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

March 14, 2022

Via Electronic Filing

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

Re: **PGE UE-294 2020 Retrospective Research & Development Projects**

Filing Center:

Enclosed pursuant to OPUC Commission Order No. 15-356, is Portland General Electric Company's annual retrospective look at Research and Development Projects for 2020. PGE inadvertently failed to file the retrospective R&D report for the year 2020. This filing corrects the omission.

Thank you for your assistance in this matter. If you have any questions or require further information, please call me at (503) 464-7488.

Please direct all formal correspondence, questions, or requests to the following e-mail address: pge.opuc.filings@pgn.com.

Sincerely,

/s/ *Jaki Ferchland*

Jaki Ferchland
Manager, Revenue Requirement

JF/np
Enclosure

Research & Development
Program / Project End Year Summary

Date: 9/10/2021

R&D Program/Project Name: Investigating thermal energy storage for flexible load and DR potential in Oregon

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
Investigating thermal energy storage for flexible load and DR potential in Oregon	Program Manager: Andy Eiden	$	$ 20,495.00	$

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Andy Macklin

Sponsoring Department: Grid Products and Integration

Project Team (internal):

Andy Eiden

Geoff Bastian

Project Team (external):

Dr. Teshome Jiru, Oregon Tech

Pamela Jackson, OIT Graduate Student

Peter Kramer, Energy Services Lead, Trane

Project Description:

Cool thermal energy storage (CTES) is a method for reducing a facility's energy and on-peak demand costs by producing and storing ice or chilled water during off-peak hours and using the stored energy during on-peak hours for cooling. Integrating CTES systems with building controls and real-time pricing or demand signals from the utility can lead to customer cost savings by acting as a flexible load; depending on the value to the grid the CTES may provide peak shaving, load shifting, and nighttime wind following.

This is a proven technology that has mostly been deployed in the southeastern United States. Partial thermal storage systems have proven to be economically attractive when they are installed for

PGE Budget/Actual:

FY19: $0

FY20: $20,495.00/$20,495

FY21: $0

Cost Share Total: N/A University sponsorship

Cost Share Percent:

new facilities, facility expansions, or plant rehabilitations. However, a widespread implementation of full-storage and partial-storage systems by retrofitting exiting buildings requires utilities involvement through rebate and incentives.

The objective of these project is therefore to assess the economic and technical feasibility of CTES systems for retrofitting existing commercial and institutional buildings in Oregon. A baseline building energy model will be developed using TRANE's TRACE 700 energy simulation program. The model will be validated using PGE AMI data from a case study building. The validated model will be used to test different ice/chilled water storage system configurations to identify the most cost-effective system. The result of this study will help PGE identify potential candidate facilities/district cooling systems for DR program targeting through the installation of grid-integrated ice/chilled water storage systems.

Benefit to PGE:

The project will uncover potential benefits to PGE's system (both bulk energy and distribution grid) by documenting ability of CTES systems to shift peak load reliably into nighttime hours. This shift is similar to other DR products currently on the market in Oregon and in our current DR portfolio, but add the value of a longer-shift period (up to 8 or even 12 hours) and ability to control the re-charge periods. (As opposed to thermostatic controls or behavioral DR programs where usage typically rebounds to makeup the foregone temperature device settings. This can be beneficial for example if high load event forecasts last for longer than predicted, potentially adding incremental system value over and above other approaches.

Customer Benefit:

Benefit to the customer is to receive an energy model of their facility usage, with performance of proposed CTES retrofit included to demonstrate potential performance improvements and cost savings. Data center customers in particular, who typically have a flat load profile and little ability to shift usage, may be able to derive benefit from adopting this technology after switching to a TOU rate or with utility incentives. Additionally, the CTES system will provide

Strategic Alignment:

PGE is developing strategies and solutions for new product offerings that can engage customers in decarbonizing the grid and meeting reliability needs. Cold Thermal Storage being studied in this project has significant untapped resource potential as demonstrated by California's 2025 Demand Response Potential Study Phase III report, and PGE's own internal modeling of DER resource potential. However, PGE lacks accurate cost data and system modeling studies showing the efficacy of this resource for Pacific NW climate zone and rate structure. This research will allow new potential products for the Flex Load Portfolio, ensuring that PGE can continue to be competitive in offering customer energy solutions by investigating emerging demand-side technologies.

redundancy and resiliency to power outages while still providing necessary system cooling services. This is a high premium that data center customers (and other customers with high process-cooling loads) are willing to pay.	

Value

PGE Participation:	**Value Derived**:
The Key Customer team has been a partner in this effort. As part of the site selection process, the project team has incorporated feedback about which sites would add the most value to PGE in terms of customer potential benefit. The result was to study the CTES technology applicable to data center customers. This is a quickly growing portion of our Cost of Service base in the industrial/hi-tech sectors, and have not historically participated in any of PGE's DR programs because of the sensitive nature of their load and high cooling needs. Additionally, the OPUC in its acknowledgement order of PGE's 2019 IRP required PGE to investigate additional non-cost-effective interventions to manage the load at data centers through energy efficiency. This research therefore promotes learning for both internal and external value to PGE and paves the way for a future field trial of this technology.	Through direct engagement with partners OIT and Trane, PGE is deriving value by learning from leading industry experts and researchers about the dynamics and considerations in implementing advanced customer energy management solutions. This is a growing focus for PGE, and we do not yet have the internal capability to lead such initiatives ourselves. Additional to the direct knowledge gained through this effort (via site visits, methodology discussions, etc.) PGE is gaining visibility to other funders and partners that have interest in this CTES technology. PGE has been engaged with NREL about leveraging their CTES chiller system at the Goldendale, CO energy integration campus, and there is mutual desire to leverage this interest into a DOE funding proposal to study applied control strategies in NREL's campus to mimic PGE rate structures and simulated building loads, as well as pursue funding for an eventual site installation for a field pilot in PGE service area.

Research & Development
EPRI Program Summary

Date: 3/19/2020

EPRI Program/Project Name: PQ Knowledge Development & Transfer

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed:

☐ Discontinued (reason) _____

Project Sponsor: Joey Baranski **Sponsoring Department**: Distribution Operations Engineering **Project Team (internal):** Ken Spencer is the lead and other engineers provide additional support as needed. **Project Team (external):** EPRI staff, utility peers, and others **Project Description:** EPRI's core Power Quality (PQ) program "PQ Knowledge" provides the essential information and resource tools needed to help eliminate our customer's economic losses and allow PGE to remain at the forefront of PQ knowledge. This program will provide access to their Power Quality Hotline services that are considered the most knowledgeable team in the world on PQ issues. EPRI will provide newsletters, email updates, and Web access detailing their on-going R&D programs and changes in electrical standards that will affect PGE and our customers. Discounts on training programs, PQ conferences, and ability to participate in Tailored Collaboration (TC) projects will be available	**PGE Budget/Actual:** FY18: $20,000/$20,000 FY19: $10,000/$10,000 FY20: $20,000/0 **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: A power quality center of excellence is available to PGE engineers. **Customer Benefit:** A power quality center of excellence is available to PGE engineers. PGE engineers use available resources to solve difficult customer power quality problems. The knowledge	**Strategic Alignment:** This project aligns with all three strategic imperatives.

base can also be used to inform design and standard changes.	

Value

PGE Participation: Provides access to PQ expertise. PGE engaged the EPRI PQ Team to address a customer issue in 2020.In this specific case, a sawmill was causing power quality issues for a group of nearby customers. The EPRI team worked with PGE and the customer to measure and define the issue, assess options, and recommend a fix working within the customer's constraints. The knowledge base is also a valuable resource for the Distribution Operations Engineering team to support customer power quality and stay ahead of grid modernization impacts.	**Value Derived**: Access to expert PQ knowledge

Research & Development
Program / Project End Year Summary

Date: 04/21/21

R&D Program/Project Name: Arc Flash Testing of 480-V Bypass Meter Socket

Project Status:

☐ Complete

☒ Will Continue Next Year

TITLE OF THE PROJECT	PROGRAM MANAGER	Cost 2019	Cost 2020	Cost 2021
EPRI P180.004: Distribution Safety Research		$ 0	$ 20,000	$ 20,000

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: **Sponsoring Department**: **Project Team (internal):** **Dan Loomis, Jonathan Wilson** **Project Team (external):** **Tom Short (EPRI)** **Project Description:** The operation of distribution circuits exposes workers and the public to hazards, including contact to energized objects (shock), arc flash from a system fault (burns), and step and touch voltages. This project aims to focus on these risks through research on: • Grounding and personnel protection • Arc flash analysis and protection • Detection and reduction of live, downed conductors • Stray and contact voltage • Manhole events • Evaluation and use of protective equipment • Technologies to improve worker safety	**PGE Budget/Actual:** FY19: FY20: $20,000/ $20,000 FY21: $20,000 **Cost Share Total:** (if applicable) **Cost Share Percent:**
Benefit to PGE: These research tasks can help utilities improve safety for the public and utility workers. Specifically, the research results could help utilities:	**Strategic Alignment:**

• Improve grounding approaches • Improve public and worker safety through leading approaches for downed conductor detection • Reduce hazards to workers from arc flash • Better use protective cover-up • Protect workers from contact to energized lines by enabling technology to reinforce better practices for line coverings • Effectively implement voltage-detection technologies to warn of hazards **Customer Benefit:**	

Value

PGE Participation:	**Value Derived**:

Date: 04/14/2021

Project Name: CEATI Stations Equipment Program (SEP)

Project Status:

☐ Complete

☒ Will Continue Next Year

- Engagement is on an annual basis and was renewed for 2021

☐ Discontinued (reason) _____

Project Sponsor: Alex Banicki **Sponsoring Department**: Asset Mgmt Engineering **Project Team (internal):** Various **Project Team (external):** CEATI Staff **Project Description:** The mission of CEATI's Station Equipment Program (SEP) is to address shared experiences and lessons learned regarding the lifecycle management of station assets – including purchasing (specifications, quality control, etc.), design, installing, commissioning, maintaining, and operating – as well as disposal and planning for future changes and trends in the utilities industry. The group assists in maximizing the safety, reliability, and efficiency of station assets while also minimizing costs, complying with applicable regulations/ laws/industry standards, and producing required reporting for applicable authorities.	**PGE Budget/Actual:** FY20: $16,800/$16,800 FY21: $TBD **Cost Share Total:** (if applicable) **Cost Share Percent:** Varies by program Costs are shared among the 145+ utility members and vary by program and project. Typically projects are supported by multiple utilities so costs would be less than 20% of the total project budget.
Benefit to PGE: The CEATI program model provides electric utilities with a cost-effective vehicle for sharing experiences and addressing issues pertinent to their day-to-day operations, maintenance, and planning. In addition to serving as a strong technical resource tool, CEATI programs include project collaboration opportunities yielding practical deliverables which organizations can use to leverage their expenditures. **Customer Benefit:**	**Strategic Alignment:** Perform

Customers benefit by PGE Implementing and maintaining the electrical grid more efficiently and reliably.	

Value

PGE Participation:	**Value Derived**:
PGE's Substation Maintenance Engineering personnel are involved and access information on the CEATI portal	Technical information and peer utility benchmarking

Research & Development
Program / Project End Year Summary

Date: 9.Sep.2021

R&D Program/Project Name: Construction Safety Research Alliance (CSRA)

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI Physical Security for Substations and T&D	PROGRAM MANAGER	$ 15,000	$ 15,000	$ 15,000

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: Bill Messner

Sponsoring Department: Health & Safety

Project Team (internal): Alden Strealy

Project Team (external):

University of Colorado staff and member utility/construction companies

Project Description:

CSRA is an alliance of industry leaders and experienced scientists who are focused on transformative construction safety research.

The CSRA is a forum where we:

• Propose and test new safety ideas and innovations

• Invite industry members to actively participate in safety research

• Explore the efficacy of new safety technologies

• Network and share best practices

• Shape the next generation of safety researchers and practitioners

PGE Budget/Actual:

FY19: $15,000

FY20: $15,000/ $15,000

FY21: $15,000

Cost Share Total: $45,000

Cost Share Percent: Total project budget varies with number of participants. For 2020 our cost share was about 3%.

Benefit to PGE:

The rate of serious injuries and fatalities has plateaued in the construction industry for nearly 20 years. The mission of the CSRA is to assemble industry leaders and worldclass researchers to conduct collaborative research that eliminates these unacceptable life-changing events.

Customer Benefit:

Strategic Alignment:

Perform – Delivering operational excellence

Having access to the latest collaborative processes and technologies to reduce work related injuries and safety incidents will support PGE's mission of providing safe and reliable power to our customers.	

Value

PGE Participation:	**Value Derived**:
PGE personnel have access to all research and technologies that are supported by the alliance. PGE can also participate in research and share safety data with other entities to provide a richer data set for analysis.	Given the large participation from utilities and construction companies across the US (33 as of 2020), PGE will have access to the latest up to date research on safety protocols for electric utilities and contractors for a fraction of the actual research cost.

Research & Development
Project Summary

Date: 03/17/2021

Project Name: Investigating Ductile Iron Poles for T&D Infrastructure – DIST35

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: **2021**

☐ Discontinued (reason) _____

Project Sponsor: **Jerry Donovan**

Sponsoring Department: **RC364**

Utility Asset Management / FITNES

Project Team (internal): **Jerry Donovan**

Project Team (external): **OSU School of Civil & Construction Engineering**

Jason H. Ideker, Ph.D. – Professor and O. Burkan Isgor, Ph.D.

Oregon State University, School of Civil & Construction Engineering

101 Kearney Hall, Corvallis, OR 97331-3212

Project Description:

Evaluate the use of ductile iron as a viable support structure material in PGE's system, including as an alternative to wood for wildfire damage mitigation. PGE is soliciting the research capabilities of Oregon State University's School of Civil and Construction Engineering. This work will support a graduate research assistant and undergraduate research assistant for general investigations into the long-term performance of ductile iron poles. This will include a thorough literature review as well as accelerated testing of ductile iron pole sections conducted under three types of degradation scenarios: (1) Corrosive environment using OSU's Qfog system. (2) Placement and initial measurements in normal and sulfate rich soil environment in CCE's outdoor exposure site. During and after the accelerated aging, OSU will do electrochemical surface measurements (EIS) mechanical property determination, visual inspection and additional other non-destructive evaluation on outdoor exposed samples. This will provide PGE with a repository of samples that can be measured periodically and will allow them continual updates, ahead of time, as to the long-term performance of ductile iron pipes. PGE has provided sections of ductile iron pipe and "comparison" pole material samples.

PGE Budget/Actual:

FY19: **$20K/$20K**

FY20: **$20K/$20K**

FY21: **$20K/$0**

Cost Share Total: **N/A**

Cost Share Percent: **N/A**

Benefit to PGE: **Ductile iron poles have the potential to improve reliability and resiliency by eliminating woodpecker damage as one of the leading causes of premature wood pole failure. Additionally, the use of ductile iron poles addresses the growing concern around use of treated wood poles in environmentally sensitive areas. Provides an alternative to wood support structures in wildfire zones.** **Customer Benefit:** **A safe, reliable and environmentally beneficial alternative to treated wood support structures. Ductile iron poles may also be a good alternative to wood poles for use in wildfire zones.**	**Strategic Alignment:** **Deliver operational excellence and competitive financial returns**

Summary

Synopsis of Project as Implemented: **Verify ductile iron pole resistance to corrosion under various environmental scenarios.** **Establish outdoor placement of pole samples to evaluate long-term performance of ductile iron poles.** **Testing of ductile iron poles for resistance to fire damage.** **Performance Against Objectives/Deliverables:** **Testing for resistance to corrosion under various environmental scenarios continued.** **Galvanized steel samples procured and received by OSU.**	**Decisions to be Made**: **Continued decisions on when and where to place additional ductile iron poles, possibly including as replacements for wood structures in certain environments and wildfire zones.** **Next Steps:** **Next report to include comparison of ductile iron performance to galvanized steel coupons.** **OSU/PGE to determine placement of pole samples in outdoor environment to evaluate long-term performance of ductile iron poles.** **Expand testing to include simulation of wildfire conditions to test resistance capabilities and determine limitations.**

Research & Development
Project Summary

Date: 4/5/2021

Project Name: Early Fault Detection System

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Jay Landstrom **Sponsoring Department**: R&D **Project Team (internal):** Jay Landstrom, Dist Design & Engineering, Asset Management **Project Team (external):** IND Technologies, Australia **Project Description:** Deploy a pilot of an Early Fault Detection (EFD) system on the distribution system for the PSPS zone on Mt Hood..	**PGE Budget/Actual:** FY20: $24000/$24,000 FY21: TBD **Cost Share Total:** (if applicable) NA **Cost Share Percent:** (if applicable) NA
Benefit to PGE: IND Technologies EFD system can detect pending failures on the high voltage distribution system before the problem evolves to a fault and outage. PGE will be able to proactively address pending failures in a timely manner. Doing so will reduce the risk of arcing on the power system leading to fires. It will also allow the repair before the failure leads to a long duration outage event, thus saving customers from interruptions and allowing for more efficient repairs. Customer Benefit: Fewer outages and lower risk of causing a wildfire in the PSPS zone. Also more efficient operations leading to reduced outage costs.	**Strategic Alignment:** (Which PGE Corporate Imperative did this project address?) **Grid Modernization** **Efficient Operations**

Summary

Synopsis of Project as Implemented:	**Decisions to be Made**:

The project is scheduled for implementation in early 2021 **Performance Against Objectives/Deliverables:** P.O. has been dispatched and a test system was received.	Evaluation of the effectiveness of the system against objectives **Next Steps:** Develop construction standards and complete siting analysis

Research & Development
Program / Project End Year Summary

Date: 4/22/21

R&D Program/Project Name: Combustion Dynamics Training

Project Status:

☒ Complete

☐ Will Continue Next Year

		Cost 2019	Cost 2020
TITLE OF THE PROJECT	PROGRAM MANAGER	$	$ 15,000

- Year to be Completed: 2020

☐ Discontinued (reason) _____

Project Sponsor: Dan Turley **Sponsoring Department**: PSES **Project Team (internal):** Brandon Humble **Project Team (external):** Bobby Noble (EPRI) **Project Description:** In addition to the combustion algorithm implemented through EPRI at Coyote Springs Unit 1 and Unit 2 this was a supplemental training to provide additional details as to what the algorithm is telling the site and how to better understand combustion dynamics of the gas turbine.	**PGE Budget/Actual:** FY19: FY20: $15k/ EPRI SDF funds **Cost Share Total:** (if applicable) **Cost Share Percent:**
Benefit to PGE: Training on Gas Turbine combustion **Customer Benefit:** More highly training employees to help monitor, troubleshoot, and understand combustion of the Coyote Springs Gas Turbine.	**Strategic Alignment:** Operational Excellence

Value

PGE Participation: Dan Turley, Hao Liu, Ivan Auer, Michael McDonough, Lester Whitehead, Angel Melendrez, Dan Peterson, Alex Banicki	**Value Derived**: 4 days of 90 minute sessions of combustion trainings from SME's including: combustions basics, combustor basics, fuel composition effects, combustion instability, monitoring combustion, and case studies.

