incentives for qualifying individuals and facilities and by supporting transit agencies in electrifying their fleets

5.1.1.6 Timeline of Upcoming Activity

2021 H2	2022 H1	2022 H2	2023 H1	2023 H2	2024 H1
Establish pilot and up to five EVSE vendors	Complete first official DR season (Oct-Mar) and begin evaluation	Design additional event to maximize performance Add additional EVSE vendors to ensure offering is in line with market share	Complete first seasonal evaluation	Pilot is set to end on Feb 22, 2024 Prepare to move to program, or ask for extension	Explore ancillary features to EVSEs

5.1.2 **Expanded Smart Charging Solutions Concept for Residential Customers**

Target Customers	# of Customers	2022 Development $	Expected MW
▪ EV drivers ▪ EV considerers/ intenders	TBD	To be requested through the proper Transportation Electrification planning proceeding	TBD

PGE is working on the concept of a suite of solutions to better support current and potential residential EV drivers to enable them to engage in home-based Flexible Load offerings. These solutions would be variously supportive of, integrated with, or informed by our current Residential Electric Vehicle pilot. We are not presently requesting funding for this activity, nor would we do so as part of our flexible load planning in the Multi-Year Plan, as it is more properly proposed as a TE program. However, we include some detail here to provide insight and transparency regarding our product development process.

Through the Residential Electric Vehicle pilot and other venues, PGE's TE team has learned more about how our residential customers charge and utilize their vehicles. We have also identified barriers to home charging and vehicle ownership that the Residential Electric Vehicle pilot does not fully address—barriers that limit the extent to which PGE and customers can take advantage of home smart charging. The suite of offerings under consideration as part of this concept are designed to address these barriers.

Offerings under consideration include:

- Rates
    - Residential rates that incentivize grid-supportive charging behavior, including potentially V2G, and keep the total cost of ownership of EVs advantageous as compared to internal combustion vehicles
    - Retail charging rates that approximate the cost of home charging, supporting equity for customers who lack home charging or access to off-street parking
- Installation support
    - Cost offsets for customers to upgrade their home electrical panel to support Level 2 home charging
- Multi-family solutions
    - Rates, billing, and infrastructure solutions to make charging an EV at a multi-family dwelling as easy and affordable as charging an EV at a single-family home

PGE anticipates that these offerings will provide residential customers and the grid the following benefits:

- Lower total cost of ownership
- Reduction in emissions
- Better air quality
- Enhanced customer experience, supported by a qualified products list, trusted installers, and charging adequacy
- Reduced peak demand
- Reduced GHG emissions stemming from reduced reliance on fossil fuels

To successfully move this concept forward, PGE will work with stakeholders to identify and address adoption barriers and shape equity considerations. PGE will also leverage key policy and regulatory processes and enablers—specifically, opportunities under HB 2165 and the Commission's TE Investment Framework docket—to advance these solutions.

PGE will also rely upon strategic partnerships with OEMs, Energy Trust, Forth, Electrify Now, municipalities, and community-based organizations to assist with program design, funding and incentives, policy issues, and program awareness.

Key Metrics	▪ # of customers accepting offer ▪ # of ports installed ▪ # of panels upgraded ▪ Access to equitable pricing for home or neighborhood charging ▪ MW of available flexible load capacity ▪ Customer experience metrics for specific points in the journey (customer effort score, customer satisfaction, net promoter score)

5.2 Coordinated Resiliency and Energy Storage Activities

Resilience is top of mind for PGE as we grapple with new challenges coming from multiple directions. Extreme weather and climate change have made "wildfire season" part of the lexicon, an ice storm as had not been seen in 40 years caused unprecedented power outages, just in the past year, and all during a once-in-a-century public health crisis. Our customers are feeling urgency to take action to prepare for the unexpected, as does PGE.

Battery energy storage plays an important role in PGE's clean energy future and in helping customers meet their resilience goals. Because of this intersection in use cases a Resiliency and Energy Storage Products team was created in Q1 2021 to consolidate work being done on customer solutions across the Company. This section outlines the work that the Resiliency and Energy Storage team is currently working on and items on the roadmap for future years.

5.2.1 **Residential Resiliency and Energy Storage**

Product Management's Resiliency and Energy Storage team is responsible for the management and evolution of the Residential Storage pilot, aka "Smart Battery". As the Smart Battery pilot matures, PGE will continue to monitor the evolution of energy storage technology and how PGE can continue to innovate and partner with our customers to meet their resiliency and clean energy needs. This might mean developing innovative ways of helping customers afford home energy storage, such as through financing options for interconnected devices, or enhanced resiliency options on the distribution side that can pair energy storage as a grid resource, such as a neighborhood level microgrid. The pilot will also explore whether letting customers control their own dispatch of the battery during a peak event (similar to PGE's Peak Time Rebates) will yield comparable savings to PGE-dispatched energy.

PGE has also been watching the emerging market of passenger EVs that have the capability to provide backup power to a home in the event of an outage. Evaluation will need to be done on the potential grid benefits of interconnected home energy storage.

Finally, PGE has also been conducting customer research among customers that have medical equipment powered by electricity or who are otherwise more vulnerable from a health and safety standpoint during a power outage. PGE seeks to understand the diversity of this population and consider what products or services may be offered to protect against negative health outcomes in the event of an outage.

5.2.2 **Commercial & Industrial Resiliency and Energy Storage**

Recent power outages have hit PGE's non-residential customers hard during an already challenging economic climate. These customers are asking how PGE can

provide them with solutions to prevent loss of inventory, keep patients safe, and allow them to remain open when customers may most need them-during a power outage.

PGE is exploring approaches for partnering with customers on solutions that can provide resiliency to the customer and Flexible Load to the utility. A potential concept envisions PGE and the customer sharing the costs and benefits, with PGE paying for the cost-effective portion of the resource and the customer paying for their share over time. This same structure could potentially also be applied to other transformational types of energy solutions such as grid-connected heavy duty EV fleet charging, pairing energy storage with vehicle charging, and to other types of customers with a different business model such as multi-family dwellings.

While PGE has identified a clear customer need for this type of support to enable customers to meet their resilience and clean energy goals, there remain barriers preventing PGE from being able to craft an economic product. One such barrier is the ability of PGE to claim the Federal Investment Tax Credit on energy storage investments, which is included in a proposed infrastructure bill at the Federal level, and PGE is closely monitoring progress.

PGE is also working on strategic revisions to Energy Partner Schedule 26 to allow C&I customers to be appropriately compensated for integrating their energy storage resources with PGE. Energy Partner was originally created to compensate customers for process load activities that would provide load shedding when dispatched by PGE. However, with the advent of advanced energy technologies customer-owned equipment can now provide, Energy Partner can now offer a variety of grid services such as contingency reserves, frequency response, and renewable power integration, all of which contribute to a more resilient grid while addressing customer needs. The full pilot-to-program transition plan and details on the proposed tariff revisions to enable this activity are outlined in Appendix B.

Resiliency is also increasingly going mobile, with fleet vehicles able to provide back-up power to facilities, and the reverse of customers needing back-up energy sources to ensure vehicles can continue to operate during a power outage for critical business needs. As this technology evolves and becomes more commercialized, PGE will continue to evaluate customer needs and identify relevant products or services to continue to serve our customers. A customer request that PGE is already investigating is the ability for fleet vehicle owners to be credited for energy put back onto the grid when they do not qualify for traditional net metering. School bus fleets in particular are hoping to find additional revenue streams to help pay for the more expensive buses through TOD bill management. PGE will investigate to determine the optimal use of this type of resource on the grid and see if an additional rate structure that enables this type of activity without cross-subsidization is warranted.

5.2.3 **Municipal / Community Resiliency and Energy Storage**

As Oregon grapples through wildfires, extreme and erratic weather, and the threat of an impending large-scale earthquake, communities and municipalities must ensure that communities have clean water, emergency services are able to function, and that citizens have a place of respite to cool off or warm up, to reach loved ones, and power critical equipment. PGE is investigating the best way to partner with municipalities on resiliency solutions for critical infrastructure as well as solutions for public community resiliency centers. These centers could be utilized for PGE's areas at risk of a Public Safety Shutoff, or in seismically sound structures that could act as a gathering site in the event of a large-scale earthquake.

Finally, if Oregon is going to achieve its decarbonization and vehicle electrification goals, citizens must be able to fully depend on charging availability. PGE envisions a need for energy storage-based emergency EV charging that could be deployed where needed either for "pop-up" charging, or as permanent charging hubs.

5.2.4 **Related Resiliency and Energy Storage Activity**

We intend to conduct a Community Resiliency demonstration project with the Office of Emergency Management, specifically the Department of Public Safety and Standards in Salem. We aim to partner with a third-party provider to deliver an on-site power plant comprising an energy storage system, PV solar, and backup generation. This service will come to the customer at a monthly cost, and ownership of the equipment will reside with PGE and/or the third-party provider. PGE will extract value from the power plant by providing bulk energy services and locational value on a daily basis, and during a grid outage, the power plant will redirect to provide resiliency service to the customer(s) within the microgrid boundary. This demonstration project will ultimately inform the development of a tariff offering, whereby PGE will offer qualifying customers a comparable Resiliency as a Service installation at a monthly payment (we are contemplating a 10-year contract term).

5.2.5 **Residential Battery Pilot**

Megawatts Procured by 2023	Total Costs (2022-2023)	Cost-Effectiveness Score[43]
1 MW	See UM 2078	NA[44]

5.2.5.1 Executive Summary

The purpose of the Residential Battery pilot is to learn how to control an aggregation of a geographically diverse DERs situated behind the meter for various co-optimized energy services. The resource will be dispatched in the aggregate so that PGE's Power

[43] Comprehensive cost-effectiveness table here: Table 20.
[44] This is a non-cost-effective technology demonstration pilot, and as such cost-effectiveness is not being measured.

Operations can control and extract services. However, because the residential battery effort is very new to PGE, it presents a need to explore other factors before being able to communicate with confidence the pathway of the effort to a formal program. For example, one of the primary learnings to be explored in the Residential Battery effort is to better understand infrastructure stability of behind the meter residential batteries.

A customer with a qualified battery who is accepted into the pilot will be compensated $40 per month (or $20 if the battery is restricted to rooftop photovoltaic charging only) in exchange for allowing PGE to operate the battery for grid services. All batteries will be owned by the customer.

Upfront rebates for select customers with a newly installed qualified battery are available, in addition to the monthly payments. Eligible customers include those within the PGE Testbed and income qualified customers.

PGE has modeled the value of some services; for others, the pilot will seek to establish a value. Each battery will provide between 3 to 6 kW of power output and 12 to 16 kWh of energy storage. The pilot intends to aggregate 525 residential batteries totaling 2 to 4 MW in size and 6 to 8 MWh in duration.

Currently the pilot has a total of 52 participating customers, 14 of whom have a configuration that allows PGE to grid charge their batteries and receive a monthly bill credit of $40. The remaining 38 customers have a battery configuration that restricts their charging to only rooftop PV and receive a monthly bill credit of $20. These PV-restricted batteries provide about half of the system value in the winter as compared to summer because they have a lower state of charge, and PGE learned from the first winter season that we must carefully balance the customer's resiliency needs with grid services. After a winter dispatch, customers whose devices could not grid charge reported dissatisfaction that it took multiple days for their batteries to recharge after a peak event dispatch. Thus far, participating batteries have provided a cumulative 400kW (1MWh) of power to the grid during peak events.

