



Portland General Electric
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August 17, 2022

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Public Utility Commission of Oregon
201 High St., SE. Suite 100
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Attn: Filing Center

RE: PGE 2021 R&D Retrospective Report on Research & Development Projects (UE-294)

Enclosed pursuant to OPUC Commission Order 15-536, is Portland General Electric Company's annual retrospective look at Research and Development Projects for 2022.

Should you have any questions or require further information please call me at (503) 464-7488.

All formal correspondence should be e-mailed to 'pge.opuc.filings@pgn.com'.

Sincerely,

A handwritten signature in black ink that reads "Jaki Ferchland". The signature is written in a cursive, flowing style.

Jaki Ferchland
Manager, Revenue Requirement
Rates and Regulatory Affairs

Encls.
JF/np

cc: Gosia Buscaglia

Date: 04/01/2023

R&D Program/Project Name: P37 Substations

Project Status:

Complete

Will Continue Next Year

- Year to be Completed: Multiyear continuing commitment with EPRI

Discontinued (reason) _____

<p>Project Sponsor: Joey Baranski Sponsoring Department: R&D Project Team (internal): Shane Freepons/Scott Brandt Project Team (external): EPRI Researchers Project Description:</p> <p>This research and development (R&D) program provides industry value through the development of tools, techniques, and methodologies to help utilities improve substation equipment inspection, assessment, maintenance, and risk-based asset management. The information provided through the collection of projects in this program can provide members with knowledge that can help them in the following ways:</p> <ul style="list-style-type: none">• Develop a technical basis for maintenance programs, including for new apparatuses such as resin-impregnated polymer (RIP) and resin-impregnated synthetic (RIS) bushings.• Provide valuable data sets from the assessment of new and emerging monitoring technologies (for example, online DGA, online bushing monitoring, and online partial discharge detection).• Extend equipment life by using maintenance guidelines.	<p>PGE Budget/Actual: FY22: \$101,361</p> <p>Cost Share Total: (if applicable) Cost Share Percent: Typically EPRI programs have an average of 40 times cost leverage.</p>
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<ul style="list-style-type: none"> • Reduce maintenance times and costs via condition-based maintenance. • Assess SF₆ Leak Sealing • Implement predictive maintenance practices to help reduce outages. • Improve the specification and maintenance of protection and control apparatuses. 	
<p>Benefit to PGE: The primary values provided by this research are:</p> <ul style="list-style-type: none"> • Development of equipment aging assessment tools—failure modes, degradation mechanisms, and diagnostics. • Assessment of the effectiveness of various diagnostic tools (online dissolved gas analysis [DGA] and online bushing and partial discharge monitoring). • Assessment of new materials (such as SF₆ alternatives and new insulation fluids). • Development of maintenance, inspection, and assessment guidelines. • Guidelines for relay configuration and settings management. • Development of webinars to transfer knowledge. • Publishing of reference books, guidelines, videos, and field guides. • Collaborative environments for sharing lessons learned and best practices. <p>Customer Benefit: Improved and more efficient operations, increased reliability, and increased safety.</p>	<p>Strategic Alignment: Perform/Operational Efficiency</p>

Value

<p>PGE Participation: Participation in Advisory meetings to gain insight and</p>	<p>Value Derived:</p>
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influence base and supplemental research direction.

Receipt of base research performed.

Participation in combining utility data to use with AI to gain better insights.

The Substations program has delivered many highly valuable reports, guides, and tools that have helped its members increase the reliability and efficiency of electric power delivery. Examples include:

- **Assessment of on-line monitoring technologies to help members in specification development:** EPRI is expanding the scope of this work in two important ways. The first is that further on-line bushing and on-line partial discharge monitors are being added to the test plan. The second important expansion is for on-line DGA monitors and it is the ability to create a new fault in the oil – namely a hot-spot. This is important since it generates unique dissolved gases in the oil that are important for the evaluation of the monitors. For all devices (on-line DGA, on-line PD and on-line bushing monitors) a repeatable test protocol is allowing for valuable data sets to assist with specification development and assessment of measurements. Since the last update, multiple on-line partial discharge monitors were added to the testing protocols. The deployed partial discharge technologies include UHF, Acoustic Emission and bushing partial discharge detection via the bushing tap.
- **Improving transformer risk assessment using new DGA (Dissolved Gas Analysis) markers:** In this project have completed the design and construction of a full lab-grade Gas Chromatograph for deployment on a transformer to research in real-time the dynamics of the new DGA markers on an in-service transformer.

The results will narrow down which markers to focus on. This result produces high value since utilities already conduct oil sampling in the laboratory - so the added value of an additional, meaningful markers for risk assessment is significant. The next step will be deployment in the field.

- **Transformer Technical**

Webinars: Throughout the year, multiple Transformer Technical Webinars continue to be held for members of this project. The Webinars are designed to provide in-depth training on important transformer topics. Content is based on the Copper Book, which serves as a valuable companion textbook for the Webinars. Attendees are also provided with Professional Development Hour certificates.

- **SF6 Leak Sealing for Circuit Breakers and Gas-Insulated Substations.** This task investigates methods that can be used by utilities to cost-effectively seal SF6 leaks. The emphasis is on identifying materials and techniques that can seal while maintaining equipment operating pressures and are easy to apply and remove by utility personnel without having to resort to outside service providers, clamps, or molds. The work began with a state-of-the-science review and continues through laboratory testing. Successful candidate materials identified in the laboratory testing are further tested in the field at utility sites. Supplemental funds may be used for further field testing.



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| | <ul style="list-style-type: none">• Battery Monitoring Systems: Multiple battery monitoring systems are subjected to bench testing and rigorous discharge and recharge cycles on battery banks of multiple chemistries to evaluate effectiveness and provide insights for procurement, installation, operation, and long-term reliability. |
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Research & Development Program / Project End Year Summary



Date: 3/24/23

R&D Program/Project Name: EPRI P174 DER Integration

Project Status:

- Complete
- Will Continue Next Year

EPRI P174 DER Integration	PROGRAM MANAGER	Cost 2020	Cost 2021	Cost 2022	Budget 2023
	Josh Davis	\$ 75,288	\$ 66,891	\$ 69,339	\$ 72,113

- Year to be Completed: 2025

Discontinued (reason) _____

<p>Project Sponsor: Jennifer Galaway</p> <p>Sponsoring Department: 565</p> <p>Project Team (internal):</p> <p>Project Team (external):</p> <p>Project Description:</p> <p>This project is ongoing and is utilized primarily for information gathering, learning, and workshop participation. 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). P174 provides insight for the adoption of IEEE 1547-2018 which enables smart inverter functionalities. Also included are valuation mechanisms for DERs and insights into utility interconnection practices and strategies related to future integration and non-wires solution (NWS) approaches.</p>	<p>PGE Budget/Actual:</p> <p>FY19:</p> <p>FY20: \$75,288</p> <p>FY21: \$66,891/\$66,891</p> <p>FY22: \$69,339</p> <p>FY23: \$72,113</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p>
<p>Benefit to PGE:</p> <p>Provides supporting documentation, workshops, and updates to analytical tools regarding managing interconnection requests, grid control applications, and integration of DER.</p> <p>Customer Benefit:</p>	<p>Strategic Alignment:</p> <p>Aligns strategies relating to hosting capacity via DRIVE. Will be key component in defining related Distributed Resource Planning (DRP) efforts. Addresses management of interconnection requests, and rules/regulations related to these requests. Reference documents provide insight relating to DER</p>



<p>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.</p>	<p>settings, operation, and protection.</p>
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Value

<p>PGE Participation: Participated in general overview meeting with EPRI and internal stakeholders.</p> <p>Will leverage P174 to better understand smart inverters and smart inverter settings.</p> <p>Will continue to leverage P174 to determine best practices when performing Hosting Capacity Analyses.</p> <p>Leveraging available resources provides guidance in decision making process relating to DER integration.</p>	<p>Value Derived: Hosting Capacity is a major topic of interest in the Distribution System Planning (DSP) docket. Participation in the DRIVE user group and active use of the DRIVE tool has been incorporated in the DSP Plan published in Q4, 2021.</p> <p>Materials provide insight regarding inverter patterns, expectations due to heavy PV penetration, and guidance relating to voltage regulation.</p>
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Research & Development Program / Project End Year Summary



Date: 05/26/2023

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

Project Status:

- Complete
- Will Continue Next Year

		Cost 2020	Cost 2021	Cost 2022
P180 – Distribution System Research	PROGRAM MANAGER	\$ 130,024	\$ 115,109	\$ 119,230

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

Discontinued (reason) _____

<p>Project Sponsor: Jay Landstrom</p> <p>Sponsoring Department: R&D</p> <p>Project Team (internal):</p> <p>Dan Loomis (Manager, Utility Standards Engineering)</p> <p>Various Internal Stakeholders (Data Science, Distribution Engineering, UAM, Standards, etc...)</p> <p>Project Team (external):</p> <p>EPRI Researchers</p> <p>Project Description:</p> <p>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.</p> <p>Examples of assets addressed in this program include wood poles, transformers, reclosers, cable terminations, and overhead conductors. Examples of industry issues include the use of reliability metrics, fleet management approaches, safety, and resiliency.</p>	<p>PGE Budget/Actual:</p> <p>FY22: \$119,230</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p> <p>Typically EPRI programs have an average of 40 times cost leverage.</p>
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<p>Benefit to PGE:</p> <ul style="list-style-type: none"> • 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 <p>Customer Benefit:</p> <p>Improved and more efficient operations, increased reliability, and increased safety.</p> <p>Participation in this program allows PGE to leverage over \$5 million worth of research activities for a low cost.</p>	<p>Strategic Alignment:</p> <p>Perform/Operational Efficiency</p> <p>Electrify</p>
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Value

<p>PGE Participation:</p> <p>Participation in Advisory meetings to gain insight and influence base and supplemental research direction.</p> <p>Receipt of base research performed. Included information related to the performance of avian covers being used on PGE's system.</p> <p>Participation in supplemental research areas, such as arc fault modeling to help better align PGE work practices with best industry practices.</p> <p>Participation in combining utility data to use with AI to gain better insights.</p>	<p>Value Derived:</p> <ul style="list-style-type: none"> • Structure performance testing. Full-scale laboratory testing of new overhead structure designs to assess performance during tree-strike events and improve resiliency. • Evaluation of online monitoring. Online monitoring systems are becoming more commercially viable and are receiving more interest from utilities in response to resiliency and reliability drivers. EPRI researchers evaluate these systems in an objective manner to understand and quantify performance. • Pole inspection technologies. Assessed the performance of nondestructive pole inspection technologies by comparing it to actual remaining pole strength. • Sensor performance testing results. Laboratory testing of line sensors provided data that utilities can use to enhance specifications. • Development of pole sensors. Development and field tests of sensors to detect pole angle and condition in real time.
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- Understanding of grounding configurations for vehicles. Laboratory testing of energized trucks informs grounding and safety practices.
- Assessment of resiliency approaches and technologies. Field, laboratory, and computer tools to help utilities understand effectiveness and prioritize options to improve resiliency.
- Collection and curation of industry practices around underground infrastructure. A robust repository of industry practices helps utilities identify areas for improvement of inspection, maintenance, and safety practices.
- Network training. Developed and implemented an online training curriculum in low-voltage meshed network systems; available through EPRI-U.
- Investigation of high-impedance faults and mitigation methods. Research into downed conductor and high-impedance faults helps utilities understand the risk and phenomena as well as the options to detect downed conductors and mitigate risks.
- Testing of underground switches. Development of new industry intelligence on switch aging and performance in underground systems.
- Laboratory testing of manhole events and restraint systems. Controlled laboratory testing of manhole events provides real-world performance information about restraint and mitigation systems.

Date: 08/09/2023

R&D Program/Project Name: P198 Strategic Sustainability Science

Project Status:

- Complete
- Will Continue Next Year
- Discontinued (reason) Lack of internal PGE support due to organizational and personnel changes. Will look to fund in later cycles if prioritized.

<p>Project Sponsor: Kristen Sheeran</p> <p>Sponsoring Department: R&D</p> <p>Project Team (internal): Direct Reports</p> <p>Project Team (external): EPRI Researchers</p> <p>Project Description:</p> <p>The Strategic Sustainability Science program identifies and develops tools, models, and analyses that utilities need in order to integrate a sustainability mindset throughout their organizations and throughout the communities they serve.</p> <p>Expectations regarding sustainability commitments and performance are rising as customers, investors, employees, and other industry stakeholders become more committed to achieving an energy transition that benefits everyone, and also underpins ambitious economy-wide decarbonization targets. Corporate strategies are advancing beyond regulatory compliance to a more comprehensive focus on driving value through economic, environmental, and social responsibility. As a result, electric power companies need ways to embed sustainable practices into day-to-day operations and strategic long-range planning.</p> <p>To address these expectations, the program explores how a commitment to sustainability</p>	<p>PGE Budget/Actual: FY22: \$45,222</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent: Typically EPRI programs have an average of 40 times cost leverage.</p>
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<p>throughout electricity generation, delivery, and utilization can support a sustainable economy. This program serves as a resource nexus to bring sustainability thought leaders together and propel progressive scientific research and analysis.</p>	
<p>Benefit to PGE: The primary values provided by this research are:</p> <ul style="list-style-type: none"> • Establishes a focal point for the present and future of sustainability-related research for the energy industry. • Enhances utilities' ability to operate more efficiently, better mitigate risk, and meet growing expectations of customers and other stakeholders. • Enables utilities to enhance strategic planning, risk management, value analysis, and communications processes by engaging colleagues in these areas directly and developing tools to help root sustainability into these functions. • Enriches the two-way interaction and dialogue on sustainability issues and solutions between various internal and external stakeholders, which drives timely, proactive engagement and improved understanding. • Empowers better-informed utility decision making on a broad range of strategic topics by incorporating sustainability dimensions. • Equips utilities to increase the maturity of their sustainability approach, thus demonstrating sustainability leadership. • Supports strategic activity, but also informs day-to-day decision making, for example, through metrics research to inform sustainability reporting. 	<p>Strategic Alignment: Decarbonization, Perform</p>



<p>Customer Benefit:</p> <ul style="list-style-type: none">• Ultimately helps in achieving the broad societal, economic, and environmental benefits associated with more sustainable companies and communities.	
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Value

<p>PGE Participation:</p> <p>Participation in Advisory meetings to gain insight and influence base and supplemental research direction.</p> <p>Receipt of base research performed.</p>	<p>Value Derived:</p> <ul style="list-style-type: none">• Facilitated workshop and goal setting using the Electric Power Sustainability Maturity Model.
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Research & Development Program / Project End Year Summary



Date: 04/01/2023

R&D Program/Project Name: EPRI P200

Project Status:

- Complete
- Will Continue Next Year

Cost 2022

EPRI P200 Distribution Planning and Operations	PROGRAM MANAGER	\$ 58,712	
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- Year to be Completed: 2025

Discontinued (reason) _____

<p>Project Sponsor: Jennifer Galaway</p> <p>Sponsoring Department: 565</p> <p>Project Team (internal):</p> <p>Project Team (external):</p> <p>Project Description: Participation in the EPRI Distribution Operations & Planning research portfolio has been key in laying foundational groundwork in updating practices and principles in Distribution Planning. EPRI's Distribution Operations and Planning research program equips 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. The group has teamed up the P18 to focus on Transportation Electrification and the new challenges that this will bring on the distribution system.</p>	<p>PGE Budget/Actual: FY22: \$58,712/\$58,712</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent: Typically EPRI programs have an average of 40 times cost leverage.</p>
<p>Benefit to PGE: Developing tools will further inform equipment analytical processes, and will provide a standard, uniform approach which will ultimately increase system reliability.</p>	<p>Strategic Alignment: Addresses PGE's Distribution Automation Initiative; will enhance the study process related to future installation of DA schemes.</p> <p>Will continue to inform Distributed Resource Planning (DRP), Transportation Electrification, and related processes moving forward.</p>