Date: 04/16/2021

EPRI Field Testing Supplemental 2020/Customer-Sited Energy Storage Field Test

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh **Sponsoring Department**: RC509 **Project Team (internal): Manny Obi** **Project Team (external):** **Nicholas Tumilowicz, EPRI** **Mike Simpson, EPRI** **Project Description:** As new products for customer-sited energy storage systems emerge, many organizations are testing equipment individually, with varying degrees of coordination and consistency of method making it difficult to draw meaningful conclusions from comparative data sets and results in several unresolved questions. This project seeks to understand functional and performance characteristics of customer-sited energy storage products. It aims to test a series of customer-sited energy storage products in parallel at a single test site with the same methodology and conditions. Additionally, the project seeks to understand key differences between available systems, including functionality and topology. New learning is expected in characterization of technical readiness, performance, and uptime of customer-sited, particularly residential, battery storage products (uptime quantifies percentage of time the product is functioning and responding as intended).	**PGE Budget/Actual:** FY20: $26,879/$26,879 **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: Results are expected to yield lessons learned to offer insight toward optimized pathways to leverage customer energy storage resilience resources to improve customer satisfaction, improve grid quality,	**Strategic Alignment:** (Which PGE Corporate Imperative did this project address?)

increase service revenue, and reduce grid operational costs. **Customer Benefit:** Direct benefits to the PGE customers include higher quality information and improved decision making for energy storage design and use. Electricity customers may be able to improve site reliability, achieve economic returns, and improve environmental responsibility of electricity use. Further integration of energy storage into power system planning and operations may result in lower costs of operation, improved reliability, and increased integration of renewable energy sources by regional electric power systems.	Decarbonize

Value

PGE Participation:	**Value Derived**:
Access to bi-monthly webcasts and site visits, as well as all related research papers and other reports.	A technical report will be provided by EPRI to PGE that will enable technology transfer that can be used in PGE's residential storage program design. PGE will also have access to EPRI's collaboration site that contains project information including data collected, system procurements and testing progress, and collaborative analysis of energy storage systems.

Research & Development
Program / Project End Year Summary

Date:

R&D Program/Project Name:

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI Utilizing DER for Advanced Distribution Resiliency Supplemental	Colin Solini	$ 0	$ 30,000	$ 30,000

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh **Sponsoring Department**: RC509 **Project Team (internal): Colin Solini** **Project Team (external):** Brian Seal, EPRI Arindam Maitra, EPRI UT Austin, Lab testing Austin Energy, Field Testing **Project Description:** Supplemental project developed with DOE and participant funds. Develops pre-event planning, analysis, and event control systems to enable resilient distribution systems which leverage existing customer DER, especially solar, to power critical facilities. Includes a field test in Austin Energy.	**PGE Budget/Actual:** FY19: $0 FY20: $30,000 / $30,000 FY21: $30,000 **Cost Share Total:** N/A **Cost Share Percent:**
Benefit to PGE: Receives project updates and reports for this project. Can lead to planning methods, controls research, and proof-of-concept for advanced resilient islands that reduce CMI, improve SAIDI, and may deepen PGE's partnerships with cities and customers. **Customer Benefit:** As PGE improves its ability to partner with customers and stakeholders to generate clean, resilient solutions, the	**Strategic Alignment:** Learnings from this research supplemental may provide knowledge and insight to enable us to provide operational excellence to our customers with economic resilience solutions.

participating customers will experience fewer/shorter grid interruptions, and may enable nearby families and businesses to contribute to supporting critical facilities in their community during a disaster.	

Value

PGE Participation: Participation in quarterly update meetings, allowing for feedback when applicable. In 2020, the project did not receive any quarterly updates.	**Value Derived**: None as of 2020.

Research & Development
Program / Project End Year Summary

Date:

R&D Program/Project Name: EPRI ESIG

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
TITLE OF THE PROJECT: EPRI Energy Sustainability Interest Group (ESIG)	PROGRAM MANAGER: Caitlin Horsley	$25,000	$25,000	$ 25,000

- Year to be Completed: Ongoing

☐ Discontinued (reason) _____

Project Sponsor: Allegra Hodges

Sponsoring Department: Strategy Integration

Project Team (internal): Caitlin Horsley

Project Team (external): EPRI Staff

Project Description:

This project enables our strategically aligned sustainability work related to the decarbonization roadmap by increasing the learnings, research and tools associated with reducing the greenhouse gas emissions of both our business operations and power supply. By striving to decarbonize with sustainability in mind, this group also helps to balance these efforts with the performance of our businesses both operationally and financially.

PGE Budget/Actual:

FY19: $25,000
FY20: $25,000/ $25,00
FY21: $25,000

Cost Share Total: (if applicable)

Cost Share Percent:

Benefit to PGE: Through this project we gather best practices from other utilities that are leaders in the sustainability and decarbonization space including Excel, Duke Energy, APS, Salt River Project, and others. By gathering best practices, we are better able to implement sustainability and decarbonization projects and initiatives that move our decarbonization roadmap forward while also benefitting our customers, community, employees and shareholders.

Strategic Alignment:

Aligns with both decarbonization and operational excellence imperatives as well as our newly release climate goals and purpose

Customer Benefit:	
This project further enables us to learn from our utility peers in the areas of sustainability, decarbonization and ESG to better meet our customers' ever-increasing expectations in this area.	

Value

PGE Participation:	**Value Derived**:
1. Embedding sustainability to drive strategic outcomes 2. Reporting on sustainability to align with stakeholder interests and uses (including investors and customers) 3. Sustainability metrics learnings	• Learning from peers directly applied to defining and releasing our new Climate Goals (November 2020) which directly inform our strategic plan and reporting

Research & Development
Program / Project End Year Summary

Date: 4/22/2021

R&D Program/Project Name: EPRI: Battery Energy Storage Fire Prevention and Mitigation

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI: Battery Energy Storage Fire Prevention and Mitigation	Jim Riehl	$0	$30,000	$30,000

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh

Sponsoring Department: 509

Project Team (internal): Jim Riehl

Project Team (external): Mike Simpson (EPRI) + other EPRI member utilities and BESS vendors participating

Project Description:

The objective of this project is to apply a holistic hazard analysis approach to evaluate battery fire threats, consequences, and mitigation options in specific instances. The project will drive collaboration between funding participants and subject matter experts to advance system level understanding of battery storage fire hazards and develop a prioritized framework for subsequent data collection, testing, and analysis.

PGE Budget/Actual:

FY19: $0
FY20: $30,000/ $30,000
FY21: $30,000

Cost Share Total: (if applicable)

Cost Share Percent:

N/A

Benefit to PGE: PGE benefits include improved understanding of risks with energy storage assets to support development of internal safety guidelines, project design specifications, and education of stakeholders who may interact with these systems.

Customer Benefit: This project is expected to provide necessary information to support owners, operators, and developers of energy storage to proactively design, build, operate, and maintain these

Strategic Alignment:

WIG 2: Clean, integrated customer solutions

systems to minimize the risk of fire. The investigations will identify, assess, and address battery storage fire safety issues so as to aid in avoidance of safety incidents and loss of property - a major challenge to the widespread deployment of energy storage. This may increase system reliability and penetration of renewable energy and reduce costs to electricity customers.	

Value

PGE Participation: PGE will participate in this effort as a collaborator, and will fund EPRI to engage with this collaborative implementation project to identify research gaps, gather available data, and provide guidance to support safe system design and operations.	**Value Derived**: The non-proprietary results of this work will be incorporated into EPRI's Energy Storage and Distributed Generation, Environmental Aspects of Fueled Distributed Generation and Energy Storage R&D programs and made available to both Collaborators and Site Hosts and eventually to the public for purchase, or otherwise. 1. Bi-monthly Updates EPRI will host quarterly webinars to discuss research priorities and review progress of studies in addition to any available interim lessons learned concerning fire hazard analysis, prevention and mitigation technologies, and leading practices. 2. Battery Storage Safety Summary Report The non-confidential lessons learned and aggregate findings from the site-specific evaluations will be documented in a single summary report provided to hosts and collaborators. This will include review of common findings, explicit list of open questions, and details of any available quantitative evaluation approaches to inform industry stakeholders. Additionally, the report will contain a set of recommendations summarizing guidance for future modeling and test procedures and criteria. 3. Knowledge Transfer Workshop EPRI will host a workshop convening funding participants and advisors to transfer site-specific investigation results and discuss next steps. The workshop is planned to occur summer 2020.

Research & Development
Program / Project End Year Summary

Date:

R&D Program/Project Name:

Project Status:

☒ Complete

☐ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI Utilizing DER for Advanced Distribution Resiliency Supplemental	Colin Solini	$ 50,000	$ 50,000	$ 0

- Year to be Completed: 2020

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh **Sponsoring Department**: RC509 **Project Team (internal): Colin Solini** **Project Team (external):** Brian Seal, EPRI Ramakrishnan Ravikumar, EPRI Miles Evans, EPRI **Project Description:** PGE supports the development of the public StorageVET tool. StorageVET stands for "Storage Value Estimation Tool" and was originally funded by CAISO to perform stacked benefits analysis of energy storage (plus optional solar), incorporating multiple streams of value to model the optimal dispatch and benefits of a project. EPRI will perform 3 stacked-benefits valuations for participating entities.	**PGE Budget/Actual:** FY19: $50,000/ $50,000 FY20: $50,000 /$50,000 **Cost Share Total:** N/A **Cost Share Percent:**
Benefit to PGE: Helps to guide StorageVET development, a tool that has been approved by the OPUC to perform transparent valuations. EPRI also performs 3 valuations of energy storage projects for PGE. **Customer Benefit:** Considering the stacked benefits of energy storage allows PGE to more favorably value this emerging technology and help lead projects	**Strategic Alignment:** The stacked benefits valuation that StorageVET performs will make energy storage projects more competitive from a cost-benefit perspective and allow PGE to deliver operational excellence in an increasingly decarbonized future. In addition, with proper incentives and understanding of how customer goals align with grid needs, energy storage can play a big role in grid electrification. StorageVET allows for

	balancing of multiple stakeholder objectives in its valuation of energy storage projects.

Value

PGE Participation: Participation in monthly StorageVET (now DER-VET) meetings to track progress and offer suggestions or guidance. Weekly meetings to collaborate on energy storage project valuation lead by EPRI.	**Value Derived**: 3 project analysis for the large storage projects in the HB2193 portfolio. EPRI set up and performed valuation on the proposed projects sited at Coffee Creek, Baldock Solar, and Port Westward II. All 3 valuations have been completed as of EoY 2020.

Research & Development
EPRI Program Summary

Date: 3/19/2020

EPRI Program/Project Name: Power Quality

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed:

☐ Discontinued (reason) _____

Project Sponsor: Joey Baranski **Sponsoring Department**: Distribution Operations Engineering **Project Team (internal):** Ken Spencer is the lead and other engineers provide additional support as needed. **Project Team (external):** EPRI staff, utility peers, and others **Project Description:** Power Quality has evolved to become a critical enabler of operation and economic excellence for modern electric utilities. Electric utilities worldwide consistently report that power quality (PQ) is a fundamental component of three key utility business performance metrics: grid system performance, utility economic performance, and customer satisfaction. A resurgence of interest in electric power quality performance is being driven by the need to increase the economic performance of existing infrastructure, reduce the cost of grid operations and repairs, manage and respond to increasing grid complexity, and retain existing and attract new load with excellent PQ performance and related customer support. Key among these are R&D imperatives to use PQ expertise and knowledge to improve utility performance and management, maximize the proactive value of PQ data, and address increasing PQ issues that are inevitable with increasing edge-of-grid complexity.	**PGE Budget/Actual:** FY18: $123,447/$123,447 FY19: $126,002/$126,002 FY20: $113,502/ $113,502 **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: The Power Quality research program offers fundamental insights on electrical grid power quality and compatibility to improve the value of electricity service for society. It may also contribute to	**Strategic Alignment:** This project aligns with all three strategic imperatives.

the overall public benefit of reliably supporting and integrating increasing levels of DER. **Customer Benefit:** The Power Quality research program offers fundamental insights on electrical grid power quality and compatibility to improve the value of electricity service for customers. It may also contribute to the overall customer benefit of reliably supporting and integrating increasing levels of DER.	

Value

PGE Participation: Provides access to PQ expertise.	**Value Derived**: Access to expert PQ knowledge

Research & Development
Program / Project End Year Summary

Date: 4/28/21

R&D Program/Project Name: P18 G133 – Foundational Elements for XFC DCaaS

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2020	Cost 2021	Cost 2022
P18 – G133 Foundational Elements for XFC DCaaS	Joe Colett	$40,000	$40,000	

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh

Sponsoring Department: RC 509 Grid Edge Solutions

Project Team (internal):

- Luke Whittemore
- Joe Colett

Project Team (selected external participants):

- Watson Collins, EPRI
- Carl Miller, EPRI
- Krish Tomatom, EPRI
- Vijay Bhavaraju, Eaton
- James Kennedy, Tritium

Project Description:

An industry consensus has emerged that DC power is the preferable means of delivering higher power to vehicles. The U.S. Department of Energy has recently coined the term Extreme Fast Charging (XFC) for 350 kW and above DC charging. This project will establish the foundational, technical transfer activities with leading utilities to: identify the technical and packaging requirements for the DC power distribution and grid connection; identify the standards needs for the DC portion of this XFC system; advance the development of technical requirements for regulatory support; and evaluate the economic implications of this XFC approach. Successfully establishing these foundational elements is expected to further efforts to achieve

PGE Budget/Actual:

FY20: $40,000 (Budget) / $40,000 (Actual)

Cost Share Total:

For this supplemental project, PGE joins Southern California Edison and Seattle City & Light to leverage our total investment through EPRI's research in collaboration with NREL. More utilities are expected to sign up as the program progresses.

Cost Share Percent:

TBD

the grid integration of XFC in an interoperable, modular, and scalable manner. It could also create a novel technology pathway that could enable DC as a service and other renewable integration approaches.	
Benefit to PGE: This research guides PGE's exploration of DC as a service and extreme fast charging for electric vehicles. **Customer Benefit:** PGE's participation in this focus area will enhance customer service by allowing us to design better informed products and services.	**Strategic Alignment:** The project supports PGE's corporate imperative of increasing electricity to 50% of total energy use by 2050.

Value

PGE Participation: PGE attended research and design meetings and provided input on preferred utility interconnection methodologies for primary metered extreme fast charging infrastructure. PGE has also had exploratory conversations with EPRI about hosting a prototype extreme fast charger at Electric Island.	**Value Derived**: PGE's participation has helped PGE anticipate the utility interconnection needs and pre-commercial technology pipeline of extreme fast charging and DC as a service.

Research & Development
Program / Project End Year Summary

Date: 4/28/21

R&D Program/Project Name: P18 – Transportation Electrification

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2020	Cost 2021	Cost 2022
	Joe Colett and Andy Eiden	$67,500	$67,500	

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: **Darren Murtaugh**

Sponsoring Department: RC 509 Grid Edge Solutions

Project Team (internal):

- Joe Colett
- Luke Whittemore
- Becca Baldwin
- Elizabeth Turnbull
- Coreen Henry
- Binh Lu
- Aaron Milano

Project Team (external):

- N/A

Project Description:

EPRI's P18 Electric Transportation research area includes strategic intelligence and fundamental research through market modeling, surveys, technical analyses, projections, and other activities. Work products include zip-code level EV sales, EV charging load forecasts, technology assessments, stakeholder collaborations, and other activities

PGE Budget/Actual:

FY20: $67,500 (Budget) / $67,500 (Actual)

Cost Share Total:

EPRI partners are expected to invest a total of $5 million in P18, leveraging PGE's contribution of $67,500 by a ratio of 74 : 1.

Cost Share Percent:

PGE contributed 1.3% of the total project budget for EPRI P18 in 2020.

Benefit to PGE:

The strategic insights, analyses, and other activities included in EPRI's Transportation Electrification focus areas will benefit PGE by providing insight into the latest trends in electric vehicle development and

Strategic Alignment:

The transportation sector is the largest source of greenhouse gas emissions in Oregon. Facilitating the use of electricity as a transportation fuel is key to

adoption. The latest vehicle adoption forecasts and technical analyses play a key role in the development of PGE's new products and services, providing direct inputs into program design documents and regulatory filings. **Customer Benefit:** PGE's participation in this focus area will also enhance customer service by allowing us to design better informed products and services. Vehicle sales projections and foresight into the latest technical trends ensure our programs will meet customer needs.	decreasing greenhouse gas emissions and, by displacing liquid fossil fuels, increasing total electricity use in Oregon.

Value

PGE Participation: PGE accessed various research documents, technology reports, and vehicle sales projections throughout the year.	**Value Derived**: PGE used EPRI's research documents, monthly digests, and sales reports to inform product development activities.

Research & Development
Program / Project End Year Summary

Date:

R&D Program/Project Name: EPRI P174

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI P174 DER Integration	PROGRAM MANAGER	$ 74,593	$ 75,288	$ 75,810

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: Frederick Harris

Sponsoring Department: 565

Project Team (internal):

Project Team (external):

Project Description:

Participation in the EPRI Integration of DER research portfolio. Research covers tools and methods for planning and operating a more integrated distribution system in a changing landscape with increased penetration of Distributed Energy Resources (DER). Also included are valuation mechanisms for DERs and insights into utility interconnection practices and strategies related to future integration approaches.

PGE Budget/Actual:

FY19: $74,593

FY20: $75,288/75,288

FY21:

Cost Share Total: (if applicable)

Cost Share Percent:

Benefit to PGE:

Provides supporting documentation, workshops, and analytical tools regarding managing interconnection requests, grid control applications, and integration of DER.

Customer Benefit:

Provide pathway for more transparent information to the customer regarding feeder DER, hosting capacity, etc. Will lead to a more visible and configurable system that will be analyzed through future ADMS. Provides groundwork for future initiatives aimed at increasing system reliability.

Strategic Alignment:

Aligns strategies relating to hosting capacity via DRIVE. Will be key component in defining related DRP efforts. Addresses management of interconnection requests, and rules/regulations related to these requests. Reference documents provides insights relating to DER settings, operation, and protection.

Value

PGE Participation:	Value Derived:
Participated in general overview meeting with EPRI and internal stakeholders. Participated in conversations relating to soft benefits of incorporating DER readiness to distribution system. Was directed to related case studies incorporating added insight. Continue to perform hosting capacity analyses on demand via DRIVE tool. Evaluation of DRIVE will be incorporated in 2021 DSP. Leveraging available resources provides guidance in decision making process relating to DER integration.	Hosting Capacity is a major topic of interest in the DSP. Participation in the DRIVE user group and active use of the DRIVE tool will be incorporated in the DSP plan. Materials provide insight regarding inverter patterns, expectations due to heavy PV penetration, and guidance relating to voltage regulation.

Research & Development
EPRI Program Summary

Date: 04/26/2021

EPRI Program/Project Name: P-183 PDU Cyber Security

Project Status: Green

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: TBD

☐ Discontinued (reason) _____

Project Sponsor: Christian Nolke **Sponsoring Department**: 775 **Project Team (internal): Toley Clague** **Project Team (external): Galen Rasche** **Project Description:** Cyber and physical security have become critical priorities for electric utilities. The evolving electricity sector is increasingly dependent on information technology and telecommunication infrastructure to ensure the reliability and security of the electric grid. Specifically, measures to ensure cyber security must be designed and implemented to protect the electric grid from both cyber and physical attacks by terrorists and hackers, and to strengthen grid resilience against natural disasters and inadvertent threats such as equipment failures and user errors. The Cyber Security Program of the Electric Power Research Institute (EPRI) focuses on addressing the emerging threats to an interconnected electric sector through multidisciplinary, collaborative research on cyber security technologies, standards, and business processes.	**PGE Budget/Actual:** FY18: $91,691/$91,691 FY19: $95,642/$95,642 FY20: $95,913/$95,913 **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: EPRI's Cyber Security Program can provide the following benefits to members and the public: • A better awareness of industry and government collaborative efforts, where members can "plug in" to current activities;	**Strategic Alignment:** (Which PGE Corporate Imperative did this project address?) Electrify Operational Efficiency

• Guidance on developing cyber security strategies and requirements for selecting effective technologies; • Guidance on security metrics; • Techniques for assessing and monitoring risk; • Practical approaches to mitigating the risk of operating legacy systems; • Early identification of security gaps through laboratory assessments of security technologies; and • Technologies which support the management of cyber incidents and increase the cyber security and resiliency of the grid. **Customer Benefit:** EPRI allows PGE to offset research costs associated with cyber security activities. PGE spends less than $100,000 to gain knowledge through EPRI labs for testing security tools within a utility. It has also provided research on security tools and techniques are best with operational technologies. Customers benefit from these activities through reducing cyber security related events. They also benefit from the research as PGE continues to focus on securing the grid to ensure that is reliable and resilient.	