PGE has partnered with the Energy Trust on trade ally management and training, as well as rebate processing. PGE leveraged the Energy Trust's well established web presence with customers interested in home solar to ensure they could also receive information about the PGE pilot and request an installation bid for energy storage.

The grid services that PGE hopes to study include:

- Distribution use cases
    - Localized demand response for distribution capacity deferral
    - Autonomous Volt/Var support
- Generation use cases
    - Generation capacity
    - Energy resource optimization
    - Contingency reserves
    - Autonomous frequency response

- Customer use case
    - Outage mitigation

5.2.5.2 Key Customer Needs Addressed, Engagement, and DEI

The Company conducted a market research study in January 2020[45] with 1,432 customers completing the survey. Results showed that almost half (45%) of survey respondents are familiar with battery storage systems, with 63% interested in learning more. Twenty of the 37 customers surveyed (54%) who already have a battery system would consider allowing PGE to manage their battery charging and discharging without any mention of an incentive, while three-quarters (76%) of customers without a battery system would hypothetically consider allowing PGE to manage their battery charging and discharging without any mention of an incentive.

One of the ways the pilot seeks to engage with participants for a deeper and more dynamic exchange of information than traditional market research activities is through PGE's Customer Conversations platform. Sixteen participants have opted to sign up for a message board to conduct discussions, ask questions about the pilot and energy storage in general, and receive additional information from PGE on the objectives of the pilot and an insider look at some of the technical research the team is conducting.

PGE has a $5,000 rebate available to customers of low-to-moderate income to ensure the pilot reaches a more diverse participant pool than the very early adopters who might otherwise be inclined to participate, thereby allowing us to understand the needs of different types of customers. Only Energy Trust Solar Trade Allies eligible to participate in the Solar Within Reach income-qualified program may offer this rebate.

5.2.5.3 Technology Principles

To ensure PGE can test locational value, a concentration of devices will be required to test impacts on the distribution system.[46] For this reason, additional incentives will be provided to customers within the three PGE testbeds to seek to achieve a measurable effect on a single distribution feeder. A single, fully-charged residential battery system may deliver 5 kW at any given point in time, which represents about 0.05% of a distribution feeder's typical load.

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[45] PGE PV/Battery Survey, 2020.

[46] See section 7.2 for more discussion of PGE's plans to study Flexible Load's provision of distribution grid services, primarily distribution capacity deferral. However, as demonstrated by Holmberg and Omar (2018), residential batteries are ideally suited to provide ancillary services such as frequency response, reserves, and reactive power services (e.g., volt-var optimization). The former two ancillary services can be provided regardless of their location on the grid (but note some market participation rules still require aggregations of > 100 kW, translating to n=20 for 5 kW systems), whereas reactive power services depend critically on the location on the distribution grid. The study authors estimate that 14 residential batteries could provide sufficient reactive power services to meaningfully change local voltage levels. Source: Holmberg, D. and Omar, F. (2018). "Characterization of Residential Distributed Energy Resource Potential to Provide Ancillary Services." NIST Special Publication 1900-601. Available at: https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1900-601.pdf

To have a measurable impact on a distribution feeder's performance, concentrations that affect the power flow of at least 3%, or 0.2-0.3 MW of energy storage per distribution feeder are necessary. Anything less than this impact is lost within the margin of error, and the opportunity to explore location-specific value diminishes. To reach 0.3 MW of capacity during the lowest production solar month on a single feeder requires a minimum of 171 batteries. PGE will pursue other methods of inducing density beyond just the Testbed, including working with new home builders who may want to include battery storage in a subdivision.

The activity in the Residential Battery pilot is not cost effective. The primary objective is to learn as much as possible in a small-scale R&D type pilot to understand the appropriate pathway to cost-effectiveness, and to inform IRP values that will be required to appropriately quantify the benefits for a future cost-effective battery storage program. PGE has worked hard to limit the total spend and thus the cost risk to which ratepayer, the utility, and participants are exposed. One of the primary reasons the project does not include an option for PGE to own the batteries is because the costs were simply too high and primary lessons to be learned could be acquired at lesser cost.

5.2.5.4 Coordination

PGE is partnering with the Energy Trust to address potential barriers to residential storage for income-constrained customers. Income-qualified customers participating in the Energy Trust's Solar Within Reach program and who install a qualified battery, are eligible for a $5,000 rebate in addition to the monthly payments. These customers may reside anywhere within PGE's service territory.

Additionally, the Energy Trust is acting as an implementation partner for the pilot, providing call center support, rebate payment fulfillment, and trade ally management.

5.2.5.5 Market

PGE's goal is to enroll 525 units in order for the pilot to have sufficient storage capacity to provide 1 MW for a 4-hour period to act as a VPP. This will include a target of 200 units within the Testbed substations, 25 income-qualified installations, and 300 units anywhere in the service territory.

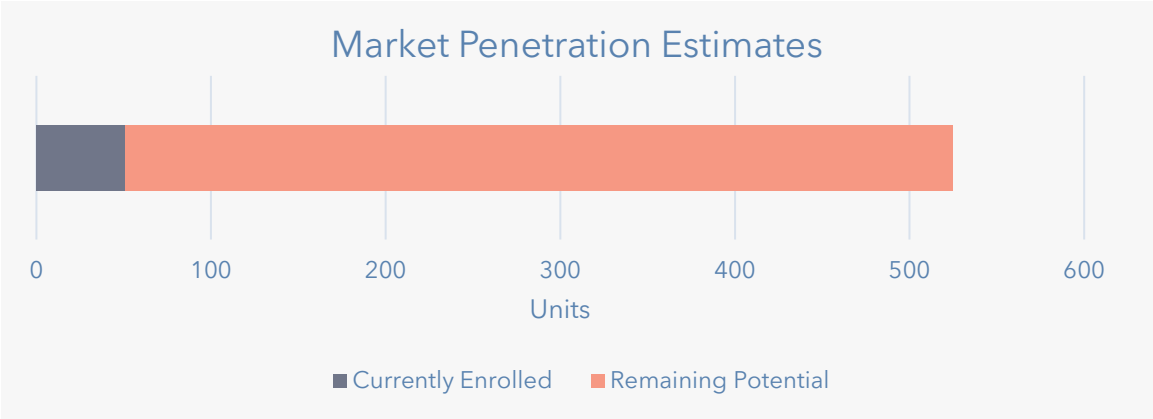

Figure 11 – Residential Battery Pilot Penetration

In PGE's service territory, there are approximately 150 residential battery installations and about 15,000 rooftop solar installations. PGE's Testbed currently has 407 rooftop solar installations and three homes with a battery installed. Achieving the targets outlined above will require more than tripling the existing battery installations in PGE's territory within three years. Market trends support these projections, with the most recent Wood Mackenzie Energy Storage Monitor forecasting a tripling of residential energy storage capacity nationwide from 2020 to 2024. However PGE does have concerns about lower-than-hoped-for uptake and is working closely with partners in marketing on outreach strategies and the Energy Trust on its Solarize campaigns to help promote the installation of energy storage and participation in the pilot.

5.2.5.6 Key Outcomes & Measures of Success:

The key objective of the Residential Battery Storage pilot is to collect as much information as possible about the impact of residential battery storage in four categories:

- **The Grid** – the primary goal of the pilot is to evaluate the ability of residential batteries to deliver locational value in support to PGE's electrical system. Locational values include shaping load, deferring distribution upgrades, providing volt-VAR optimization, and relieving hosting capacity constraints. PGE will also explore the compatibility of these values and the frequency of conflicting dispatch priorities.
- **The Energy Portfolio** – the pilot has the potential to stack values relevant to PGE's bulk energy portfolio. The pilot will evaluate the cumulative contribution to bulk energy use and the associated value as well as test assumptions around load following and frequency response.
- **The Customer** – develop operating protocols that balance the needs of the grid with those of individual customers. It will specifically identify how best to extract the greatest value for PGE's investment without jeopardizing customer participation in the pilot.
- **To Inform Future Program Design** – in addition to learning about customer needs and grid value of battery storage, PGE will utilize the pilot to inform a

future recommendation on scalable program design and the most appropriate business model for PGE in the residential battery storage market.

5.2.5.7 Timeline of Upcoming Activity

The Residential Battery pilot is currently in operational mode, focused on continuing customer recruitment and the enablement of the use cases wished to be studied. Upcoming grid activities for 2022 include continuing to test fast frequency response functionality and testing of dispatch through ADMS and the PGE Balancing Authority. PGE is eager to partner with Energy Trust on their 2022 Solarize campaign and continue to innovate on outreach strategies.

The comprehensive mid-pilot evaluation will be due in the second half of 2023, so that year will be focused on documenting and uncovering results from the pilot's operations to-date. These evaluation activities will likely include-but are not limited to-participant interviews, interviews with customers who own battery storage but opted not to participate, installer interviews, PGE staff interviews, data from the event calls, quantification of the resilience benefit through evaluation of PGE's outage management system.

The pilot is scheduled to conclude July 31, 2025. The final evaluation report and recommendations for the evolution to a scalable and cost-effective residential battery program will be delivered after conclusion of the pilot.

Chapter 6 Other Activity

6.1 DER Data Management System (DERDMS)

With DERs playing an increasingly important role in decarbonizing the grid and ensuring flexible operations under high renewable penetration, PGE has identified the need for a DER system of record. PGE is in the early stages of developing business requirements for such a DER system of record, which we internally refer to as the DER Data Management System or DERDMS. Also known in the industry as a DER database or DER measure database, we expect the DERDMS to organize and structure information such as:

- DER attribute data, telemetry data, locational data, and customer information
- DER program performance data
- DER cost-effectiveness and evaluation results
- Energy efficiency integration with Energy Trust

Analytics performed on these data will streamline utility business functions including application processes, incentive payments, DR event performance, standard reports for filings, and integration with planning tools. The DERDMS will also improve visibility for operators, integrate interconnection data, help evaluate the impacts of EV charging, and highlight opportunities for product and program improvement.

Beginning in 2022, PGE expects to contract with EPRI as part of a collaborative R&D effort that will help ensure this project follows industry best practices. Figure 12, below, represents the breadth of an enterprise-wide single source of truth for DER data.

The project is expected to benefit PGE business functions as follows:

- **Planning and evaluation** – enabling more accurate studies through awareness of each DER's capabilities and operational characteristics
- **Operations** – supporting real-time decisions by providing awareness of DER location, characteristics, and expected impact
- **Product teams** – streamlining program management, reporting, incentive processing, cost-effectiveness calculations, and program design
- **DER customer support** – providing DER customers with improved information
- **Field crews** – ensuring accurate information about DERs for maintenance assessment and crew safety
- **Coordination with PGE Power Operations** – supporting requirements necessary for DERs to provide bulk system services

Figure 12 – EPRI's illustration of a DER data management system (DERDMS)

6.2 The Pandemic and the Effects on the Portfolio

The ongoing worldwide pandemic and public health crisis has affected DSM acquisition for both PGE and the Energy Trust. Energy Trust was able to address the market challenge by increasing incentives and requesting more dollars to meet those incentive commitments. PGE has been working to meet the pandemic with short-term changes to deployment strategies. However, as the pandemic continues, what were thought to be short-term market changes are extending and creating uncertainty about the best course of action to adjust our approach to meet savings goals in these challenging times.