<p>Approaches to P200 has informed PGE's future path regarding Distribution Resource Planning and Transportation Electrification.</p>	<p>Will be referenced to address DSP and the TE Plan.</p>
<p>Customer Benefit:</p>	
<p>Tools produced from program provides additional efficiency within the planning process, ultimately leading to increased future system reliability.</p>	

Value

<p>PGE Participation: Participated in Distribution Operations and Planning Webinars.</p> <p>Distribution Automation (DA) switch/recloser placement tool continues to be a key analytical tool used by Planning Engineers. DRIVE is used for Hosting Capacity Analysis.</p> <p>Leveraged reference documents. Provides guidance related to distribution system and DER modeling. Informs additional options analyses including non-wires alternatives. Provides some operational insight relating to ADMS.</p>	<p>Value Derived: Continues be leveraged to meet electrification and decarbonization goals.</p> <p>Tools and materials support scenario planning, and sensitivity assessments. Will add value regarding options analysis and decision making.</p>
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Date: 08/16/2023

R&D Program/Project Name: EPRI Technology and Innovation

Project Status:

- Complete
- Will Continue Next Year
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<p>Project Sponsor: Jay Landstrom</p> <p>Sponsoring Department: R&D</p> <p>Project Team (internal): Jay Landstrom, Allegra Hodges</p> <p>Project Team (external): EPRI Researchers</p> <p>Project Description:</p> <p>EPRI's Technology Innovation (TI) program drives thought leadership, and couples early-stage and emerging R&D with technology scouting, incubation, and assessment, to accelerate a pipeline of emerging solutions in support of the future Integrated Energy Network.</p> <p>The TI program—funded by all EPRI members at over \$30 million annually—is a core benefit of EPRI membership. EPRI members, at no additional cost, may access all TI products (about 150 unique activities per year) and may participate in industry interest groups, thought leadership forums, and other collaborative activities. Many TI resources are also made publicly available, free of charge, to encourage more inclusive industry discussions on emerging topics, trends, and technologies.</p> <p>TI's work involves exploration, ideation, collaboration, and acceleration across four functional program components:</p> <ul style="list-style-type: none">• Strategic Insights• Global Innovation Hub• Strategic Research Priorities• Long-Term Sector R&D	<p>PGE Budget/Actual: FY22: \$0</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p> <p>This program is funded by all EPRI members through participation in any programs. The annual budget for TI research is \$30 million, and all program outputs area available to all EPRI members.</p>
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<p>Benefit to PGE: Insight into leading edge technology and thought leadership to help inform programs and strategies.</p> <p>Customer Benefit:</p> <p>Implementation of new technologies can further enable customer participation in the new power grid. Additionally these new technologies can help deliver a more reliable and resilient grid.</p>	<p>Strategic Alignment: Decarbonization, Perform</p>

Value

<p>PGE Participation:</p> <p>Participation in Advisory meetings to gain insight and influence base and supplemental research direction.</p> <p>Receipt of base research performed.</p>	<p>Value Derived:</p> <p>Participation in:</p> <ul style="list-style-type: none"> • Incubatenergy Labs • Utility Business Model Working group • 24/7 Carbon Free Energy Interest Group • University Global Research Grants
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Research & Development Program / Project End Year Summary



Date: 8/9/2023

R&D Program/Project Name: EPRI Global Innovation Effectiveness

Project Status:

- Complete
- Will Continue Next Year

Cost 2022

Cost 2023

EPRI Global Innovation Effectiveness	Jay Landstrom / Allegra Hodges	\$ 17,093	\$ 35,000
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- Year to be Completed: 2023

Discontinued (reason) _____

<p>Project Sponsor: Jay Landstrom</p> <p>Sponsoring Department: R&D, Project Integration</p> <p>Project Team (internal): Strategic Innovation</p> <p>Project Team (external): EPRI, Innovation Force</p> <p>Project Description: Continue participation in EPRI Global Innovation Effectiveness cohort for peer collaboration and best practices related to innovation</p>	<p>PGE Budget/Actual: FY22: \$25,000 (\$17,093 used SDF) FY23: \$35,000</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p>
<p>Benefit to PGE: Established best practice approaches related to Strategic Alignment, Process, Resources, Technology related to successful innovation.</p> <p>Customer Benefit: Building a discipline and practice for innovation that supports greater efficiency, quicker decision-making on new technologies, and greater organization-wide visibility into innovation findings.</p>	<p>Strategic Alignment: Strategic Innovation was a focus of the 2022 Board of Directors' strategy retreat, and has now become a WIG deliverable. Creating an efficient and effective process to manage innovation work is critical to achieving our long-term strategic goals around decarbonization, electrification, and performance.</p>

Value



PGE Participation:

PGE has been an active participant in monthly meetings, collaborating with EPRI and peer utilities throughout the year to develop metrics for innovation, define best practices and definitions, and to share learnings.

Value Derived:

Through participation in this program, PGE has identified its strengths and opportunities for innovation. As a result, PGE has been able to develop and begin implementing a strategy for innovation management, establish a new function to prioritize ideas and govern decision-making, and begin to track the efficiency of our processes so that we can improve upon them.

Research & Development Program / Project End Year Summary



Date: 3/7/2023

R&D Program/Project Name: Iron Flow Battery Project

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

	Kevin Whitener	\$ 0	\$ 31,430	\$ 43,570
Iron Flow Battery Project				

- Year to be Completed: 2023

Discontinued (reason) _____

<p>Project Sponsor: Darren Murtaugh</p> <p>Sponsoring Department: RC509/Grid Edge Solutions</p> <p>Project Team (internal): Kevin Whitener, Colin Solini</p> <p>Project Team (external): Steve Cox (Nikos), ESS, Inc.</p> <p>Project Description: ESS, Inc. to install 250kW battery at their cost. PGE will install communications and controls to dispatch it. Project is 2-year duration to explore flow battery technology.</p>	<p>PGE Budget/Actual: FY21: \$0/\$0 FY22: \$75,000/\$31,430</p> <p>Project was scheduled for Q3 2022 completion but delays on ESS's part have pushed the schedule to Q3 2023. That is why we need \$43,570 to complete the project in 2023.</p> <p>Cost Share Total: (if applicable) Cost Share Percent:</p>
<p>Benefit to PGE: PGE gets to control and dispatch a flow battery with 8-hour duration and explore the technology. Cost to PGE is only the communications and controls because ESS will provide the equipment and construction to install the battery at their cost.</p> <p>Customer Benefit: In this case, we are working with our customer, ESS, Inc. who is an emerging producer of iron flow long duration batteries. This project benefits them directly by have PGE dispatch their battery in real time allowing them to demonstrate and test their product in an actual grid-tied environment. PGE's rate paying customers benefit from this arrangement due to paying a fraction of what full price would be for this energy storage resource.</p>	<p>Strategic Alignment: Ensure resource adequacy as we decarbonize</p>



Value

<p>PGE Participation: For PGE to purchase and install a battery like this would normally be in the \$1MM range. Such a project would normally have a 10-year life or \$100k per project year. For this project, with a 2-year life, we are spending \$75k, so \$37.5k per project year. After 2 years, PGE will remove our equipment from site and that equipment retains its value and can be used on other projects.</p>	<p>Value Derived: \$200k - \$75k = \$125k plus \$20k in equipment that we retain when the project is over; net \$145k.</p>
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Research & Development Program / Project End Year Summary



Date: 2/24/23

R&D Program/Project Name: Program 60: Electromagnetic Fields and Radio-Frequency Health Assessment and Safety

Project Status:

- Complete
- Will Continue Next Year

		Cost 2021	Cost 2022	Cost 2023
Program 60: EMF and RF Health Assessment and Safety	Rob Roloson	\$ 152,280	\$ 156,282	\$ 160,394

- Year to be Completed: 2025

Discontinued (reason) _____

<p>Project Sponsor: Forrest Carithers</p> <p>Sponsoring Department: Health & Safety</p> <p>Project Team (internal): Rob Roloson/ Brian Williams</p> <p>Project Team (external): Phung Tran / Mike Silva</p> <p>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 regarding both the community and workers. In 2023 the focus will remain on epidemiology, synthesis of health research, risk communication tools to address key health concerns, practical exposure characterization tools, and management guidance for existing and new sources of exposure including interference with implanted medical devices. Epidemiologic research is focused on issues such as childhood leukemia, neurodegenerative diseases, and pregnancy outcomes. 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 has developed computer-based training on various topics related to EMF that is available to all of PGE.</p>	<p>PGE Budget/Actual: FY21: \$105,426/\$152,282 FY22: \$156,282</p> <p>Cost Share Total: N/A</p> <p>Cost Share Percent: 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.</p>
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<p>Benefit to PGE: PGE will be able to provide proactive risk management strategies to address high 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.</p> <p>Customer Benefit:</p> <p>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.</p> <p>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.</p>	<p>Strategic Alignment:</p> <p>Participation in EPRI's Programs fully meets the company strategies of: Delivering an exceptional customer experience (See Customer Benefits below):</p> <ol style="list-style-type: none"> 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.
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Value

<p>PGE Participation:</p> <p>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</p>	<p>Value Derived:</p> <p>PGE has hosted two EPRI Knowledge Transfer Initiatives that have helped to inform transmission and substation design to reduce EMF, brought knowledge to PGE regarding 5G and RF safety, and is continuing</p>
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Research & Development Program / Project End Year Summary



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 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.

to provide training on various EMF and RF issues. PGE has implemented an EMF/RF Working Group and Program document that helps guide the EMF/RF customer concern process and management of 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. PGE (Rob Roloson) presented Electromagnetic Fields in the Utility Industry at the 2023 Governor's Occupational Health & Safety conference to share learnings across different industries.

Research & Development Program / Project End Year Summary



Date: 06/19/2023

R&D Program/Project Name: P94

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

	Darren Murtaugh	\$ 90,460	\$ 93,174	\$ 96,901
P94 Energy Storage				

- Year to be Completed: 2025

Discontinued (reason) _____

<p>Project Sponsor: Darren Murtaugh</p> <p>Sponsoring Department: RC509</p> <p>Project Team (internal): Darren Murtaugh</p> <p>Project Team (external): Erin Minnear</p> <p>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 systems, distribution systems, 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 that are safe, reliable, cost-effective, and environmentally responsible.</p>	<p>PGE Budget/Actual:</p> <p>FY21: \$90,460/ \$90,460</p> <p>FY22: \$93,174/ \$93,174</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p>
<p>Benefit to PGE:</p> <p>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</p> <p>Customer Benefit:</p>	<p>Strategic Alignment:</p> <p>(Which PGE Corporate Imperative did this project address?)</p> <p>Decarbonize</p>



<p>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</p>	
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Value

<p>PGE Participation:</p> <p>Webinars, twice-annual advisory meetings, and access to web portal</p>	<p>Value Derived:</p> <p>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.</p> <p>BESS Commissioning Guide BESS Handbook Review of Utility and 3rd Party Programs</p>
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Date: 8/9/2023

R&D Program/Project Name: P161 – Geospatial Informatics (GIS)

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

TITLE OF THE PROJECT	PROGRAM MANAGER:	Cost 2021	Cost 2022	Cost 2023
P161 – Geospatial Informatics (GIS)	Eric Stipe	\$ 144,315	\$ 147,701	\$ 151,125

- Year to be Completed: 2025

Discontinued (reason) _____

<p>Project Sponsor: Rob Weik Sponsoring Department: 319 Project Team (internal): Eric Stipe Project Team (external): EPRI Project Description: 161H is the Geospatial Informatics (GIS) track in 161. This tract performs industry studies, organizational surveys, performs research on emerging technologies and multi-year trends, as well as contributes to pilots. It offers a common platform for discussion among geospatial professionals at utilities and offers insight into the rapidly evolving landscape of how geospatial technology is operationalized.</p>	<p>PGE Budget/Actual: FY21: 144,315/\$144,315 FY22: \$147,701/ \$147,701</p> <p>Cost Share Total: (if applicable) Cost Share Percent:</p>
<p>Benefit to PGE: 161H provides a benefit to PGE in numerous ways. First, by creating an open forum for peer utilities 161H offers PGE an opportunity to gain insights into what new technological developments are being adopted across the industry to advance geospatial operations. It offers space to share firsthand</p>	<p>Strategic Alignment: With decarbonization goals on the horizon and operations rapidly expanding to meet that need the reliance on geospatial data is continually growing. Participation in this track allows for PGE to be tuned in to how others are developing in similar</p>



<p>knowledge and experience of programs or initiatives and for others to gain valuable perspective on successes and lessons learned. 161H also provides a source of documentation, standards, and goals for benchmarking to help provide a common framework across the board, resulting in saved time in developing them independently.</p> <p>Customer Benefit: In creating an open space to share information, ideas, technology, and the documentation that accompanies those efforts, PGE is contributing in a process to ensure that we are up to date on industry trends that maximize efficiency and benefit our customers. Whether that be organizational efficiencies in the structure of GIS teams, the standardization of symbology, or pilots to evaluate emerging tech, breaking down silos between utilities in the industry offers PGE an opportunity to structure our geospatial operations in a way that maximizes customer outcomes including time and cost management.</p>	<p>areas, whether that is transportation electrification, storage, or otherwise. The geospatial track provides valuable insight and awareness that impact the grid model used by major operational platforms at PGE.</p>
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Value

<p>PGE Participation:</p> <p>EPRI meetings and workshops Input on shaping EPRI surveys to larger community Technology webinars</p>	<p>Value Derived:</p> <p>161H, Geospatial Informatics (GIS), provides leading practices for optimizing GIS system value. Address GIS data quality and data management challenges with a focus on the science and technology of acquiring, storing, cleaning, modeling, analyzing, producing, presenting, and disseminating geospatial datasets. Developing tools and insights that enable the next-generation GIS, including the support of immersive 3D environments. Assess geospatial technologies that enable utilities to expand their GIS capabilities for advanced analytics, network management, and process automation.</p>
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Research & Development Program / Project End Year Summary



Date: 8/9/2023

R&D Program/Project Name: P218 Heat Recovery Steam Generators

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

	TJ Mulqueen	\$ 30,000	\$ 30,584	\$ 31,296
P218 Heat Recovery Steam Generators				

- Year to be Completed: 2023

Discontinued (reason) _____

<p>Project Sponsor: Maria Ouellette</p> <p>Sponsoring Department: PSES - 551</p> <p>Project Team (internal): Brent Lee, Brad Hanna, Jason Dobson</p> <p>Project Team (external):</p> <p>Project Description: Reliability of our gas assets will be crucial for meeting 24/7 energy needs today and are central to an affordable and reliable clean energy future. Subscription to P218 will help with identifying ongoing cycling fatigue and creep damage on our combined cycle plants thru pro-active identification of component failures using industry best practices for Non-Destructive Examination (NDE) and introduction of new technologies for remote inspections. The HRSG is a critical plant component and P218 helps utilities improve plant reliability and availability by better understanding of the impacts of thermal cycling and other factors that influence remaining component life.</p>	<p>PGE Budget/Actual:</p> <p>FY21: \$30,000</p> <p>FY22: \$30,584</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p>
<p>Benefit to PGE: Teams are currently leveraging industry standards and specifications for upcoming projects and compliance program improvements such as the specifications development for the Port Westward 1 CO and SCR catalyst replacements, HP Superheater Replacement, Beaver Economizer Replacements, and the fleet-wide Covered Piping Compliance program focusing on hanger audits and assessments.</p>	<p>Strategic Alignment:</p> <p>WIG 3 – Increase Operational Efficiency</p>