Value

PGE Participation:	**Value Derived**:
The P-183 project allows multiple organizations within PGE to work together. Currently we have representatives from numerous parts of Grid Architecture, Integration and System Operations, as well as Information Technology that are actively engaged in many of these projects. We are regularly engaged in meetings and are advisors on many of the projects that are associated with the projects under P-183. We attend technical meetings and advisory meetings that help shape the projects.	**OT Cybersecurity:** EPRI focuses on security challenges that affect multiple operations domains, such as designing security into products, creating security metrics for the electric sector, and developing technical solutions for meeting security compliance requirements. In 2020, EPRI: Incident Management and Threat Management: Technical solutions and guidelines to increase the capabilities and efficiency of incident and threat management tools and processes for power delivery systems. In 2020, EPRI:

	• Updated guidelines for implementing an Integrated Security Operations Center (ISOC) • Developed advanced monitoring and analytics platforms for recording and searching data for security events • Enhanced the cyber-attack scenario library for control centers and substations to include attack modeling and incident response playbooks • Developed ICS forensics analysis field guides for operational technology (OT) devices • Developed playbooks and technology highlights for security orchestration automation and response (SOAR) tools in the Cyber Security Research Laboratory (CSRL) • Developed methods to secure remote data and serially transmitted data Cyber Security for Transmission and Distribution Operations and Systems: Technical solutions and guidelines to improve the security posture of transmission and distribution systems. In 2020, EPRI: • Supported the expansion of utility remote access capabilities in response to public health guidance by tracking both policy and technology responses at member utilities • Coordinated with the DNP Users Group to accelerate the development of an authentication mechanism to secure critical systems from unauthorized control actions • Developed a methodology to assess how specific vendor solutions can be applied to demonstrate and maintain NERC CIP compliance • Leveraged past research and cross-program collaboration to develop a comprehensive approach to the secure management of substation devices Cyber Security for DER and Grid-Edge Systems: Security requirements, solutions, and reference architectures for the deployment and integration of distributed generation and grid-grid technologies. In 2020, EPRI developed and published: • Security Architecture for Microgrid Integration • "Smart Grid Hardware Security: Utility Procurement Guidelines, Reference Design for Secure Communication Module & Trusted Platform Module Demonstration" (Video) • Cyber Security Assessment of IEEE 2030.5 for DER Integration • Cyber Security Recommendation for California Rule 21 Implementation

	• Electric Vehicle eXtreme Fast Charging (XFC) Ecosystem: Cybersecurity Risk Assessment, System Architecture, and Recommended Controls • Cyber Security for Demand-Response Ready Buildings • EPRI also hosted the second annual EPRI DER Cybersecurity Workshop with industry stakeholders, including utilities, regulators, and academia. Cyber-Security Metrics: A common set of metrics that quantify the effectiveness of cyber-security operations. In 2020, EPRI developed and published: • EPRI Security Metrics Data Points Definitions and Data Collections Guide • OpenMetCalc V2 Guidebook and Workbook • EPRI also worked with three utilities to operationalize EPRI metrics through the Metrics Hub framework and established a Metrics Technical Working Group under the Metrics Advisory Council to facilitate industry engagement and adoption

Research & Development
Program / Project End Year Summary

Date: 11/18/2020

R&D Program/Project Name: EPRI P193B/206 Wind Generation

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI P193B Wind Generation Annual Research Program	Alex Triplett	$ NA	$ 123,773	$ 34,000

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Alex Triplett

Sponsoring Department: PSES

Project Team (internal): Alex Triplett, Greg Bingham, Scott Phares, Jesus Carrera

Project Team (external): Brandon Fitchett (EPRI), Raja Pulikollu (EPRI)

Project Description:

Participation in the EPRI Wind Program Annual Research Program.

PGE Budget/Actual:

FY20: $123,773/$123,773

FY21: $34,000

Cost Share Total: Leveraged funding is estimated to be 10 to 1 in 2021.

Cost Share Percent: NA

Benefit to PGE:

The objective this program is to reduce capital and O&M costs, increase capacity factors, and increase component reliability for wind turbine owners. Participation provides PGE the opportunity to stay informed of best practices for operating, monitoring, and maintaining a wind fleet.

Customer Benefit:

Wind plays a major role in PGE's vision for a clean energy future. It is important to take actions to make our wind fleet a reliable and cost-effective renewable generating resource for our customers.

Strategic Alignment:

This program is in alignment with PGE's corporate imperatives to Decarbonize and Perform.

Value

PGE Participation:	Value Derived:
- Generation Advisory Meetings, Feb 2020 - Generation Advisory Meetings, Sept 2020 - Wind Innovators Network (WIN) meetings with EPRI and other wind operators - Wind Component Reliability Database Webinars - Numerous 1-on-1 interactions with EPRI Wind staff to address opportunities specific to PGE	- Utilized predicted generator failure rates to budget/plan for 2021 maintenance. - Reviewed turbine operating data in an effort to identify leading indicators of a particular generator failure mode. - Reviewed specific gearbox failure modes with industry experts to identify methods for early detection and mitigation. - Reviewed blade structural design and health monitoring research to understand blade failure modes and best practices for health monitoring. - Put in contact with other program members who have similar turbine types and issues to share knowledge and best practices. - Reviewed technology assessments of wind turbine condition monitoring systems. - Ongoing participation in wind component reliability database to better understand expected major component reliability over the life of a wind turbine.

Research & Development
Program / Project End Year Summary

Date:

R&D Program/Project Name: EPRI P198

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
TITLE OF THE PROJECT: EPRI Strategic Sustainability Science (P198)	PROGRAM MANAGER: Caitlin Horsley	$ 50,276	$ 50,276	$ 50,276

- Year to be Completed: Ongoing

☐ Discontinued (reason) _____

Project Sponsor: Allegra Hodges

Sponsoring Department: Strategy Integration

Project Team (internal): Caitlin Horsley

Project Team (external): EPRI Staff

Project Description:

While PGE has invested in the development of our sustainability program and disclosure, like many other companies we have not fully realized the opportunity to optimize company decisions, inform public and stakeholder priorities, and engage on future customer, city, state, and federal sustainability-related initiatives. This program is designed to (1) develop the strategic tools and resources needed to embed a sustainability mindset into all electric power company operations and (2) create the forums where P198 members can collaborate and enhance the cross-sector dialogue with industry stakeholders who have an interest in sustainable electricity as we explore how the electric power industry can support a sustainable economy. This project is directly related to our decarbonization roadmap work for which Caitlin Horsley is now the lead.

PGE Budget/Actual:

FY19: 50,276

FY20: 50,276 /$50,276

FY21: 50,276

Cost Share Total: (if applicable)

Cost Share Percent:

Benefit to PGE: PGE's participation in this program provides us the tools and resources we need to execute on all three of our strategic imperatives: O Reduce greenhouse gas emissions by more than 80% by 2030: For many of our stakeholders, decarbonization and clean energy are synonymous with sustainability. Our engagement in P198 will help us to further define and drive a shared understanding with our stakeholders around what "sustainable electricity" means for us at PGE. O Increase electricity to 50% of total energy use by 2050: As applicable, the P198 program will assist with increasing electricity uses in our own and customer uses as it pertains to sustainability and decarbonization. For example, this research with help with the PGE Fleet Decarbonization Study outcomes and takeaways by strategically embedding them into the business with metrics, engagement and best practice information. O Deliver operational excellence and competitive financial returns: Research has shown how a commitment to sustainability can have positive impacts on corporate culture and employee engagement. This program will give us the resources we need to demonstrate PGE's sustainability commitment, not only enhancing the decisions we make as a company but also the environment that we foster for our employees every day. With decarbonization as a company imperative and sustainability at the core of PGE's Vision, Mission, and Values, becoming members of P198 provides us the opportunity to proactively address sustainability throughout our company and drive value not only for our company, but our stakeholders as well in service to decarbonization and our goal to reduce GHG emissions by more than 80%. **Customer Benefit:** This project further enables us to learn from our utility peers in the areas of sustainability, decarbonization	**Strategic Alignment:** PGE's participation in this program provides us the tools and resources we need to execute on all three of our strategic imperatives (decarbonize, electrify, and perform) as well as our purpose and climate goals.

and ESG to better meet our customers' ever-increasing expectations in this area.	

Value

PGE Participation:	**Value Derived**:
1. Sustainability value to the business and how to capitalize on that value in service to our decarbonization imperative and roadmap. 2. By joining P198, we will gain insights into how we may more-proactively engage our customers in the sustainability dialogue. 3. Previous sustainability projects/initiatives follow up for updates and context (including the 2014 Maturity Model for GHG (2018 EPRI Tech Transfer Award Winner) and the 2016 Priority Issues/Materiality Assessment)	• Learning from peers directly applied to defining and releasing our new Climate Goals (November 2020) • Participation has enabled our ability to participate in two assessment programs offered by EPRI (sustainability program assessment and priority sustainability issues assessment) which will directly benefit our internal sustainability strategy and roadmap as well as our external communications and reporting. Both assessments were kicked off in 2020.

Research & Development
Program / Project End Year Summary

Date: 9.Sep.2021

R&D Program/Project Name: EPRI Pandemic-Resilient and Sustainable Transmission and Distribution (T&D) Systems

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2020	Cost 2021	Cost 2022
EPRI Physical Security for Substations and T&D	PROGRAM MANAGER	$ 20,000	$ 20,000	$ 20,000

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: Bill Messner

Sponsoring Department: Health & Safety

Project Team (internal): Linda Keezer

Project Team (external):

EPRI SME's and other utility funders

Project Description:

This project aims to assess the near- and long-term impacts of COVID-19 and provide a rigorous technical basis for future pandemicresilient and sustainable T&D operations.

Key project focuses of this project include:

• Evaluating the efficacy of existing and new protocols and technologies and developing new or improved processes for health, safety, and disinfection for T&D applications

• Developing new processes and tools that enhance control center and field crew operations and asset management under normal and pandemic conditions

• Forecasting near-term electricity demand and deferred capital and maintenance work impacts, identifying potential operational reliability challenges, and specifying associated mitigation options

• Assessing the long-term economic impact on system demand and sustainability strategies including impact to generation capacity factors, emissions and pollution, and renewables deployment and curtailment

PGE Budget/Actual:

FY20: $20,000/20,000

FY21: $20,000

FY22: $20,000

Cost Share Total: $120,000

Cost Share Percent: Total project budget is about $7,000,000 which makes our cost share at 1.7%.

• Evaluate disinfectant processes, personal protective equipment (PPE), and health monitoring to enhance safe workspaces • Evaluate work processes and facility designs to enable safe, reliable, and efficient operations • Assess and prepare for future demand impacts and mitigate potential operating challenges. • Understand sustainability implications to decarbonization and renewable energy targets	
Benefit to PGE: Rarely do electric utilities around the world simultaneously face the same critical challenge as they are with the COVID-19 pandemic. This provides a unique opportunity to collaboratively develop a scientifically informed foundation for new T&D operations processes and technology applications that enable safe, reliable, affordable, and sustainable delivery of electricity under pandemic and nonpandemic circumstances. PGE is expected to receive the technical basis for evolving company-specific pandemic response plans and sustainability strategies to meet current and future needs. **Customer Benefit:** Having access to the latest collaborative processes and technologies to effectively operate in a pandemic environment will support PGE's mission of providing safe and reliable power to our customers.	**Strategic Alignment:** Perform – Delivering operational excellence

Value

PGE Participation: Participation in routine calls allows PGE health & safety personnel and operations staff to be involved with research on a deep technical level. Feedback from program participants is directly used to shape the content of ongoing research and provide input to our own plans.	**Value Derived**: Given the large participation from utilities across the globe, PGE will have access to the latest up to date research on COVID-19 protocols for electric utilities for a fraction of the actual research cost.

Research & Development
Program / Project End Year Summary

Date: 9.Sep.2021

R&D Program/Project Name: EPRI Physical Security

Project Status:

☒ Complete

☐ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI Physical Security for Substations and T&D	PROGRAM MANAGER	$ 0	$ 15,000	$ 0

- Year to be Completed: 2020

☐ Discontinued _____

Project Sponsor: Bill Messner

Sponsoring Department: Corporate Security

Project Team (internal): Wayne Svilar

Project Team (external):

EPRI SME's and other utility funders

Project Description:

This research seeks to enhance resiliency and reduce the potential of disruptions and/or damage by better understanding physical security and intentional electromagnetic interference (IEMI) events and the efficacy of mitigation and response options.

PGE Budget/Actual:

FY20: $15,000/$15,000

Cost Share Total: N/A

Cost Share Percent: Depends on the number of project funders, but typically is 10 to 20 times individual funding levels.

Benefit to PGE:

- Enhanced resiliency and security
- Protect assets and public and employee safety
- Increased understanding of component vulnerability to physical and IEMI attack
- Identify potential mitigation options and assess their effectiveness
- Improved awareness and decision making based on third-party, unbiased findings

Strategic Alignment:

Perform – Delivering operational excellence

Customer Benefit:	
This project supports the development of a safe and reliable electric grid. Understanding potential security issues will enable PGE to better manage those risks moving forward, which translates into greater electrical system resiliency for our customers.	

Value

PGE Participation:	**Value Derived**:
Participation in routine calls allows PGE security and engineering staff to be involved with research on a deep technical level. Feedback from program participants is directly used to shape the content of testing parameters.	EPRI provides detailed test plans, protocol and analysis of testing results through regular conference calls and PowerPoint presentations. Upon the completion of the program, a final report of findings will be published and provided to PGE. This report will assist PGE in developing a successful security strategy for future system upgrades.

Research & Development
Program / Project End Year Summary

Date:

R&D Program/Project Name:

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
TITLE OF THE PROJECT: EPRI Sustainability Assessment Services	PROGRAM MANAGER: Caitlin Horsley/ McKena Miyashiro	$ 0	$ $65,000	$ $45,000

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Brett Greene

Sponsoring Department: Strategy

Project Team (internal): Caitlin Horsley, McKena Miyashiro, Geoff Moore, Elysia Treanor, Peter Davis

Project Team (external): EPRI Staff

Project Description:

While PGE has invested in the development of our sustainability program and disclosure, like many other companies we have not fully realized the opportunity to optimize company decisions, inform public and stakeholder priorities, and engage on future customer, city, state, and federal sustainability-related initiatives. These assessment services will help to build a best in class sustainability program and related priority/material sustainability issues to align with increasing stakeholder expectations and allow the successful execution of PGE's updated sustainability and decarbonization goals.

PGE Budget/Actual:

FY19: 0

FY20: $65,000

FY21: TBD

Cost Share Total: (if applicable)

Cost Share Percent:

Benefit to PGE:

This work directly ties to PGE's decarbonization imperative and updated sustainability and

Strategic Alignment:

decarbonization goals. PGE's customers have expectations around the sustainability of our business and many of them have sustainability commitments of their own. Participation in this program demonstrates our commitment to sustainability as we seek to build business value while simultaneously acting as environmental stewards and corporate citizens in the communities we serve. These services will provide us with tools and recommendations in order to execute on our updated sustainability and decarbonization commitments while also directly answering to investor requests (specifically the Sustainability Priority Issue Assessment). **Customer Benefit:** This project further enables us to learn from our utility peers in the areas of sustainability, decarbonization and ESG to better meet our customers' ever-increasing expectations in this area.	PGE's participation in this program provides us the tools and resources we need to execute on all three of our strategic imperatives (decarbonize, electrify, and perform) as well as our purpose and climate goals.

Value

PGE Participation: 1. Investor requested Priority Sustainability Issues assessment will enable learnings for executing on our most priority issues while also communicating this important baseline work to our investors and other stakeholders. 2. The Sustainability Program assessment will enable us to set up a governance framework and other foundational elements to a program that is poised to successfully execute our sustainability and decarbonization commitments.	**Value Derived**: Assessments kicked off late 2020 so value will be realized in 2021.

Date: 02/10/2020

EPRI Program/Project Name: Educating Power Engineers for a Future Distribution Grid

Project Status:

☐ Complete

☒ Will Continue Next Year

- Engagement is on an annual basis and was renewed for 2021

☐ Discontinued (reason) _____

Project Sponsor: Jay Landstrom **Sponsoring Department**: R&D **Project Team (internal):** Jay Landstrom **Project Team (external):** EPRI Staff **Project Description:** EPRI | U for Transmission provides high-quality, foundational technical training for utility engineers and other transmission staff that work in assets, asset management, operations, and planning. The project includes a combination of training on demand, distance learning and face-to-face training geared toward engineers and technical staff..	**PGE Budget/Actual:** FY20: $10,000/$10,000 FY21: $10,000/$0 **Cost Share Total:** (if applicable) **Cost Share Percent:** 8.3%
Benefit to PGE: Provides PGE engineering staff access to the latest training on various topics that are critical to the development and continuing education of the technical staff **Customer Benefit:** Customers benefit by PGE having a highly trained workforce to implement and maintain the electrical grid.	**Strategic Alignment:** Perform

Value

PGE Participation:	**Value Derived**:

Courses are a mixture of Computer based, On-demand and traditional classes. Employees sign up and attend through the EPRI LMS system	Training of new and seasoned engineers and technical professionals

Research & Development
Project Summary

Date: 5/19/2021

Project Name:

Customer Flexible Load Resource at Scale

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Jason R. Salmi Klotz, Tim Treadwell

Sponsoring Department: Grid Products and Integration

Project Team (internal): Tim Treadwell, Blair Hasler

Project Team (external):

Project Description:

Opportunity to understand the flexible load capabilities and benefits or value streams of grid enabled water heaters at scale while also testing and validating the operational sustainability of various device communication approaches; LAN (Wi-Fi), LTE and NAN. (Water heaters are a major resource in our decarb plan). Opportunity to understand the role and capabilities of PGE's Neighborhood Area Network and vet the communication stability of LAN and LTE to communicate and utilize an at scale flexible resource pursuant to PGE's integrated grid vision. Proposal is to saturate a feeder within the SGTB with grid enabled or "smart" water heaters. This work would likely be deployed in conjunction with BTM battery deployment per UM 1856. The project would be coordinated within PGE's Test Bed project to maximize the affect, lessons to be captured, efficiency of activity and dollars spent. The project would leverage ETO's heat pump water heater incentive and a pilot PGE demand response HPWH incentive combined with money spent here to offer at lowest possible cost purchase and installation of HPWH to single family home customers on a targeted feeder within the Test Bed. Lessons to be learned: (1) Communication infrastructure usability and stability. (most BTM devices will be LAN likely aggregated and orchestrated through third party) (2)

PGE Budget/Actual:

FY19: $15,000/$0

FY20: $92,000/$92,000

FY21: $10,000/

Cost Share Total:

Cost Share Percent

Distribution operation impacts of a concentrated flexible load asset; (3) Benefits and value streams to the local distribution network; (4) Communication and dispatch issues when attempting to integrate such resources into our NAN; (5) Energy services and values identification; (6) PGE's ability and operational gaps when operating such a resource; (7) How to engage single family households around flexible load (not entirely equal to DR); (8) How to successfully electrify water heating loads.	
Benefit to PGE: This is in part an effort to develop and understand a positive customer experience and journey when we deploy and seek to acquire significant amount of flexible load. The concentration of a grid enabled customer resource (flexible load) will help us better understand the challenges of making our integrated grid interoperable. We'll also learn through in-field testing the value and costs of operating a flexible resource "at scale" on the distribution system. By coordinating internally and externally we demonstrate to all internal and external stakeholders our pursuit for excellence in our work. This is an opportunity to vet and optimize our FAN and ADMS for DER optimization. **Customer Benefit:** Customers within the project will receive at significantly reduced cost a smart grid enabled energy efficient water heater. The project will benefit all customers by advancing our understand of the value of such a resource and its ability to offset the need to build a more traditional supply side natural gas asset. This will help us understand the challenges of using water heater as balancing resources or as a resource to address local distribution operations such as voltage and frequency. The project will lend insight into peak demand reductions employed in concert with the additive service of renewable integration. The project will enable us to learn more about utilizing our FAN and ADMS for the purpose of making operational DERs for various gird services. This is an internal communications project which should help us identify operational shortcomings, if any, of our FAN and ADMS for DER operations. This approach should save ratepayer investment.	**Strategic Alignment:** ☒Deliver exceptional customer experience ☒Invest in a reliable and clean energy future ☒Build and operate a smarter, more resilient grid ☒Pursue excellence in our work

Summary

Synopsis of Project as Implemented:

The project has experienced a number of challenges and setbacks since implementation began. Most notably is the impact of COVID, which has limited our ability to effectively engage and recruit customers, as well as the global chip shortage which has extended timelines and delivery dates for manufacturing of the universal communications module (UCM) hardware. Despite these issues, the project has been steadily progressing.