When the pandemic first began in 2020, we suspended marketing activity of our programs, not knowing how best to represent our activity and protect our employees and customers as the COVID crisis unfolded. We also suspended our direct installation work with Residential Smart Thermostat, Energy Partner Schedule 25 Smart Thermostats, and MFWH controls. As it became apparent that safety concerns would persist, our Residential Smart Thermostat pilot's direct install channel shifted to a new "virtual installation" model, with installations completed by the customer but remotely-assisted by a trained technician via special software. However, virtual installations were less appealing to customers: whereas we booked upwards of 120 direct thermostat installations per week pre-COVID, we now averaged only 14 virtual

thermostat installations per week. PGE saw additional impact to our DR targets when Energy Partner Schedule 26 customers temporarily reduced summer nominations by 1.6 MW due to COVID forced closures. There were some bright spots in summer 2020 for PGE's Peak Time Rebate program. While we were uncertain about how stay at home orders would impact customers' ability to shift energy, PGE saw the dividends of our customer engagement strategy (providing educational materials, family-based activities and checklists, and an online customer appreciation concert) which contributed to a 50% increase in evaluated results from Summer of 2019.

PGE slowly returned to customer installations, first with Commercial Smart Thermostats and MFWH controls, but waited until July 2021 to resume direct installations for residential smart thermostats, with safety protocols in place, including offering virtual installation assistance as a backup if customers changed their minds at the time of the installation appointment.

The pandemic has affected our Demand Response programs in other more indirect ways as well. In early 2021, the Energy Trust experienced a budget crisis as a result of unanticipated market uptake of short-term incentives for lighting. In order to control their budgeting issues, the Energy Trust met with each of the funding utilities to discuss increasing funding to manage procurement costs beyond the budgeted 2020 budget, and to deal with cascading affects for the 2021 and 2022 budgets.

6.2.1 **Load Pattern Changes**

Energy Trust's overspend was a result of their pivot to address the pandemic. Starting in 2020, Energy Trust switched some focus from high customer investment capital measures to lower cost O&M measures, reporting that they saw "huge uptick" in measure adoption as a result, and accumulated a backlog of projects that extended into 2021. These measures included thermostats, insulation, and windows. Facing budget overruns in 2021, Energy Trust elected to mitigate those overruns by first reducing, and then eliminating, thermostat incentives by mid-year 2021. This particular measure had the least overall market impact as compared to other trade-ally driven, longer lead-time measures. An unintended consequence of this suspension was reduction in the available population of customers to enroll in PGE's DR program. To counter these impacts, PGE filed for a temporary increase in incentives and increased our customer outreach efforts to bridge the gap. However, given the timing, PGE may miss 2021 goals by approximately 25%.

6.2.2 **Additional Challenges for 2021**

The catastrophic ice storm in February 2021 caused PGE to suspend pilot and program marketing to focus on restoring power and customer support needs. This took pilot and program recruitment down for a period of six weeks. World-wide supply line shortages (also a biproduct of the pandemic) have impacted availability of equipment to support our activities. For example, the global microchip shortage has impacted our customers' ability to purchase qualified EV chargers, with PGE only

expected to achieve 25% of our goal this year. PGE has worked with its vendor to mitigate issues with MFWH controllers by making larger advance purchases.

Chapter 7 Cost Effectiveness Approach

The legislature has found that DR resources result in more efficient use of existing resources and reduce the need for procuring new power generating resources, which, in turn, reduces energy bills, protects the public health and safety, and also improves environmental benefits.[47]

PGE has, in alignment with direction from OPUC Staff's comments to PGE's Flexible Load Plan, undertaken an effort to update DER cost-effectiveness (CE).[48] In the Flexible Load Plan, PGE outlined several areas in which the 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.

To quantify the new grid services that Flexible Loads can provide, PGE must invest in updating its tools and capabilities for assessing Flexible Loads. This section provides an update on three key areas of work related to improving the CE of the Flexible Load portfolio that PGE has undertaken in response to Order 21-158[49]:

- National best practice review of CE methods for DERs
- Evolving the grid services value capture as outlined in the Flexible Load Plan
- Updated CE results with sensitivity scenarios

7.1 National Best Practice Review of CE Methods for DERs

As stated in the Flexible Load Plan, PGE is seeking to align its CE approach with national best practices. The National Energy Screening Project (NESP) is a stakeholder organization focused on improving benefit cost analysis (BCA) practices. With support from regulators, utilities, and third-party experts, the NESP developed the National Standard Practice Manual (NSPM), a comprehensive look at the best practices around developing BCA for different purposes from single resource to portfolio of DERs and from EE and DR to TE.[50]

PGE performed a high-level review that shows how the NSPM is consistent with the practices adopted in other jurisdictions such as New York's BCA handbook and California's avoided cost calculator approach.[51] Additionally, the US DOE also

[47] See ORS 757.054(2)(b).
[48] PGE's Flexible Load Plan, available at: https://apps.puc.state.or.us/edockets/docket.asp?DocketID=22696.
[49] Order 21-158, Docket UM 2141, available at: https://apps.puc.state.or.us/orders/2021ords/21-158.pdf.
[50] Available at https://www.nationalenergyscreeningproject.org/wp-content/uploads/2020/08/NSPM-DERs_08-24-2020.pdf.
[51] As detailed in Matter Number: 16-01448 and Resolution E-5150, respectively.

references these specific approaches in their recommendations for grid modernization and broader CE framework.[52]

Based on this review, PGE has begun work needed to develop a new CE tool capable of performing robust analysis that is aligned with the NSPM and regional best practices. To ensure we leverage best-in-class approaches from other leading national sources and jurisdictions, we have engaged third party consultants Applied Energy Group and The Cadmus Group to inform and guide this work.

Our new CE tool will ensure DERs can be valued through multiple perspectives, accounting for energy system, host customer, and societal impacts. Through this project, PGE will:

- Review our current CE methodology and inputs
- Perform gap analysis and valuation research
- Refine and develop CE methodology and inputs, which may include-but are not limited to-incorporating 8760 load and DER profiles, integrating system level transmission and distribution impacts of DERs, and adding non-energy benefits and low-income benefits where appropriate

The first phase of this work is expected to end in Q4 2021 with the second phase planned for 2022.

In 2022, PGE will build on the new CE tool to enable economic analysis for non-wire solutions and perform studies to calculate other societal benefits. PGE expects work to focus on refining the functions of the tool as well as aligning with new and emerging grid service values (and associated inputs) described in section 7.2.

7.2 Evolving the Grid Services Outlined in the Flexible Load Plan

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.[53] Table 16 below shows the grid services capabilities of PGE's current and planned portfolio at the time of filing the Flexible Load Plan.

[52] DOE's Modern Distribution Grid Report - https://gridarchitecture.pnnl.gov/media/Modern-Distribution-Grid-Volume-III.pdf.

[53] See section 4.4.1 of the Flexible Load Plan, available here: https://edocs.puc.state.or.us/efdocs/HAS/um2141has132229.pdf.

Table 16 – Grid Services Capabilities of Current and Planned Portfolio

Resources							
Grid Service	**DLC Daily**	**DLC Seasonal**	**Behavioral DR**	**Res Battery**	**C&I Battery**	**EV**	**PV Smart Inverters**
Distribution Services							
Volt/Var control				Current	Current		
Frequency response				Current	Current	Near-term	
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	Near-term	
Regulation				Near-term	Current	Near-term	
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
TOU 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 Table 16.

7.2.1 **Distribution Services**

While PGE's current residential and C&I battery pilots can provide volt/var control, the largest potential distribution services value is T&D upgrade deferral.[54] Upgrade deferral refers to avoiding or deferring the need for traditional distribution system upgrades to address capacity constraints triggered by load growth.

In the Flexible Load Plan, we stated that distribution upgrade deferral would apply when the application was tailored to address the specific constraint and the DER characteristics aligned with the identified system need.[55] 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 historic 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 17 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.[56] During the summer of 2020, PGE called DR events on seven days

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[54] See for example Brattle (2019) report "The National Potential for Load Flexibility: Value and Market Potential through 2030". The study authors state 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. Report available at: https://www.brattle.com/wp-content/uploads/2021/05/16639_national_potential_for_load_flexibility_-_final.pdf.

[55] 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 Part II of the initial DSP submittal, scheduled for August 2022.

[56] While these two measures are not an apples-to-apples comparison due to their derivation by different analytical methods, 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

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 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 17 – 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 in preparation for submitting Part II of the DSP, which focuses on constraint identification and solutions identification. Our investments in the IOC and 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.

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month-hour combination, whereas the right-hand side shows relative probabilities that PGE's resources will be less than that 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.

In Order 21-152 of LC73, OPUC directed PGE to utilize the T&D avoided costs applied to EE under UM 1893. PGE presents sensitivity analysis using Energy Trust's avoided T&D costs in Section 7.3 for purposes of illustrating changes to CE in response to OPUC request. PGE notes that this is for illustrative purposes only until further analysis is conducted under the DSP Part II, wherein PGE will undertake additional analyses to identify and value the distribution services associated with our Flexible Load portfolio.

7.2.2 **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:

7.2.2.1 Capacity Value

In Order 21-152 as part of LC73, Staff requested that PGE perform sensitivity analysis showing CE of Flexible Load activity using a non-emitting proxy resource. 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 has recently submitted an IRP extension waiver to allow us to more fully bring to life the vision of Oregon's new clean energy law (HB 2021) and encourage a more robust 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. Table 18 shows the net capacity cost for all supply-side resources considered in the 2019 IRP Update, along with updated draft inputs compiled for our upcoming IRP.

Table 18 – Comparison of Net Cost of Capacity for Various Capacity Products

Resource Type	2019 IRP Update final values	Draft Values for Upcoming IRP
SCCT	$109.74	$120.41
2-hr battery	$130.01	$83.06
4-hr battery	$165.77	$94.91
6-hr battery	$203.45	$139.60
Pumped storage	$260.10	$186.57

PGE presents sensitivity analysis using the 4-hr and 6-hr battery net capacity values from the 2019 IRP Update in Section 7.3 for purposes of illustrating potential changes to CE in response to OPUC request. We note that the draft values for the net cost of capacity for each of the batteries shown in Table 18, above, have decreased significantly from the 2019 IRP Update. However, these values are not yet final, and so we include both the 2019 IRP Update values and the draft IRP values for our upcoming IRP.

7.2.2.2 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., those 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 develop economic co-optimization tools within our AdopDER modeling framework 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.

7.2.3 **Flexibility Services**

In our 2019 IRP, we studied the contribution of all dispatchable resource types to provide system flexibility value.[57] 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 19.

[57] See section 6.2.2 of the 2019 IRP, available at: https://portlandgeneral.com/about/who-we-are/resource-planning.

Table 19 – Flexibility Values of New Dispatchable Resource Options[58]

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 to distributed batteries and water heaters, reflecting the fact that these products can perform daily dispatch and have quick response times, as opposed to seasonal products like thermostats.[59]

PGE is planning to contract 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.[60]

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 resources toward one or another use case. For instance, research has shown that the potential in California for providing regulation reserves with thermostatically controlled loads (air conditioners, heat pumps, water heaters, and refrigerators) surpasses the total requirement of the California Independent System Operator

[58] Source: PGE 2019 IRP.
[59] In Testbed Phase II, PGE will investigate whether the ability to employ more flexible dispatch of thermostats will justify including flexibility-adequacy value in the future.
[60] See discussion in Lee et al. (2020). "Providing grid services with heat pumps: A review", ASME Journal of Engineering for Sustainable Buildings and Cities, 1(1).

(CAISO).[61] PGE plans to evaluate the technical potential and relative economic benefit of utilizing Flexible Loads (other than batteries and water heaters, which already are attributed the flexibility value) to provide frequency regulation as part of the work under DSP Part II.