<p>Customer Benefit: Benefit to the customer has been and will be realized through optimization of capital and O&M spend. Involvement in this program informs our inspections during planned outages and allows us to address 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.</p>	
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Value

<p>PGE Participation: High-level value consists of the following:</p> <ul style="list-style-type: none"> • Reduce risk of in-service failures to high-temperature and pressure components • Significantly reduce the impact of lost availability due to HRSG tube failures • Make fitness-for-service decisions to determine if components can remain in service or if repair or replacement activities are required • Safely extend time between outages and inspections through use of advanced inspection and analysis techniques <p>Application products and services leveraged to improve capital and O&M optimization include the following:</p> <ul style="list-style-type: none"> • Accessing EPRI historical documents • FAC inspection guidelines • Implement learnings into FAC inspection program • Implement learnings into Covered Piping Program (CPP) documentation • CO and SCR procurement guidelines • HRSG tube failures and life-assessment research, which develops a comprehensive methodology to assess cycling capability, including optimizing startup in terms of thermal transients. • Attended Generation Advisory and Council meetings in Chicago, Illinois in 2023 • Regional workshops covering HRSG tube failures, cycle chemistry, inspection and FAC, assisting with the technology transfer of the program 	<p>Value Derived: In the past year we've used the information derived from P218 to support specification development for the CO and SCR Replacement at Port Westward 1 and are currently leveraging the program to develop specifications for economizer replacements at the Beaver facility. The team continues to develop PGE's Covered Piping Program (CPP), focused on high-energy piping (HEP) pipe hanger assessments, frequency of inspections, and documentation templates. Risk Ranking for Coyote Springs HEP was completed. The resources leveraged through the program have helped in determining root causes of boiler tube failures and replacement options, the Superheater Replacement at Port Westward is moving toward the execution phase and the Beaver Economizers are currently under evaluation for replacement.</p>
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Research & Development Program / Project End Year Summary



Date: 12/30/2022

R&D Program/Project Name: EPRI P226 Boiler and Turbine Steam and Cycle Chemistry

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

	PROGRAM MANAGER	\$ 30,000	\$ 30,587	\$ 31,296
EPRI 226				

- Year to be Completed: 2025

Discontinued (reason) _____

<p>Project Sponsor: Alex Banicki</p> <p>Sponsoring Department: Maintenance, Monitoring, & Diagnostics Engineering</p> <p>Project Team (internal): Alex Banicki, Charles Linder</p> <p>Project Team (external): NA</p> <p>Project Description:</p> <p>Joined EPRI Program 64 (now Program 226) to allow Fleet Chemist and other stakeholders access to EPRI guidelines for optimal cycle chemistry control to provide long term asset protection, reduce overall operating and maintenance costs, increase steam turbine efficiency, minimize chemical cleanings, and increase operator knowledge of cycle chemistry. Inclusion in this program is essential in guiding the Thermal Fleet Chemist role and shape the PGE boiler and steam chemistry programs with best practices and the latest advances in industry knowledge. 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.</p>	<p>PGE Budget/Actual: FY21: \$30,000/\$30,000 FY22: \$30,587/30,587</p> <p>Cost Share Total: NA</p> <p>Cost Share Percent: NA</p>
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<p>Benefit to PGE:</p> <p>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 knowledge sharing from plant to plant. Access to the P226 catalog provides access to resources and information enabling PGE to stay current on the latest cycle chemistry information, standards, and areas of concern across the power generation industry.</p> <p>Customer Benefit:</p> <p>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 PGE chemistry programs and will allow us to develop internal subject matter expertise at a faster rate.</p>	<p>Strategic Alignment:</p> <p>Perform – Delivering operational excellence</p>

Value

<p>PGE Participation:</p> <p>We have utilized our access to EPRI programs to update HRSG chemical treatment control, water and steam quality limits, investigate advances in online continuous chemistry analyzer technologies and how to utilize the data for asset protection. Membership has allowed PGE to participate in the EPRI Research Advisory Meetings in P226 and gain exposure to other emerging programs of significance such as Carbon Reduction and Energy Storage Technology Programs during 2022.</p>	<p>Value Derived:</p> <p>We have utilized the information accessible through EPRI to inform our thermal generation plants of the latest changes in water and steam quality guidelines, instrumentation, and operational and maintenance best practice recommendations for the Beaver and Carty Water Treatment Plants. We will continue to utilize the information available as ongoing development of the Chemistry Program Manager hired on in 2020.</p>
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Research & Development Program / Project End Year Summary



Date: 4/17/2023

R&D Program/Project Name: Sense Energy Monitor Demonstration

Project Status:

- Complete
- Will Continue Next Year

Cost 2020 Cost 2021 Cost 2022

Sense Energy Monitor Demonstration	Timothy Treadwell	\$ 0.00	\$ 0.00	\$ 50,000.00
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- Year to be Completed: 2024

Discontinued (reason) _____

<p>Project Sponsor: Timothy Treadwell</p> <p>Sponsoring Department: Grid Edge Solutions</p> <p>Project Team (internal): Timothy Treadwell, Quinn Cherf, Emily Haynes, Manny Obi</p> <p>Project Team (external): Sense</p> <p>Project Description:</p> <p>This project will support/inform several PGE initiatives, including those related to the Smart Grid Testbed, Grid Products, Distribution Planning, and Customer Digital Solutions work. With this funding, PGE will procure and install 500 Sense units within the study area of the DOE Connected Community/SGTB Flexible Feeder Demonstration. Once installed, the team will use the data collected to understand the composition of loads, behavioral patterns (e.g., timing), and explore using this real-time experience to drive demand flexibility. In addition, PGE will collaborate with Sense explore a variety of grid analytics use cases derived from detailed, real-time data. We will use these data to identify and geolocate power quality issues, faults, and events; identify potential failing assets; better understand the composition of loads down to the transformer; and determine the best ways to scale the integration of detailed edge data. This project will be housed within and managed by the Smart Grid Testbed team.</p>	<p>PGE Budget/Actual:</p> <p>FY20: \$0.00</p> <p>FY21: \$0.00</p> <p>FY22: \$50,000.00</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p> <p>PGE will leverage an estimated \$150k in funding from the Smart Grid Testbed Flexible Feeder demonstration project in 2023. This funding will come either from the deferral Testbed deferral or the DOE Connected Communities budget. Match funding will be spent in 2023-25.</p>
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<p>Benefit to PGE: Customers are not well versed in the appliances and behaviors that drive their demand. Providing real time usage information at the device level will increase awareness and enable greater participation/effectiveness in flexible load programs, such as Peak Time Rebates. These same data, aggregated to the circuit level, will help distribution planning and operations teams evaluate and implement strategies that incorporate customer load flexibility into their core functions.</p> <p>Customer Benefit: Customers will benefit from more effective planning and program design/delivery, reducing costs and the associated impact on rates.</p>	<p>Strategic Alignment:</p> <p>Providing enhanced insights on customer-level energy usage (e.g., real time consumption, disaggregated load, etc.) to customers themselves, planners, and operators will support PGE's load flexibility development activities, increase operational efficiency, and allow for increased investment in and reliance on renewable generation.</p>
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Value

<p>PGE Participation:</p> <p>Insights from this project will provide important lessons to PGE on how to incorporate high resolution, grid edge data into our planning and operations functions.</p>	<p>Value Derived:</p> <p>Devices are not scheduled to be deployed until later this year, so no data has been collected or value realized yet in the project.</p>
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Research & Development Program / Project End Year Summary



R&D Program/Project Name: EPRI P206 Wind Generation

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

Program/Project Name	Lead	Cost 2021	Cost 2022	Cost 2023
EPRI P206 Wind Generation Annual Research Program	Alex Triplett	\$ 30,000	\$ 30,587	\$ 31,296

- Year to be Completed: 2025

Discontinued (reason) _____

<p>Project Sponsor: Alex Triplett</p> <p>Sponsoring Department: RC283</p> <p>Project Team (internal): Alex Triplett, Greg Bingham, Scott Phares, Jesus Carrera, Ian Brook, Alex Banicki</p> <p>Project Team (external): Brandon Fitchett (EPRI), Raja Pulikollu (EPRI)</p> <p>Project Description: Participation in the EPRI Wind Program Annual Research Program.</p>	<p>PGE Budget/Actual: FY21: \$30,000/\$30,000 FY22: \$30,587/\$30,587</p> <p>Cost Share Total: 50:1</p> <p>Cost Share Percent: P206 ARP total 2022 funding was \$1.545MM. PGE's contribution was \$30,581.</p>
<p>Benefit to PGE: The objective of 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.</p> <p>Customer Benefit: Wind plays a major role in PGE's vision for a clean energy future. It is important to take actions that make our wind fleet a reliable and cost-effective renewable generating resource for our customers.</p>	<p>Strategic Alignment: This program is in alignment with PGE's corporate imperatives to Decarbonize and Perform.</p>



Value

<p>PGE Participation:</p> <ul style="list-style-type: none">- Attended 2022 Winter Generation Advisory meetings in Tucson, AZ.- PGE presentation to EPRI Generation Advisory Council on the benefits of wind farm Monitoring & Diagnostics.- Monthly meetings with EPRI wind team to discuss new updates and PGE specific issues.	<p>Value Derived:</p> <ul style="list-style-type: none">- PGE awarded EPRI Tech Transfer award for Wind Turbine Health Monitoring Tools to Detect Major Component Damage.- Utilized EPRI Reliability Database for maintenance forecasting, a tool to make data driven predictions for unplanned capital maintenance.- Developed and reviewed generator thermal fatigue modelling, a potential data analysis technique to enable more proactive action with generator failures.- Discussed benefits of using a mixture model for Weibull forecasts of wind turbine failures.- Collaborative sessions with peer utilities and EPRI facilitators to discuss industry best practices and opportunities.
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Research & Development Program / Project End Year Summary



Date: 03MAR2023

R&D Program/Project Name: Tucannon Blade Health Assessment

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

	Alex Triplett	\$ 0	\$ 14,978	\$ 0
Tucannon Blade Health Assessment	Alex Triplett	\$ 0	\$ 14,978	\$ 0

- Year to be Completed: 2022

Discontinued (reason) _____

<p>Project Sponsor: Alex Banicki</p> <p>Sponsoring Department: RC288</p> <p>Project Team (internal): Alex Triplett, Anthony Mathews, Jagdish Konathala, Scott Phares</p> <p>Project Team (external): Tugan Eritenel, Megan Rotondo, Hidenori Araki (ONYX Insight)</p> <p>Project Description: This assessment utilized wind turbine SCADA and Condition Monitoring System (CMS) vibration data. ONYX Insight processed and analyzed the data to assess blade health and identify turbines with suspected damage. The analysis results were compared against historical internal and external blade inspections to assess whether the techniques were successful and could be operationalized to detect future blade damages at the site.</p>	<p>PGE Budget/Actual: FY21: NA FY22: \$14,978/\$14,978</p> <p>Cost Share Total: (if applicable) NA Cost Share Percent: NA</p>
	<p>Strategic Alignment: This program is in alignment with PGE's corporate imperatives to Decarbonize and Perform.</p>



Benefit to PGE:

This project is a prudent use of funds to mitigate a risk with both a high likelihood and high consequence of failure. Online monitoring has potential to optimize wind turbine blade O&M. While some vendors offer sensors that claim to detect damage, there are no “industry-proven” solutions. Utilizing existing CMS sensors and SCADA data is a simple option to consider before investigating more complicated, costly alternatives.

Customer Benefit:

The cost of blade repair and/or sensor retrofits to mitigate risk will ultimately be shouldered by PGE’s ratepayers. It is prudent to pursue the most efficient mitigation possible.

Value

PGE Participation:

PGE provided access to relevant turbine data for the analysis. PGE evaluated the results of the health assessment for opportunities to operationalize. Reference ONYX Insight report *IUS-000874-DC-001-A Tucannon Blade Vibration* for the complete analysis.

Value Derived:

PGE ultimately determined that using drivetrain CMS sensors to detect blade damage does not provide reliable results. In 2023, PGE is building on this knowledge and trialing a pilot with acoustic sensors in effort to get early detection of blade damage.

Research & Development Program / Project End Year Summary



Date: 3/22/2023

R&D Program/Project Name: EPRI DCOI Assessment

Project Status:

Complete

Will Continue Next Year

Cost 2020

Cost 2021

Cost 2022

	PROGRAM MANAGER	Cost 2020	Cost 2021	Cost 2022
EPRI DCOI		\$ 0	\$ 40,000	\$ 40,000

- Year to be Completed: 2023

Discontinued (reason) _____

<p>Project Sponsor: Jacob Leeney</p> <p>Sponsoring Department: RC 311</p> <p>Project Team (internal): Standards</p> <p>Project Team (external): EPRI</p> <p>Project Description: To aid the widespread adoption of DCOI as an alternative pole treatment to Penta, EPRI will be testing DCOI-treated poles over the next three years. The testing will be focused on understanding DCOI's effectiveness in preventing pole decay, maintenance requirements, effect on pole strength, necessary inspection period, environmental risks, and proper disposal methods.</p>	<p>PGE Budget/Actual:</p> <p>FY21: \$40,000 /\$40,000</p> <p>FY22: \$40,000/\$40,000</p> <p>FY23: \$40,000</p> <p>Cost Share Total: N/A</p> <p>Cost Share Percent: N/A</p>
<p>Benefit to PGE: PGE benefits from this study by better understanding how to own and maintain wood poles treated with DCOI, a wood preservative that is replacing Penta.</p> <p>Customer Benefit: Increased reliability driven by proper maintenance on DCOI poles</p>	<p>Strategic Alignment: Customer Focus, Increased Reliability</p>

Value

<p>PGE Participation: Direct information sharing with EPRI on the new preservative and how to best maintain poles treated with DCOI. Other studies on DCOI that are available to PGE are very limited in scope, and do not provide a comprehensive review of</p>	<p>Value Derived: Pole treatment and maintenance work practices that are appropriate for DCOI, the new wood pole preservative that is replacing Pentachlorophenol.</p>
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Research & Development
Program / Project End Year Summary



the new preservative.	
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Research & Development Program / Project End Year Summary



Date: 3/24/2023

R&D Program/Project Name: Program 62: Occupational Safety and Health

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

Program 62: Occupational Safety & Health	Rob Roloson	\$ 39,585	\$ 42,478	\$ 44,361
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- Year to be Completed: 2025

Discontinued (reason) _____

<p>Project Sponsor: Forrest Carithers</p> <p>Sponsoring Department: Health & Safety</p> <p>Project Team (internal): Rob Roloson / Ben Lumsden</p> <p>Project Team (external): John Shober</p> <p>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, fatigue management, vehicle/driver safety, and human performance. 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.</p>	<p>PGE Budget/Actual: FY21: \$46,648/\$39,585 FY22: 46,648/\$42,478</p> <p>Cost Share Total: (if applicable)</p> <p>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.</p>
<p>Benefit to PGE: Program 62 Occupational Safety and Health deliverables for 2022:</p> <ul style="list-style-type: none"> - Contractor Safety Management Best Practices for Utility Operations (3002024761) 	<p>Strategic Alignment: Deliver exceptional customer experience Pursue excellence in our work</p>