The project team has contracted with Apricity for the design and manufacture of 50 CTA-2045 UCMs, which allow for utility dispatch commands to be passed from the DERMS to participating water heaters. We have experienced a number of engineering issues associated with the UCM power supply, which are currently under investigation. Final delivery of the UCMs is now scheduled to occur in late May. The team also contracted with VirtualPeaker (VP) to complete integrations into their DER controls platform. These integrations are underway. L+G was engaged to design and install an RF mesh network in the N. Portland portion of the SGTB. The network and associated software were fully commissioned in late April and is now being used to field test the UCMs.

On the participant recruitment side of the project, the team has been activity engaging customers since late Q1. More than a dozen wifi water heaters have begun commissioning in VP and outreach to additional customers is underway. The team is also recruiting customers into the mesh portion of the pilot, with a goal of 30 customers. LTE customer recruitment has not yet begun, due to the team's focus on the mesh issues. We anticipate recruiting LTE customers in early Q3.

Performance Against Objectives/Deliverables:

Project objectives and deliverables are primarily focused on the testing of communications and equipment performance. The project's progress to date has not allowed for this testing to occur; however, we are gaining valuable insights into customer recruitment strategies, issues with existing wifi product offerings from water heater OEMs, and hardware/software challenges that will face any fullscale implementation of a single family water heater DR program.

Decisions to be Made:

The team anticipates challenges identifying and recruiting existing CTA-2045 water heater customers into the LTE portion of the project and may collaborate with a local water heater contractor to provide spiffs for enrolling new units into the program.

Next Steps:

The next steps on the project is to complete trouble shooting of the UCM power supply issue, enabling dispatch of the mesh water heaters. The team is also finalizing the water heater dispatch plan and communications testing plan. Following completion of these documents, the team will recruit and enroll LTE customers and begin implementing the testing plan.

Research & Development
Program / Project End Year Summary

Date: 04/14/2021

R&D Program/Project Name: FlowTech Water system

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
FlowTech Water Systems	PROGRAM MANAGER	$ 0	$ 157,000	$ 0

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Mark White

Sponsoring Department: N/A

Project Team (internal):

- **Mark White – Plant & Operations Manager, Port Westward**
- **Austin Curtis – Maintenance Manager, Port Westward**
- **Charles Linder – Senior Env. Specialist**

Project Team (external):

- **Gary Post – Sales Engineer, FlowTech**
- **Greg Itoh – Itoh Water**

Project Description:

FlowTech Water Systems has a chemical free water treatment system that reduces hardness scale, corrosion and inhibits bacteriological growth. The system uses low bandwidth AM radio waves to alter water chemistry and force hardness minerals out of solution and into a soft sludge that collects in the cooling tower basin. The radio waves also damage cell walls in bacteria which cause cells to spend time repairing themselves instead of reproducing thus preventing biological slime growth. FlowTech is willing to a trial at the Port Westward Generating Station on the cooling tower. PGE would set the parameters of

PGE Budget/Actual:

FY19: $146,000 / $0 project postponed until 2020
FY20: $157,000 / $157,000
FY21: $0 / $0

Cost Share Total: N/A

Cost Share Percent: N/A

what a successful trial would look like. FlowTech would require PGE to purchase the equipment upon the successful completion of the trial. If the trial is successful, we could then use this technology at other power plants. By far, the largest chemical spend at any plant is for cooling tower chemicals and in 2017 it ranged from about $112,000 to $177,00. A non-chemical treatment would show a very large reduction in chemical spend.	
Benefit to PGE: Could potentially remove water tower treatment chemicals from generations sites, saving $250,000 - $300,000 per year in chemical costs and minimizes possibility of violating NPDES permits and allows for non-chemical treatment to extend the life expectancy of valuable PGE assets. **Customer Benefit:** PGE's customers would see PGE using a greener technology to maintain valuable plant assets and a reduction in operating costs.	**Strategic Alignment:** ☐Deliver exceptional customer experience ☒Invest in a reliable and clean energy future ☐Build and operate a smarter, more resilient grid ☒Pursue excellence in our work

Value

PGE Participation: The FlowTech system has been in service in parallel with NALCO's cooling water treatment system. A plan is currently in place to begin lowering NALCO's cooling water treatment chemicals once it has been determined that there have not been detrimental effects to the circulating water system.	**Value Derived**: The long-term evaluation is still underway. We will continue quarterly corrosion coupon evaluations to understand whether the system can maintain corrosion prevention. During the 2021 Port Westward 1 outage we will also perform cooling tower fill material weighing to determine whether any excess scaling has occurred during the time that the FlowTech system has been in service. During the outage, we will also make visual observations to the steam turbine condenser tubes to ensure that no scaling or organic growth has fouled tube passages.

Research & Development
EPRI Program Summary

Date: 03/23/2021

EPRI Program/Project Name: Educating Power Engineers for a Future Distribution Grid

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Jay Landstrom **Sponsoring Department**: R&D **Project Team (internal):** Jay Landstrom **Project Team (external):** EPRI Staff **Project Description:** The GREAT with Data initiative will develop and deliver T&E materials (both professional and university training) to address issues for merging Grid Operations Technology (OT) and Information Technology (IT). The central theme is to create necessary T&E activities for the next generation power engineers and data scientists, so they can design and develop the grid architecture and infrastructure to enable the integration of distributed energy resources (DER). The project will train, educate, and recruit qualified personnel into the electric utility industry through enhanced industry coordination and workforce readiness initiatives. New and revised university curricula will prepare incoming engineers and computer scientists for the newly evolving grid architecture and infrastructure. Further, this project will develop credentials for the training and education needed in the electric industry workplace to transform the grid.	**PGE Budget/Actual:** FY20: $10,000/$10,000 FY21: $10,000/$0 **Cost Share Total:** (if applicable) **Cost Share Percent:** 8.3%
Benefit to PGE: The GREAT with Data initiative will address T&E for workforce skills in five key technical areas: 1. Power system fundamentals;	**Strategic Alignment:** Decarbonize Electrify

2. Data science, including descriptive, prescriptive, and predictive analytics, and machine learning; 3. Cyber security; 4. Information and communication technologies (ICT) including increased grid interoperability and standardization; and 5. Integration of solar photovoltaic (PV) and other synergistic distributed energy resources (DER) such as energy storage, electric vehicles, demand response (DR), etc. Access to this training will help PGE up-level the skills of current and new employees to meet the challenges of the emerging grid. **Customer Benefit:** Customers benefit by PGE developing a smarter grid that will enable greater amounts of DER's.	

Value

PGE Participation:	**Value Derived**:
Attending advisory meetings in the Spring and Fall. Named affiliate universities to participate, PSU and OSU.	Affiliate universities gain access to all educational materials. PGE has access to all materials in addition to a limited number of free spots to attend training seminars on emerging smartgrid topics.

Research & Development
Program / Project End Year Summary

Date: 9.Sep.2021

R&D Program/Project Name: HD Charging Infrastructure O&M Strategy and Training

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2020	Cost 2021	Cost 2022
HD Charging Infrastructure O&M Strategy and Training	PROGRAM MANAGER	$ 100,000	$ 100,000	$ 100,000

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: Andy Eiden

Sponsoring Department: Grid Edge Solutions

Project Team (internal): Andy Eiden, Joe Colett

Project Team (external):

Daimler Trucks North America (DTNA), PNNL, PSU

Project Description:

PGE plans to support transportation electrification by ensuring there is adequate infrastructure in place for customers' fueling needs across a variety of use cases. Significant activity has taken place to understand the LDV market dynamics and associated needs. However, there is a gap in knowledge related to emerging medium-duty (MD) and heavy-duty (HD) vehicles and fleets. This research will help fill this gap by detailing various data and operational needs of MDHD vehicle charging infrastructure and related internal PGE infrastructure planning processes.

PGE Budget/Actual:

FY20: $100,000 /100,000

Cost Share Total: Not available

Cost Share Percent: DTNA is contributing over $5 million towards equipment procurement and installation at the demonstration site and will also be funding general operations and maintenance activities (land lease, site maintenance, etc.) for up to 10 years. DTNA's funding would include charging infrastructure software licenses, communications, property and building maintenance, site security, and energy costs. PGE's funding will focus on charging infrastructure operations and maintenance plan development and deployment for three years. After the end of the project, PGE may offer these services for a fee to DTNA and other customers (this could be similar to the services that PGE offers TriMet for bus charging infrastructure operations and maintenance).

The project will also allow coordination and collaboration with PNNL's Electricity Infrastructure Group and partner with them for their ongoing internal lab-directed R&D effort to develop a methodology for placement and operation of smart, grid-friendly charging infrastructure.

PNNL aims to work on developing a conceptualization of the optimization problem, and in so doing PGE will be able to contribute to cutting-edge DOE-supported

	research and position ourselves to continue learning the nuances of this emerging market with a leading-class research group. The PNNL project has cost-share in terms of in-kind staff support to transmit knowledge and explore solution sets iteratively with a utility partner. PGE will in turn have the opportunity to contribute funds or in-kind support for the current effort and future, larger lab calls to attract much larger pots of DOE funds. At the very least, providing PGE distribution topologies and data will help tailor the development of this joint co-optimized model for optimal EV infrastructure siting.
Benefit to PGE: The proposed project will help facilitate customer adoption of MHDVs in PGE service territory by lowering or eliminating barriers to adoption of zero-emission vehicles related to utility planning processes, new load analyses, distribution impact and siting studies, and ongoing charger O&M needs. In addition, this project will help PGE learn the skills required to operate and maintain extreme fast charging equipment and determine if these services can be profitably offered to other customers. PGE's ability to operate and maintain electric vehicle fueling infrastructure also helps improve reliability and access for customers that depend on electricity as a transportation fuel, improves safety by keeping equipment well maintained, and enhances customer service by limiting equipment downtime. Lastly, this project will help deliver operational excellence for our customers by providing the distribution planning team and the customer outreach team with additional tools to vet upgrade alternatives, proactively identify locations on the grid that can accommodate different levels of EV charging at different speeds, and allow for development of a future self-service interface where customers can weigh costs/benefits of locating their MHDV charging depots at different potential locations. **Customer Benefit:** More modernized planning tools and processes will allow PGE utility experts to integrate and manage customer lever DER's to benefit both the customer and enhance grid reliability.	**Strategic Alignment:** Perform – Delivering operational excellence Decarbonize Electrify

Value

PGE Participation:	Value Derived:
Multiple technical experts within PGE will participate in the project to ensure the following deliverables are met: Deliverables for the DTNA portion: 1. Draft extreme fast charging operations and maintenance strategy and standard operating procedures. 2. Draft Extreme fast charging operations and maintenance strategy 3. Mid-project report 4. Final strategy and standard operating procedure. 5. End-of-Pilot report and recommendation. Deliverables for the PSU portion: 1. Monthly check in meetings with PGE and PSU project team. 2. Coordination with PNNL as identified by parties. 3. Python and CYME scripts with annotations 4. Final report documenting recommendations, key findings, and next steps to integrate with PGE tools and planning processes.	1. Develop knowledge and skills necessary to operate and maintain extreme fast charging infrastructure, integrated energy storage systems, and on-site generation, including a data collection plan to integrate load profile and operations data from these charging assets into internal planning and reporting dashboards. 2. Create a strategy and determine the feasibility of offering operations and maintenance services to other customers, and understand steps required to extrapolate and apply lessons learned on MDHD grid impacts to entire distribution network. 3. Leverage real-world learnings from site operations to better understand service and maintenance needs and improve distribution planning modeling within CYME to evaluate tradeoffs in customer site-designs (e.g., presence of DERs or location) with respect to potential grid impacts.

Research & Development
Program / Project End Year Summary

Date: 9.Sep.2021

R&D Program/Project Name: Hydrogen Electrolyzer Feasibility Study

Project Status:

☒ Complete

☐ Will Continue Next Year

		Cost 2020		
Hydrogen Electrolyzer Feasibility Study	PROGRAM MANAGER	$ 50,000		

- Year to be Completed:

☐ Discontinued (reason) _____

Project Sponsor: Andy Macklin **Sponsoring Department**: Grid Products & Integration **Project Team (internal):** Andy Macklin, Brent Olsen **Project Team (external):** **National Renewable Energy Laboratory:** Alex Badgett, William Xi, Mark Ruth, Kevin Harrison, Nancy Dowe **Project Description:** This project produced a feasibility analysis of the suitability of the Boardman site for production of Hydrogen via electrolysis. PGE believes the site is well-suited for such use given availability of land, water rights, gas pipeline, proximity to transmission, proximity to renewables generation, proximity to hydro generation, and proximity to transportation routes such as I-84 and the Columbia River. Hydrogen is considered a renewable fuel and would contribute to PGE's decarbonization efforts. The feasibility analysis considered technical and economic aspects of production and uses relative to the Boardman site.	**PGE Budget/Actual:** FY20: $50,000 /$50,000 **Cost Share Total:** N/A **Cost Share Percent:** Depends on the number of project funders, but typically is 10 to 20 times individual funding levels.
Benefit to PGE: This project will give PGE a sense of whether hydrogen electrolysis would be advantageous to pursue at the Boardman site. This has the potential of creating new revenue streams and benefitting from a carbon market (should one exist in the future), leveraging existing assets, and assisting in the decarbonization of PGE's energy supply.	**Strategic Alignment:** Perform Decarbonize Electrify

Customer Benefit: Further potential to decarbonize PGE's resource mix and leverage low cost renewable energy to reduce customer costs.	

Value

PGE Participation:	**Value Derived**:
PGE subject matter experts will engage with NREL staff to help develop the study	A final report with the following deliverables: • Analysis of hydrogen demands in nearby industrial systems and transportation • Initial economic analysis of hydrogen production via PEM electrolysis at Boardman and pathways for hydrogen storage and injection into natural gas pipelines • Review of PEM electrolysis system costs and future expectations for system capital costs and performance • Resource assessment of existing biogas streams for use in biomethanation systems near the Boardman site.

Research & Development
Project Summary

Date: 03/23/2021

Project Name: EPRI Incubatenergy Labs

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: 2020, Renewal is on a yearly decision basis

☐ Discontinued (reason) _____

Project Sponsor: Jay Landstrom **Sponsoring Department**: R&D **Project Team (internal):** Jay Landstrom, Darren Murtaugh, David Worth, Larry Bekkedahl, Jake Wise, Aaron Milano, Andy Macklin **Project Team (external):** EPRI **Project Description:** Incubatenergy® Labs is built for startups to engage utilities in paid demonstration projects. A utilities summit and collaborative demonstrations program in one, the program links startup companies leading the advancement of electrification, decarbonization and grid modernization with utilities from around the world. Innovative companies are encouraged to submit products and projects from selected areas of interest in: • Customer and Community Engagement • The Digital Utility • Integration of Distributed Energy Resources • Electric Mobility • Customer and Community Resilience • Workforce of the Future	**PGE Budget/Actual:** FY19: $50,000 FY20: $50,000$50,000 **Cost Share Total:** $50,000 **Cost Share Percent:** Approximately 10% Costs are shared between participating utilities: American Electric Power (AEP), Con Edison, Edison International, Enel, Nebraska Public Power District, New York Power Authority, Portland General Electric (PGE), Xcel Energy, Ameren, Tennessee Valley Authority (TVA), and Southern California Edison (SCE)
Benefit to PGE: PGE will have access to and engage with cutting edge companies that will shape the next generation electrical grid.	**Strategic Alignment:** Perform and Customer Satisfaction

Customer Benefit:	
Many of the new technologies in this effort are directed directly at the customer. As these technologies become more available PGE could offer them to customers to enhance their interaction with the grid.	

Summary

Synopsis of Project as Implemented:	**Decisions to be Made**:
PGE participated in the review and selection of companies that were chosen to develop demonstration projects with participating utilities. The finalists were: • **Kognitiv Spark** (Fredericton, New Brunswick , Canada) – Augmented reality-enabled app to help utility workers learn new skills on the job. • **Switched Source** (Vestal, N.Y.) – Power electronics based distribution-automation solutions to help manage distribution system load and improve power quality. • **RWI Synthetics** (Edmonton, Alberta, Canada) – AI-driven intelligent systems modeling tool to help grid planners with scenario planning and distributed energy resource integration. • **Sharc Energy Systems** (Port Coquitlam, British Columbia, Canada) – Multifamily building wastewater heat recovery systems. • **ev.energy** (Palo Alto, Calif.) – Wireless platform that optimizes electric vehicle charging to save customers money, fully utilize renewable energy, and delivers an alternative to expensive grid upgrades. • **IND Technology, Inc.** (New York, N.Y.) – Technology that detects electrical faults before they occur, which could prevent power losses, wildfires, and other consequences. • **PingThings** (El Segundo, Calif.) – Artificial intelligence platform that processes, stores, and uses high-definition sensor data from across the electric power system in real-time, at grid scale. • **Recurve** (Mill Valley, Calif.) – Software as a Service tool that analyzes how to use energy more efficiently and effectively in response to cost, carbon reduction, and other customer data. • **LineVision** (Somerville, Mass.) – Non-contact, overhead line sensor technology that	PGE is implementing a pilot project with IND Technology to install their Early Fault Detection System on the high wildfire risk feeders on Mt Hood. **Next Steps:** Participation for the 2021 program was approved.

provides situational awareness, asset health monitoring, and increases capacity. • **GridFruit** (Pittsburgh, Pa.) – Grid-responsive scheduling of machine cycles to provide demand management and flexibility from commercial foodservice refrigeration systems. **Performance Against Objectives/Deliverables:** The Project delivered the final demonstration results in October 2020.	

Research & Development
2020 Year End Summary Proposal for OIT Study

Date: 04/16/2021

Investigation on Transient and Steady State Behavior of Microgrids Before, During and After Islanding in Terms of Frequency and Voltage

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh **Sponsoring Department**: RC509 **Project Team (internal): Manny Obi** **Project Team (external): Eklas Hossain (OIT)** **Project Description:** In the proposed work, a detailed literature will be prepared to investigate the present condition of various types of microgrids. The factors to establish the microgrid parameters and well-defined boundaries will be extensively studied. The transient and steady state response of the system in terms of frequency and voltage for pre-islanding, during islanding and post-islanding conditions are to be observed. Moreover, the effect of under and over frequency or voltage on the microgrid and utility grid will be experimented. Several case studies with grid support, peak load shedding, peak shaving, load shifting, and voltage or frequency support will be observed.	**PGE Budget/Actual:** FY20: $50,000 / 50,000 FY21: $50,000 / 50,000 **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: Research into microgrid behavior before, during, and after islanding will support PGE's transition to cleaner energy. **Customer Benefit:** A better understanding of microgrid boundaries would support future PGE projects providing resiliency and reliability as a service to customers by reducing risk costs through outage mitigation.	**Strategic Alignment:** (Which PGE Corporate Imperative did this project address?) Decarbonize

Value

PGE Participation:	Value Derived:
Monthly meetings with OIT, provide technical guidance and PGE CYME models.	Microgrids with energy storage systems in addition to the reliability and resiliency benefits during islanded mode can also provide benefits while grid-connected such as bulk energy to be dispatched during peak demand, ancillary services (i.e. regulation, load following, spinning reserves, voltage support, and black start), and potential distribution equipment deferral. A final presentation and formal report from OIT of the project findings and recommendations for microgrid implementation.