7.2.4 **Environmental Benefits**

In the Flexible Load Plan, we stated, "PGE has quantified this value as the cost of carbon in energy prices…Because many Flexible Load programs have minimal energy impact, the modeled environmental benefit of those programs is also minimal."[62]

PGE is undertaking new analysis within the IRP to comply with HB 2021 requirements to achieve 80% clean electricity served to customers 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.

7.2.5 **Participant Benefits**

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 our recently filed DSP Part I, we define 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 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 (see section 4.2.2.2 and section 4.2.2.4). For example: during the 2021 winter ice storms, PGE's Residential Smart Battery pilot demonstrated how these resources can provide customer ride-

[61] H. Hao, et. al. (2015). "Potentials and economics of residential thermal loads providing regulation reserve", Energy Policy (79), 115-126.
[62] UM 2141 PGE's Flexible Load Plan section 4.3.2.4 at page 112.

through to minimize loss of service even when the grid is down. Due to the initial stages of this pilot and the anticipated severity of the weather event, PGE opted not to dispatch these devices (N=10, 50 kW) for grid service provision in order to provide maximal ride-through capability for expected outages.

This undoubtedly changes the cost effectiveness calculation, given the assumption that the full capacity of these resources would be available to meet grid needs. To resolve this tradeoff, PGE is investigating options to optimally share benefits between grid and customer resiliency outcomes. The charge/discharge determinations, particularly around extreme weather events, depend on the use case with the highest value.

During the recent CUB Policy Conference, Commissioner Tawney indicated that issues of integrating customer resiliency into CE should be a priority for the DSP.[63] PGE looks forward to working with participants in the leadup to Part II of our inaugural DSP filing to examine what metrics and methodologies are most appropriate to answering these important tradeoffs.

7.3 Flexible Load CE Results and Sensitivity Scenarios

This section presents an update to the CE results presented in the Flexible Load Plan for each mature Flexible Load pilot activity. We first show an update based on current avoided costs from the IRP Update using the same input variables as initially filed in the Flexible Load Plan. Then, we explore a variety of sensitivity scenarios to show how results would change if different proxy grid service values were applied to each product, as discussed in Section 7.2.

[63] CUB Policy Conference proceedings, October 15, 2021. Session titled, "Resilience: Who is it Good For?" More details available at: https://oregoncub.org/cubcon21/.

Table 20, below, provides a summary of costs and benefits by program, using the updated cost of avoided generation capacity from the 2019 IRP Update of $109.74/kW-yr.

Table 20 – Updated Cost Effectiveness by Program (at current avoided costs)

Pilot/Program	2023 MW		TRC	TRC2*	RIM
	Summer	Winter			
Energy Partner (Sch 26)	30.5	27.0	0.82	1.20	0.62
Energy Partner (Sch 25)	1.8	1.1	0.32	0.48	0.24
FLEX (PTR + TOD)	22.4	16.8	0.86	0.99	0.61
Multi-family Water Heaters	6.8	10.2	0.61	0.66	0.37
Residential Smart Thermostats	39.9	9.7	0.89	1.09	0.54
Total	**101.4**	**64.8**	**0.77**	**0.95**	**0.51**

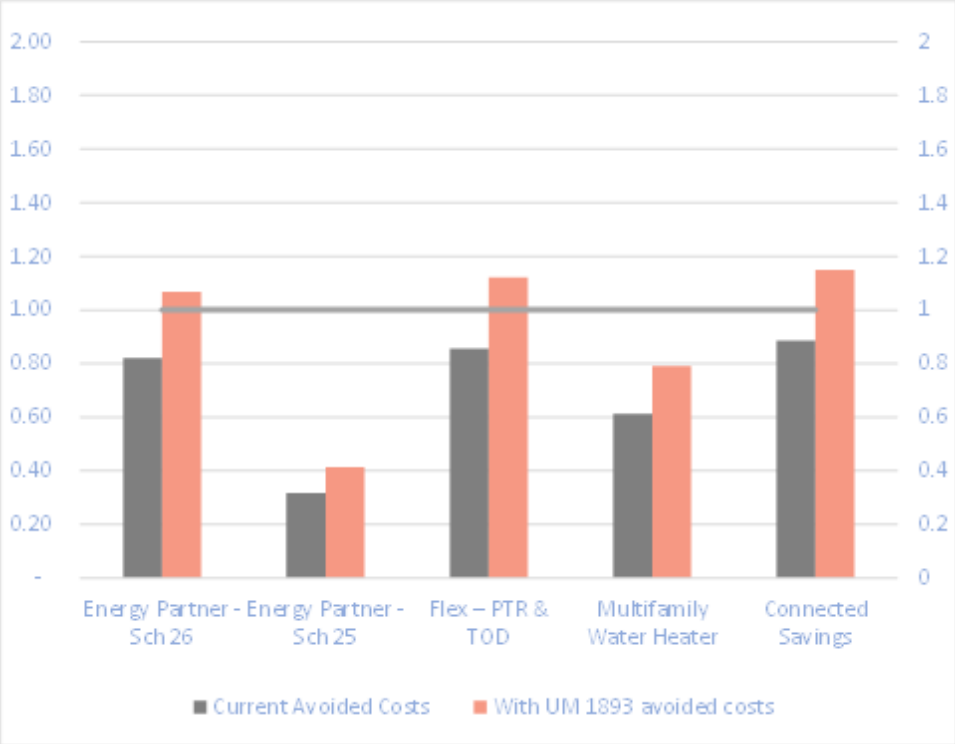
**TRC2 adjusted for Without Value of Service Lost*

PGE conducted sensitivity scenarios that are meant to illustrate potential improvements to CE as the Flexible Load products continue to mature and are able to provide an increasing range of grid services. First, we provide a comparison of the TRC test with and without the value of lost service.

Chart 6 – Sensitivity BCR Results: Value of Lost Service

Next, we provide a sensitivity using Energy Trust's T&D avoided costs. Order No. 20-464 approved PGE's avoided cost values of $9.38/kW-yr. for transmission deferral and $24.39/kW-yr. for distribution deferral.[64] Chart 7, below, shows test results with and without the T&D avoided capacity cost:

Chart 7 – Sensitivity BCR Results: T&D Avoided Costs

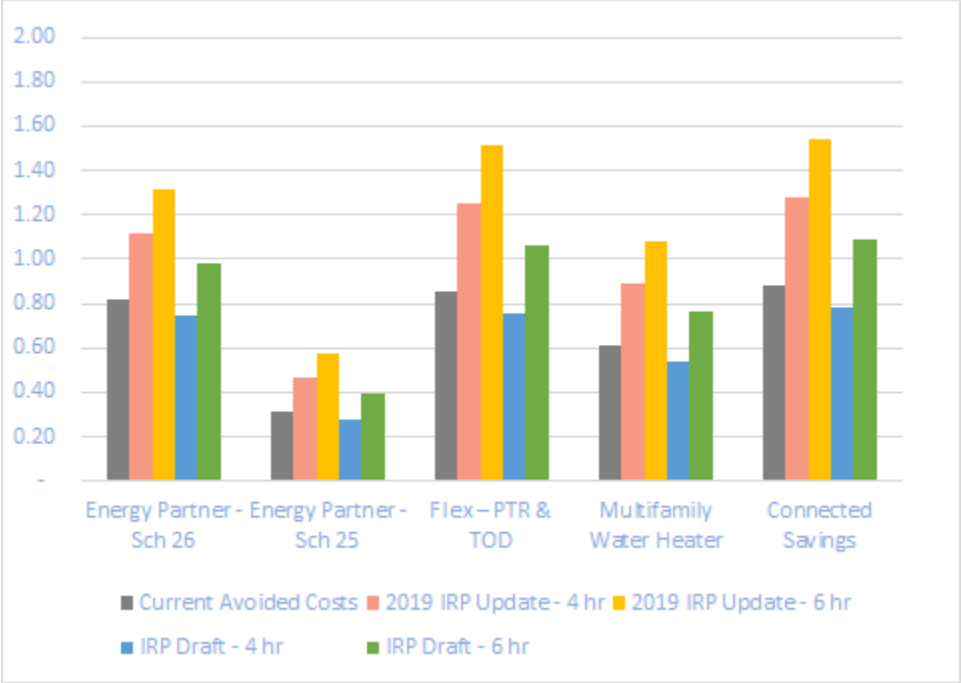


Finally, to understand the relative influence on benefit cost ratios of changing the proxy capacity resource to a non-emitting source, we analyzed our Flexible Load pilots using the net capacity cost for both the 4-hour and 6-hour batteries. Chart 8, below, shows the results of this analysis across existing Flexible Load products.[65]

[64] See Attachment 1 of Order No. 20-464 available at: https://apps.puc.state.or.us/orders/2020ords/20-464.pdf.

[65] For the purposes of this sensitivity, PGE updated the net cost of capacity to the values in Table 19 but kept the ELCC constant at the same level as used for the SCCT proxy resource. We may adjust this assumption in the future.

Chart 8 – Sensitivity BCR Results: Non-emitting Proxy Capacity Resource



As demonstrated by this sensitivity, improvements to CE resulting from switching to a non-emitting proxy resource are impacted by the vintage of data and the duration of the battery resource. Some programs (Energy Partner – Schedule 26 and Connected Savings) show an increase to above 1.0 on the TRC in all scenarios except for the Draft IRP value for 4-hr battery, while others (Energy Partner – Sch 26 and Multi-family Water Heaters) are either not cost-effective under any sensitivity for generation proxy value or only 2019 IRP Update values.

It is important to reiterate that PGE provides these sensitivity results in order to be responsive to OPUC direction, and that they do not represent PGE's recommended values or final approach to assessing the CE of the Flexible Load portfolio.

In addition to sensitivity scenarios, PGE is also exploring the optimal value of DERs, given that some grid services compete with one another, and a decision must be made about which use case provides the highest and best value. Through the work performed in PGE's DSP Part II, PGE will explore how the different services outlined in Section 7.2 can be optimized to maximize customer value. This analytical approach will help more accurately assess CE, especially for DERs such as batteries and water heaters, which can operate continuously.

PGE plans on conducting additional analysis in 2022 to investigate how system needs may shift as PGE advances toward HB 2021 targets and applying those lessons to the

planned evolution of our Flexible Load portfolio.[66] In accordance with Order 21-152, PGE will undertake analysis within the IRP to assess whether additional non-cost-effective EE would be selected when included under a supply curve approach. PGE also plans to evaluate whether non-cost-effective Flexible Loads would be selected, thus indicating additional system value that has yet to be quantified and included in Flexible Load CE studies. PGE will discuss its methodology and results with IRP and DSP participants before the next IRP is filed.

[66] For example, the NWPCC's Draft 2021 Power Plan indicates that value of DR has significantly reduced for programs that simply operate as peak load shed resources. Rather, the 2021 Draft Plan found that value has shifted to resources that can operate more flexibly and provide benefits during the morning and evening ramp periods. PGE will continue to engage with the Power Council and stakeholders to understand how the changing nature of both Flexible Loads and grid needs require new evaluation methods to capture the full suite of benefits from integrating this resource at scale.