Research & Development Program / Project End Year Summary



<ul style="list-style-type: none"> - Incident Investigation Process Improvement (3002021762) - Predictive Analytics Workshop (3002024757) - Human Performance Workshop (3002024759) - Practical Fatigue Measurement Approaches for Utility Field Operations: Technology Scouting and Pilot Test (3002025011) - Using Visual Literacy to Improve Hazard Recognition in Electric Utility Designs: Guidance for Practice, Research Findings and Recommendations, Fact Sheet (3002025015, 3002025013, 3002025014) - Design and Field Testing of a New Ergonomic Tool for Moving Electric utility Manhole Covers (3002025797) <p>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.</p>	<p>Participation in EPRI's Program 62 fully meets the company strategies of:</p> <ul style="list-style-type: none"> 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.
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Value

<p>PGE Participation:</p> <p>PGE Participation 2022:</p> <ul style="list-style-type: none"> - 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. - Incorporated learnings into program management and safety messages/alerts. - Attended EPRI Advisory Council Meetings in Austin and online. 	<p>Value Derived:</p> <ul style="list-style-type: none"> - 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. - 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 - Human performance workshop attended by PGE HP Specialist. - Contractor Safety Management Best Practices for Utility Operations has informed PGE's Contractor Safety Management Program - Incident Investigation Process Improvement has informed PGE's program.
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Research & Development Program / Project End Year Summary



Date:

R&D Program/Project Name:

Project Status:

Complete

Will Continue Next Year

Cost 2022

Cost 2023

Cost 2024

UNIFI Grid-Forming Inverter Consortium	Ian Beil	\$ 40,000	\$ 40,000	\$ 40,000
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- Year to be Completed: 2024

Discontinued (reason) _____

<p>Project Sponsor: Ian Beil</p> <p>Sponsoring Department: 595 Transmission Planning</p> <p>Project Team (internal): Song Wang</p> <p>Project Team (external): Ben Kroposki (NREL), many contributors from NREL, PNNL, EPRI, and university settings</p> <p>Project Description:</p>	<p>PGE Budget/Actual:</p> <p>FY22: 40,000/\$40,000</p> <p>2023 and 2024 will be covered with SDF(Self Directed Funds)</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p>
<p>Benefit to PGE: The Universal Interoperability for Grid-Forming Inverters (UNIFI) Consortium brings together leading researchers, industry stakeholders, utilities, and system operators to collaboratively pursue advances in a broad range of grid-forming (GFM) inverter technologies. UNIFI will conduct and coordinate enabling research, development, and demonstration, as well as create educational- and workforce-training materials focusing on planning, designing, and operating grids with a high level of GFM Inverter-based Resources (IBRs).</p> <p>Customer Benefit: Grid-forming inverter technology is a fundamental requirement of power system with large concentrations of inverter-based resources (wind and solar), such as those mandated by Oregon HB2021. This research will play a key role in developing the technology that underpins the stable operation of large amounts of renewable resources.</p>	<p>Strategic Alignment:</p> <p>The UNIFI Consortium is a forum to address fundamental challenges in seamless integration of grid-forming (GFM) technologies into power systems of the future</p> <p>Bringing the industry together to <u>unify</u> the integration and operation of inverter-based resources and synchronous machines</p> <p>Three major focuses:</p> <p>Research & Development</p> <p>Demonstration & Commercialization</p> <p>Outreach & Training</p>

Value

PGE Participation:	Value Derived:
<p>UNIFI will develop and evaluate solutions for GFM technology integration at a rate that goes above and beyond consensus-building efforts promulgated by prevailing standards development organizations. Summarized below are key innovations that UNIFI will yield:</p> <ul style="list-style-type: none">□ <i>By systematically curating Interoperability Guidelines and Functional Requirements, and federating standardized testbeds, UNIFI will universally standardize GFM technologies.</i>□ <i>By bringing together GFM manufacturers, utilities, and system operators, UNIFI will address barriers to GFM integration at scale.</i>□ <i>By connecting top researchers to collaboratively address technical barriers, UNIFI will accelerate development, deployment, and adoption of GFM solutions.</i>	<p>By joining the UNIFI consortium, including attending in-person meetings and being involved with the working groups, PGE will leverage the expertise of leading industry figures to determine how best to deploy wind, solar, and battery resources at large scale across the power system. This may include, for instance, adjusting Generator Interconnection standards to require grid-forming inverters. Such approaches have not been used by US utilities in the past, but are increasingly being seen as a necessary step to ensuring long-term stability of the power system.</p>



Date: 5/31/2023

R&D Program/Project Name: Primary Frequency Response Detection and Archiving System

Project Status:

- Complete
- Will Continue Next Year
- Discontinued (reason) _____

<p>Project Sponsor: Jay Landstrom</p> <p>Sponsoring Department: R&D</p> <p>Project Team (internal): Mani Obi</p> <p>Project Team (external): PSU Electrical Engineering faculty and students</p> <p>Project Description: Power system balancing authorities are routinely affected by sudden frequency oscillations. These frequency events can initiate cascading outages and cause damage to both customer-owned and utility equipment. For this project, the Portland State University capstone team developed a regression-based algorithm that is capable of detecting frequency events within a short period of time after the onset of an event. This frequency detection algorithm rapidly detects frequency events and generates flags, which can then be used to actuate response assets. The algorithm has three parameters that can be adjusted, making it highly tunable. The team also developed an Algorithm Evaluation Environment, which the team used to evaluate the algorithm and quantify its efficacy using a suite of evaluation metrics. Within this report, the team demonstrates how to use the Algorithm Evaluation Environment to tune the algorithm parameters in order to best align results with industry expert opinions. Engineers can use this evaluation environment to tune the detection algorithm to best match the definition of a</p>	<p>PGE Budget/Actual: FY22: \$18,581</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent: N/A</p>
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<p>frequency event, as defined by their own experts, prior to implementing the frequency response algorithm within their balancing area.</p>	
<p>Benefit to PGE: This capstone team has developed a process for evaluating the ability of an algorithm to detect frequency events. The Algorithm Evaluation Environment (AEE) uses an event archive consisting of 135 PMU data sets to quantify the ability of an algorithm to reproduce the observations of industry experts. Because of its speed, sensitivity, and tuneability, this algorithm shows significant promise and will be implemented in the PSU real-time frequency event detection system in Summer 2021. In addition to developing the AEE and the regression algorithm, the team also achieved the following:</p> <ul style="list-style-type: none"> • Developed a visualization tool for stored PMU data to plot frequency and slew rate over time. • Compiled a Frequency Event Archive of 135 frequency events, near-events, and non-events of PMU data. • Developed a GUI-based analysis tool for event classification. • Created an online survey for classifying events that can be easily sent to industry experts. • Developed an automated program that compares algorithm output to industry expert assessment. <p>Customer Benefit: Greater situational awareness for detecting frequency events translates into more reliable operations and reliability for customers.</p>	<p>Strategic Alignment: Efficient Operations</p>

Value

Research & Development Program / Project End Year Summary



PGE Participation:

PGE engineering participated in providing data and feedback to the research

Value Derived:

Tools and algorithms that can be implemented by PGE system operations.

Date: 05/31/2023

EPRI Program/Project Name: Educating a Digital Power Workforce to be GREAT with Data

Project Status:

- Complete
- Will Continue Next Year
 - Year to be Completed: 2023
- Discontinued (reason) _____

<p>Project Sponsor: Jay Landstrom</p> <p>Sponsoring Department: R&D</p> <p>Project Team (internal): Jay Landstrom, Alex Banicki</p> <p>Project Team (external): EPRI Staff</p> <p>Project Description:</p> <p>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).</p> <p>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.</p>	<p>PGE Budget/Actual: FY22: \$10,000</p> <p>Cost Share Total: N/A</p> <p>Cost Share Percent: Typically EPRI programs have an average of 40 times cost leverage.</p>
<p>Benefit to PGE:</p> <p>The GREAT with Data initiative will address T&E for workforce skills in five key technical areas:</p> <ol style="list-style-type: none"> 1. Power system fundamentals; 	<p>Strategic Alignment:</p> <p>Decarbonize Electrify</p>



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:

Attending advisory meetings in the Spring and Fall. Named affiliate universities to participate, PSU and OSU. GridEd trainings attended by PGE engineers

Value Derived:

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.



Date: 5/31/2023

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 Pandemic-Resilient and Sustainable Transmission and Distribution Systems	Linda Keezer	\$ 20,000	\$ 20,000	\$ 20,000
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- Year to be Completed: 2022

Discontinued (reason) _____

<p>Project Sponsor: Anthony Gomez</p> <p>Sponsoring Department: Health & Safety</p> <p>Project Team (internal): Linda Keezer</p> <p>Project Team (external): Annette Rohr, EPRI Project Manager EPRI SME's and other utility funders</p> <p>Project Description: This project aims to assess the near- and long-term impacts of COVID-19 and provide a rigorous technical basis for future pandemic resilient and sustainable T&D operations.</p> <p>Key project focuses of this project include:</p> <ul style="list-style-type: none"> • 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 	<p>PGE Budget/Actual: FY20: \$20,000/20,000 FY21: \$20,000/\$20,000 FY22: \$20,000</p> <p>Cost Share Total: \$120,000</p> <p>Cost Share Percent: Total project budget is about \$7,000,000 which makes our cost share at 1.7%.</p>
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<ul style="list-style-type: none"> • 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 	
<p>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 non-pandemic 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.</p> <p>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.</p>	<p>Strategic Alignment: Perform – Delivering operational excellence</p>

Value

<p>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.</p>	<p>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.</p>
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Date: 5/26/2023

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) _____

<p>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.</p>	<p>PGE Budget/Actual: FY22: \$15,000/\$15,000 Cost Share Total: \$160,000 Cost Share Percent: 6.25%</p>
<p>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. The solar lab is also the solar standard for developers to measure potential against as a benchmark.</p>	<p>Strategic Alignment: Decarbonize & Electrify</p>

Summary

<p>Synopsis of Project as Implemented: Data is accessed for solar facility studies</p>	<p>Decisions to be Made: None</p>
<p>Performance Against Objectives/Deliverables:</p>	<p>Next Steps:</p>

Research & Development Project Summary



	Provide access to solar data across PGE business units
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Research & Development Program / Project End Year Summary



Date:

R&D Program/Project Name: Equity Map and Resource Planning Model

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Portland General Electric Heat Equity Mapping for Energy	Adam Gardels	\$	\$ 35,000
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- Year to be Completed: 2022

Discontinued (reason) _____

<p>Project Sponsor: Darren Muraugh Sponsoring Department: DRP Project Team (internal): Andy Eiden Project Team (external): CAPA Strategies Project Description: CAPA's Presentation summarizes affects of demographic (age, income, etc.) and locational characteristics (tree canopy & impervious surface cover, and building types) on health outcomes from extreme weather during 2021 Heat-Dome. The resulting vulnerability map will help PGE in planning efforts focused on hardening the grid to withstand extreme weather loads necessary to sustain these vulnerable communities.</p>	<p>PGE Budget/Actual: FY21: FY22: \$35,000/\$35,000</p> <p>Cost Share Total: (if applicable) Cost Share Percent:</p>
<p>Benefit to PGE: Transmission distribution planning inputs.</p> <p>Customer Benefit: Protecting vulnerable communities from health stresses posed from extreme weather. Map will be used to direct municipal cooling initiatives to communities of greatest need, and help PGE plan for new summer load peaks.</p>	<p>Strategic Alignment: Cost efficient T&D investments.</p>

Value

<p>PGE Participation: PGE load and grid data.</p>	<p>Value Derived: PGE specific grid planning outputs.</p>
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Research & Development
Program / Project End Year Summary



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Date: 5/31/2023

Project Name: Cascadia Lifelines Project

Project Status:

- Complete
- Will Continue Next Year (OSU is continuing the research initiative beyond the original 5 year timeline)
- Discontinued (reason) _____

<p>Project Sponsor: James Landstrom</p> <p>Sponsoring Department: R&D</p> <p>Project Team (internal): James Landstrom</p> <p>Project Team (external): Dan Cox, Mike Olsen, Armin Stuedlein</p> <p>Project Description:</p> <p>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 six years.</p>	<p>PGE Budget/Actual: FY22: \$50,000</p> <p>Cost Share Total: \$150,000</p> <p>Cost Share Percent: 20%</p>
<p>Benefit to PGE:</p> <p>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.</p> <p>Customer Benefit:</p> <p>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.</p>	<p>Strategic Alignment:</p> <p>Perform/Operational Efficiency</p>

Summary

Synopsis of Project as Implemented:

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. Additionally new tools are being developed to help in planning for catastrophic events that help to increase our response.

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

Decisions to be Made:

Next Steps:

Continue work on the third major objective:

3. Determine how collaboration/cooperation between stakeholders can improve Grid resiliency.

Date: 8/8/2023

Project Name: CEATI Generation Interest Groups

Project Status:

- Complete
- Will Continue Next Year
 - Engagement is on an annual basis and was renewed for 2023 for the Dam Safety, Hydraulic Plant Life, Asset Management Generation, and Thermal Generation programs
- Discontinued (reason):

<p>Project Sponsor: Maria Ouellette</p> <p>Sponsoring Department: Engineering Services</p> <p>Project Team (internal): Various</p> <p>Project Team (external): CEATI Staff</p> <p>Project Description:</p> <p>Dam Safety(DSIG): Composed of dam owners who jointly sponsor research & development projects designed to help assess and improve the safety of dams. Research is required for the development and evaluation of new diagnostic monitoring tools and techniques in order to assess the stability and safety of existing dams. New repair materials and techniques can reduce the cost of required dam safety improvements.</p> <p>Hydraulic Plant Life (HPLIG): Focuses on required capital investments in equipment and parts replacement to ensure outage times and cost for equipment repair and maintenance are optimized.</p> <p>Asset Management Generation (AMIG): Covers all aspects of Asset Management, from development of policies and strategies, to risk frameworks, asset management plans, and investment management to achieve strategic objectives.</p> <p>Thermal Generation Programs (TGIG): Objective is to identify immediate design, operational, and maintenance issues, and to monitor and develop emerging thermal technologies.</p>	<p>PGE Budget/Actual: FY22: \$76,587</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent: Varies by program</p> <p>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.</p>
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<p>Benefit to PGE:</p> <p>The PGE Dam Safety (Civil) Engineering team actively collaborates with the CEATI Dam Safety Interest Group (DSIG). PGE has engineers who participate in various task force groups, project development teams, and general business needs. These groups include Gates Task Force, Penstock Working Group, Seismic Working Group, and Dam Safety Maturity Matrix development and implementation. As a group, the DSIG works with our domestic peer organizations to collaborate and advocate for the industry by bringing together expertise and providing a coordinated effort to provide the FERC comment on new initiatives and regulation. From the lens of professional network, PGE is able to share and benefit through collaboration with peers from around the world.</p> <p>PGE acts as project monitors for multiple projects related to lubrication and vibration programs for thermal, wind, and hydro for the TGIG.</p> <p>In general, 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.</p> <p>Customer Benefit:</p> <p>Customers benefit from PGE Implementing and maintaining power generation more efficiently and reliably.</p>	<p>Strategic Alignment:</p> <p>Perform</p>
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Value