Research & Development
Program / Project End Year Summary

Date: 9.Sep.2021

R&D Program/Project Name: EPRI Modernizing Distribution Planning using Automated Processes and Tools Level 1

Project Status:

☒ Complete

☐ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI Modernizing Distribution Planning using Automated Processes and Tools Level 1	PROGRAM MANAGER	$ 9,977	$ 30,023	

- Year to be Completed:

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh

Sponsoring Department: T&D Planning

Project Team (internal): T&D Planning

Project Team (external):

EPRI SME's and other utility funders

Project Description:

New processes, methods, and tools are needed to meet the challenges of tomorrow's distribution system planning. Future planning tools must provide a comprehensive, efficient, flexible, and integrated approach to planning the distribution system. This project seeks to develop, test, and demonstrate a new planning and evaluation method that enables more holistic and integrated distribution planning and informs no regrets, prioritized decision making for grid modernization investments.

PGE Budget/Actual:

FY20: $40,000

Cost Share Total: N/A

Cost Share Percent: Depends on the number of project funders, but typically is 10 to 20 times individual funding levels.

Benefit to PGE:

• Collaborate with industry to identify gaps to meet future planning objectives and enhance distribution planning processes
• Develop a flexible and comprehensive planning process
• Develop prototype planning tool
• Test, refine, and validate new planning process with utility use cases.

Strategic Alignment:

Perform – Delivering operational excellence
Decarbonize

Customer Benefit:	
More modernized planning tools and processes will allow PGE utility experts to integrate and manage customer lever DER's to benefit both the customer and enhance grid reliability.	

Value

PGE Participation:	**Value Derived**:
Participation in routine calls allows PGE engineering staff to be involved with research on a deep technical level. Feedback from program participants is directly used to shape the content of testing parameters and shape the development of new planning tools.	EPRI provides detailed test plans, protocol and analysis of research results through regular conference calls and PowerPoint presentations. Upon the completion of the program, a final report of findings will be published and provided to PGE. This report will assist PGE in developing a successful strategy for future planning system studies that involve new generation and load types.

Research & Development
Project End Year Summary

Date: 03/05/21

R&D Program/Project Name: Northwest End Use Load Research (EULR)

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: 2022/2023

☐ Discontinued (reason) _____

Project Sponsor: Andy Eiden

Sponsoring Department: Smart Cities & Grid Products (formerly Consumer Energy Solutions)

Project Team (internal):

- Andy Eiden, Steering Committee Member
- Ashleigh Keene, Working Group Member

Project Team (external):

- David Clement, NEEA, Project Manager
- Residential vendor, Evergreen Economics
- Commercial vendor, DNV
- Steering Committee, various participants
- Working Group, various participants

Project Description:

The End Use Load Research (EULR) Project is a collaborative effort of utilities and energy organizations to better understand behind-the-meter consumption patterns of residential and commercial buildings in the Northwest. Managed by the Northwest Energy Efficiency Association (NEEA), the primary goal of the project is to produce typical hourly load shapes for a range of end uses using circuit-level meter data. Project results will update industry-standard end use profiles developed in the 1980s

One-minute data is collected continuously over a five-year period and is accessible project funders. Aggregated data will eventually be made available for public use. Detailed end use data has several important uses for PGE, including informing our deep decarbonization planning, demand response planning, bottom-up forecasting, and rate design.

PGE Budget/Actual:

2018: $130,000
2019: $130,000
2020: $130,000/$130,000
2021: $130,000
2022: $130,000
Total: $650,000

Cost Share Total:

The total 5-year budget for the project is $12.7 million, of which PGE is contributing $650k. The remaining budget will be covered by the other member utilities as well as regional stakeholders such as the Energy Trust and BPA, and the US Department of Energy.

Cost Share Percent:

PGE's share of the total 5-year project budget is 5%.

Benefit to PGE:

The data collected as part of this study will be a critical input as we take on a more distributed view of planning and resource deployment. The end use load data will inform the deployment, forecasting, and analysis of deep decarbonization measures on our grid. It will also improve our ability to conduct granular, bottom-up load forecasting to inform distribution resource planning efforts.

Customer Benefit:

Research from this project will help PGE better plan and develop programs that fit customer lifestyles and meet their desire for clean, reliable energy.

Strategic Alignment:

This research project is an example of PGE's commitment to investing in a reliable and clean energy future, and building and operating a smarter, more resilient grid. Underlying both strategic initiatives is a detailed, empirical understanding of how our customers use electricity so that we can develop accurate forecasts and effective demand response programming.

Collaborating with regional partners to improve shared data sources and increase our understanding of behind-the-meter consumption patterns is also evidence of PGE's drive to pursue excellence in our work.

Value

PGE Participation

While Covid-19 impacts put additional metering installations on hold after March 2020, the project moved forward with decisions and scoping for analytical deliverables from project implementers. Specifically, the working group recommended that the residential study not to attempt a data normalization process to align energy consumption patterns pre- and post-Covid-19 due to systemic shifts that are expected to hold (eg, remote office workers).

Instead, the working group has recommended that the study move to:

1) Leverage participant surveys to provide context to notable changes in end use energy patterns to better understand how residential consumptions patters have changed during the pandemic and what changes might stay, and
2) Align whole home energy usage impacts with end use data to develop a disaggregation model.

Value Derived Performance Against Objectives/Deliverables:

Steering Committee member Andy Eiden was able to leveraged the 1-minute residential data for some additional work with two national labs, NREL and PNNL, the latter of which resulted in a $60,000 award to PGE for contributing data to a machine learning approach to solar load disaggregation.

A primary goal for the PGE project team in 2021 is to work with Load Research and IT to bring in and process the available meter data for internal uses, such as model training, forecast improvements, and demand response learnings, among others.

Research & Development
Program / Project End Year Summary

Date: 4/2021

R&D Program/Project Name: 161F – Next Gen Meter Vision and Criteria

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
TITLE OF THE PROJECT "Next Generation Smart Meter Vision and Criteria"	PROGRAM MANAGER	$	$ 12,500	$ 25,000

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: David Worth **Sponsoring Department**: RC712 DCIO Smart Grid **Project Team (internal):** Erik Cederberg, Kirk Page, Bob Simpson, Jay Landstrom, Jonathan Wilson **Project Team (external):** EPRI – Ed Beroset **Project Description:** Consortium of utilities looking to align on the vision for next gen metering solutions to inform strategy and vendor / market trajectory (more detail in proposal)	**PGE Budget/Actual:** FY20: $12,500/$12,500 FY21: $25,000 **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: Informing the market is critical to achieve corporate objectives targeting direct customer and operational outcomes. Metering is a significant financial cost **Customer Benefit:** Earlier realization of vision by driving the market. Shared R&D work partnering with other utilities with a good planning structure helps manage costs.	**Strategic Alignment:** Metering is a key technical component in achieving critical use cases within PGE's long-term imperatives of decarbonize, electrify, and perform. Metering capabilities are a key constraint in offerings to customers and operations.

Value

PGE Participation:	**Value Derived**:

EPRI meetings and workshops	- Understanding of emerging technologies - Information on vendor strategies - Forcing function to advance PGE planning - Hearing perspective from industry SME's both as utility stakeholders and external advisors - Networking

Research & Development
2020 Year End Summary – OIT Second Life Battery

Date: 04/16/2021

Oregon Institute of Technology Second Life Battery

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh **Sponsoring Department**: RC509 **Project Team (internal): Manny Obi** **Project Team (external): Eklas Hossain (OIT)** **Project Description:** Knowledge of second life battery cycle life will enable PGE to successfully plan and deploy Second Life Battery Energy Storage Systems (SLBESS). This will provide a significant cost benefit and allow PGE to be on the forefront of a changing grid system, using energy storage to facilitate integration of renewables while minimizing reserve generation. The Project will construct a 250kW/1000kWh test pack for real world testing at the Oregon Renewable Energy Center (OREC at Oregon Tech) and in a PGE facility. Four battery packs will be prepared with different State of Charge (SOC), varying from 40% to 80%. Two packs will be used for determining battery cycle life and two packs will be used for system management development. Analysis will be performed on the SOC%, capacity, life cycle, efficiency, charge-discharge, and reaction time. The tabulated data will be used to determine the cycle life of different battery types. After simulation, the battery management system hardware will be developed.	**PGE Budget/Actual:** FY20: $30,000/$30,000 **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: Development of a battery management system will allow PGE to effectively deploy second life batteries for renewable energy integration and grid resiliency. **Customer Benefit:** PGE customers will benefit from PGE's ability to repurpose second life batteries and minimize recycling cost.	**Strategic Alignment:** (Which PGE Corporate Imperative did this project address?) Decarbonize

Value

PGE Participation:	**Value Derived**:
Webinars, twice-annual advisory meetings, and access to web portal	PGE shall be presented with a final report that will compile the team's findings, including life cycle analysis, comparisons between first-life and second-life batteries, estimation models, battery management system configurations, and suggestions for how to proceed/opportunities to be sought for further research/investigation regarding second-life batteries.

Research & Development
2020 Year End Summary Proposal for OIT Study

Date: 04/16/2021

Investigation on Transient and Steady State Behavior of Microgrids Before, During and After Islanding in Terms of Frequency and Voltage

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh **Sponsoring Department**: RC509 **Project Team (internal): Manny Obi** **Project Team (external): Eklas Hossain (OIT)** **Project Description:** In the proposed work, a detailed literature will be prepared to investigate the present condition of various types of microgrids. The factors to establish the microgrid parameters and well-defined boundaries will be extensively studied. The transient and steady state response of the system in terms of frequency and voltage for pre-islanding, during islanding and post-islanding conditions are to be observed. Moreover, the effect of under and over frequency or voltage on the microgrid and utility grid will be experimented. Several case studies with grid support, peak load shedding, peak shaving, load shifting, and voltage or frequency support will be observed.	**PGE Budget/Actual:** FY20: $50,000 / 50,000 FY21: $50,000 / 50,000 **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: Research into microgrid behavior before, during, and after islanding will support PGE's transition to cleaner energy. **Customer Benefit:** A better understanding of microgrid boundaries would support future PGE projects providing resiliency and reliability as a service to customers by reducing risk costs through outage mitigation.	**Strategic Alignment:** (Which PGE Corporate Imperative did this project address?) Decarbonize

Value

PGE Participation:	Value Derived:
Monthly meetings with OIT, provide technical guidance and PGE CYME models.	Microgrids with energy storage systems in addition to the reliability and resiliency benefits during islanded mode can also provide benefits while grid-connected such as bulk energy to be dispatched during peak demand, ancillary services (i.e. regulation, load following, spinning reserves, voltage support, and black start), and potential distribution equipment deferral. A final presentation and formal report from OIT of the project findings and recommendations for microgrid implementation.

Research & Development
Program / Project End Year Summary

Date: 12/9/2020

R&D Program/Project Name: Partitioning studies of the PGE network for synchrophasor, microgrid, and static/dynamic voltage analysis

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
Partitioning studies of the PGE network for synchrophasor, microgrid, and static/dynamic voltage analysis	PROGRAM MANAGER	$ 30k	$ 30k	$ 30k

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: Ian Beil

Sponsoring Department: Transmission Planning

Project Team (internal): Ian Beil, Jennifer Galaway

Project Team (external): Eduardo Cotilla-Sanchez (OSU)

Project Description:

Advance protection of the next generation power transmission and distribution infrastructure. With assistance from the growing PMU network at OSU, a composite dynamic load model can be estimated in real time and provide useful insight into the design of microgrid protection schemes. This will address challenges such as reverse flows, automatic reclosing, or delayed relay tripping.

PGE Budget/Actual:

FY19: $30k/$30k
FY20: $30k/$30k
FY21: $30k/$30k

Cost Share Total: (if applicable)

Cost Share Percent:

Benefit to PGE:

The original scope of this project was to use synchrophasor data to develop model parameters for the "Composite Load Model," which is a WECC-approved model beginning to be used in transmission planning studies. Having these parameters would allow PGE to model behind-the-meter load components that are not typically visible from a transmission perspective, such as solar PVs and batteries. This would create more accurate system-wide models, and allow PGE Transmission Planning

Strategic Alignment:

Decarbonization – this project will lead to better planning models, which will aid in determining the best investment decisions for the future as PGE seeks to reduce its carbon footprint

Perform – the transmission models developed in planning are passed on to the operations group, and the increased accuracy of these models allows operations to have better visibility into the PGE

to better anticipate issues related to the increased deployment of distributed energy resources. **Customer Benefit:** More accurate models allow PGE transmission planners to better determine the needs of the future transmission system, optimizing capital investments and keeping rates affordable. It may also allow for better continuity of service by helping to plan a system that is more robust during multiple-outage conditions.	system

Value

PGE Participation:	**Value Derived**:
We discussed with Eduardo how his ongoing work could continue to support PGE. This included a better modeling strategy for understanding the behavior of distributed solar resources on PGE's system, as well as continued use of OSU synchrophasor network data. We agreed to set up continued (remote) meetings in 2021 to get updates on the progress of this work.	The microgrid/synchrophasor initiative allows PGE transmission planning engineers the chance to work with OSU and study how synchrophasor deployments could be leveraged to provide better insight into the behavior of the system. Of particular interest are the voltage dynamics during times when the system may be "partitioned," either due to a series of line outages or possibly from an extreme weather event or fire.

Fall 2020 progress report:

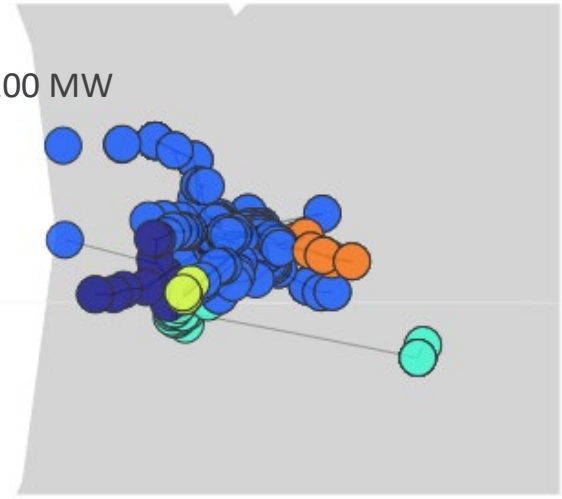
VCA Clustering groups buses for analysis using an electrical distance based on the power flow Jacobian.

By breaking the analysis up into zones, we can find VQ margins for a few key buses rather than every bus, which reduce computation time.

Zone	Buses	Generators
1	11	0
2	376	41
3	37	7
4	5	1
5	14	2

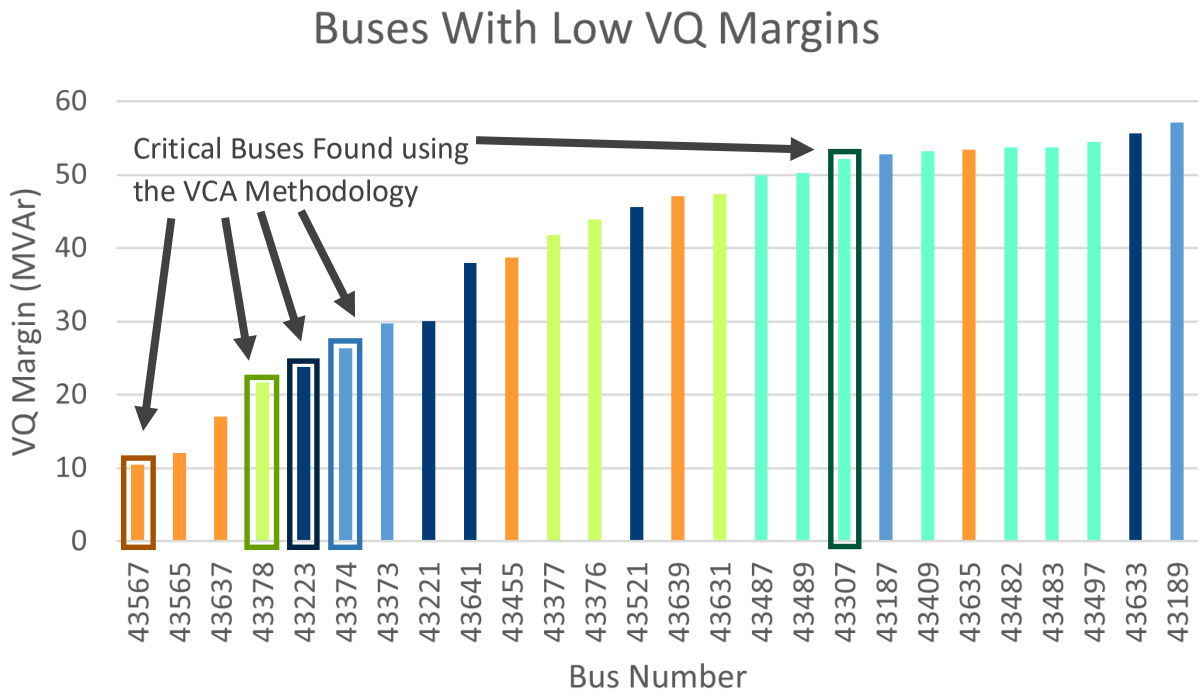
Critical Contingency:

GEN 43486 '1' BETHEL, 100 MW



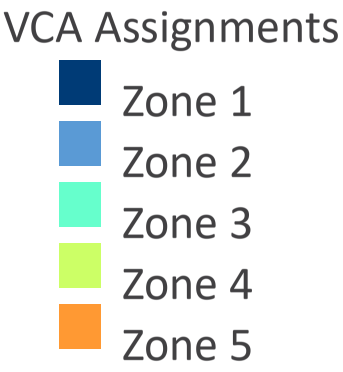
Geographic Plot (coordinates shifted)

The VCA Method found five critical buses which matched similar results from an entire system sweep using VQ margin. Except for Zone 2, the other buses with low VQM in each zone are electrically close to the critical bus so that any reactive support at the critical bus should improve the nearby buses.



Computation Time

VCA Method	All Buses
3 min	22 min



Research & Development
Program / Project End Year Summary

Date: 12/7/2020

R&D Program/Project Name: Microgrid Synchrophasor

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
TITLE OF THE PROJECT	PROGRAM MANAGER	$ 30k	$ 30k	$ 30k

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: Ian Beil

Sponsoring Department: Transmission Planning

Project Team (internal): Ian Beil, Jennifer Galaway

Project Team (external): Eduardo Cotilla-Sanchez (OSU)

Project Description:

Advance protection of the next generation power transmission and distribution infrastructure. With assistance from the growing PMU network at OSU, a composite dynamic load model can be estimated in real time and provide useful insight into the design of microgrid protection schemes. This will address challenges such as reverse flows, automatic reclosing, or delayed relay tripping.

PGE Budget/Actual:

FY19: $30k/$30k
FY20: $30k/$30k
FY21: $30k/$30k

Cost Share Total: (if applicable)

Cost Share Percent:

Benefit to PGE:

The original scope of this project was to use synchrophasor data to develop model parameters for the "Composite Load Model," which is a WECC-approved model beginning to be used in transmission planning studies. Having these parameters would allow PGE to model behind-the-meter load components that are not typically visible from a transmission perspective, such as solar PVs and batteries. This would create more accurate system-wide models, and allow PGE Transmission Planning to better anticipate issues related to the increased deployment of distributed energy resources.