Chapter 8 Cost Recovery Proposal

Beginning in 2011, following deployment of PGE's advanced metering infrastructure (AMI) system, PGE initiated its DR pilots with Energy Partner, which provided an automated DR option for large non-residential customers. Those costs were deferred for separate ratemaking treatment under Docket No. UM 1514 and approved for cost recovery via PGE Schedule 135. Since then, Energy Partner has evolved into two DR pilots[67] and PGE has implemented the following additional DR pilots, all of which have cost recovery through PGE Schedule 135:

Table 21 – DR Activities with Cost Recovery through Schedule 135

Activity	Docket	Schedule(s)
Energy Partner	UM 1514	25 and 26
Direct Load Control Thermostats	UM 1708	5
Peak Time Rebates	UM 1708	7
Multi-family Residential DR Water Heater	UM 1827	4
Smart Grid Testbed	UM 1976	13, 14, and 25

Additionally, PGE is conducting a Residential Energy Storage pilot through Schedule 14, Docket UM 2078. Also, our Residential EV pilot has a DR component. The total program costs are deferred through Docket No. UM 2003. Electric Avenue has also demonstrated some Flexible Load capabilities and DR savings through utilization of a peak pricing surcharge. These costs are also deferred through Docket No. UM 1938. Separately PGE has developed and made available a Time of Day rate. Within the Testbed, PGE is also conducting collaborative work with the Energy Trust on two EE and Flexible Load demonstrations: single family DR-enabled water heaters and DR-enabled ductless heat pumps. The Testbed is also conducting work with FleetCarma to test various time of use structures and incentives for EV charging.

As stated in PGE's current general rate case,[68] the pilots' labor-related costs will be accounted and tracked to base rates because labor is more flexible and can be applied to a variety of DR programs, whereas the non-labor components of Flexible Load resource development are dedicated to individual programs, pilot, and demonstrations and only for specific activities. Non-labor pilot costs, therefore, will continue to be deferred and amortized through supplemental schedules until Commission action on the Multi-Year Plan.

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[67] The non-residential direct load control pilot (PGE Schedule 25) and the non-residential demand response pilot (PGE Schedule 26).

[68] PGE Exhibits 500 and 600 in Docket No. UE 394.

Base rates represent regular, stable, and ongoing costs of doing business. Although base costs are subject to certain variability, they can be forecasted with reasonable accuracy and their variability typically falls within a normal range of business risk. PGE's DR pilots, however, are still quite new. Those activities that have matured are still in a state of transition to become a full operational and planning resource. Our Flexible Load activity faces considerable uncertainty with respect to costs, customer participation and in some cases completion of testing and deployment of enabling technologies. Our pilots are subject to future evaluations to finalize learnings and to establish the means to achieve overall goals. Even as the pilots transition to programs, they are not immediately mature and stable. Instead, there is a period of significant ramping and growth as the programs experience increases in scale and scope. Once stabilized, performance can be forecasted within acceptable tolerances and the resource must be incorporated into Power Operations for dispatch. While the resource is helpful to our Power Operations team, it is nonetheless a very different type of resource, not a machine but an aggregation of collective customer activity. This customer foundation is an aspect and variable which requires Power Operations to develop best practices through continued utilization and modification of program variables such as event notification, total run times, ramp rates, and resource profile. Because of the newness of these resources to PGE and the region, there are likely several years of development and modification which are to take place. This does not mean the resources are not used and useful, but rather because the resource is not a static machine, that flexibility and the ability to evolve the resource is necessary. In short, until the programs become fully mature and stable, they do not represent regular, on-going costs suited for forecasting in base rates but are more appropriate for alternative cost recovery treatment.

Deferred accounting has been useful and appropriate during the pilots' initial phases when operating parameters and enabling technologies are being tested and evaluated over a series of years. This allowed PGE to accumulate sufficient data and customer survey results to provide meaningful learnings to guide the pilots to cost-effective, scalable operations. As PGE has expanded the number and magnitude of DR pilots, however, the treatment of the pilots as separate deferrals has made it increasingly difficult to identify aggregate rate impacts. Consequently, there is consensus that a more comprehensive approach is needed.

PGE believes there are two similar methods that provide reasonable alternatives to deferred accounting. Both involve the use of cost recovery by means of a supplemental schedule, with or without a balancing account, as described in more detail below. Ultimately, the two methods align with a multi-year plan that would be for a set amount of cost recovery over a specific period of time. As described below, they also allow for a transition from the first alternative to the second alternative if PGE were to continue the FLP through a series of multi-year plans.

The first, our preferred alternative, would involve cost recovery through use of a supplemental schedule supported by a balancing account mechanism. This alternative recognizes the significant amount of ramping and growth that Flexible Load resources will experience as they expand their scale and scope in transitioning from pilots to programs. This is particularly evident by PGE's IRP goal of expanding Flexible Load resources from the current 80 MW to 211 MW by 2025. This alternative would also recognize that some determination remains on the overall efficacy of Flexible Load resource operations and maintenance activities being performed by third-party contractors versus internal PGE personnel and systems. Beginning with this alternative does not remove the option of transitioning to the second alternative once scale and maturity of practice enables PGE to carry greater risks. To address the significant change that is inherent in this phase of PGE's Flexible Load development, PGE proposes to establish a mechanism that consists of the following aspects:

- A supplemental schedule to collect a levelized, forecasted plan amount over two years. The supplemental schedule can remain fixed over the period or allow the flexibility of updates, if appropriate, to account for changes in programs, scale or scope, and/or goals.
- A balancing account to track the flow of costs and tariff collections. This would allow the matching of revenues and costs over time so that intertemporal cost fluctuations would not impact PGE's operating results in a given year.

The second alternative, one into which PGE can mature, would also involve cost recovery through use of a supplemental schedule, but not one supported by a balancing account mechanism. This alternative recognizes the continued transition from evolving programs to mature programs and the remaining growth the Flexible Load resources will experience as their final scale and scope are being identified and achieved. To address the level of change inherent in the latter phase of Flexible Load development, PGE proposes the establishment of a mechanism that consists of the following aspects:

- A supplemental schedule to collect a levelized, forecasted plan amount over two years. The supplemental schedule can remain fixed over the period or allow the flexibility of updates, if appropriate, to account for changes in programs, scale or scope, and/or goals.
- No balancing account to track the flow of costs and tariff collections. This means all FLP costs and revenues will flow to PGE's income statement and that PGE would bear the forecast risk of annual costs against revenue (i.e., intertemporal cost fluctuations would impact PGE's operating results).

PGE envisions that the multi-year plan will entail a maximum amount of cost recovery for the supplemental schedule to collect over the specified period. Because the proposed supplemental schedules would not involve an automatic true-up to actual costs, as occurs with the current deferrals, PGE also proposes the following treatment:

- If PGE incurs more cost than the forecasted maximum amount of cost recovery, and if PGE does not achieve Flexible Load capacity greater than the established goal, then PGE will absorb the excess costs.
- If PGE incurs more cost than the forecasted maximum amount of cost recovery, and if PGE achieves Flexible Load capacity greater than the established goal, then: 1) customers will absorb the excess costs in proportion to the amount of excess capacity compared to forecasted capacity; and 2) PGE will absorb any additional costs above the customers' share.
- If PGE incurs less cost than the forecasted maximum amount of cost recovery, and if PGE does not achieve the Flexible Load capacity goal, then PGE will refund the underspend costs to customers.
- If PGE incurs less cost than the forecasted maximum amount of cost recovery, and if PGE does achieve or exceeded the Flexible Load capacity goal, then PGE and customers will share the underspent costs on a 90/10 basis, with customers being refunded 90% of the underspent costs and PGE retaining 10%.
- Finally, during the preparation of test year forecasts for general rate cases, PGE will fully separate multi-year plan costs from base costs so as not to double collect them.

PGE proposes using the first alternative cost recovery approach using a supplemental with balancing account, keeping open alterative two, which can be used once PGE's activities reach maturity and stability as demonstrated through additional cycles of Multi-Year Planning. Additionally, PGE requests the additional five treatments outlined above be applied to the supplemental with balancing account cost recovery proposal. These treatments hold PGE accountable for overspend and non-performance while providing a modest incentive for outstanding performance in meeting savings goals under budget.

Appendices

Appendix A Regulatory Reference

Table 22 – Regulatory Reference

Reference	Title or Reference	Link
ADV 20-18	PGE Schedule 8, Residential EV Charging Pilot	https://apps.puc.state.or.us/edockets/docket.asp?DocketID=22516
HB 2021	Oregon's "100% Clean Energy" bill	https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2021
HB 2062	Energy Efficiency Standards	https://olis.oregonlegislature.gov/liz/2021R1/Downloads/MeasureDocument/HB2062
HB 2165	Requires electric companies that make sales of electricity to 25,000 or more retail electricity consumers in this state to collect amount from all retail electricity consumers, to be expended to support transportation electrification pursuant to plan accepted by Public Utility Commission	https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2165
HB 2618	Directs Department of Environmental Quality to study methods for disposal of sharps waste and provide results of study in report to interim committees of Legislative Assembly no later than September 15, 2022	https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB2618
HB 2842	Healthy Homes Repair Fund	HB2842 2021 Regular Session - Oregon Legislative Information System (oregonlegislature.gov)
HB 3141	Reduces public purpose charge for retail electricity consumers within service areas of electric companies and Oregon Community Power.	https://olis.oregonlegislature.gov/liz/2021R1/Measures/Overview/HB3141
LC 73	Integrated Resource Plan	https://apps.puc.state.or.us/edockets/DocketNoLayout.asp?DocketID=21929
Order 17-386	2016 IRP Acknowledgement	https://apps.puc.state.or.us/orders/2017ords/17-386.pdf
Order 20-152	Commission Adopted a Demand Response MW goal of 211MW summer and 141MW winter by 2025	https://apps.puc.state.or.us/orders/2020ords/20-152.pdf
Order 20-464	"Request for approval of Energy Efficiency Avoided Cost data to be used	https://apps.puc.state.or.us/orders/2020ords/20-464.pdf
Order 21-158	Flexible Load Plan Acceptance	https://apps.puc.state.or.us/orders/2021ords/21-158.pdf
SB 1547	Requires each electric company providing electricity to retail electricity consumers located in this state to eliminate coal-fired resources from electric company's electricity supply	https://olis.oregonlegislature.gov/liz/2016R1/Measures/Overview/SB1547
UM 1856	PGE Draft Storage Potential Evaluation	https://apps.puc.state.or.us/edockets/docket.asp?DocketID=20913
UM 1938	Transportation Electrification Plan	https://apps.puc.state.or.us/edockets/DocketNoLayout.asp?DocketID=21371
UM 1976	PGE Testbed Phase II Proposal	https://edocs.puc.state.or.us/efdocs/HAD/um1976had145212.pdf

Appendix B Schedule 26 Pilot-to-Program Transition Plan

B.1 Executive Summary

Energy Partner ("program") was designed to support PGE's 2016 IRP goal of acquiring at least 77 MW (Summer) and 69 MW (Winter) of DR capacity by 2021 in a manner that meets the needs of participating customers, as specified by Commission Order 17-386 (Docket No. LC 66).

To date, Energy Partner has operated as a two-tariff pilot that captures customer DR capacity in distinct ways. Schedule 25 is a non-residential direct load control pilot that deploys Smart thermostats in small to medium businesses. Temperature setpoints are automatically adjusted during peak time events to capture DR capacity. Schedule 26 is a non-residential DR pilot designed to provide custom, flexible participation options to large commercial and industrial customers. dedicated sales representatives and engineering staff (provided by CLEAResult) who can work on site with customers. Unlike residential DR efforts leveraging a "mass market" approach, Schedule 26 is based on the premise that business customers require individualized, ongoing focus to ensure their operations are not disrupted by DR.

Schedule 25 is currently undergoing a pilot delivery redesign to improve cost effectiveness and enhance customer acquisition and experience. Schedule 26 is the focus of this pilot-to-program transition plan.