<p>PGE Participation:</p> <p>PGE's Generation Operations and Design and Asset Management engineering personnel are involved and access information on the CEATI portal</p>	<p>Value Derived:</p> <p>Technical information and peer utility benchmarking</p>
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Research & Development Program / Project End Year Summary



Date: July 18, 2023

R&D Program/Project Name: **EMCB Use case**

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

EMCB Use case	Manny Obi	\$ 0	\$ 36,008	\$
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- Year to be Completed: 2022

Discontinued (reason) _____

<p>Project Sponsor: Manny Obi</p> <p>Sponsoring Department: Grid Edge Solutions</p> <p>Project Team (internal): Manny Obi</p> <p>Project Team (external): Robert Bass, PhD</p> <p>Project Description: Eaton Corporation in collaboration with EPRI, the Electric Power Research Institute is conducting field tests with the EMCB in 12 regional utilities across the U.S., stretching from North Carolina to Hawaii (including PGE). Energy Management Circuit Breakers (EMCBs) offer means to remotely operate, manage, and control customer loads. PGE has identified five use cases that will provide insight into how EMCBs may bring benefits to PGE customers: programmable load control, island support, load research, EV managed charging, and cold load pickup mitigation.</p>	<p>PGE Budget/Actual:</p> <p>FY22: \$36,008</p> <p>FY23:</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent: N/A</p>
<p>Benefit to PGE: Using aggregations of grid-enabled appliances, controllable via smart devices like the Eaton EMCB to control devices such as WHs, rather than traditional generators to provide grid services eliminates much of the the capital, O&M, and real estate costs associated with such plants.</p> <p>Customer Benefit:</p>	<p>Strategic Alignment: The Grid services provides PGE with dispatch flexibility, which improves system reliability and allows for a greater proportion of renewable resources within PGE's generation portfolio.</p>

Value

<p>PGE Participation:</p> <p>PGE provided the smart EMCB breakers, and technical direction for the project. PGE was also involved in the preparation of a technical IEEE paper that was published on the benefits of the EMCB to utilities that others could benefit from.</p>	<p>Value Derived:</p> <p>PGE programs that use grid-enabled appliances controllable via devices like the EMCB can pass on the financial benefits to participating customers, which will encourage additional customers to adopt smart electrical appliances.</p>
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Date: 07/6/2022

R&D Program/Project Name: P40 Transmission Planning

Project Status:

- Complete
- Will Continue Next Year
 - Year to be Completed: Multiyear continuing commitment with EPRI
- Discontinued (reason) _____

<p>Project Sponsor: Jay Landstrom Sponsoring Department: R&D Project Team (internal): Jennifer Galaway, Ian Beil Project Team (external): EPRI Researchers Project Description: Traditional power system planning methods and tools are increasingly challenged in today's power system environment as utilities embark on de-carbonization pathways and prepare for climate change related impacts. Transmission owners and operators not only need to plan for future demand growth and increasingly uncertain generation portfolios, but also to provide transmission services for scenarios with vast amount of distributed resources and central generation resources that include significant portions of variable generation (VG) technologies that are often remote from load centers and have significantly different behavior from synchronous generation. The challenge of meeting reliability and resilience requirements with the changing landscape and increasing levels of uncertainty may necessitate adjusting and enhancing transmission planning criteria and methods, and may require new tools and models for transmission planners. Some of the areas for significant research that will help planners to deal with challenges moving forward are:</p>	<p>PGE Budget/Actual: FY21: \$97,765</p> <p>Cost Share Total: (if applicable) Cost Share Percent: Typically EPRI programs have an average of 40 times cost leverage.</p>
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<p>Generic, easy to use models of emerging generation and transmission technologies that can be validated periodically for planning studies.</p> <p>Efficient approaches to generate and screen contingencies for stability concerns to reduce resource and time burden.</p> <p>Practical framework to plan the system to withstand extreme events such as the impacts of geomagnetic disturbances, electromagnetic pulses, natural events, and various physical security attacks on system resilience.</p> <p>Consideration of impact of extreme weather events on transmission resilience</p> <p>Consideration of impact of climate change along with other policy goals on long-term planning</p> <p>Application of risk-based reliability approaches for optimal investment decision for long-term transmission reliability</p> <p>Use of high-performance computing (HPC) architecture along with machine learning (ML) and artificial intelligence (AI) for planning studies</p> <p>Use of node-breaker models for reliability studies</p> <p>Integration of power electronic-interfaced transmission assets such as HVDC, FACTS, grid enhancing technologies (GETs), energy storage, and distributed resources in transmission planning.</p> <p>Voltage and reactive power management with higher integration of inverter-based resources (IBR)</p> <p>Study methods and tools for more specialized topics like sub-synchronous resonance, control interactions, transmission power quality, electromagnetic studies (EMT) etc.</p> <p>Finally, protection consideration to keep up with the changing grid specifically including efficient tools to check protection settings for changing system conditions, tools for proactively identifying protection mis-operations and near-misses from a large data repository, validating short-circuit models based on event data, and incorporating protection models in planning studies for higher accuracy in certain cases</p>	



<p>Benefit to PGE:</p> <p>The primary values provided by this research are:</p> <p>Innovative methods and tools for reliable and economic integration of new energy resources and end-use loads</p> <p>Tools, methods, key insights to transmission planners to save time, mitigate risks, and reduce costs while maintaining reliability and resilience</p> <p>Engagement with various stakeholders including regulatory agencies, industry standard groups, and government agencies to advance state-of-the-art transmission planning to benefit public at large and reduce risk for grid operators</p> <p>Forum for members to collaborate among each other, expert researchers, and technology specialists to solve near-term issues as well as identify and prioritize long-term research needs that collaborative research should address</p> <p>Customer Benefit:</p> <p>Improved and more efficient operations, increased reliability, and increased safety. Grid operational and analysis enhancements that increase DER implementation.</p>	<p>Strategic Alignment:</p> <p>Perform/Operational Efficiency</p> <p>Electrify</p>
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Value

<p>PGE Participation:</p> <p>Participation in Advisory meetings to gain insight and influence base and supplemental research direction.</p> <p>Receipt of base research performed.</p> <p>Participation in supplemental research areas, such as arc EPRI University for Transmission, Pandemic-Resilient and Sustainable Transmission and Distribution (T&D) Systems,</p>	<p>Value Derived:</p> <p>The Transmission Planning program delivers valuable information that helps its members, other electric power stakeholders, and society in numerous ways. Some examples include the following:</p> <p>Protection Settings Evaluation Tool (PSET) (3002018182, 3002020178): These deliverables provide macros that integrate into commercial short circuit analysis software tools to allow the user to configure aspects of a system-wide short circuit study and then execute the simulations and report on the results. Based on the configuration from the user, the tool identifies protection systems which may mis-operate allowing the user to identify potentially</p>
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incorrect relay settings prior to mis-operation occurring.

Power Plant Parameter Derivation (PPPD) Version 14.0 (3002022342): The PPPD software tool is a simulation program that can be used for validating and parameter estimation of models for synchronous generator power plant, wind and PV power plants, and static var systems. The tool uses measured generation equipment responses to system disturbances to validate the generator, excitation system, and governor control system transient stability models. This tool allows generation owners to perform ongoing model validation as system disturbances occur to support system reliability and to comply with emerging North American Electric Reliability Corp. (NERC) requirements to periodically validate the generator models.

Load Component Export Tool (LCET) 4.1 (3002022343): The LCET simplifies the process of calculating composite load model parameters and exporting them to file formats used by simulation tools Siemens PTI PSS®E and GE PSLF™. Users can export load model parameters for multiple areas/zones in a planning case.

Automated Contingency Generation Tool (ACGT), Version 6.0.1 Beta (3002021522): The ACGT software automatically generates contingencies using node-breaker topology for steady-state as well as dynamic studies. The contingencies generated cover a wide gamut ranging from N-1 to G-1-1, N-1-1, bus faults, breaker failure, stuck breaker, and common-mode as defined in the NERC planning standard TPL-001-4. This tool can potentially result in a significant saving in amount of time and labor required for assessing system reliability. Also, this approach is much less error prone as opposed to manually generating contingencies.

Contingency Screening & Ranking Tool (CSRT) - Transient Stability Module V1.0 Beta (3002021530): This software was developed to screen a large number of contingencies and rank them in order of severity from transient stability perspective.

Contingency Screening & Ranking Tool (CSRT) - Dynamic Voltage Module V2.0 Beta (3002021528): The tool analyzes the post-contingency voltage performance at the local and global level to rank contingencies based upon the nature of the post-

	<p>contingency voltage according to a set of pre-defined voltage performance metrics</p> <p>Protection in Planning Studies Tool (PIPS), Version 4.0 Beta (3002021886) The purpose of this tool is to create appropriate protection relay models on particular grid equipment and populate the device models with conservative setting assumptions. The tool can then be tested on real grids to assess if these generic protection relay models can successfully identify credible protection issues.</p> <p>Risk-Based Planning Scenario Builder Tool (3002021757): This software considers uncertainties in system load, renewable generation, hydro generation, demand-side resources, and economic growth to generate power flow scenarios that can capture a wide range of possible system states. In addition, the tool also generates contingencies for each power flow case based on historical performance of generator and transmission components.</p> <p>Transient Recovery Voltage (TRV) Screening Tool (3002021354): This tool is developed on EMTP-RV platform to perform simulations to screen TRV results against available circuit breaker capability. The tool performs breaker TRV analysis with predefined circuit configurations for easy setup and quick initial assessment. Planners can use this tool to determine if a detailed TRV analysis is needed.</p> <p>Categorizing Line TOV Values for Determining Minimum Approach Distances (3002004444): This report documents a technical basis for characterizing transient overvoltage values (TOV) that drive the minimum approach distances for conducting live-line work. The report summarizes the maximum TOV magnitudes expected for various line characteristics and associated operational practices</p> <p>Controlled Transmission Expansion Planning (CPLANET) (3002021766): CPLANET explores various mathematical modeling and numerical optimization approaches for transmission expansion planning considering power flow control devices such as phase-shifting transformers (PSTs)</p> <p>GICcharm (3002021347): This tool is designed to study GMD-related harmonics</p> <p>Coordinated Expansion Planning JHSMINE Tool V1.0 and V2.0 (3002021771, 3002021770): The coordinated expansion planning (CEP) - Johns</p>
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	<p>Hopkins Stochastic Multi-Stage Integrated Network Expansion (JHSMINE) is a planning software based on stochastic optimization to perform long-term generation and network expansion planning under uncertainties.</p>
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Research & Development Program / Project End Year Summary



Date: 03/30/2023

R&D Program/Project Name: P173 Bulk Renewables and DER Integration

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

TITLE OF THE PROJECT	PROGRAM MANAGER	Cost 2021	Cost 2022	Cost 2023
P173 Bulk Renewables and DER Integration	Ian Biel	\$ 63,655	\$ 65,565	\$ 67,860

- Year to be Completed: Multiyear continuing commitment with EPRI

Discontinued (reason) _____

<p>Project Sponsor: Ian Beil</p> <p>Sponsoring Department: Transmission Planning</p> <p>Project Team (internal): Song Wang</p> <p>Project Team (external): EPRI Researchers</p> <p>Project Description:</p> <p>Over the last fifteen years, the installed capacity of renewable and distributed energy resources has increased significantly, owing to policy decisions such as state renewable portfolio standards and federal clean air and clean water standards, as well as cost reductions and customer preferences. As the penetration of renewable and distributed resources grows, bulk power system planners and operators will require new tools and resources to provide consumers with reliable, sustainable, and cost-effective power. EPRI's Bulk System Renewables and Distributed Energy Resources Integration research program (P173) addresses these research needs by providing members integrating increased levels of renewable energy with critical information to ensure the changing power system's reliability and economic efficiency.</p> <p>Tools to help achieve these goals include:</p> <p>(1) improved and/or new sources of system flexibility to respond to and accommodate increased energy variability and uncertainty</p> <p>(2) the development of additional transmission infrastructure to deliver energy from remote locations</p>	<p>PGE Budget/Actual:</p> <p>FY21: \$63,655</p> <p>FY22: \$65,565</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p> <p>Typically EPRI programs have an average of 40 times cost leverage.</p>
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<p>(3) planning and operations methodologies and software to effectively plan and operate the bulk power system with these new resources, many of which may be at the distribution level.</p> <p>Recent announcements at the federal, state, and utility levels demonstrate significant ambitions to increase clean energy, including renewables and battery storage, to meet decarbonization goals, and have increased the need to explore higher penetrations of renewables, in some cases up to 100%. Much of the expected development of renewables includes variable and/or distributed energy resources (VER/DER), such as onshore and offshore wind and solar photovoltaic (PV), which, when integrated into the grid, pose new challenges for maintaining reliable system operation. Emerging technologies such as battery energy storage, demand response, and increased energy system integration are also expected to support these new resources. New techniques and tools are needed to study and operate these systems, which is the focus of this program.</p>	
<p>Benefit to PGE:</p> <p>The primary benefits of this research are:</p> <p>Provide innovative planning, operations and protection methodologies, tools and models, and integration analysis to help utilities and system operators integrate emerging resources into the grid reliably and economically.</p> <p>Supporting and advancing the development of integrated energy systems with more renewable, sustainable resources for the benefit of society</p> <p>Provide actionable insights, tools, and collaborative opportunities to increase resource adequacy and reliability for a decarbonized future.</p> <p>Customer Benefit:</p> <p>Improved and more efficient operations, increased reliability, and enhanced security. Grid operations and analytics enhancements that facilitate DER deployment.</p>	<p>Strategic Alignment:</p> <p>Perform/Operational Efficiency</p> <p>Electrify</p>

Value

<p>PGE Participation:</p> <p>Participate in advisory meetings to gain insight and influence the direction of basic and supplemental research.</p> <p>Receive the results of basic research.</p> <p>Participate in complementary research areas, such as the arc EPRI University for Transmission, Pandemic-Resilient and Sustainable Transmission and Distribution (T&D) Systems,</p>	<p>Value Derived:</p> <p>The Bulk System Renewables and Distributed Energy Resources Integration program has provided industry leadership and helped produce valuable results in areas such as modeling and transmission planning tools, system protection, operating reserves, frequency response and resource adequacy. Some highlights include</p> <ul style="list-style-type: none"> • Generic models and model validation for wind, solar PV, energy storage, and hybrid resources, where EPRI's leadership in industry forums and related model validation tools and studies have resulted in the incorporation of improved generic models into existing commercial software packages. • Novel system strength metrics and the associated Grid Strength Assessment Tool provide planners with information on potential instability in weak areas and solutions to address these challenges. • Model development, validation and application for grid shaping inverters to support the analysis required to understand the role such resources can play. • A screening-level tool, the Transmission Hosting Capacity Tool, that can assess the additional injection of VER that a portion of the grid can accommodate under pre-defined conditions. • Electromagnetic transient (EMT) type, time domain, and associated frequency domain models of converter-connected wind turbines, solar PV, and batteries that can be used for short-circuit studies to determine how they affect system protection and the development of related guidelines. • Model parameterization tool for Voltage Control Current Source inverters in protection software. • Dynamic equivalent models for DER and modeling approaches for representing active distribution systems in transmission models, and a software tool for developing aggregated DER models. • Operating reserve procurement approaches to manage the variability and uncertainty of variable generation, and delivery of a software tool (DynADOR) to calculate operating reserve requirements. • Developing reserve sizing methodologies to ensure that contingency events can be
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	<p>managed under normal and extreme conditions, and providing a software tool (DynADeCR) to assist operators.</p> <ul style="list-style-type: none">• Ongoing assessment of the changing nature of frequency response in systems with high penetration of VER and DER, including studies of frequency response with high VER.• A software tool (FRADT) that allows users to calculate the available primary frequency response and inertia on their system for future time periods and can be used to study frequency response adequacy.• Software to monitor inertia levels on the system at both the system and regional levels.• A framework and set of metrics and a tool (Inflexion) that can help planners assess the operational flexibility of the system to meet the increased ramping requirements associated with wind and PV.• Guidelines and studies to outline and explore how resource adequacy methodologies may need to be adapted to the changing resource mix and how different resources contribute to adequacy.• Methods for developing scenarios for resource adequacy studies that ensure both extreme and typical events are adequately considered, along with risk modeling of resources on the system.• Modeling approaches for integrating DER, energy storage, and hybrid resources into resource adequacy studies.• Operator guides to help those new to DER integration get up to speed on the most relevant material and issues for operating the system.• Various survey and overview documents on topics such as DER in operations, ancillary services, low inertia operations, and offshore wind integration.
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Research & Development Program / Project End Year Summary