Strategic Alignment:

Decarbonization – this project will lead to better planning models, which will aid in determining the best investment decisions for the future as PGE seeks to reduce its carbon footprint

Perform – the transmission models developed in planning are passed on to the operations group, and the increased accuracy of these models allows operations to have better visibility into the PGE system

Customer Benefit: More accurate models allow PGE transmission planners to better determine the needs of the future transmission system, optimizing capital investments and keeping rates affordable. It may also allow for better continuity of service by helping to plan a system that is more robust during multiple-outage conditions.	

Value

PGE Participation:	**Value Derived**:
We discussed with Eduardo how his ongoing work could continue to support PGE. This included a better modeling strategy for understanding the behavior of distributed solar resources on PGE's system, as well as continued use of OSU synchrophasor network data. We agreed to set up continued (remote) meetings in 2021 to get updates on the progress of this work.	The microgrid/synchrophasor initiative allows PGE transmission planning engineers the chance to work with OSU and study how synchrophasor deployments could be leveraged to provide better insight into the behavior of the system. Of particular interest are the voltage dynamics during times when the system may be "partitioned," either due to a series of line outages or possibly from an extreme weather event or fire.

Date: 1/14/2020

Project Name: Program 60: Electromagnetic Fields and Radio-Frequency Health Assessment and Safety

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Alden Strealy **Sponsoring Department**: Environment, Health & Safety **Project Team (internal):** Rob Roloson **Project Team (external):** Phung Tran (EPRI Program Manager) and Mike Silva (Research Engineer and President of Entertech Consultants) **Project Description:** The Program conducts and supports research addressing key environmental health and safety issues related to public and worker exposure to EMF environments associated with electric power system infrastructure. The program is the largest and most comprehensive EMF/RF research program in the United States. It provides a balanced research approach that addresses health & safety issues with regard to both the community and workers. In 2021 the focus will remain on experimental and epidemiologic research to help address issues such as childhood leukemia, neurodegenerative diseases, pregnancy outcomes, and EMF interference with implanted medical devices. EPRI's EMF research and expertise can augment and build in-house EMF issue management capabilities-gained from EPRI meetings, technical updates, webcasts and reports. In addition, EPRI held a Knowledge Transfer workshop at PGE that was attended by Engineers, Project Managers, Communication Relay Technitions, and other professionals to help us understand 5G radio-frequency concerns.	**PGE Budget/Actual:** FY18: $144,588/$144,588 FY19: $97,472/$97,472 FY20: $170,371/$170,524 FY21: $152,280 **Cost Share Total:** PGE's 1-year leverage for P60 is 26:1. For every dollar that PGE invests, it is being leveraged by $26 from other utilities **Cost Share Percent:** NA
Benefit to PGE: PGE will be able to provide proactive risk management strategies to address high	**Strategic Alignment:** Participation in EPRI's Programs fully meets the company strategies of:

priority issues concerning potential health effects related to EMF and RF exposures by contributing to the body of scientific knowledge, contributing to accurate health risk evaluations, and informing exposure guideline development. PGE will maintain expertise in the field through access to scientific experts and be able to share the expertise with other areas of the organization through the EPRI Knowledge Transfer Initiative. PGE will be able to provide scientific information to ratepayers that address issues raised by local constituencies with respect to new construction or upgrades of transmission lines or substations.

Customer Benefit:

Both EMF and RF have been classified by the International Agency for Research on Cancer as possible human carcinogens. As our infrastructure ages, the grid expands to address electric vehicles, renewable integration, and new technologies (T&D construction, smart meters); we need to understand the latest in EMF research. PGE's support of P60 demonstrates our leadership and proactive approach to addressing potential community and regulatory concerns. Without this participation, PGE would be unable to access experts and the benefits of EMF and RF research geared toward the electric utility industry.

Ultimately, the EPRI EMF/RF Program provides research, analyses, and expertise to better inform public dialogue and regulatory oversight on EMF and RF health and safety issues that is based on sound science.

Delivering an exceptional customer experience (See Customer Benefits below)

1) Investing in a reliable and clean energy future by supporting plans to build infrastructure where we anticipate EMF/RF being issues and can work to proactively mitigate them.
2) Building a smarter, more resilient grid by developing and implementing design criteria to support EMF reduction in new construction.
3) Pursuing excellence in our work by having access to world class research, information, and tools needed to support external shareholder engagement.

Summary

Synopsis of Project as Implemented:
Participation in Program 60 has improved internal/external communication on EMF/RF issues and supported plans to build infrastructure where we anticipate EMF/RF being issues. PGE has hosted an EPRI Knowledge Transfer Initiative that has helped to develop RF training and informed worker safety. PGE has implemented an EMF/RF Working Group and Program document that helps guide the EMF/RF customer concern process and management of

Decisions to be Made: How T&D engineering will incorporate EMF reduction into the design of new construction of transmission lines and substations.

Next Steps: Attend EPRI Advisory meetings and schedule the first PGE EMF/RF Working Group meeting of 2021.

EMF/RF Safety. Learnings from EPRI Program 60 participation and attending EPRI advisory council meetings have been shared across the company and to management in EMF/RF Working Group meetings. **Performance Against Objectives/Deliverables:** Met all objectives/deliverables, including: EMF/RF Working Group meetings, participating in EPRI Program Advisory Meetings, partnered with EPRI to provide EMF Knowledge Transfer Initiative with Bob Olsen from WSU on 5G, receiving EMF Gateway emails and sharing learnings across the company.	

Research & Development
Program / Project End Year Summary

Date: 11/13/2020

R&D Program/Project Name: EPRI P64 Boiler and Steam Turbine Cycle

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI P64 Boiler and Steam Turbine Cycle	Charles Linder	$ 33,727	$ 35,076	$ 36,829 (est.)

- Year to be Completed: 2024

☐ Discontinued (reason) _____

Project Sponsor: Maria Ouellette

Sponsoring Department: PSES

Project Team (internal): Alex Banicki, Charles Linder

Project Team (external): NA

Project Description:

Joined EPRI program 64 to allow Fleet Chemist and others access to EPRI guidelines for optimal cycle chemistry control to provide long term asset protection, reduce overall operating costs, increase steam turbine efficiency, minimize chemical cleanings and increase operator knowledge of cycle chemistry. Inclusion in this program is essential in helping to shape the Fleet Chemist role, as this is a new role for PGE. It will help PGE develop cycle chemistry and water treatment programs that are current, effective, and standardized across the Thermal Generation Fleet; which will help to ensure long term success with critically important aspects of thermal plant operations and asset protection.

PGE Budget/Actual:

FY19: $33,727/$33,727
FY20: $35,076/$35,076
FY21: est. $36,079

Cost Share Total: NA

Cost Share Percent: NA

Benefit to PGE:

Access to this EPRI program provides us access to valuable operating experience, research, and other documentation as it relates to steam water cycle chemistry. This is an area in the power generation industry that lends itself well to user experience and

Strategic Alignment:

Perform – Delivering operational excellence

knowledge sharing from plant to plant. In addition, our fleet chemist recently left PGE abruptly and access to the P64 catalog will provide the new hire for this position access to resources and information to help stay current on the latest cycle chemistry standards, information, and areas of concern across the power generation industry. **Customer Benefit:** Benefit to the customer will be realized through best use of capital and O&M resources. Involvement in this program allows us to leverage industry best practices for development and maintenance of our chemistry programs;2 and will allow us to develop internal subject matter expertise at a faster rate.	

Value

PGE Participation: We have utilized our access to EPRI programs to investigate new technologies and areas such as pressure wave cleaning technology and traveled to the EPRI conference in 2019. We have flipbooks/field guides from EPRI to utilize during upcoming outage inspections.	**Value Derived**: We have utilized the information accessible through EPRI to inform our design and operations for the Carty Water Treatment Plant project. We also plan to utilize the information available to help with onboarding and development of the new fleet chemist hired on in 2020.

Research & Development
Program / Project End Year Summary

Date: 11/24/2020

R&D Program/Project Name: EPRI Program 79

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
TITLE OF THE PROJECT	PROGRAM MANAGER	$ 0	$ 107093	$ TBD

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: Dan Peterson

Sponsoring Department: PSES

Project Team (internal): Ivan Auer, Dan Peterson

Project Team (external):

Project Description:

EPRI Program 79 provides resources to address all aspects of the life management of conventional and advanced gas turbines, and addresses aspects of combined cycle plant-wide integration. This program researches areas such as operations and maintenance of gas turbines, repair techniques, performance monitoring, and future trends and technology. Program 79 also collaborates and coordinates technical activities with the Steam Turbine program (P65) and Heat Recovery Steam Generator program (P88). PGE has 4 combined cycle power plants with newer gas turbines (Mitsubishi 501Gs, GE 7FA) to vintage units (GE 7B). This program will cease in 2021 and split into P216 & P217.

PGE Budget/Actual:

FY20: $107,093/$107093
FY21: $109,771/$TBD
FY22: $112,515/$TBD

Cost Share Total: (if applicable)

Cost Share Percent:

Benefit to PGE: Access to Program 79 (Soon to be P216 and P217) provides access to research and data on programs, technology, and equipment that directly relates to our generating fleet. Access to this information will improve our programs and engineering design for related projects.

Strategic Alignment:

Perform – Delivering operational excellence

Customer Benefit: EPRI P79 has provided critical data for material properties of combustion turbine hot gas path parts. They have conducted third party review of combustion upgrades proposals from OEMs. They have provided combined cycle evaluation guidance. EPRI SME's have provided guidance on compressor stator vane rock limits and repair. Access to EPRI documentation and technology, such as PCRT, has driven improvements in our inspection and repair specifications.	

Value

PGE Participation: PGE has been actively using the research conduct by EPRI, participated in every EPRI P79 user and adviser meeting, participated in special training on combustion dynamics provided by EPRI for PGE at the request of PGE, and actively participated in special projects such as utilizing Digital Twin modeling to evaluate OEM performance claims from part upgrades. EPRI has access to proprietary testing of parts that is used in the airline industry but not in land-based generation. It is our hope that R&D project will allow for better tracking of OEM and Third-Party repair quality and reduce the chances of failure.	**Value Derived**: Our involvement has given PGE SMEs direct access to research to better inform recommendation and decision at Generating sites. Has given PGE source for a third-party review of OEM claims, thus better protecting PGE assets and finances. Value would be diminished if PGE elects to only continue access with one of the Programs, 216 or 2017.

Research & Development
Program / Project End Year Summary

Date:

R&D Program/Project Name: EPRI Program 88

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI Program 88	PROGRAM MANAGER	$ 81097	$ 85152	$ TBD

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: Dan Peterson

Sponsoring Department: PSES

Project Team (internal): Dan Peterson, Brent Lee, Brad Hanna, & TJ Mulqueen

Project Team (external): N/A

Project Description:

Subscription to program 88 provides best practice guidelines for HRSG and balance of plant equipment operation, maintenance and optimization for cyclic operation. This project will use the research provided by Program 88 to refine the core activities encompassing a Covered Piping Program (CPP), optimize HRSG inspection and repair through the use of new technology, NDE guidelines, and techniques for improving access, and increasing HRSG reliability through better understanding of thermal cycling and transients.

PGE Budget/Actual:

FY19: $78,833/$81,097
FY20: $80,536/$85,152
FY21: TBD/TBD

Cost Share Total: (if applicable)

Cost Share Percent: (if applicable)

Benefit to PGE:

Access to Program 88 (soon to be P218) provides access to research and data on programs, technology, and equipment that directly relates to our generating fleet. Access to this information will improve our programs and engineering design for related projects.

Customer Benefit:

Benefit to the customer has been and will be realized through best use of capital and O&M resources. Involvement in this program informs our inspections during planned outages and allows us to address

Strategic Alignment:

Perform – Delivering operational excellence

industry concerns and potential issues during planned outages, which is economical when compared to possibly needing to repair with a forced outage. EPRI also advises on operational strategies, which improves expected life of equipment plant availability, and flexibility to meet the changing demand associated with increased renewable energy.	

Value

PGE Participation:	**Value Derived**:
We have completed the following items: • Accessing EPRI historical documents • Review FAC inspection guidelines • Implement learnings into FAC inspection program • Review Covered Piping Program (CPP) reports • Implement learnings into CPP documentation • Gathered CO and SCR procurement guidelines • Investigated SCR procurement guidelines for Coyote Springs upgrade (deferred project in 2019) • Utilized information around risk ranking for high energy piping and CPP for Carty, Port Westward, and Coyote Springs • Identified and evaluated attemperator issues utilizing information available via P88 We plan to complete the following in 2021: • Evaluate CO and SCR procurement guidelines/considerations for the possible SCR upgrade for Port Westward • Continue to evaluate improvements to Generation's FAC program and CPP based on historical and current information available to EPRI members • Continue to develop/refine risk ranking tool for high energy piping as it relates to the CPP (focus on Coyote Springs and eventually Beaver)	PGE has utilized technical data provided in the forms to apply to our programs, developed internal forms based on EPRI provided examples, and incorporated guidelines into our project and program work. Specifics include the risk ranking for our high energy piping (e.g., where should we focus our efforts) and being able to identify and address dissimilar metal weld concerns before they become a significant event based on industry experience.

Research & Development
EPRI Program Summary

Date: 04/14/2021

EPRI Program/Project Name: P94

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed:

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh **Sponsoring Department**: RC509 **Project Team (internal): Darren Murtaugh** **Project Team (external): Ben Kaun** **Project Description:** This program covers research related to energy storage and fueled distributed generation (DG) technologies. The scope covers energy storage connected to utility transmission system, distribution system, and customer premises. These technologies may provide a range of services and benefits to different stakeholders, including stacked services. It also covers fueled DG of less than 10 MW capacity, such as fuel cells or combined heat and power (CHP) connected to the utility distribution system or customer premise. The research covers and integrates multiple activities, including technology evaluation, economic and technical modeling to support grid planning and operations, and field demonstration, with a goal to support energy storage technology options and integration approaches which are safe, reliable, cost-effective, and environmentally responsible.	**PGE Budget/Actual:** FY19: $126,575/$126,575 FY20: $126,575/$126,575 FY21: $126,575/$0 **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: Program development for energy storage offerings, energy storage as a grid resource to support a more decarbonized resource portfolio, energy storage as a T&D resource to support a more flexible and more reliable system including Microgrid support and expansion of Hosting Capacity **Customer Benefit:** Program development for energy storage offerings, energy storage as a grid resource to support a more decarbonized resource portfolio, energy storage as a T&D resource to support a more flexible and more	**Strategic Alignment:** (Which PGE Corporate Imperative did this project address?) Decarbonize

reliable system including Microgrid support and expansion of Hosting Capacity	

Value

PGE Participation:	**Value Derived**:
Webinars, twice-annual advisory meetings, and access to web portal	Reports on resiliency initiatives at other utilities, including examples of installations, cost/benefit and lessons learned. Examples of Non-wires Alternatives installations. Insights into technology development, as well as current fire safety practices and standards. Review of various use cases and operational trends for energy storage at other utilities. Access to DER-VET software tool for co-optimized benefits analysis.

Research & Development
EPRI Program Summary

Date: 03/06/2020

EPRI Program/Project Name: EPRI 161

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: Ongoing

☐ Discontinued (reason) _____

Project Sponsor: David Worth **Sponsoring Department**: RC712 DCIO Smart Grid **Project Team (internal):** David Worth, Joey Baranski, Kellie Cloud, Jess Borrevik, Dale Walker **Project Team (external):** Rish Ghatikar, Ed Beroset, Patricia Brown, Sean Crimmins **Project Description:** (From proposal)	**PGE Budget/Actual:** FY18: $174,630/$174,630 FY19: $184,196/$184,196 FY20: $163,596/$163,569 **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: Research and Development cooperation between utilities in order to deliver grid modernization. Includes architectures, designs, and pilots that enable utilities to partner with vendors to deliver utility operations. Growing capability to provide reference architecture which can be leveraged to save solution planning hours. **Customer Benefit:** Helps maximize customer outcomes including cost management. Shared research efforts and collaboration ensure PGE is reviewing decisions and factors common across North American and international utilities that impact functionality, cost, reliability, and performance.	**Strategic Alignment:** This aligns to all three imperatives, Decarbonization through specific research into DER adoption and enablement, Electrification through the delivery of grid connected DERs like electric fleet and consumer vehicles and perform through shared information about costs and business cases for enablement at a good cost. The geospatial track provides valuable insight and awareness that impact the grid model used by major operational platforms at PGE.

Value

PGE Participation:	Value Derived:
EPRI meetings and workshops	Direct and provide feedback on EPRI research efforts, learn about the results of prior research efforts.
Cyber Security Project Set Webcasts	Low cost, no travel, receipt of research and intelligence on cyber protection and security as it relates to utility operations. This is interlinked between 161E (Enterprise Architecture and Integration) being the foremost, and 183 Cyber Security.
Interoperability webcasts	161F (metering) and 161H (geospatial informatics) also have seen increased involvement at PGE as both are in early stages of transformative strategy work.
Technology transfer webcasts	Define and drive open standard adoption to increase market choices and interoperability between systems, including the convergence of Operational Technology and Information Technology
	Receipt of specific learnings and materials from demonstration projects

Research & Development
Program / Project End Year Summary

Date: 03/29/2021

R&D Program/Project Name: P180 Distribution System Research

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
P180 – Distribution System Research	PROGRAM MANAGER	$ 134,810	$ 130,024	$ 115,109

- Year to be Completed: Multiyear continuing commitment with EPRI due to ongoing and emerging issues on distribution

☐ Discontinued (reason) _____

Project Sponsor: Jay Landstrom

Sponsoring Department: R&D

Project Team (internal):

Dan Loomis (Manager, Utility Standards Engineering)

Various Internal Stakeholders (Data Science, Distribution Engineering, UAM, Standards, etc…)

Project Team (external):

EPRI Researchers

Project Description:

Research addressing the full asset life-cycle is designed to improve utilities' ability to acquire, operate, maintain, and dispose of distribution assets. This research can produce results impacting specifications, inspection tools,

maintenance practices, fleet management, and other key aspects of distribution owners' responsibilities.

Examples of assets addressed in this program include wood poles, transformers, reclosers, cable terminations, and overhead conductor. Examples of industry issues include use of reliability metrics, fleet management approaches, safety, and resiliency.

PGE Budget/Actual:

FY19: $134,810
FY20: $130,024
FY21: $115,109

Cost Share Total: (if applicable)

Cost Share Percent:

Benefit to PGE:	Strategic Alignment:
• Enhance safety of utility workers and the public regarding distribution assets • Improve specifications for new assets • Develop maintenance practices based on a technical basis • Reduce maintenance costs • Proactively plan capital and maintenance budgets • Increase distribution system resiliency • Improve asset and system reliability **Customer Benefit:** Improved and more efficient operations, increased reliability, and increased safety. Participation in this program allows PGE to leverage over $5 million worth of research activities for a low cost.	Customer Experience – Resiliency and Hardening Perform/Operational Efficiency Electrify

Value

PGE Participation:	Value Derived:
Participation in Advisory meetings to gain insight and influence base and supplemental research direction. Receipt of base research performed. Included information related to the performance of avian covers being used on PGE's system. Participation in supplemental research areas, such as arc fault modeling to help better align PGE work practices with best industry practices. Participation in combining utility data to use with AI to gain better insights.	• Improve specifications, inspection and maintenance approaches, and workmanship practices associated with underground switches and cable accessories • acquire strategic intelligence on emerging technologies • increase engineering staff expertise in overhead distribution • improve the quality in overhead distribution system design • lower overhead distribution maintenance costs • gain more accurate and timely knowledge about asset condition and life expectancy • improve system reliability and safety and reduce environmental impacts

Research & Development
Program / Project End Year Summary

Date: 3/5/2021

R&D Program/Project Name: PNNL Integrated Grid – Transportation Scenario Modeling and Tool Development

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2020	Cost 2021	Cost 2022
PNNL Integrated Grid – Transportation Scenario Modeling and Tool Development	Andy Eiden	$50,000	$0	$0

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Andy Eiden

Sponsoring Department: RC 535 Distributed Resource Planning

Project Team (internal):

- Andy Eiden
- Amrit Rajagopal
- Derrick Harris

Project Team (external):

- Michael Kintner-Meyer, PNNL
- Richard Pratt, PNNL
- Siddharth Sridhar, PNNL
- Xing Jie, PNNL

Project Description:

The project has two components. The first component involves performing an impact analysis of EV adoption on 1 or 2 critical PGE feeders. PNNL will work with PGE to identify an acceptable penetration of electric vehicles for the selected feeders, in addition to an acceptable physical distribution of charging infrastructure on the feeder, such that any adverse distribution system impacts would be expected to be limited or negligible. The second requirement for this component is to set up the actual feeder model for

PGE Budget/Actual:

FY20: $50,000 (Budget) / $50,000 (Actual)
FY21: $0
FY22: $0

Cost Share Total:

None. PGE and PNNL team submitted grant proposal to DOE that was not awarded.