Customers participating in Energy Partner Schedule 26 may choose from a variety of participation options including:

- Seasons in which to participate (Summer, Winter, or both)
- Maximum number of event hours per season
- Amount of notice given before load reduction events are called
- Time periods during the day

Customer incentives are comprised of monthly per-kW capacity payments based on the customer's chosen participation options and event-based per-MWh-shifted from the Mid-Columbia Electricity Index (Mid-C). Customers must achieve 70% of their nominated capacity to receive incentive payments.

The pilot is popular among customers and successful at delivering cost-effective DR. PGE recommends keeping the design largely consistent when it transitions to program status. However, PGE will work to expand opportunities that can contribute to Flexible Load services by utilizing advanced technologies have matured since the origination of Energy Partner. Revisions to the Schedule 26 tariff will be filed subsequent to this Multi-Year Plan.

Through the pilot phase of Schedule 26, PGE tested marketing approaches, customer recruitment, implementation, and customer engagement; measured customer

satisfaction (average satisfaction score 9.7/10 [69]); and demonstrated cost effectiveness (see Section 4.3.1 for TRC).

As a result of these successes, PGE believes that Schedule 26 now meets the OPUC criteria to transition from a pilot to a program. This document will outline how the Schedule 26 Energy Partner pilot has demonstrated program readiness based on the key components outlined by the OPUC.

B.2 Purpose of the Program

The Energy Partner pilot, open to commercial and industrial customers on rate schedules 32, 38, 47, 49, 75, 83, 85, 89, and 90, is part of PGE's DR portfolio. Participating customers earn monetary incentives to shift or lower their energy usage during times of peak energy demand. PGE works with customers to develop custom participation strategies to provide flexibility and control over how they participate. Within this appendix, PGE will refer to the previous performance of Energy Partner as "the pilot," and the proposed future state as "the program."

This program will continue to expand the integration of DR resources without requiring PGE to acquire them through capital investment. By utilizing DR resources that PGE customers already have, we can more effectively leverage these resources to reliably support the grid during peak load times.

Energy Partner provides a diversity of participation levels, allowing customers to select differing availability periods, notification times, and maximum event hours. This pilot also allows customers with multiple Service Points the ability to self-aggregate. Customers participate in summer, winter, or both seasons. The pilot makes several firm load reduction options available to customers including maximum event hours per season, notification periods, and event windows. For each season, the customer chooses one option for maximum event hours and one notification period. The customer also chooses whether to participate in each event window (i.e., time period for an event) per season.

Current pilot status (as of October 2021):

- Summer DR Potential: 23.4 MW
- Winter DR Potential: 18.0 MW
- Customer Count: 75
- Sites: 179

[69] Guidehouse, "Energy Partner Schedule 26 Process Evaluation" Internal PGE Report, (Guidehouse, March 2021).

B.3 Program Goals

PGE hired a third-party consultant to analyze PGE's DER and Flexible Load market potential.'[70] The report states that the 2027 economic achievable potential capacity within Energy Partner is 36 MW in summer and 32 MW in winter.

The program has the following objectives:

- **Objective 1:** 30.5 MW of peak capacity by end of 2023 [71]
  - The previous goal of 27 MW of peak capacity by end of year 2020 was stated in the 2020 PGE Flexible Load Plan (December 2020). PGE is now targeting 30.5 MW by December 31, 2023, and will achieve this by enabling the integration of additional sources of Flexible Load and encouraging medium-sized customers to participate who have not historically been targeted. The goal is to capture all the economically achievable potential capacity by 2027.
  - PGE will also continue to pursue the transition of customers with manual event dispatch onto automatic dispatch to ensure that existing customers are easily able to contribute their maximum potential during each event.
- **Objective 2:** Benefit cost ratio of greater than 1.0 as measured by the TRC test
  - The pilot has a current TRC (without Value of Service Lost) of 1.20, and PGE will continue to seek ways to improve benefits and reduce costs.
- **Objective 3:** Able to provide PGE with the following grid services: generation capacity, fast frequency response, contingency reserve, and volt/VAR support.
  - While generation capacity DR will continue to be the primary use case of the program; the addition of inverter-based resources will enable the other grid services.
  - The program will encourage inverter-based resources to participate with the enhanced incentive structure for No Notice dispatch[72] and Grid Support options[73], as well as volt/VAR support.
- **Objective 4:** Score at least 9.8 out of 10 for customer participant satisfaction rating as measured by third-party evaluations.
  - Energy Partner has achieved 9.8 out of 10 based on the most recent evaluation. PGE will support the customer experience by continuing popular aspects of the program and pursue continuous improvement as areas for enhancement are identified.

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[70] See Appendix G of PGE's Distribution System Plan, "PGE DER and Flexible Load Potential - Phase I" Report, available at: Distribution System Planning | PGE (portlandgeneral.com).
[71] Portland General Electric. "PGE Flexible Load Plan" (puc.state.or.us, 2020).
[72] See Appendix B.5.1 for detail on No Notice dispatch.
[73] See Appendix B.5.2 for detail on Grid Support options.

B.4 Expected Benefit to the Ratepayer

B.4.1 Portfolio Consideration

The program will continue to prioritize enabling non-residential customers from a broad array of industries to participate in DR according to their schedules and unique business needs. The program will deliver this by offering a flexible set of options that allow participants to select the number of hours, seasons, and the notification period required prior to load curtailment. These options each come with different reservation payments. Customers have expressed that they like these flexible options. Participants also earn a performance incentive for their actual energy curtailment during an event.[74] These incentives are an important tool to encourage participation during the seasons when PGE experiences peak demand.

PGE will continue to require that participating customers commit to the following terms:

- Participate in at least one event season
- Deliver a minimum of 70% of the committed load reduction on average over each event for which the customer is enrolled in that month
- Have interval metering and meter communication in place prior to participation

While customers own any behind the meter equipment used to participate in Schedule 26, all infrastructure leading up to the meter is owned by PGE. Because the customer provides their own equipment, it is essential that this program is flexible enough to allow all appropriate products are eligible to participate. Rather than requiring specific equipment, PGE instead requires that specific DR capabilities are demonstrated to participate. This provides maximum flexibility for PGE customers while contributing to the primary goals of the program. PGE notifies each customer of an upcoming event within a set notice window. The customer either manually shuts off their equipment or they have an automated system which is automatically adjusted when PGE calls an event. PGE will continue to work with customers to enable automatic dispatch and transition away from manual adjustment where possible.

The proposed tariff revisions will unlock more Flexible Load capacity and provide even more customer choice in the form of additional grid service nomination options with more advanced technologies as outlined in the section Proposed Tariff Updates.

B.4.2 Environmental & Carbon Impacts

Peak power events are likely to rely on carbon-based thermal resources. Reduced dependence on these plants will be critical to achieving the GHG reduction goals Oregon has set for electric utilities. With the increased frequency of extreme temperatures, PGE needs resources for grid resiliency during unprecedented weather events.

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[74] The methodology for calculating these performance incentives is outlined in the Infrastructure Stability section.

B.4.3 Impact on Vulnerable Populations

All customers benefit from the cost-effective acquisition of flexible. During times of peak demand, the cost of power on the open market can increase significantly. As part of the ongoing evaluations (as discussed in the section Evaluation Plan), special attention will be paid to this programs' impact on underserved communities, such as the number of projects that increase equitable access to DR.

B.5 Design Strategy: Proposed Tariff Updates

PGE intends to keep the structure of the program stable, yet PGE will also look to expand through, strategic updates to better incorporate advanced technologies, specifically energy storage, electrified fleets and EV charging, and other firm capacity resources (such as liquid nitrogen or other thermal storage). The updates include:

- an option for "No Notice" dispatch of DR,
- the ability for customers to opt into frequency response and contingency reserve,
- the ability to front-load incentive payments for select customers, and
- the enablement of energy storage without an offsetting load (such as EV charging or stand-alone energy storage) to participate in Energy Partner.

PGE contemplated the integration of DR for electrified fleets within the Flexible Load Plan[75] filed on December 23, 2020:

> *The charging equipment would be grid enabled, meaning it could participate in Flexible Load grid events (such as demand response). It is anticipated Energy Partner schedule 26 will be adjusted to dispatch these loads over time.*

The goal of these tariff changes is to accelerate the adoption of integrated DR resources by pairing customers' installation of electrified transportation, resiliency, and other sophisticated electrical equipment with proven incentive structures. PGE projects this will:

- Enhance grid efficiency due to increased number of DR assets and the number of hours available to call upon during an event
- Increase customer resiliency for those who are encouraged to purchase and install energy storage systems
- Reduce reliance on gas powered "peaker plants"
- Reduce greenhouse gas emissions, criteria air pollutant emissions, and water pollution in PGE's service territory and beyond

B.5.1 "No Notice" Dispatch

PGE proposes to allow select resources that are directly dispatchable by PGE to enroll in a "No Notice" dispatch option that is in addition to the 18-hour, 4-hour, and 10-minute options. This is primarily intended for stationary energy storage that can be

[75] Portland General Electric. "PGE Flexible Load Plan" (puc.state.or.us, 2020), p 203.

immediately dispatched for seasonal load reduction according to Balancing Authority needs. In alignment with the existing reservation payments the "No Notice" reservation price for each reservation window is 6.5% higher than the adjacent notification period. A project will be undertaken in the future to determine whether and how the reservation payments should be updated.

B.5.2 Grid Support Options

Another grid service that PGE wishes to enable with tariff updates is the ability for customer resources to provide frequency response and contingency reserve. Customers that opt into this year-round, "No Notice" dispatch will receive an annual payment of $28.10 per nominated kW. This payment is calculated based on the 2019 IRP value of ancillary services. A customer wishing to participate in this service must be integrated with PGE Power Operations and be able to respond to a PGE dispatch signal within five seconds. The technology that controls this dispatch is currently integrated into existing grid operations. Customers will also be asked to enroll for a full year on this option and make themselves available at any day and any time, as the need for frequency response and contingency reserve are not seasonal and may be called upon at any time to provide emergency support to the grid.

B.5.2.1 Frequency Response

Frequency response refers to an injection of power provided to the grid within seconds of receiving a dispatched signal. The frequency of the electrical system must remain at a nominal 60 hertz (Hz) or else face power quality issues, or even total collapse of the grid if it were to fall too low. When frequency declines outside of pre-defined bounds due to an unplanned grid disturbance, a qualified resource may respond by immediately feeding energy back on to the system to raise the frequency back to the nominal 60 Hz. Energy storage is particularly effective at providing frequency response, and by using customer-sited resources, PGE can free-up its other existing frequency response resources (mostly hydro-electric power plants) to generate clean energy.

B.5.2.2 Contingency Reserve

Contingency reserve obligation (CRO) is the second component of the Grid Support Options. The North American Electric Reliability Corporation (NERC) requires PGE to have a minimum of the sum of 3% of load and 3% of generation on hand to rapidly respond to an unexpected loss of generation within PGE's Balancing Authority area [76]. PGE currently maintains a minimum 85 MW of CRO through the Dispatchable Standby Generation (DSG) program. The DSG program leverages a portfolio of large generators located on customer premises. Integrated energy storage and other firm capacity resources have the potential to decarbonize PGE's CRO resources and avoid the need for additional fossil fuel generators to meet these requirements.

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[76] NERC. Disturbance Control Standard – Contingency Reserve for Recovery from a Balancing Contingency Event. (Template - Standard (Results Based) (nerc.com)).