Date: 8/9/2023

R&D Program/Project Name: Heavy Duty Charging Infrastructure

Project Status:

Complete

Will Continue Next Year

Cost 2020

Cost 2021

Cost 2022

Heavy Duty Fleet Charging Infrastructure O&M Strategy and Training	PROGRAM MANAGER	\$	\$ 100k	\$ 100k
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- Year to be Completed: 2022

Discontinued (reason) _____

<p>Project Sponsor: Ian Beil</p> <p>Sponsoring Department: 509</p> <p>Project Team (internal): Becca Baldwin, Ian Beil, Andy Eiden</p> <p>Project Team (external): Tomoki Ito, Dexter Gauntlet, Brian Dillard (Panasonic)</p> <p>Project Description: Explore</p>	<p>PGE Budget/Actual:</p> <p>FY20: -</p> <p>FY21: \$100k / \$19,100</p> <p>FY22: 100K/\$51,373</p> <p>Cost Share Total: Panasonic has dedicated a project engineer from their team to oversee the integration work, which is a significant in-kind cost share contribution.</p> <p>Cost Share Percent: N/A</p>
<p>Benefit to PGE:</p> <p>Creating of a grid-edge controller that is able to monitor and throttle the power of the chargers at Electric Island. This controller will provide a better understanding of the requirements for integrating electric vehicle chargers into PGE control systems</p> <p>Customer Benefit: Allowing PGE to control EV loads will reduce the burden on associated distribution infrastructure, which in turn reduces interconnection costs for customers. These cost savings can spur additional EV purchases and reduce customer energy bills.</p>	<p>Strategic Alignment:</p> <p>This work aligns with PGE's efforts to electrify the transportation sector. By better understanding the tools available to manage EV loads via the installed controller, PGE will be able to reduce EV loads at times of stress on the system, subsequently allowing for further adoption of EVs on a given distribution circuit.</p>



Value

<p>PGE Participation:</p> <p>PGE continued to coordinate with Panasonic on the use cases for the installed grid-edge controller at the Electric Island site. This included possible opportunities to use the controller to interact with the various electric vehicle supply equipment (EV charger) vendors at the site, allowing for a level of control and dispatchability of the chargers.</p>	<p>Value Derived:</p> <p>The “eFleetAggregator” concept is valuable to PGE as a guide to how future Distributed Energy Resource Management Systems will be designed, and how they may interact with PGE advanced distribution management systems. Better understanding the interplay between aggregators (like Panasonic), end use vendors (EV chargers), and the utility provides PGE the ability to design future contracts and business practices that provide the most benefit to the customer.</p>
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Date: 05/26/2023

Project Name: EPRI Incubatenergy Labs

Project Status:

- Complete
- Will Continue Next Year
 - Year to be Completed: 2023, Renewal is on a yearly decision basis
- Discontinued (reason) _____

<p>Project Sponsor: Jay Landstrom</p> <p>Sponsoring Department: R&D</p> <p>Project Team (internal): Jay Landstrom, Darren Murtaugh, Allegra Hodges</p> <p>Project Team (external): EPRI</p> <p>Project Description:</p> <p>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:</p> <ul style="list-style-type: none"> • Customer and Community Engagement • Decarbonization and Sustainability • Fixed Premise Electrification • Electric Mobility • Predictive & Prescriptive Operations • Resilience and Adaptation • Robotics • Waste-Derived Renewable Fuels • Workforce of the Future • Nuclear Assists 	<p>PGE Budget/Actual: FY22: \$60,000/\$60,000</p> <p>Cost Share Total: \$60,000</p> <p>Cost Share Percent: Approximately 10%</p> <p>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), Fortis and others</p>
<p>Benefit to PGE:</p> <p>Access to cutting edge companies in the power sector.</p>	<p>Strategic Alignment:</p> <p>Perform and Customer Satisfaction</p>

PGE will have access to and engage with cutting edge companies that will shape the next generation electrical grid.

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:

PGE participated in the review and selection of companies that were chosen to develop demonstration projects with participating utilities. A selection of finalists were:

- **Demand Q:** The project, between AEP and DemandQ, will demonstrate the company's demand optimization software and services in action at one of EPRI's buildings in Charlotte, N.C., to understand the technology's potential for reducing peak load and delivering seasonal, dispatchable peak demand curtailment services for C&I customers.
- **Dryad:** The company will work with Pacific Gas & Electric to demonstrate its Silvanet large scale IoT network solution for early wildfire detection in Northern California. The Silvanet network includes asset-mounted sensors, a mesh network utilizing LORAWAN for communications, and a cloud-based data analysis dashboard.
- **Electric ERA:** ElectricFish, Ameren and EPRI will partner to demonstrate the value of ElectricFish's patented Community Resilience Score (CoReScore™) within a defined geographical area in a utility's service territory. The outcome is to proactively identify areas which will become burdened with higher EV demand relative to grid capacity gaps, and climate/power outage risks.
- **Enersion:** The company will be building a mobile solar-powered shipping container that provides cooling, hot water, and electricity. The energy cubed product will be fully off-grid, powered solely by solar panels with battery storage. It will be tested at EPRI's Knoxville,

Decisions to be Made:

PGE is following up with participating companies for potential pilot programs.

Next Steps:

Participation for the 2023 program was approved.

TN laboratory, then transferred to Con Edison in New York City where it will be evaluated for use as an off-grid disaster command center and for its energy efficiency properties. ElectroDunas, a distribution utility in Peru and a subsidiary of Grupo Energia Bogota, also will evaluate the project for potential application of the technology in its service territory.

- **Proxxi:** The company will demonstrate its voltage sensor wristband technology with Tennessee Valley Authority personnel who generally work around de-energized equipment to understand and document the technology's potential to help workers avoid near-miss situations.
- **SW Sensewaves:** The company will demonstrate its Adaptix.Grid solution with Grupo Energia Bogota and Southern California Edison to investigate the power of artificial intelligence to provide granular insights from sensor and time-series data to quantify material value that the solution may deliver.
- **Singularity:** The company will be conducting four separate demonstrations of its real-time carbon intensity platform with Ameren, New York Power Authority, Southern California Edison and Xcel Energy, to evaluate real-time carbon intensity information for electricity consumption in various use cases.
- **Renewell:** This project will investigate the company's Gravity Well (abandoned well-to-energy storage) technology by assessing Renewell's pilot installation in Bakersfield, CA. EPRI's team will collect data and evaluate the characteristics of the technology in action, using the ESIC Energy Storage Test Manual and data submission guidelines as guides.

Performance Against Objectives/Deliverables:

The Project delivered the final demonstration results in October 2022.

Research & Development Program / Project End Year Summary



Date:

R&D Program/Project Name:

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

Project Name	NEEA	Cost 2021	Cost 2022	Cost 2023
Northwest End Use Load Research (EULR)	NEEA	\$ 130,000	\$ 130,000	\$ 0

- Year to be Completed: 2025

Discontinued (reason) _____

<p>Project Sponsor: Andy Eiden</p> <p>Sponsoring Department: Smart Cities & Grid Products (formerly Consumer Energy Solutions)</p> <p>Project Team (internal):</p> <ul style="list-style-type: none"> • Andy Eiden, Steering Committee Member • Ashleigh Keene, Working Group Member <p>Project Team (external):</p> <ul style="list-style-type: none"> • David Clement, NEEA, Project Manager • Residential vendor, Evergreen Economics • Commercial vendor, DNV • Steering Committee, various participants • Working Group, various participants <p>Project Description:</p> <p>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.</p>	<p>One-minute data is collected continuously over a five-year period and is accessible to project funders. Aggregated 15-minute 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.</p> <p>PGE Budget/Actual:</p> <p>2018: \$130,000 2019: \$130,000 2020: \$130,000 2021: \$130,000 2022: \$130,000 Total: \$650,000</p> <p>Cost Share Total:</p> <p>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.</p> <p>Cost Share Percent:</p> <p>PGE's share of the total 5-year project budget is 5%.</p>
<p>Benefit to PGE:</p> <p>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</p>	<p>Strategic Alignment:</p> <p>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,</p>



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.

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

Through this project, PGE has strengthened working relationships with utilities and other energy organizations throughout the NW.

For residential and common commercial building types, PGE has access to 1-min sub-metered (circuit-level) data for aggregated by individual end-use to use for analytics internally or with external vendors.

PGE, along with other funders, has priority option to recommend and facilitate additional research that can be funded within the larger project budget.

Value Derived:

Steering Committee member Andy Eiden provided 1-minute residential data for 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.

The PGE project team continues to work with Distribution System Planning, Load Research and IT to bring in and process the data for internal uses, such as model training, forecast improvements, and demand response learnings, among others.

Research & Development Program / Project End Year Summary



Date:

R&D Program/Project Name:

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

Project Name	PROGRAM MANAGER	Cost 2021	Cost 2022	Cost 2023
Large-signal PV Inverter Enhanced Grid Model for Rural Area Voltage Stability Analysis and Control		\$ 30k	\$ 30k	\$ 40k

- Year to be Completed: 2023

Discontinued (reason) _____

<p>Project Sponsor: Ian Beil</p> <p>Sponsoring Department: 509 & 595</p> <p>Project Team (internal): Ian</p> <p>Project Team (external): Yue Cao (OSU), Vinson Guov (OSU), Md Tariquzzaman (OSU)</p> <p>Project Description: PGE rural-area customers are facing potential voltage stability issues due to the increased solar PV penetration and distanced distribution networks. This project proposes to study and prevent such PV caused localized system collapse, especially under N-1 or N-1-1 contingencies. We will focus on constructing a large-signal model describing the PV-tied power electronics inverter based distribution systems, with the coupling of transmission networks in mind. Using the model, we will analyze the voltage stability using an L-index approach. Further, we propose a holistic control solution to guarantee voltage stability, including but not limited to, inverter enabled PV curtailment and reactive power support, possible inverter-tied energy storage add-on, in addition to traditional means such as on-load tap changer (OLTC) or capacitor bank (CB) regulation. We apply a mixed-integer optimization such that the discrete OLTC/CB voltage support can be maximized by the continuous operating spectrum of the active PV inverters. The developed model will also allow PGE to study the impact of PV penetrated distribution systems onto the transmission</p>	<p>PGE Budget/Actual: FY22: \$30k / \$30k</p> <p>Cost Share Total: N/A</p> <p>Cost Share Percent: -</p>
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<p>systems (coupled T&D). Last, the effect of the single-phase PV inverter penetration causing an unbalanced three-phase system can be further investigated and yield a potential mitigation plan.</p>	
<p>Benefit to PGE:</p> <p>The project addresses the challenge of increased PV penetration, which is a renewable resource to help reduce greenhouse gas emissions and increase electricity usage especially in rural areas. The proposed solution will mitigate voltage instability issues so that the customers receive enhanced power quality.</p> <p>Customer Benefit:</p> <p>This project will provide a better understanding of the impacts to rural feeders due to high penetrations of solar PV resources. It will enhance existing PGE planning tools in order to model PV behavior during weak system voltage stability, aiding in the identification of potential trouble spots and providing insight into how the system can be reinforced to avoid such scenarios.</p>	<p>Strategic Alignment:</p> <p>The internal team will conduct periodic updates with the external team regarding the progress, including presentations and reports. The team will demonstrate the effectiveness of the proposed solution by performing multiple simulation studies as well as necessary hardware-in-the-loop experiments. The team will disseminate the research outcome through peer-reviewed conference and/or journal publications.</p>

Value

<p>PGE Participation:</p> <p>Modeled a power system topology that mimicked the rural PGE 57kV network around Mt Hood, using both phasor-domain (PowerWorld) and electromagnetic transient (EMTP) tools.</p> <p>Simulated the impacts to voltage stability when large amounts of solar generation are present on the 57kV network.</p> <p>Identified points in the system where energy storage would be the most electrically impactful in terms of boosting voltage support and stability.</p> <p>Published the following paper: Guov, Vinson, Yue Cao, and Ian Beil. "Islanding of a Topologically Realistic Rural Grid Using Grid-Forming Inverters." <i>2022 IEEE 13th International Symposium on Power Electronics for Distributed Generation Systems (PEDG)</i>. IEEE, 2022.</p>	<p>Value Derived:</p> <p>Ability to better understand where energy storage and photovoltaic resources could best be deployed in rural areas, such as the Mt Hood 57kV corridor, in order to improve system stability. These results will help inform future grant applications and PGE capital projects that aim to boost renewable production on parts of the power system that are more vulnerable to stability issues than the 115kV network.</p>
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Research & Development Program / Project End Year Summary



Date:

R&D Program/Project Name:

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

Pulsed Power DC Microgrid for Remote Area Highway Fast Charging Stations	PROGRAM MANAGER	\$ 30k	\$ 30k	\$ 40k
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- Year to be Completed: 2023

Discontinued (reason) _____

<p>Project Sponsor: Ian Beil & Manny Obi</p> <p>Sponsoring Department:</p> <p>Project Team (internal): Ian & Manny</p> <p>Project Team (external): Yue Cao (OSU), Derek Jackson (OSU), Adam Morey (Daimler Truck North America)</p> <p>Project Description: As multiple DC fast charging stations are mapped along Highway I-5, utility infrastructures must meet these new load demands. Such DC fast charging stations can be viewed as pulsed power loads, as described by short-duration high-power draws from the grid. Instead of significant transmission and distribution infrastructure investment, a localized DC microgrid concept can be an attractive alternative. Onsite energy storage is an essential element to supply the pulsed loads while getting recharged from the grid at slower timescales. Batteries usually have high energy density but not high power density, whereas supercapacitors offer the reversed benefit to meet even faster transient peak loads. Such passive energy storage can support the DC microgrid in large, but an active power/energy control through DC/DC power converters between the energy storage and the DC bus is preferable for optimal energy storage sizing and better power quality, as well as system stability concerns. Additional onsite or nearby PV farms with DC/DC may offer additional benefits, although optional..</p>	<p>PGE Budget/Actual: FY22: \$30k / \$30k</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p>
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<p>Benefit to PGE:</p> <p>The project supports PGE to meet the increasing DC fast charging demands as a result of the growing EV market.</p> <p>Transportation electrification is one primary driver for greenhouse gas reduction as well as electricity usage instead of fossil fuels. The project addresses PGE's infrastructure upgrade challenges by offering a much cheaper alternative of localized microgrids instead of constructing more transmission and distribution lines and facilities.</p>	<p>Strategic Alignment:</p> <p>The internal team will conduct periodic updates with the external team regarding the progress, including presentations and reports. The team will demonstrate the effectiveness of the proposed solution by performing multiple simulation studies as well as necessary hardware-in-the-loop experiments. The team will disseminate the research outcome through peer-reviewed conference and/or journal publications.</p>
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Value