Cost Share Percent:

None.

simulation using GridLAB-D. Once established, PNNL will use GridLAB-D to model EV charging objects, wherein they will define properties of both the charging infrastructure and driving patterns that influence charging behaviors. PNNL will use USDOT's National Household Survey dataset to furnish the EV model with real-world data on daily miles driven, time of departure, time of arrival, among other parameters. These capabilities of GridLAB-D enable the study of EV charging behaviors and subsequent impacts to the grid.

The second component of the proposed work is to develop a new object model within GridLAB-D using actual PQ data from PGE circuits with presence of varying levels of high-powered EV charging (50 kW+, including 150 and 450 kW transit centers). This capability within GridLAB-D will allow for significant future study of potential HDV charging impacts on the distribution grid and effective strategies to manage any adverse impacts.

Benefit to PGE:

The project will help facilitate PGE planning for expected customer adoption of heavy-duty EVs in PGE service territory. PGE distribution engineers will benefits from receiving a hosting capacity analysis for EVs from leading researchers using a best-in-class modeling tool (GridLAB-D), thus adding confidence to our own internal studies. In addition, PGE Product Development and DRP teams will be able to demonstrate to OPUC and stakeholders what kind of analysis and planning we are undertaking for new potential grid impacts and how to mitigate their impact on the distribution grid. The usefulness of the work will be extended given that PGE has numerous ongoing R&D projects with PSU's EE lab, which has been modeling in GridLAB-D and can make use of PNNL's model base for further studies.

Customer Benefit:

TriMet is pursuing an aggressive electrification plan to reach their non-Diesel bus plan goals for 2040 fleet transition. Currently, they have worked to implement managed charging in order to avoid peak coincident charging and excessive distribution upgrade costs. Having the results of this study will help inform PGE planners about different customer mechanisms to

Strategic Alignment:

The transportation sector is the largest source of greenhouse gas emissions in Oregon. Electrification of heavy-duty vehicles will reduce emissions and increase electricity use by displacing diesel fuel.

In order to maintain a robust and resilient grid as EV penetration increases, it is important to develop new tools and capabilities to assess and mitigate impacts of new loads such as transit buses. This project aligns with our corporate imperative to electrify, decarbonize, and perform. By vetting current charging profiles for on-route and depot charging of transit buses with a best-in-class power flow tool, we gain more confidence in assessing the potential grid impacts of EV charging and can take appropriate steps to make pre-emptive upgrades or changes to our service design standards for T&D planning.

balance the load impacts on the system (e.g., Time of Day pricing)	

Value

PGE Participation:	**Value Derived**:
The principal benefit of PGE participation in this effort is to improve the research agenda around grid impacts of EVs, particularly MDHDV such as transit charging. PGE is working with Staff at OPUC to increase the transparency around efforts to plan for potential impacts to the distribution grid. Thus taking existing charging patterns and studying a wide array of impacts via time-series Powerflow in GridLAB-D will provide benefit to PGE Distribution Engineering, the new TE Team, and the DRP. This will help inform future efforts with TriMet's expansion as well as other transit and freight providers.	Building the analysis in GridLAB-D allows for more robust modeling of end use loads that can help offset charging peak loads. This is a critical area for future expansion of PGE's flexible load portfolio, especially after ADMS is live and we have more refined measurements on the system. By mapping a CYME network model to GridLAB-D, we have developed a repeatable process using Python code to translate PGE network models into GridLAB-D, thus facilitating future add-on work. Moreover, we will have a study from a national lab that can be included as an appendix in the upcoming TE Plan and Distribution System Plan filings, both areas where Staff and stakeholders are eager to learn more about potential grid impacts of EV charging and what steps utilities are taking to mitigate these potential costs. This will help promote transparency and build trust with key participants as we roll out our long-term TE strategy.

Research & Development
EPRI Program Summary

Date: 04/01/2021

EPRI Program/Project Name: Program 62 Occupational Safety and Health, Project # 14

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI P62 Occupational Safety and Health	Messner	$ 45,054	$ 44,555	$ 39,585

These numbers are copied from the PGE R&D Expense Tracking Spreadsheet and the R&D Proposal for 2021 Funding

Please compare to below numbers copied from 2018 proposal

- Year to be Completed: 2025

☐ Discontinued (reason) _____

Project Sponsor: Alden Strealy

Sponsoring Department: **Environment Health & Safety**

Project Team (internal): Rob Roloson / Ben Lumsden

Project Team (external): Eric Bauman, EPRI Senior Technical Leader

Project Description: EPRI's Program 62 provides members with research relative to current and anticipated occupational health and safety (OH&S) issues. Deliverables derived from PGE's engagement are on-going and will be used to build, update and sustain our occupational health program. Deliverables relate directly to influence worker protective clothing (heat/cold stress) economic evaluation of ergonomic interventions, economic safety metrics/indicators and the development of an exposure database. Additional deliverables include monthly webcasts (recorded), a technical workshop and access to EPRI technical staff. By utilizing EPRI, PGE has an information resource that will allow for better short- and long-term safety planning and strategizing. The program is designed to address both current issues and anticipate those of tomorrow.

PGE Budget/Actual:

FY19: $45,054/$45,054
FY20: $44,555/$44,555
FY21: $39,585/

Cost Share Total: (if applicable)

Cost Share Percent:

The last 3-years the funding leverage has ranged from 33:1 to 35:1. For every dollar that PGE invests, it is being leveraged by $33-35 dollars from other utilities.

Research & Development
EPRI Program Summary

Benefit to PGE:

Program 62 Occupational Safety and Health deliverables for 2020:

- Heat Stress Management Strategies for the 2020 Heat Season-webcast and white paper.
- Human Performance Study for Assessing the Gaps, Reasons, and Results Between Work Planned and Work Performed.
- Occupational Health and Safety Database Trends: 2019 data infographic
- Occupational Health and Safety Annual Report, 2020: Occupational Health and Safety Trends Among Electric Power Industry Workers 1995-2018
- Implementing Fatigue Management Strategies in the Electric Utility Industry: Workshop Summary
- EEI-EPRI Collaborative Industrial Hygiene Sampling Archive: Status Update 2020
- Fatigue Management Strategies in the Electric Utility Sector: Workshop Results and Research Opportunities
- 2020 Ergonomics: delivered videos on awkward postures for overhead, underground, substation job tasks incl. ergonomic solutions for reducing risk factors for sprains and strains

Customer Benefit: Participation in Program 62 will provide PGE with past, current and future research designed to address safety and health issues facing PGE. Implementing these research findings will lead to enhanced customer service and operational efficiency through the development of improved safety practices and procedures

Strategic Alignment:

Deliver exceptional customer experience

Pursue excellence in our work

Participation in EPRI's Program 62 fully meets the company strategies of:

a) Delivering an exceptional customer experience (See (Customer Benefits below)
b) Investing in a reliable and clean energy future by supporting plans to build infrastructure where we anticipate safety and health being issues.
c) Building a smarter, more resilient grid by developing and implementing design criteria to support safety and health issue being part of new construction.
d) Pursuing excellence in our work by having access to information and tools needed to support external shareholder engagement around safety and health issues.

Value

PGE Participation:

PGE Participation 2020:

- Participated in all webcasts and have involved SMEs across the company to be engaged in Ergonomics, Fatigue, Human Performance, and Driver Safety
- Shared White Papers with SME's across the company.

Value Derived:

- 2020 EPRI Technology Transfer Award won for use of the Heat Stress infographic and video.
- Fatigue management information shared with work groups that will assist PGE in the development of a Fatigue Management Program.

- Incorporated learnings into program management and safety messages/alerts.	- Driver Safety learnings shared with Fleet Safety group and have assisted with safety investigations. - Occupational Health and Safety Database Trends and Annual Report has assisted the H&S department and data analyst discuss trends of Injury Data within the Electric Utility Industry.

Research & Development
Project Summary

Date: 04/05/2020

Project Name: Cascadia Lifelines Project

Project Status:

☐ Complete

☒ Will Continue Next Year

☐ Discontinued (reason) _____

Project Sponsor: James Landstrom **Sponsoring Department**: Generation Engineering **Project Team (internal):** James Landstrom **Project Team (external):** Dan Cox, Mike Olsen, Armin Stuedlein **Project Description:** Cascadia Lifelines Program is a targeted research consortium aimed at improving Oregon's infrastructure resilience in a cost and value informed manner. Professor Dan Cox is the director of the program. Regular members at a cost of $50,000/year are ODOT, PGE, NWN, BPA, Port of Portland. Being at this level provides a seat on the Joint Management Committee. This is an important because the Joint Management Committee determines the research projects. This is a continuation of PGE's support over the last five years.	**PGE Budget/Actual:** FY20: $50,000/$50,000 FY21: $50,000 **Cost Share Total:** $150,000 **Cost Share Percent:** 20%
Benefit to PGE: Data derived from Cascadia Lifelines will be used to develop economic risk values that will directly inform the budgeting for T&D retrofits (near and long-term planning initiatives). This will in turn reduce the overall economic risk, make the grid more resilient and benefit the region. **Customer Benefit:** At the customer level, PGE will be able to prioritize projects that increase resiliency of our system which serves the critical loads like hospitals, fire stations and rescue centers.	**Strategic Alignment:** Build and operate a smarter, more resilient grid.

Summary

Synopsis of Project as Implemented:	Decisions to be Made:
PGE is continuing to collaborate with OSU and the Cascadia Lifelines project. Project deliverables, such as the structure fragility database tool, will support PGE's seismic modeling efforts into the future. **Performance Against Objectives/Deliverables:** Detailed Project Reports were delivered, including cost-benefit analysis. Two of three critical objectives were addressed: 1. Determine what parts of the Grid/Infrastructure are most vulnerable during a severe seismic event 2. Determine what changes to components/operations can increase Grid resiliency	**Next Steps:** Address the third major objective: 3. Determine how collaboration/cooperation between stakeholders can improve Grid resiliency.

Research & Development
Program / Project End Year Summary

Date: 21.Apr.2021

R&D Program/Project Name: Research and Testing of Alternatives to SF_6

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI Research and Testing of Alternatives to SF_6	PROGRAM MANAGER	$ 0	$ 60,000	$

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Brett Phillips

Sponsoring Department: Engineering Services, Substation Design Engineering

Project Team (internal): Rebecca Prich, Shane Freepons

Project Team (external):

Utility program participants include National Grid, New York Power Authority, Consolidated Edison, United Illuminating, PNM

Project Description: This EPRI special research and testing program examines alternative gases that have been earmarked to directly replace sulfur hexafluoride (SF6), a potent greenhouse gas, in utility equipment applications. Extensive testing procedures developed by EPRI examine safety, reliability, and operating characteristics of four (4) identified alternative gases during normal operation and electrical fault scenarios.

PGE Budget/Actual:

FY19: N/A

FY20: $60k/$60k

FY21:

Cost Share Total: N/A

Cost Share Percent: N/A

Benefit to PGE:

The results of the research program will shape future equipment procurement strategy and minimize purchase of SF6 filled equipment in PGE transmission and distribution systems. The initiative strengthens PGE's position in SF6 management and reduction in anticipation of heightened federal or state regulations for greenhouse gases – like California Air Resources Board's recently adopted state-wide SF6 regulations.

Strategic Alignment:

Decarbonize: While highly effective in electric utility applications, SF6 is the most potent greenhouse gas and is estimated to remain in the atmosphere for 3,200 years when emitted due to its high molecular stability. SF6 is a synthesized gas, and 80% of global production is for use in the electric utility industry. Purchase of SF6 alternate equipment is critical for reducing global production of the gas, as well as reducing emissions associated with typical maintenance and aging of installed SF6 assets.

Customer Benefit: The project aligns with PGE's decarbonization strategy, including net zero emissions by 2040. Our customers and communities are passionate about clean energy, and this research program supports the message of PGE's Full Clean Ahead campaign. In addition to decarbonization, this initiative supports cost efficient procurement decisions. Results of testing will provide third-party verification of alternative gas performance and will identify "best fit" equipment for future installations. This evaluation prior to large-scale investment will reduce purchasing risk.	

Value

PGE Participation:	**Value Derived**:
Participation in routine calls allows PGE engineering to be involved with research on a deep technical level. Feedback from program participants is directly used to shape the content of testing parameters.	EPRI provides detailed test plans, protocol and analysis of testing results through regular conference calls and PowerPoint presentations. Upon the completion of the program, a final report of findings will be published and provided to PGE. This report will assist PGE in developing a successful procurement strategy for future equipment purchases.

Research & Development
Program / Project End Year Summary

Date:

R&D Program/Project Name: Shared Circuits to Increase EV Adoption

Project Status:

☒ Complete

☐ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
Shared Circuits to Increase EV adoption	Aaron Milano	$	$ 34,941	$

- Year to be Completed: 2020

☐ Discontinued (reason) _____

Project Sponsor: Aaron Milano?

Sponsoring Department: Grid Products

Project Team (internal):

Anik Shrestha- Product Development

Andy Eiden- Integrated Resource Planning

Sema Ette-Umoh- Grid Edge

Project Team (external):

Dr. Robert Bass- Portland State University

Spencer Harrison- Neocharge

Project Description:

We will support 10 employees who do not have sufficient capacity in their home electrical panel to support the installation of an EV charging station. For many customers this is a barrier to buying an EV. Many customers, however, have a dryer on a NEMA 10-30 or 14-30 circuit in their garage. For those participating customers, we will provide them a "Smart Splitter" that will allow a customer to plug their EV charger and dryer into the same circuit (only allowing current to the charger when the dryer is not in use).

In addition to testing customer acceptance and impact on a customers' decision to buy an EV, PGE also aims to study the impacts on service-level transformers. Because 40% of dryer loads and ~50% home charging loads occur between 3pm-8pm, our hypothesis is that homes with EV charging and Dryers on separate circuits are more likely to trigger early failure of service-level transformers. Through this study, we will monitor load impacts of dryers and home charging stations and conduct financial modelling to estimate whether or not their could be cost savings through deferred capital investment.

PGE Budget/Actual:

FY19:

FY20: $35,000 Budget, $34,941 Actual

FY21:

Cost Share Total: (if applicable)

Cost Share Percent:

Benefit to PGE: Operational efficiency—reduced strain on service-level transformers **Customer Benefit:** Reduced customer friction – easier for customers to adopt EVs and install home charging stations	**Strategic Alignment:** The Neocharge devices was tested as a device to help reduce customer friction around installing EVSE. One of the barriers to EV purchases is the lack of knowledge and ability to install a L2 EVSE at home. With this device, our employees were able to purchase and install EVSE without the need to upgrade panels. This also could help reduce strain on PGE's service level transformers.

Value

PGE Participation: 10 PGE employees participated in this R&D project.	**Value Derived**: Overall, employees were satisfied with the product. However many found it more difficult to install than originally anticipated.

Date: 04/16/2021

Sherwood Training Center Energy Storage Demo Project

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: 2021

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh **Sponsoring Department**: RC509 **Project Team (internal): Manny Obi, Kevin Whitener, Keith Miller** **Project Team (external): None** **Project Description:** This project will investigate how Residential energy storage can be used to back feed the system for intentional island support. The objective is to explore safety, testing and commissioning practices with PGE field operation linemen, wiremen, metering and communication techs. Funding will allow for a Tesla Powerwall or similar energy storage system which can be tied to the grid at our Sherwood training facility. Three different systems with ConnecteDER meters are being proposed for installation, namely: (a) Eaton Smart Breaker Panel (b) SPAN smart panel and a (c) Critical Load Panel	**PGE Budget/Actual:** FY20: $67,251.39/$67,251.39 **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: With the proliferation of energy storage within PGE service territory, the primary aim of this project is to equip PGE personnel on the operation of PGE's traditional systems in tandem with residential energy storage systems **Customer Benefit:** Customers will be better supported by PGE after PGE personnel and linemen are adequately trained following the completion of this project.	**Strategic Alignment:** (Which PGE Corporate Imperative did this project address?) Decarbonize

Value

PGE Participation:	Value Derived:
Installation, commissioning, testing and operation of the residential batteries after installation.	Training for PGE linemen and ops teams on how to operate and interact with residential batteries. This project will further increase PGE's understanding of real-world Return on Investment (ROI) for residential battereis; and identification of processes around grid interfacing and maintenance of battery storage solutions.