B.5.3 Front-loading Incentives

One of the largest barriers to the adoption of advanced energy technologies that PGE repeatedly hears from customers is the "first cost". Energy storage and grid connected EV charging remain much more expensive than their more carbon intensive counterparts, and customers are looking to PGE to help them adopt clean energy technologies. The revised tariff proposes to allow incentive payments to be front-loaded for the duration of the contract to help customers buy down the initial cost of advanced technology to help them achieve clean energy or resiliency goals.

Energy payments would not be eligible for front-loading due to their variable nature and to keep an economic performance signal for participating customers. Customers would also be subject to repayment of reservation payments for failing to meet the obligations outlined in the tariff. Additionally, PGE would only allow customers deemed to have a high degree of confidence in their ability to meet the committed load reduction to receive payments in advance.

B.5.4 EV Charging Backfeeding

In the current pilot structure of the tariff, electrified fleets or energy storage without a firm load baseline are not eligible to participate in Energy Partner, because it is dependent on a measured load reduction. The proposed tariff revisions add a special condition that allows resources not eligible for net metering to backfeed energy onto to PGE's grid, though only when dispatched by PGE for the Energy Partner tariff. This will allow EVs to provide energy to PGE during peak events and may help customers with a source of revenue to offset the higher cost of electrified fleets.

B.6 Prior Learnings

Since program revisions in 2017, Energy Partner has demonstrated load drop stability. Performance of the resource has remained within the 15-20% of nominated capacity. [77] As previously discussed, expanding the types of Distributed Energy Resource (DER) equipment eligible for this program will increase the number of resources available to call upon during an event, which in turn increases the overall reliability of this resource from a grid integration standpoint.

Preliminary results of the Flexible Load provided by Energy Partner indicate that it delivered an average of 15.8 MW of demand response across seven peak time events in the summer of 2021 and an average of 11.7 MW across three peak time events during the winter 2020-21 season. The Energy Partner pilot is currently the largest source of non-residential DR for PGE.

B.6.1 Infrastructure Stability

The pilot's operational structure and enabling elements are functional and stable, running smoothly through the retirement of a program manager and onboarding of a new resource, and through the COVID pandemic, when so many businesses were

[77] Portland General Electric. "PGE Flexible Load Plan" (puc.state.or.us, 2020), p 167.

forced to alter their operations. The infrastructure includes the key elements of implementation vendors, the dispatch enablement software, event notification capabilities, the on-site equipment for communications and measurement during event dispatches, and the customer's management of their participation.

B.6.2 Program Implementation:

PGE contracts with CLEAResult, a third-party program implementation vendor, to perform customer outreach and recruitment. PGE continues to manage its use of vendor services to ensure they provide cost effective value in program execution. CLEAResult also issues incentive payments to customers via paper check. The program team investigated whether customers would prefer to receive their incentive payments on the utility bill, and the overwhelming feedback was that customers would prefer to continue receiving their incentives as a separate check. At this time, PGE will continue to issue paper incentive checks, but will continue to seek feedback from customers as to whether they would prefer an alternative payment method.

B.6.3 Demand Response Management System Software Platform:

PGE is using the Enbala Concerto software platform as the DRMS for their automatic DR dispatch. The software is performing well, and PGE is satisfied with the performance of the grid services provided.

B.6.4 Event Notification System

Enbala's software platform includes a customer notification system that automatically generates messages to program participants in advance of peak time events. Notifications are sent via the participant's chosen communication method (email, text, and/or telephone call) at the participants' chosen notification period (18-hour, 1-hour, 10 minute). The integration of event management and notification systems ensures consistent and timely participant communications that meet the required notification parameters set forth in the customer agreement.

B.6.5 Participant Web Portal

A web-based customer portal offers participants access to their energy interval data, current program nomination status and event performance history.. The portal is developed by Energy Data Metrics (EDM), a work order and customer management system vendor. Participants can manage their program participation via the portal.

B.6.6 Event Performance Measurement and Verification

When customers are enabled into the pilot, cellular communication equipment is installed on a customer's KYZ pulse energy meter to wirelessly communicate customer interval energy usage data to the Enbala DRMS platform. Pulses are sent from the KYZ reader via cellular data to Pelican, a wireless meter data collection and control system that stores raw meter data from KYZ meter pulses and converts it to energy usage. The data is transmitted from Pelican via application programming interface to Enbala.

To measure the energy curtailment achieved by a participating customer during a peak time event, customer energy use baselines are determined based on site energy

usage during the previous 10 days prior to the event. The 10 days do not include weekend, event, or opt out days. The five days with the highest load during event participation hours are averaged to determine a baseline. Customer performance is measured as the difference between actual energy usage during the event period relative to the baseline. Preliminary event performance is captured in the DRMS.

Customer event performance is then confirmed by comparing customer meter data using PGE's Advanced Metering Infrastructure interval dataset to the cellular data captured in the Enbala DRMS. Pelican data is the preferred source to determine customer event performance. The data is compared with AMI data to ensure accuracy. If there is an issue with the communication equipment, AMI data is used instead. Customer incentives are calculated based on customer event performance. The actual curtailment is subtracted from the baseline to determine whether a customer meets their nomination capacity. A customer must achieve 70% of their nomination in order to receive an incentive payment.

B.6.7 Customer Experience

This pilot has a proven track record of customer success. All customers in 2018, and all but one customer in 2019, planned to continue their participation in the pilot. From 2018 to 2019, the pilot scored 9.8 out of 10 on a scale where 1 means "extremely dissatisfied" and a 10 means "extremely satisfied." From 2019 to 2020, the average score was 9.6 out of 10.

Customer testimonials[78]:

> *"[Schedule 26 is] easy to do, makes sense, and at no cost to us."*
>
> *"The incentives relative to the amount of effort required [means] it doesn't make sense to quit."*
>
> *"The [Energy Partner program flexibility] is a big part of my decision to continue to participate."*

PGE submitted the Guidehouse Pilot-to-Program readiness evaluation in Q3 2021; it contains a comprehensive summary of performance to date.

B.7 Participation Target

To continue to meet DR goals as a scalable program, PGE will seek to expand its recruitment from the largest customers to medium-sized customers and also enable additional Flexible Load services. Expanding to include additional DER and broadening the customer base will reduce the reliance on a small number of very large contributors and continue to ensure consistent and reliable DR.

Since the pilot was first developed, advancements in battery energy storage and other similar technologies have opened additional grid service value streams that PGE will

[78] Guidehouse, "Energy Partner Schedule 26 Process Evaluation Interview Summary – Summer 2020," Internal PGE Report, (Guidehouse, March 2021).

seek to optimize with customer resources. The proposed additional grid services include contingency reserve, fast frequency response, volt/VAR, and an option for customers with eligible resources to provide firm load reduction with no prior notice from PGE.

There is no limit to the number of eligible customers who can participate in Schedule 26, thus, this program is designed to continue to operate until it either needs to be changed or retired in the case that it is no longer serving the needs of our customers or operating at an adequate cost-effective value.

After the transition to a program and with proposed tariff updates, key features will include:

Utility Features

- Enhanced grid efficiency due to increased number of DR assets and more of hours available to call upon during an event
- Reduced reliance on gas-powered "peaker plants"
- Reduced greenhouse gas emissions, criteria air pollutant emissions, and water pollution in PGE's service territory and beyond

Customer Features

- Multiple nomination options to meet customer needs
- Increased resiliency for customers that purchased and installed energy storage systems
- Increased opportunity to earn incentives
- Customizable participation rates to avoid disrupting operations
- Opportunity to support statewide decarbonization goals with minimal effort

B.8 Potential Scale and Other Relevant Market Research

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

The combined 2023 target for Schedule 25 and 26 is 32.3 MW.

B.9 Schedule

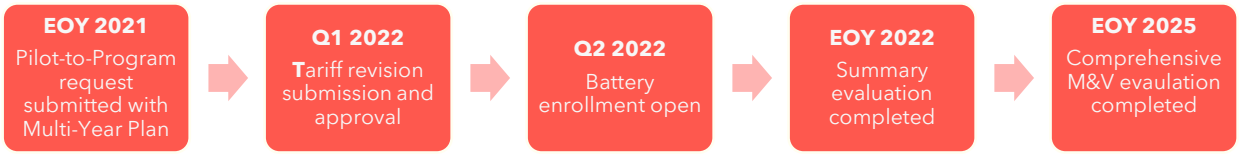

Figure 13 – Schedule 26 Timeline

The Pilot-to-Program transition plan is being filed as an appendix within the Flexible Load Multi-Year Plan. The transition plan also outlines proposed tariff revisions that

PGE intends will encourage the integration of inverter-based resources and other firm capacity resources capable of providing additional grid services beyond peak shaving. PGE has begun developing the operational plan for these new types of customers and will be able to dispatch resources upon tariff approval.

PGE anticipates that integrations of energy storage will be a slower uptake, with new customers in the single digits for a year or two as the technology continues to mature and prices are forecasted to decline. There are currently seven non-residential battery energy storage systems interconnected with PGE, with the current largest installation being 30 kW. The low incidence of currently eligible energy storage on the system, plus the lengthy sales and construction cycle for new energy storage installations (from six months to multiple years, depending on the scale and complexity) gives PGE time to prepare for "at scale" integrations, even after tariff approval.

PGE does not anticipate significant near-term budget impacts from these tariff updates, and the May 2022 budget update will reflect the forecasted impacts of the tariff revisions and additional customers.

B.10 Budget

PGE proposes a budget outlined in the Flexible Load Multi-Year Plan (See Section 4.3.1)

B.10.1 Cost Effectiveness

As of October 2021, Energy Partner's TRC (without Value of Service Lost) is 1.20; the current costs are represented in Table 23 below. PGE is updating its methodology for calculating cost effectiveness in the coming year and will be soliciting OPUC review and comment as that initiative progresses. As new cost-effectiveness models are implemented, these will be reported to the OPUC at the first annual advice filing.

Table 23 – Energy Partner Schedule 26 Program Cost Effectiveness

$000s	TRC		TRC without Value of Service Lost		PAC		RIM		PCT	
	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits	Costs	Benefits
Administrative costs	12,495		12,495		12,495		12,495			
Avoided Costs of Supplying Electricity		14,924		14,924		14,924		14,924		
Bill Reductions										166
Capital Costs to Utility	-		-		-		-			
Environmental Benefits		13		13						
Incentives Paid					11,386		11,386			11,386
Revenue Loss from Reduced Sales							166			
Transaction Costs to Participant										
Value of Service Lost	5,693		-						5,693	
Benefit Cost Ratio	**0.82**		**1.20**		**0.62**		**0.62**		**2.03**	

B.10.2 Cost Recovery Strategy

Energy Partner expenses will be recovered through a rate supplemental, in accordance with the Multi-Year Plan and pending approval.

B.11 Reporting Requirements

PGE will provide an annual advice filing, including a summary report on the status of the program, after launch. Every three years, PGE will conduct a comprehensive measurement and verification (M&V) evaluation to assess performance, customer experience, and opportunities for improvement. PGE plans to report out the data in regular planning documents such as the Multi-Year Plan.

B.11.1 Evaluation Plan

PGE will maintain the existing evaluation structure to continue to measure the program's effectiveness in meeting its objectives, identify areas for continuous improvement, and assess energy impacts on PGE's system.