<p>PGE Participation:</p> <p>Building off the initial work in 2021, the project progress in 2022 to include the following</p> <ul style="list-style-type: none"> - Detailed power electronic models of EV charging equipment and battery inverters - Long-duration simulations of the interactions between EV charging, on-site battery discharging, and overall grid impact. - Publication of the following paper: Jackson, Derek, Yue Cao, and Ian Beil. "Bi-Level Optimization Framework for Heavy-Duty Electric Truck Charging Station Design." <i>2022 IEEE Transportation Electrification Conference & Expo (ITEC)</i>. IEEE, 2022. - Development of an optimization tool that will allow PGE to better size batteries co-located with EV charging sites, in order to minimize the total power demand during peak system loading. 	<p>Value Derived:</p> <p>Better understanding of MD/HD EV site designs, including sizing of chargers, deployment of battery energy storage, and potential microgrid applications.</p> <p>Ability to help guide customers as they attempt to design sites similar to Electric Island.</p> <p>Insights into how stationary storage and related distributed resources can alleviate loading at peak times, and a framework for valuing this service.</p>
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Research & Development Program / Project End Year Summary



Date:

R&D Program/Project Name:

Project Status:

Complete

Will Continue Next Year

Cost 2020

Cost 2021

Cost 2022

	PROGRAM MANAGER	\$	\$	\$
OSU Synchrophasor Project			30k	30k

- Year to be Completed: 2022

Discontinued (reason) _____

<p>Project Sponsor: Ian Beil Sponsoring Department: 509 Project Team (internal): Ian 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.</p>	<p>PGE Budget/Actual: FY21: \$30k / \$30k Cost Share Total: N/A Cost Share Percent: -</p>
<p>Benefit to PGE: More accurate models allow PGE transmission planners to better determine the needs of the future transmission system, optimizing capital investments and keeping rates affordable. Customer Benefit: Better understanding of voltage and frequency dynamics on the system through the use of a synchrophasor measurement device which is a newer approach being used by other local utilities and especially BPA. PGE is interested in better understanding how these PMUs can be leveraged to</p>	<p>Strategic Alignment: The internal team will conduct periodic updates with the external team regarding the progress, including presentations and reports. The team will demonstrate the effectiveness of the proposed solution via updated simulations that capture realistic system conditions. The team will disseminate the research outcome through peer-reviewed conference and/or journal publications.</p>



aid in system observation and control, and where they would best be placed. These investments will provide increased reliability to our customers in the long run.

Value

<p>PGE Participation:</p> <ul style="list-style-type: none"> - PGE and OSU have engaged in meetings throughout the course of the project - This has been an iterative process, where OSU conducted initial analysis work, PGE provided feedback and later, transmission models, and OSU refined the analysis for PGE's specific system conditions - OSU and PGE, along with regional entities PacifiCorp and BPA, have engaged in regular meetings with the "NAPSI" organization, which provides monthly updates on synchrophasor applications for power system operations and planning purposes. 	<p>Value Derived:</p> <ul style="list-style-type: none"> - OSU has investigated the concept of voltage control areas in detail and provided insights to PGE on how this analysis could extend to internal planning processes - This research has implications for both bulk power system analysis and microgrid applications - It also provides guidance for where synchrophasor would be most beneficial to the grid - The synchrophasor measurements collected by neighboring utilities also provide a key source of model validation data for NERC MOD-33 compliance tasks.
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Research & Development Program / Project End Year Summary



Date: July 18, 2023

R&D Program/Project Name: Service-Oriented Load Control (SOLOC)

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

EMCB Use case	Manny Obi	\$ 0	\$ 25,972	\$

- Year to be Completed: 2022

Discontinued (reason) _____

<p>Project Sponsor: Manny Obi</p> <p>Sponsoring Department: Grid Edge Solutions</p> <p>Project Team (internal): Manny Obi</p> <p>Project Team (external): Robert Bass, PhD</p> <p>Project Description: PGE and several other partners are developing a Distributed Energy Resource (DER) Management System (DERMS) based on a service-oriented architecture (SOA). This is PGE's effort to better understand customer behaviors in support of Department of Energy's Electrical Grid Of Things (EGOT) FOA, for which PGE is a sub-awardee. In SOA systems, a grid service provider (the DERMS) posts requests for DER participation within a service registry.</p>	<p>PGE Budget/Actual:</p> <p>FY22: \$25,972</p> <p>FY23:</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent: N/A</p>
<p>Benefit to PGE: This project will benefit PGE and its customers by demonstrating to PGE the feasibility of using an SOA-based DER aggregation system that ensures private, secure, and trustworthy information exchange.</p> <p>Customer Benefit:</p> <p>This project will benefit PGE and its customers by demonstrating to PGE the feasibility of using a system that ensures private, secure, and trustworthy information exchange. Such a system considers the customer's interests first, and ensures they always has final control of their appliances, as opposed to a direct-control system that could jeopardize customer comfort.</p>	<p>Strategic Alignment: This project will help reduce PGE's greenhouse gas emissions by having a host of DERs that can be used as FLEX loads. Such loads can also contribute towards PGE resource mix availability and ancillary services.</p>

Value

<p>PGE Participation:</p> <p>PGE provided oversight, student coordination and project supervision.</p>	<p>Value Derived:</p> <p>PGE will benefit from such pilots because it will help PGE better understand and improve operational efficiency by leveraging DERMS capability within our service territory.</p>
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Research & Development Program / Project End Year Summary



Date: 3/23/2023

R&D Program/Project Name: EPRI Program P216 & P217

Project Status:

- Complete
- Will Continue Next Year

		Cost 2020	Cost 2021	Cost 2022
EPRI Program P216 & P217	Lee Cramer	\$ 107,093	\$ 60,000	\$ 61,174

- Year to be Completed: 2025

Discontinued (reason) _____

<p>Project Sponsor: TJ Mulqueen</p> <p>Sponsoring Department: PSES</p> <p>Project Team (internal): Ivan Auer</p> <p>Project Team (external):</p> <p>Project Description: EPRI Program P216 & P217 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 P216 and P217 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). Being part of the user group, knowledge base, and support service of EPRI is critical to our continued reliable and efficient operation.</p>	<p>PGE Budget/Actual: FY20: \$107,093/\$107,093 FY21: \$60,000/\$60,000 (\$30K each) FY22: \$61,174/\$61,174</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p>
<p>Benefit to PGE: Access to Program 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.</p>	<p>Strategic Alignment: Perform – Delivering operational excellence</p>



<p>Customer Benefit: EPRI P216 and 217 have provided critical data for material properties of combustion turbine hot gas path parts. PGE has utilized EPRI's compressor maintenance and operation guidance documents for developing and refining our maintenance program. EPRI has supplied guidance documents on inspection and repair of all HGP components that we are utilizing as guiding documents for our own inspection and repair specification. EPRI has 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 and Major Overhaul guidebooks, has driven improvements in our inspection and repair specifications.</p>	
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Value

<p>PGE Participation: PGE SME is an active advisor and participant on all P216 and P217 meetings and conferences. Participating in these has allowed access to presentation on combustion turbine OEM upgrades, future technological developments, Third-party presentation on maintenance, cleaning and repair services offered for a range of components which allows for additional competitive bidding and service sourcing. PGE SMEs actively utilize the user group and communicate with EPRI SMEs and other industry SMEs to inquire about GT modification such as pinning, cleaning methods, and case cracking issue. We have started to incorporate EPRI's PCR testing to ensure we are installing quality hot gas path parts and added valuable long-term data to our parts history. This inspection method is much faster and cheaper than X-Ray or UT inspection. We have completed inspection of the buckets for Beaver Unit 4 during the first quarter of 2023 and will complete inspection of the Coyote Springs Unit 1 buckets later in 2023. In 2022, we laid plans to complete a validation of the rotor shop inspection guidance documents from EPRI during our 2023 outage season.</p>	<p>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.</p>
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Research & Development
Program / Project End Year Summary





Date: 03/27/2023

R&D Program/Project Name: P34 Transmission Asset Management Analytics

Project Status:

- Complete
- Will Continue Next Year
 - Year to be Completed: Multiyear continuing commitment with EPRI
- Discontinued (reason) _____

<p>Project Sponsor: Joey Baranski</p> <p>Sponsoring Department: R&D</p> <p>Project Team (internal): Shane Freepons</p> <p>Project Team (external): EPRI Researchers</p> <p>Project Description:</p> <p>The Transmission Asset Management Analytics program performs research to develop analytics, methodologies, and asset knowledge enablers, such as failure rates and asset health assessment algorithms, to help utilities make better transmission equipment and component life-cycle management decisions. The results of this research provide utilities with new knowledge, algorithms, and data vital for effective equipment asset management. Research results are transferred to members through scientific reports, easy-to-use software and analytical methodologies, reference guides, webcasts, and workshops.</p> <p>Specific research activities include:</p> <ul style="list-style-type: none"> • Develop data models that guide utilities on identifying data important for asset management analytics, such as developing failure rates, quantifying present condition (health) of in-service assets, prioritizing assets that need attention, formulating 	<p>PGE Budget/Actual: FY22: \$27,993</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p> <p>Typically EPRI programs have an average of 40 times cost leverage.</p>
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<p>spares policies, and better managing asset fleets.</p> <ul style="list-style-type: none"> • Collect and analyze industrywide failure and performance data for transmission assets to develop new metrics and analytics. • Develop novel approaches to curate and query data sets to enhance their value. • Develop analytics using various data sources to uncover asset characteristics and insights to support maintenance and capital planning strategies. • Develop asset health assessment algorithms and risk mitigation strategies (for example, spares policies and equipment risk assessments). • Develop an approach for a consistent analytical basis for making capital and O&M decisions. • Produce reference books, guidelines, and technology transfer webcasts and workshops. • Provide collaborative forums for sharing lessons learned and best practices. 	
<p>Benefit to PGE:</p> <p>The primary values provided by this research are:</p> <ul style="list-style-type: none"> • A sound technical basis for consistent and efficient decision-making • More effective use of existing infrastructure and data • Early identification of type issues, reducing unplanned outages • Improved reliability and availability using analyses based on actual asset health and risk to determine maintenance actions • Reduced reliance on time-based maintenance • Improved capital planning decisions based on industrywide equipment performance and failure data • Reduced unplanned expenses and increased benefits and value of planned work • Improved reliability of electric service 	<p>Strategic Alignment:</p> <p>Perform/Operational Efficiency</p>



<ul style="list-style-type: none"> • Managed life-cycle costs and risks that contribute to keeping electric rates affordable • Help in assessing and managing risks <p>Customer Benefit:</p> <p>Improved and more efficient operations, increased reliability, and increased safety.</p>	
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Value

<p>PGE Participation:</p> <p>Participation in Advisory meetings to gain insight and influence base and supplemental research direction.</p> <p>Receipt of base research performed.</p> <p>Participation in supplemental research areas, such as arc EPRI University for Transmission.</p> <p>Participation in combining utility data to use with AI to gain better insights.</p>	<p>Value Derived:</p> <ul style="list-style-type: none"> • Metrics for Managing and Assessing Transmission Asset Performance: EPRI intends to survey members and other power delivery organizations to better understand the metrics presently used to manage and assess transmission asset performance. • Data Specification for Asset Performance Analysis: EPRI intends to provide a catalogue of what asset characterization data, including demographic and condition assessments, are useful as inputs to EPRI asset management analytics and the formats required by those analytics. • Population Performance Metrics: Compile and analyze in-service, historical maintenance, replacement, and failure data on different types of circuit breakers from member utilities. define and develop metrics and processes for mining and analyzing these data to develop insights that could lead to better-informed decisions regarding maintenance program development;
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	<p>task and timing selection; benchmarking comparison among utilities and breaker makes and models; replacement decision support and specification and selection of new breakers.</p> <ul style="list-style-type: none">• Utilize industry wide transformer and tap changer historical failure and in-service population data and advanced statistical analysis techniques to develop hazard rates for various transformer groups. These hazard rates may be used to assess the performance (aging and failure rates) for select groups and to plan capital and spares policies for these groups.•
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Research & Development Program / Project End Year Summary



Date: 05/31/2023

R&D Program/Project Name: Low Carbon Resources Initiative (LCRI)

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

Cost 2024

LCRI	\$ 150,000	\$ 150,000	\$ 328,878	\$ 328,878
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- Year to be Completed: 2024

Discontinued (reason) _____

<p>Project Sponsor: Jay Landstrom</p> <p>Sponsoring Department: R&D</p> <p>Project Team (internal): Darren Murtaugh</p> <p>Project Team (external): EPRI Researchers</p> <p>Project Description: The Electric Power Research Institute (EPRI) and GTI Energy have created the Low-Carbon Resources Initiative (LCRI) to accelerate the deployment of low- and zero-carbon energy technologies required for deep decarbonization. LCRI is specifically targeting advances in the production, distribution, and application of low-carbon, alternative energy carriers and cross-cutting technologies that enable their integration at scale. These energy carriers—which include hydrogen, ammonia, synthetic fuels, and biofuels—are needed to enable affordable pathways to achieve deep carbon reductions across the energy economy. The LCRI is focused on technologies that can be developed and deployed beyond 2030 to support the achievement of a net zero emission economy by 2050.</p>	<p>PGE Budget/Actual: FY22: \$150,000</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent: Typically EPRI programs have an average of 40 times cost leverage. This initiative is highly leveraged at over 100 times.</p>
<p>Benefit to PGE:</p> <ul style="list-style-type: none"> • Determine the potential role of renewable fuels to contribute to deep decarbonization across the energy economy by mid-century. • Identify opportunities, constraints, and risks (research, development and 	<p>Strategic Alignment: Perform/Operational Efficiency</p> <p>Electrify</p> <p>Decarbonize</p>



<p>demonstration activities, policy impacts, market impacts, etc.) for facilitating increased renewable fuels utilization in a low-carbon future.</p> <ul style="list-style-type: none"> • Pursue research and demonstrations to support key renewable fuels technologies. <p>Customer Benefit: Greater carbon-free energy from their electric supply</p>	
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Value

<p>PGE Participation:</p> <p>Participation in Advisory meetings to gain insight and influence research direction.</p> <p>Gain insight into zero carbon fuels technology to inform resource direction</p>	<p>Value Derived:</p> <p>Access to technical reports on decarbonization of the power industry such as:</p> <ul style="list-style-type: none"> • Fuel Cell Technology Assessment—Potential Future Costs and Low-Carbon Fuel Considerations • Carbon Capture for Fossil Fuel Combustion—State of Technology • Modeling the Flexible Operation of Electrolyzers for Hydrogen Production in a Low-Carbon Energy System: Important Considerations • Conversion of Existing Natural-Gas-Fired Duct Burners to Hydrogen—State of Knowledge and Issues Assessment • LCRI Net-Zero 2050: U.S. Economy-Wide Deep Decarbonization Scenario Analysis • Hydrogen Cofiring Demonstration at New York Power Authority’s Brentwood Site: GE LM6000 Gas Turbine <p>And many more.</p>
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Research & Development Program / Project End Year Summary