Research & Development
Project Summary

Date: 2/24/2020

Project Name: Smart Streetlight Technology Pilots

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: 2020

☐ Discontinued (reason) _____

Project Sponsor: Andy Macklin

Sponsoring Department: T&D/Smart City Initiatives

Project Team (internal):

- Andy Macklin, Project Sponsor
- Kevin Muck, Key Resource/OLS Subject Matter Expert
- Erik Cederberg, Key Resource/NDO Subject Matter Expert
- Joe Barra, Consultant/Subject Matter Expert
- Theresa Haskins, Customer Insights/Market support
- Coreen Henry, Product Development support
- Colin Wright, Rates & Regulatory support
- Kari Nordquist, Project Manager

Project Team (external):

- Curtis Johnson, Itron/SSN support
- Dave Urda, Sensus support
- Peter Passarelli, City of Milwaukie
- Delora Kerber, City of Wilsonville

Project Description: Streetlights are seen as critical infrastructure in the 'Smart City' landscape. Technology vendors have developed networks and smart devices that monitor vehicular and pedestrian traffic, air quality and environmental conditions. Streetlight fixtures are often ideal locations to deploy these systems, along with lighting controls that allow cities and municipalities the option to remotely control lighting level to suit specific conditions (e.g. traffic

PGE Budget/Actual:

FY2020: $5,500/$5,500

Cost Share: Sensus will provide a preferred partner discount to PGE in the amount of $6,000 (this has been subtracted from the total requested for 2019). There are no additional leveraged or matching funds available for this Smart Streetlight technology pilot.

levels, special events, emergencies). To stay relevant, bring thought leadership to customers and to understand feasibility of providing these products and services, PGE is exploring this area in more detail. There are several vendors who are working to bring Smart City Enablement platforms to the market and understanding as much as possible about these vendors and what they can provide is key to defining a solution for PGE and their customers. Although there are several vendors entering this market, there is currently one strong market leader. Itron Network stands out in both mesh networking in general and streetlight management in particular. PGE is also looking to expand exploration of this technology with their current AMI provider, Sensus, and believes both pilot projects are needed to fully understand existing capabilities of the offerings and to do an 'apples to apples' comparison between the two. This pilot will also provide PGE the opportunity to work very closely with a different vendor in this space and compare from a technical and business perspective to determine if they can work well with PGE and their customers (especially considering that Itron is a newly merged company). This will also help spur competition with Sensus as they will see PGE looking out into the market for what other options are available if they cannot meet PGE's needs. The Itron pilot project will deploy the vendor's 'pilot package' of ~130 streetlights in the City of Milwaukie's downtown area and potential other locations. The expanded Sensus portion of the pilot will deploy 50 smart streetlights in the City of Wilsonville. Both of these pilots are being implemented to test the following high level areas: Install smart streetlight controllers on maximum of 250 streetlights, including upgrading to 7 pin LEDs; Verify lighting control strategies (scheduling, dimming, trimming, etc…); Third party access/shared data and control; Outage and other maintenance information availability and usefulness; Ability to integrate use of sensors and data to provide additional city services; Establish baseline data and assess accuracy of usage data collected.	
Benefit to PGE: This Smart Streetlight technology pilot identifies most closely with two of PGE's strategic pillars: • Deliver exceptional customer experiences – our streetlight customers want better equipment capabilities and services. This offering is designed to simplify the customer's experience doing business with PGE (e.g. billing, outage response), remove barriers to new technology adoption, and support smart	**Strategic Alignment:** **Alignment with corporate strategy:** ☒Deliver exceptional customer experience ☐Invest in a reliable and clean energy future ☒Build and operate a smarter, more resilient grid

streetlighting options for all municipal customers. • Build a smarter, more resilient grid – this offering supports the development of a network of smart, connected devices (controls and/or sensors) to meet municipal customer data needs, as well as providing a base for additional smart city technologies and capabilities. **Customer Benefit:** Customer benefits associated with Smart Streetlight technology: • Show customers that PGE is interested in addressing their streetlight needs. • Reduce barriers to implementation of Smart LEDs and communication technology for streetlights. • Make the process easy for customers to monitor and control their streetlights. • Support customers with their smart city goals by enabling them with the needed infrastructure. • Provide customers with solutions that support their key initiatives (safety, resiliency, environmental, etc.) in the context of smart city capabilities. • Show customers that PGE is emerging as a thought leader in this area and can be a resource for them as they continue to evolve. • Save energy through smart LED upgrades and features such as dimming and trimming of the lights. • Enhance outage response by leveraging automated outage reporting. • Improve granularity and timeliness of streetlight energy consumption via actual usage data.	☐Pursue excellence in our work

Summary

Synopsis of Project as Implemented: The project team was able to successfully implement ~130 Itron smart streetlights in the City of Milwaukie as well as 50 Sensus Smart Streetlights in the City of Wilsonville. All planned tests were successfully performed with Itron and the City received training on the software and access to use it to test ease of use and assess whether or not they would be interested in this type of functionality going forward.	**Decisions to be Made/Next Steps:** These smart streetlight pilots are providing useful information from a technology, vendor and city perspective, but they are only focused on smart streetlighting and the benefits of a mesh network (which the addition of streetlights and other devices will strengthen). The financial case for a smart streetlight network across PGE service territory does not pencil out at this time. It needs benefits associated with DER/DR and other potential uses of

Sensus tests are still outstanding due to issues with the environment set up. All of the lights and modules were installed; however, we still have tests that we need to complete. We have requested R&D funds in 2020 to complete this work since it was not able to be finished in 2019. If funds become available, we will plan to continue these final tests with the City of Wilsonville. The city is very interested to test these lighting features to determine if this system has functionality that they would want to use for their outdoor lighting longer term.

Performance Against Objectives/Deliverables:

The project team was able to test all of the areas of our test plan with the Itron Smart Streetlight pilot in the City of Milwaukie. The following areas were tested successfully:

- Ability to communicate with modules/view in the software
- Remotely control lights: on/off, brighten, dim, flash
- Ability to support multiple secure user roles, which would allow municipalities access to specific features they need/want
- Scheduling: specific date ranges, times
- Ability to export interval data/usage, alarm data/information
- Establish baseline data and assess accuracy of usage data collected
- Ease of implementation of pilot software/hardware
- Service level of technology vendor
- Secure cloud capabilities
- Automatic asset tracking

the network in the future, so we are recommending more field testing be done to prove out the technical feasibility of these other uses of a 'network' before making any further decision on how to proceed.

The team has been in touch with the Test Bed project and an interested vendor to test their mesh network communication with water heaters and possibly other devices in the home. Knowing that this type of communication can be successful with these other devices (as well as streetlights), will significantly help build the case for this type of network at PGE. We have also been in touch with Itron to explore connecting other devices through the existing pilot network that is set up for streetlighting to gather additional data points.

We do not have to deploy a service territory-wide mesh network in order to meet the needs of a specific customer who may be requesting smart streetlighting, smart city applications or other functionality that could communicate over a NAN. For these customers, before PGE has made an official decision on the long-term network strategy, we could leverage Sensus or deploy a "pop-up NAN" similar to the small-scale pilot network that we are currently using in Milwaukie. The functionality provided by Sensus for smart streetlighting is very similar to other vendors in this space and we already have the network deployed (lowest cost option) and a team at PGE highly skilled at using and maintaining the system.

Sensus does not appear to be the best choice, per the information receive in our recent RFI, if we move past streetlighting into other smart city applications or DERs. However, we have shown that implementation of a small network that controls a certain area of streetlights and other devices could be deployed if/as necessary to meet customer needs.

Research & Development
Project Summary

Date: 04/05/2021

Project Name: Solar PV Monitoring Laboratory – U of O

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: TBD, Ongoing support to gather solar radiation metrics

☐ Discontinued (reason) _____

Project Sponsor: Jay Landstrom **Sponsoring Department**: R&D **Project Team (internal):** Jay Landstrom **Project Team (external):** Dr. Frank Vignola, UofO **Project Description:** The University of Oregon collects data from a network of 30 Pacific NW monitoring stations. They submit this data to the National Renewable Energy Lab (NREL) and post this data on a Public website. The U of O maintains this network of solar PV monitoring stations.	**PGE Budget/Actual:** FY19: $10,000/$10,000 FY20: $10,000/$10,000 **Cost Share Total:** $160,000 **Cost Share Percent:** 6.25%
Benefit to PGE: Access to solar data that will help with analysis of future solar generation facilities **Customer Benefit:** Helps move PGE to a more renewable and carbon free generation mix.	**Strategic Alignment:** Decarbonize resources

Summary

Synopsis of Project as Implemented: Data is accessed for solar facility studies **Performance Against Objectives/Deliverables:** Data consolidated from all measuring points in 2020	**Decisions to be Made**: None **Next Steps:** Provide access to solar data across PGE business units

Date: 04/16/2021

Stacked Services from Aggregated Distributed Energy Resources (PSU)

Project Status:

☒ Complete

☐ Will Continue Next Year

- Year to be Completed:

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh **Sponsoring Department**: RC509 **Project Team (internal): Manny Obi** **Project Team (External): Robert Bass (PSU), Tylor Slay (PSU)** **Project Description:** This project investigated how a Distributed Energy Resource (DER) Aggregation System (DERAS) can be used to aggregate DER and dispatch them to provide concurrent ancillary services. A DERAS must be able to communicate is capabilities to PGE's generation optimization system (GenOps), which ultimately is how such services are scheduled. As such, this project will investigate how aggregations of DER may be represented to a GenOps system.	**PGE Budget/Actual:** FY20: $45,794/$45,794 **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: This project will benefit PGE by supporting the integration of renewables and enhancing system resiliency. One of the projects leaning objectives is to understand how aggregations of distributed energy resources (DER) may be dispatched to provide ancillary services. PGE uses such services to improve system reliability by regulating system frequency, controlling ramp rates, suppressing peak demand, and mitigating voltage fluctuations. Renewable energy resources exasperate these problems, and as such, warrants exploration of non-traditional means for providing ancillary services such as DER **Customer Benefit:** As the proportion of renewable energy resources within PGE's generation portfolio increases, the need for dispatchable loads and energy storage to compensate for non-dispatchable generation has	**Strategic Alignment:** (Which PGE Corporate Imperative did this project address?) Decarbonize

increased. Aggregated DER, including loads and energy storage, provide means for offsetting the loss of dispatchability, generation intermittency, and reduction of system inertia that occur with high penetration of renewables.	

Value

PGE Participation:	**Value Derived**:
Supervision of project, PGE will determine criteria for ancillary services and for various DER, identify constraints to DER dispatch, and then use these characteristics to inform a GenOps-compatible template	A final report summary report was prepared by PSU. PGE is reviewing this report and will be implementing any changes that will be used to improve our systems.

Research & Development
Project Summary

Date: 4/05/2020

Project Name: Energy Systems Innovation Center (ESIC)

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: TBD this is a continuation of support for WSU Power Engineering Programs

☐ Discontinued (reason) _____

Project Sponsor: James Landstrom

Sponsoring Department: 985

Project Team (internal):

- Larry Bekkedahl – ESIC Board Member (primary)
- Jay Landstrom – ESIC Board Representative (backup)
- Jay Landstrom – PGE R&D Committee Chair

Project Team (external):

Mani Venkatasubramanian, Director, ESIC

Project Description:

The Energy Systems Innovation Center (ESIC) at Washington State University is a leading center of excellence, both nationally and internationally, for research, education, technological innovation, and technology transfer in energy systems, including smart grids. With an exceptional team of faculty in power, energy, and computer science, and more than 20 faculty in allied fields (including economics, public policy, and sociology), ESIC provides a strong synergistic environment for conducting major multi-disciplinary studies on electric energy and its social and economic impacts, facilitating the development of public policy at the state and national levels.

PGE Budget/Actual:

FY18: $15,000/$15,000

FY19: $15,000/$15,000

FY20:$15,000/$15,000

Cost Share Total: (if applicable)

Cost Share Percent: (if applicable)

There were 13 ESIC members in 2018 including Puget Sound Energy, Seattle City Light, Snohomish PUC, Pacific Northwest National Lab, and BPA.

Current ESIC funding from DOE totals approximately $13M.

Benefit to PGE:

ESIC collaborates with governments and industries at local, state, regional, national, and international levels on research and development, education, workforce training, and economic development. ESIC is also establishing strong linkages with leading educational institutions around the world to promote collaborative

Strategic Alignment:

Decarbonize/Electrify

research and educational programs as well as faculty and student exchanges. **Customer Benefit:** Participation in ESIC provides PGE an opportunity to leverage our research funding through partnerships with other NW utilities, WSU, and PNNL. Outcomes will provide PGE additional tools to develop and manage the grid of the future and will provide a forum to help shape state and federal energy policy.	

Summary

Synopsis of Project as Implemented: PGE participated in semi-annual ESIC Board meetings to review project progress, guide future focus areas, and prioritize funding. Meeting synopsis were distributed internally to key partners. The team identified areas of opportunity to partner/collaborate with ESIC on research projects including microgrid resiliency, infrastructure security, cyber security, smart grid analytics, and ADMS. Opportunities were also identified for supporting student engagement (e.g. hosting PGE tours/internships) and leveraging PGE research dollars. **Performance Against Objectives/Deliverables:** Objectives for 2020 were met.	**Decisions to be Made**: 1. N/A **Next Steps:** 1. Review current research projects and provide feedback to ESIC on projects of interest to PGE 2. Fund 2021 ESIC membership

Research & Development
Program / Project End Year Summary

Date: 4/20/21

R&D Program/Project Name: Utilizing DER for Advanced Distribution Resiliency

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI Utilizing DER for Advanced Distribution Resiliency Supplemental	Colin Solini	$ 0	$ 30,000	$ 30,000

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: Darren Murtaugh

Sponsoring Department: RC509

Project Team (internal): Colin Solini

Project Team (external):

Brian Seal, EPRI

Arindam Maitra, EPRI

UT Austin, Lab testing

Austin Energy, Field Testing

Project Description:

Supplemental project developed with DOE and participant funds. Develops pre-event planning, analysis, and event control systems to enable resilient distribution systems which leverage existing customer DER, especially solar, to power critical facilities. Includes a field test in Austin Energy.

PGE Budget/Actual:

FY19: $0

FY20: $30,000 /$30,000

FY21: $30,000

Cost Share Total: N/A

Cost Share Percent:

Benefit to PGE: Receives project updates and reports for this project. Can lead to planning methods, controls research, and proof-of-concept for advanced resilient islands that reduce CMI, improve SAIDI, and may deepen PGE's partnerships with cities and customers.

Customer Benefit: As PGE improves its ability to partner with customers and stakeholders to generate clean, resilient solutions, the

Strategic Alignment:

Learnings from this research supplemental may provide knowledge and insight to enable us to provide operational excellence to our customers with economic resilience solutions.

participating customers will experience fewer/shorter grid interruptions, and may enable nearby families and businesses to contribute to supporting critical facilities in their community during a disaster.	

Value

PGE Participation: Participation in quarterly update meetings, allowing for feedback when applicable. In 2020, the project did not receive any quarterly updates.	**Value Derived**: None as of 2020.

Research & Development
Program / Project End Year Summary

Date:

R&D Program/Project Name: P200

Project Status:

☐ Complete

☒ Will Continue Next Year

		Cost 2019	Cost 2020	Cost 2021
EPRI P200 Distribution Planning and Operations	PROGRAM MANAGER	$ 60,124	$ 60,551	$ 54,759

- Year to be Completed: 2022

☐ Discontinued (reason) _____

Project Sponsor: Frederick Harris

Sponsoring Department: 565

Project Team (internal):

Project Team (external):

Project Description:

Participation in the EPRI Distribution Operations & Planning research portfolio. The mission of EPRI's Distribution Operations and Planning research program is to equip distribution planners and operators with the means necessary to meet the challenges of today and tomorrow. This includes the supporting and development of new planning processes and frameworks, models, tools, reliability assessment analytics, as well as incorporation of new automation, protection, and control technologies that will be required to transform the current distribution system into an active distribution system that integrates and uses new distributed technologies.

PGE Budget/Actual:

FY19: $60,124
FY20: $60,551/ $60,551
FY21: $54,759

Cost Share Total: (if applicable)

Cost Share Percent:

Benefit to PGE:

Developing tools will further inform equipment analytical processes, and will provide a standard, uniform approach which will ultimately increase system reliability.

Approaches to P200 has informed PGE's future path regarding Distribution Resource Planning.

Customer Benefit:

Strategic Alignment:
Addresses PGE's Distribution Automation Initiative; will enhance the study process related to future installation of DA schemes.

Will continue to inform DRP and related processes moving forward.

Will be referenced to address DSP.

Tools produced from program provides additional efficiency within the planning process, ultimately leading to increased future system reliability.	

Value

PGE Participation: Participated in Distribution Operations and Planning Webinars (focused discussion on DER forecasting, leveraging AMI data, probabilistic planning, DER considerations, and VVO control demonstrations). Distribution Automation (DA) switch/recloser placement tool has been fully integrated in the analytical process and is fully used by planning engineers. Leveraged reference documents. Provides guidance related to distribution system and DER modeling. Informs additional options analyses including non-wires alternatives.	**Value Derived**: Continues be leveraged to meet electrification and decarbonization goals. Tools and materials support scenario planning, and sensitivity assessments. Will add value regarding options analysis and decision making.

Research & Development
Project Summary

Date: 11/13/20

Project Name: Smart PDX Air Sensors Partnership

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: **2023**

☐ Discontinued (reason) _____

Project Sponsor: Jake Wise **Sponsoring Department**: R&D **Project Team (internal):** Jake Wise **Project Team (external):** Christine Kendrick (Smart PDX, CoP), John Fink (PSU), Brianne Suldovsky (PSU), Molly Kramer (PSU), Dawn Nolan (PSU) **Project Description:** The City of Portland BPS/ Smart PDX has deployed air quality sensors in a variety of areas within the metro area and calibrated the data collected to the State of Oregon Department of Environmental Quality (DEQ) on SE Lafayette/ SE 58th. Their NIST-funded study is nearing completion and requires additional funding to continue the sensor install and maintenance, data collection, validation and analysis.	**PGE Budget/Actual:** FY20: $15000/ $10000 (per non-EPRI xls) FY21-23: **$1000** each year subsequent ($18000 in total) **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: Sensors are a potential part of a future Smart City offering that leverages PGE communications infrastructure, and this presents an opportunity to partner with a real expert (and potential customer) to understand technical aspects and market solutions. In partnership with Portland State University, Smart City PDX will provide objective evaluation for identification of locations of interest, research study criteria, methodology, communication strategies, data and findings to support beneficial electrification siting.	**Strategic Alignment:** Electrify/ Increase Structural Parity (e.g., grow load via beneficial electrification)

Data to be shared: seasonal and diurnals trends for sensor locations, distributions of hourly averages of pollutant concentrations **Customer Benefit:** PGE is interested in supporting this work because it will inform where to locate industrial electrification projects that will reduce diesel pollutants for the benefit of locationally disadvantaged communities. Smart Cities are a conceptual vessel for improving the quality of life (QoL) of our customers. It is through this lens that Smart Cities intends to affect change. A better QoL is represented by public safety, reduced congestion, sense of community, climate action, and economic development in a manner that promotes broad-based access and inclusion and respects the security and privacy of the data. This project in particular provides a research benefit to all of our municipal customers and a potential health benefit to their citizens.	

Summary

Synopsis of Project as Implemented: • City accepted funding via ordinance (Dec 2019) • The $15k provided in support of the Smart PDX Air Sensors Partnership may be allocated across 2020-2021 as we recognize the City's focus has shifted to COVID relief efforts. Additionally, it is entirely within the scope of this project to allocate funds toward a guide that promotes awareness and provides education to community members who, as we learned in our survey work with PSU, asked for more information and guidance in this area. We are also excited to entertain ways in which to integrate our data with other public data sets to provide our communities better analysis tools.	**Decisions to be Made**: • None at this time **Next Steps:** • Quarterly research briefs expected until data, report and presentation of study findings (Dec 2023)

Performance Against Objectives/Deliverables:

- Quarterly research brief that details online survey and technical field work ~~forthcoming (Mar 2020)~~complete "Smart Cities Report"

  Smart Cities Report _ Final .pdf

  - Qualtrics survey complete (~~has received~~ approx. 420 respondents) ~~(as of 3/21/20).~~
    - Team is currently focused on getting more non-white respondents (to mirror the racial/ethnic breakdown in the city and avoid getting a primarily white sample) Response rates have stalled with the Coronovirus crisis.

Research & Development
Project Summary

Date: 11/13/20

Project Name: Smart PDX Air Sensors Partnership

Project Status:

☐ Complete

☒ Will Continue Next Year

- Year to be Completed: **2023**

☐ Discontinued (reason) _____

Project Sponsor: Jake Wise **Sponsoring Department**: R&D **Project Team (internal):** Jake Wise **Project Team (external):** Christine Kendrick (Smart PDX, CoP), John Fink (PSU), Brianne Suldovsky (PSU), Molly Kramer (PSU), Dawn Nolan (PSU) **Project Description:** The City of Portland BPS/ Smart PDX has deployed air quality sensors in a variety of areas within the metro area and calibrated the data collected to the State of Oregon Department of Environmental Quality (DEQ) on SE Lafayette/ SE 58th. Their NIST-funded study is nearing completion and requires additional funding to continue the sensor install and maintenance, data collection, validation and analysis.	**PGE Budget/Actual:** FY20: $15000/ $10000 (per non-EPRI xls) FY21-23: **$1000** each year subsequent ($18000 in total) **Cost Share Total:** (if applicable) **Cost Share Percent:** (if applicable)
Benefit to PGE: Sensors are a potential part of a future Smart City offering that leverages PGE communications infrastructure, and this presents an opportunity to partner with a real expert (and potential customer) to understand technical aspects and market solutions. In partnership with Portland State University, Smart City PDX will provide objective evaluation for identification of locations of interest, research study criteria, methodology, communication strategies, data and findings to support beneficial electrification siting.	**Strategic Alignment:** Electrify/ Increase Structural Parity (e.g., grow load via beneficial electrification)

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○ Team is currently focused on getting more non-white respondents (to mirror the racial/ethnic breakdown in the city and avoid getting a primarily white sample) Response rates have stalled with the Coronovirus crisis.	