B.11.2 Customer/Market Learnings

A key aspect of PGE's evaluation and to enable the capture of all cost-effective DR is a robust understanding of why customers choose to participate and the factors influencing energy usage with a very diverse customer segment. Some of the learnings that PGE's evaluation will seek to uncover across a diverse set of non-residential customer segments include:

- Validation of PGE's assessment of customer barriers to non-residential DR
- Customer barriers to DR, utility opportunities, and potential solutions
- Customer barriers to program participation, including:
    - Customers' internal processes and timelines

    - Attractiveness of the incentive
    - Impact of non-financial support such as expanding types of DR
    - Impact of customer commitments and requirements
- PGE's level of influence in customers' decisions to bring DR to the program, and the materials, information, and/or analyses that could most effectively accelerate DR product adoption
- Tracking of customer participation and satisfaction levels with program offerings (e.g., planning, design, incentives, installation, and assistance)
- Impact on underserved communities, such as the number of projects that increase equitable access to DR

B.11.3 Implementation Learnings

Looking internally, PGE will also study its own barriers and opportunities for improvement for the program. As PGE evaluates our success in implementing this program we will assess:

- PGE's ability to automatically integrate Schedule 26 dispatch into Power Operations
- The benefits of the new Enbala Concerto system across a full set of use cases
- Enhancements of the internal PGE program documentation on processes and change histories
- Barriers to customer contracting and opportunities for enhanced processes to accelerate review and approval of customer contracts to enable faster and higher conversion rates

B.11.4 Evaluation Partner

The third-party evaluator, Guidehouse, has been conducting impact evaluations including seasonal interviews (summer and winter) with participants for quality assurance of Energy Partner since winter 2017. Guidehouse interviews each participating group annually and conducts interviews after each event season to help facilitate timely and effective program change. They also conduct comprehensive impact evaluations to ensure performance calculations and customer incentives are accurate.

B.11.5 Methodology

To conduct the impact evaluation, Guidehouse primarily uses AMI data provided by PGE. If AMI data is not available or complete, Guidehouse supplements the gaps with data from the Pelican data collection system, provided by CLEAResult. In contrast, to estimate impacts for CLEAResult's settlement processes, CLEAResult primarily uses Pelican data, where available. If Pelican data was not available or complete, CLEAResult used AMI data from their daily feed. For the winter 2017-18 and summer 2018 evaluation cycles while CLEAResult was still in the process of implementing Pelican devices at customer sites, Guidehouse and CLEAResult used identical data sources, which were mainly AMI interval data supplemented by Pelican data.

B.11.5.1 Empirical Data:

In addition to the customer interviews and review of PGE's implementation activities, Guidehouse also uses a variety of data to further support the impact evaluation. This includes, but is not limited to the following:

- Participant interval data
- Participant cross-sectional data
- Event schedule
- Customer with on-site generation
- Performance summary data

B.11.6 Data Evaluation

As a condition of participation, PGE will require customers to have interval metering and meter communication in place prior to initiation of service under this schedule. PGE will provide and install necessary equipment which allows PGE and the customer to monitor the customer's energy usage. PGE will also continue to conduct annual evaluations of customers who participate in this program through a third-party evaluation service. PGE's evaluation vendor will analyze customer participation data to further assess customer load impacts and impacts to PGE's system. PGE plans to report out the data in regular planning documents such as the Multi-Year Plan.

B.12 Conclusion

PGE believes that Energy Partner pilot is mature, stable, and reliable, and has demonstrated readiness to transition to a program to continue its acquisition of cost-effective non-residential DR. Upon reviewing the five key considerations of customer experience, infrastructure stability, grid performance, financial performance, and dispatch integration, PGE believes that it is warranted and prudent to approve the transition of this pilot to a program. Further, while PGE intends on keeping the program largely as it currently is, strategic updates of the tariff are proposed to meet the increasing sophistication of customer energy usage and a decarbonized energy future.

Appendix C Budgets

Table 24 – Budget Summary by Product Stage

Product Stage	2022	2023	Total
Product Development	$2,130,000		$2,130,000
Program Management	$15,083,803	$15,611,770	$30,695,572
Smart Grid Testbed	$1,197,070	$1,067,565	$2,264,635
	$ 18,410,873	**$ 16,679,335**	**$35,090,207**

Table 25 – Budget Summary by Program/Pilot

Product Stage	Program/Pilot	2022	2023
Product Development	Home Energy Bundle	$350,000	-
	Community Microgrids	$250,000	-
	Single Family Water Heater (SFWH)	$1,130,000	-
	New Construction Bundle	$200,000	-
	Commercial Resiliency Solution	$200,000	-
Program Management	Residential - Flex PTR	$3,445,000	$3,445,000
	Residential - Flex TOD	$695,000	$695,000
	Residential - Thermostats	$2,732,250	$2,911,675
	Com - Energy Partner Sch 25	$1,403,162	$1,448,149
	Com - Energy Partner Sch 26	$4,065,259	$4,211,624
	Com - MFWH	$2,743,132	$2,900,322
Smart Grid Testbed	Phase II	$1,197,070	$1,067,565
		$18,410,873	**$16,679,335**

Table 26 – Budget Detail: Incremental Contract Labor

Product Stage	Program/Pilot	2022	2023
Product Development	Home Energy Bundle	$325,000	-
	Community Microgrids	$175,000	-
	Single Family Water Heater (SFWH)	$500,000	-
	New Construction Bundle	$100,000	-
	Commercial Resiliency Solution	$150,000	-
Program Management	Residential - Flex PTR	-	-
	Residential - Flex TOD	-	-
	Residential - Thermostats	-	-
	Com - Energy Partner Sch 25	$3,000	$3,000
	Com - Energy Partner Sch 26	$6,000	$6,000
	Com - MFWH	-	-
Smart Grid Testbed	Phase II	-	-
		$1,259,000	**$9,000**

Table 27 – Budget Detail: Incremental PGE Labor

Product Stage	Program/Pilot	2022	2023
Product Development	Home Energy Bundle	-	-
	Community Microgrids	-	-
	Single Family Water Heater (SFWH)	-	-
	New Construction Bundle	-	-
	Commercial Resiliency Solution	-	-
Program Management	Residential - Flex PTR	-	-
	Residential - Flex TOD	-	-
	Residential - Thermostats	-	-
	Com - Energy Partner Sch 25	-	-
	Com - Energy Partner Sch 26	-	-
	Com - MFWH	-	-
Smart Grid Testbed	Phase II	$357,070	$357,565
		$357,070	**$357,565**

Table 28 – Budget Detail: DRMS Provider

Product Stage	Program/Pilot	2022	2023
Product Development	Home Energy Bundle	-	-
	Community Microgrids	-	-
	Single Family Water Heater (SFWH)	$75,000	-
	New Construction Bundle	-	-
	Commercial Resiliency Solution	-	-
Program Management	Residential - Flex PTR	-	-
	Residential - Flex TOD	-	-
	Residential - Thermostats	$892,000	$980,000
	Com - Energy Partner Sch 25	$68,712	$75,583
	Com - Energy Partner Sch 26	$638,081	$701,890
	Com - MFWH	$227,500	$227,500
Smart Grid Testbed	Phase II	$300,000	$130,000
		$2,201,293	**$2,114,972**

Table 29 – Budget Detail: Evaluation

Product Stage	Program/Pilot	2022	2023
Product Development	Home Energy Bundle	-	-
	Community Microgrids	-	-
	Single Family Water Heater (SFWH)	-	-
	New Construction Bundle	-	-
	Commercial Resiliency Solution	-	-
Program Management	Residential - Flex PTR	$95,000	$95,000
	Residential - Flex TOD	$95,000	$95,000
	Residential - Thermostats	$370,000	$370,000
	Com - Energy Partner Sch 25	$36,750	$38,588
	Com - Energy Partner Sch 26	$91,350	$95,918
	Com - MFWH	$184,000	$95,000
Smart Grid Testbed	Phase II	-	-
		$872,100	**$789,505**

Table 30 – Budget Detail: Recruitment & Customer Outreach

Product Stage	Program/Pilot	2022	2023
Product Development	Home Energy Bundle	$25,000	-
	Community Microgrids	$75,000	-
	Single Family Water Heater (SFWH)	$125,000	-
	New Construction Bundle	$50,000	-
	Commercial Resiliency Solution	$50,000	-
Program Management	Residential - Flex PTR	$300,000	$300,000
	Residential - Flex TOD	$600,000	$600,000
	Residential - Thermostats	$150,000	$150,000
	Com - Energy Partner Sch 25	$50,000	$50,000
	Com - Energy Partner Sch 26	$25,000	$25,000
	Com - MFWH	$15,000	$15,000
Smart Grid Testbed	Phase II	$90,000	$100,000
		$1,555,000	**$1,240,000**

Table 31 – Budget Detail: 3rd party Implementer

Product Stage	Program/Pilot	2022	2023
Product Development	Home Energy Bundle	-	-
	Community Microgrids	-	-
	Single Family Water Heater (SFWH)	-	-
	New Construction Bundle	-	-
	Commercial Resiliency Solution	-	-
Program Management	Residential - Flex PTR	$600,000	$600,000
	Residential - Flex TOD	-	-
	Residential - Thermostats	$36,000	$36,000
	Com - Energy Partner Sch 25	$865,200	$882,504
	Com - Energy Partner Sch 26	$1,203,430	$1,227,499
	Com - MFWH	$564,910	$593,156
Smart Grid Testbed	Phase II	$350,000	$265,000
		$3,619,540	**$3,604,158**

Table 32 – Budget Detail: Direct Installation/Field Labor/Materials

Product Stage	Program/Pilot	2022	2023
Product Development	Home Energy Bundle	-	-
	Community Microgrids	-	-
	Single Family Water Heater (SFWH)	-	-
	New Construction Bundle	-	-
	Commercial Resiliency Solution	-	-
Program Management	Residential - Flex PTR	-	-
	Residential - Flex TOD		
	Residential - Thermostats	$370,000	$370,000
	Com - Energy Partner Sch 25	$318,500	$334,425
	Com - Energy Partner Sch 26	$396,398	$416,218
	Com - MFWH	$1,324,000	$1,456,400
Smart Grid Testbed	Phase II	$50,000	$50,000
		$2,458,898	**$2,627,043**

Table 33 – Budget Detail: Incentives

Product Stage	Program/Pilot	2022	2023
Product Development	Home Energy Bundle	-	-
	Community Microgrids	-	-
	Single Family Water Heater (SFWH)	$430,000	-
	New Construction Bundle	$50,000	-
	Commercial Resiliency Solution	-	-
Program Management	Residential - Flex PTR	$2,450,000	$2,450,000
	Residential - Flex TOD		
	Residential - Thermostats	$914,250	$1,005,675
	Com - Energy Partner Sch 25	$61,000	$64,050
	Com - Energy Partner Sch 26	$1,705,000	$1,739,100
	Com - MFWH	$427,722	$513,266
Smart Grid Testbed	Phase II	$50,000	$165,000
		$6,087,972	**$5,937,091**

Table 34 – Cumulative MW by Program (Summer)

Program/Pilot	2022	2023
Residential Energy Storage	0.3	1.0
Residential - Thermostats	34.7	39.9
Residential - Flex PTR	21.4	22.4
Com - Energy Partner Sch 26	28.3	30.5
Com - Energy Partner Sch 25	1.5	1.8
Com - MFWH	5.8	6.8
Residential - EV	0.5	1.0
	92.6	**103.4**

Table 35 – Cumulative MW by Program/Pilot (Winter)

Program/Pilot	2022	2023
Residential Energy Storage	0.3	1.0
Smart Thermostat	9.2	9.7
PTR	16.1	16.8
Energy Partner Sched 26	24.5	27.0
Energy Partner Sched 25	1.1	1.1
MFWH	8.7	10.2
Residential Electric Vehicle	0.5	1.0
Winter Total	**60.4**	**66.8**