Date: 05/26/2023

R&D Program/Project Name: P51 T&D Environmental Issues

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

P51 – Transmission & Distribution Environmental Issues	PROGRAM MANAGER	\$ 58,998	\$ 60,535	
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- Year to be Completed
- Discontinued (reason) Dropped participation due to lack of internal PGE support and higher priority EPRI programs in 2023

<p>Project Sponsor: Jay Landstrom Sponsoring Department: R&D Project Team (internal): Jay Landstrom, Alex Konopka Project Team (external): EPRI Researchers Project Description: EPRI's research regarding T&D Environmental Issues (P51) is designed to inform utilities managing the environmental aspects of T&D across a wide value spectrum by conducting research on protecting resources, managing environmental impacts, protecting human health, and informing permitting, regulatory compliance, corporate strategy, and social responsibility.</p>	<p>PGE Budget/Actual: FY21: \$58,998</p> <p>Cost Share Total: (if applicable) Cost Share Percent: Typically EPRI programs have an average of 40 times cost leverage.</p>
<p>Benefit to PGE:</p> <ul style="list-style-type: none"> • Reduced costs for ROW maintenance; utility pole and other asset management; mineral oil spill and other risk management; and spill prevention, control, and countermeasure compliance. • Improved power system reliability by decreasing the potential for T&D outages from avian/animal interactions, applying enhanced and emerging vegetation management best practices, and reducing vulnerabilities and risks to substation reliability. 	<p>Strategic Alignment: Perform/Operational Efficiency</p>



<ul style="list-style-type: none"> • Reduced ecological and human health risks along T&D ROWs through vegetation management, by preventing avian and other wildlife impacts, and by remediating soil and water contamination at T&D facilities. • Enhanced T&D line permitting and regulatory compliance along T&D ROWs and at substations. <p>Customer Benefit:</p> <p>Improved and more efficient operations, increased reliability, and increased safety.</p> <p>Participation in this program allows PGE to leverage over \$2.5 million worth of research activities for a low cost.</p>	
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Value

<p>PGE Participation:</p> <p>Participation in Advisory meetings to gain insight and influence base and supplemental research direction.</p>	<p>Value Derived:</p> <ul style="list-style-type: none"> • Cleanup endpoints for substations contaminated with dielectric fluids or arsenic. • Data and tools that informed substation retrofit plans acceptable to regulators and that minimize risk and reduce costs. • "Immediate" estimates of potential oil losses in failure events. • Research that helped inform the designation of out-of-service wood poles as nonhazardous. • Bird strike indicator/animal activity monitor deployment/avian collision avoidance at utility sites to clarify operational impacts and reduce liabilities from avian and wildlife interactions with facilities. • Criteria defining cost-effective, sustainable performance standards for integrated vegetation management. • Data to inform the power industry's use of integrated vegetation management as a strategy compatible with North American Electric Reliability Corporation (NAERC) standards. • Guidance and information to enhance pollinator habitat and address invasive species on T&D ROWs.
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	<ul style="list-style-type: none">• Data on costs of deferring vegetation management.• Animal-caused outages mitigation product evaluations.• Stormwater management along ROWs.
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Research & Development Program / Project End Year Summary



Date: 8/9/23

R&D Program/Project Name: P183 -

Project Status:

Complete

Will Continue Next Year

Cost 2021

Cost 2022

Cost 2023

TITLE OF THE PROJECT	PROGRAM MANAGER	Cost 2021	Cost 2022	Cost 2023
		\$ 84615	\$ 86495	\$ 88500

- Year to be Completed: TBD (202X)

Discontinued (reason) _____

<p>Project Sponsor: Joey Baranski Sponsoring Department: 775 Project Team (internal): Toley Clague Project Team (external): Ben Sooter Project Description:</p> <p>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.</p> <p>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</p>	<p>PGE Budget/Actual: FY21: \$84615 FY22: \$86495</p> <p>Cost Share Total: (if applicable) Cost Share Percent:</p>
<p>Benefit to PGE:</p>	<p>Strategic Alignment: Perform</p>



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;
- 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:

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

Value Derived:

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.

meetings and advisory meetings that help shape the projects.

In 2022, EPRI performed research and delivered results in the following areas:

Collaboration: Track industry and government activities and provide technical contributions to key working groups.

Incident Management: Improve the electric sector's ability to scan for devices and vulnerabilities in OT areas, and better understand the true risks associated with those activities.

Threat Management: Develop strategies and guidelines for using the latest generation of intrusion detection and prevention systems on the market designed to operate in the OT space.

Cyber Security Forensics: Create additional ICS forensics field guides for OT devices and deploy a mobile field guide application for the guides.

Transmission and Distribution Control Center Security: Develop a comprehensive control center model to determine cyber security requirements and solutions.

Transmission and Distribution Substation Security: Develop a secure IED management guidebook that provides a comprehensive assessment of management requirements for intelligent substation equipment with a recommended substation management strategy.

DER Security: Update the DER Cyber Security Guidebook to include considerations for cyber security engineering approaches

for securing DER systems. Develop cyber security guidelines for DERMS to provide security architects and engineers with risk-informed and practical approaches for securing DER management systems.

DER Technologies: Provide guidelines for deploying intrusion detection and prevention technologies (IDS/IPS) with DER systems.

Develop security reference architectures for microgrids with a focus on the integration of community microgrids.

Knowledge Applications: Develop additional cyber security metrics, including resiliency metrics. Support metrics adoption and enabling benchmarks of relevant cyber security program performance. Deliver cyber security program assessments and develop novel training opportunities.

Research & Development
Program / Project End Year Summary



Date: 5/26/2023

R&D Program/Project Name: P200: Distribution Planning and Operations

Project Status:

Complete

Will Continue Next Year

Cost 2022

EPRI P200 Distribution Planning and Operations	PROGRAM MANAGER	\$ 58,712	
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- Year to be Completed: 2025 (PGE will assess future involvement at this time)

Discontinued (reason) _____

<p>Project Sponsor: Frederick Harris</p> <p>Sponsoring Department: 565</p> <p>Project Team (internal): Distribution Planning</p> <p>Project Team (external): EPRI Staff</p> <p>Project Description: Participation in the EPRI Distribution Operations & Planning research portfolio has been key in laying foundational groundwork in updating practices and principles in Distribution Planning. EPRI's Distribution Operations and Planning research program equips 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.</p>	<p>PGE Budget/Actual: FY21: \$54,759/\$54,759</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent: Typically EPRI programs have an average of 40 times cost leverage.</p>
<p>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.</p>	<p>Strategic Alignment: Addresses PGE's Distribution Automation Initiative; will enhance the study process related to future installation of DA schemes. Will continue to inform Distributed Resource Planning (DRP) and related processes moving forward.</p>



Customer Benefit:

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.

Distribution Automation (DA) switch/recloser placement tool continues to be a key analytical tool used by Planning Engineers.

Leveraged reference documents. Provides guidance related to distribution system and DER modeling. Informs additional options analyses including non-wires alternatives. Provides some operational insight relating to ADMS.

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.



Date: 08/09/2023

R&D Program/Project Name: Fleet Electrification Planning and Assessment

Project Status:

- Complete
- Will Continue Next Year
- Discontinued (reason)

<p>Project Sponsor: Darren Murtaugh</p> <p>Sponsoring Department: R&D</p> <p>Project Team (internal): Colin Solini, Nico Varela</p> <p>Project Team (external): EPRI Researchers</p> <p>Project Description:</p> <p>The transition towards electrified transportation is underway, with increasing numbers of new electric vehicle sales each year. Freight and delivery companies, bus and taxi operators, service stations, and many other fleet entities have the potential to rapidly introduce fleet charging. Although distribution utilities are aware that fleet electrification is imminent, there is still significant uncertainty on where demand on the grid for fleet charging will be, what their needs will be, and how a utility can proactively prepare to support its customers and the grid. To support this need, EPRI's Electric Transportation and Distribution Operations and Planning R&D programs have developed new processes and analytical capabilities to enable utilities to efficiently plan and design cost-effective solutions for fleet electric vehicle (EV) charging infrastructure. This project seeks to apply these new resources to help utilities evaluate vehicle and charging, characterize fleet travel patterns and technology needs, predict future fleet locations and sizes, quantify grid capacity to accommodate fleet electrification, and identify cost-effective integration solutions.</p>	<p>PGE Budget/Actual: FY22: \$110,000</p> <p>Cost Share Total: (if applicable)</p> <p>Cost Share Percent:</p> <p>Typically EPRI programs have an average of 40 times cost leverage.</p>
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<p>Benefit to PGE: The primary values provided by this research are:</p> <ul style="list-style-type: none"> • Meet broad electrification and sustainability targets by pro-actively planning for future electrification needs • Quantify fleet load characteristics, charging infrastructure needs, and forecasts of future fleets • Enable strategic and cost-effective investment by identifying high-priority feeders for grid-strengthening <p>Customer Benefit:</p> <ul style="list-style-type: none"> • Provide faster turnaround time on fleet customers' interconnection applications 	<p>Strategic Alignment: Decarbonization, Perform</p>

Value

<p>PGE Participation: Provide system data for fleet studies</p>	<p>Value Derived:</p> <ul style="list-style-type: none"> • Assess wide-area grid electrification opportunity: Apply advanced grid analytics tools to assess the capability of the grid to integrate fleet electrification. Identify areas with under-utilized assets that can support electrification as well as areas with limited capabilities. • Future Fleet Electrification Assessment: Identify potential fleet segment vehicle sites, estimate the number and type of vehicles using aerial imagery, and estimate the demand/energy needs associated with electrification. • Grid readiness and integration assessment: Merge fleet forecast parameters (location, demand, etc.) with the wide-area assessment to identify how much electrified fleet load can be accommodated with existing infrastructure and identify high-priority feeders for grid
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Research & Development
Program / Project End Year Summary



	<p>strengthening investment. Assess integration costs and mitigation solutions (grid infrastructure, NWA, charge management, etc.)</p>
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Date: 5/19/2023

EPRI Program/Project Name: Power Quality

Project Status:

- Complete
- Will Continue Next Year
 - Year to be Completed:
- Discontinued (reason) _____

<p>Project Sponsor: Joey Baranski</p> <p>Sponsoring Department: Distribution Operations Engineering</p> <p>Project Team (internal): Neil Curran and Sam Morland are the leads and other engineers provide additional support as needed.</p> <p>Project Team (external): EPRI staff, utility peers, and others</p> <p>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.</p>	<p>PGE Budget/Actual: FY18: \$123,447/\$123,447 FY19: \$126,002/\$126,002 FY20: \$113,502/ \$113,502 FY21:\$90,134/ \$90,134</p> <p>Cost Share Total: (if applicable) Cost Share Percent: (if applicable)</p>
<p>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</p>	<p>Strategic Alignment: This project aligns with all three strategic imperatives.</p>



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.

Distribution Operations Engineering is the first call for technical quality analysis, by partners in the Special Tester group who measure service anomalies. We continue to learn from hands-on experience as and from industry technical resources to grow and expand our expertise. The EPRI Power Quality program has been critical to developing this expertise, and will be a more critical resource as PGE expand bi-directional power flow, non-linear sources and loads on the distribution system (e.g., distributed solar, distributed batteries, DERMs, transportation electrification, VPPs, V2G, etc.), and other reliability and resiliency initiatives (VVO, CVO, CMI reduction, etc.).

Value

PGE Participation: Provides access to PQ expertise.

Value Derived: Access to expert PQ knowledge



Date: 08/09/2023

R&D Program/Project Name: P18 Electric Transportation

Project Status:

- Complete
- Will Continue Next Year
 - Year to be Completed: Multiyear continuing commitment with EPRI
- Discontinued (reason) _____

<p>Project Sponsor: Elyssia Lawrence Sponsoring Department: R&D Project Team (internal): Darren Murtaugh, Nico Varela Project Team (external): EPRI Researchers Project Description: EPRI's Electric Transportation program (P18) has supported the decarbonization of the transportation industry by leading the necessary researching, developing, and demonstrating to prove the concept, collect the necessary data, and demonstrate the technology to lead to scale and mass market adoption. This includes electric vehicle (EV) charging technology and approaches; modelling EV adoption rates of utility customers and evaluating load impacts; educating consumers and policymakers; informing EV standards development; and identifying strategic pathways for the adoption and integration of electric transportation.</p>	<p>PGE Budget/Actual: FY22: \$60,133</p> <p>Cost Share Total: (if applicable) Cost Share Percent: Typically EPRI programs have an average of 40 times cost leverage. P18 is over 90 times cost leverage with \$5.5 million in research value</p>
<p>Benefit to PGE: The primary values provided by this research are:</p> <ul style="list-style-type: none"> • Greater understanding of EV-related customer preferences and behaviors to 	<p>Strategic Alignment: Decarbonization, Perform</p>

inform the design of effective utility EV programs

- Deeper knowledge of local and regional EV markets to inform the design of effective utility EV programs
- Improved understanding of national and global EV markets, technologies, and trends to inform utilities as they design effective EV programs and adapt their systems and operations to EVs
- Greater understanding of the potential benefits of EVs for the environment, grid operations, customers, and society
- Deeper utility engagement with key EV stakeholders nationally and globally, including automakers, equipment manufacturers, charging station operators, national laboratories, and regulators
- Enhanced ability to anticipate grid impacts of EVs and to provide reliable grid infrastructure that can support charging needs of light-, medium-, and heavy-duty EVs
- Smarter management of charging to enable smooth grid integration of EVs
- Greater understanding of the performance, durability, reliability, and operational costs of EVs and their components
- Enhanced ability to advance and refine various light-, medium-, and heavy-duty electric transportation technologies
- Increased knowledge to address technical challenges, inform standards, and enhance safety and reliability of electric transportation and grid infrastructure
- Enhanced standards and equipment interoperability, which can enable EV adoption
- Reduced uncertainty and costs associated with large-scale deployment of EVs and related infrastructure

Customer Benefit:

- Reduced greenhouse gas emissions and improved air quality as a result of widespread EV adoption



<ul style="list-style-type: none"> • Enhanced grid reliability and safety and lower electricity costs as a result of effective integration of EVs • More customer choice regarding energy use, technology adoption, and charging infrastructure • Greater awareness and understanding of EV technologies and applications 	
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Value

<p>PGE Participation:</p> <p>Participation in Advisory meetings to gain insight and influence base and supplemental research direction.</p> <p>Receipt of base research performed.</p>	<p>Value Derived:</p> <ul style="list-style-type: none"> • Analyses of consumer and fleet driving and charging behavior, customer preferences and needs, EV load shapes, charging infrastructure requirements, and EV market potential to inform design of effective utility EV programs • Laboratory testing and collaborative field demonstrations of EVs and EV charging equipment (AC and DC) to collect data and analyze performance and grid impacts • Deep analyses of transportation electrification potential to inform the effective design of utility EV programs or infrastructure investment decisions, including: economic, environmental and equity impacts of EVs to utilities and their customers; smart charging and vehicle-to-grid systems' impact on electricity rate structures, flexibility and demand response, and costs and benefits for grid operations; local EV market assessments in specific utility service areas, including current EV sales, future EV sales projections, and mapping to charging infrastructure. • Development of user-friendly tools to help utilities identify cost-effective solutions to accommodate new loads from commercial and industrial EV fleets, or that utilities' commercial and industrial customers can use to determine cost-effective ways to
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	deploy charging infrastructure for their EV fleets.
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