2024 Innovation Impact Report

Advancing toward a clean energy future

Biglow Canyon

About Portland General Electric

Portland General Electric is a fully integrated energy company that generates, transmits and distributes electricity, serving roughly half of Oregon's population and nearly two-thirds of its commercial and industrial activity.

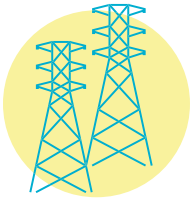
CORPORATE STRATEGIC IMPERATIVES

Decarbonize

Reduce greenhouse gas emissions associated with electricity served to retail customers by at least 80% by 2030 and 100% by 2040.

Electrify

Increase beneficial electricity use to capture the benefits of new technologies while building an increasingly clean, flexible and reliable grid.



Perform

Improve efficiency, safety and system and equipment reliability while maintaining affordable energy service and growing earnings per share 5% to 7% annually.

For more information on Strategic Innovation at PGE, please contact:

Larry Bekkedahl
Senior VP of Advanced Energy Delivery
larry.bekkedahl@pgn.com

Allegra Hodges
Head of Strategic Innovation
allegra.hodges@pgn.com

Lauren Kerr
Strategic Innovation Portfolio Manager
lauren.kerr@pgn.com

For general inquiries: 503-464-2067 or email pgecommunications@pgn.com

On the cover: Pachwáywit Fields

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Transmission lines at T.W. Sullivan Hydroelectric plant

The history of Strategic Innovation at PGE

Innovation has always been at the heart of Portland General Electric. Since 1889, when PGE built the very first long-distance transmission line in the country from Willamette Falls to downtown Portland, our employees have been leading the way to put new technology to work for customers.

PGE continues to take bold steps toward achieving our climate goals, providing a safe, reliable, and affordable grid. PGE has led energy efficiency and clean energy innovation, building wind, solar, and battery storage projects to power our grid for decades.

The passage of House Bill 2021, state legislation that requires PGE to decarbonize its energy supply by 80% by 2030 and 100% by 2040, catalyzed further acceleration of our historic work to achieve decarbonization and modernize our grid. In recent years, as innovation projects have rapidly increased, PGE created its Strategic Innovation team to bring a centralized and standardized approach to managing innovation.

Until October 2022, PGE had managed a handful of independent "innovation projects" focused on investigating emerging technologies and their potential applications to perform, grow, or transform our business. As we navigate the clean energy transition, PGE has expanded the Strategic Innovation portfolio to test ideas that promise to deliver the highest customer value. The energy industry faces evolving challenges, including increasing wildfire risk, as well as anticipated load growth driven by artificial intelligence (AI) use, data centers, and accelerating electrification. At the same time, PGE is installing and testing technology designed to enhance the grid that will enable greater flexibility, bolstered by intelligent capabilities that can integrate as a Virtual Power Plant (VPP). As we navigate this dynamic landscape and pursue grant funding opportunities, innovation plays a crucial role in identifying the best technologies to deliver on PGE's strategy, all while keeping prices as low as possible for customers.

We established the Strategic Innovation function learning from industry leaders and universities across the nation to develop standardized processes and procedures to track and accelerate innovative ideas. Innovation offers better ways to operate a clean grid, which benefits customers. We are committed to building on our legacy of innovation to engage customers and employees across the business to embrace the value of new technologies in the years to come.

AI-driven wildfire cameras in Mt. Hood National Forest

Case study: Leveraging artificial intelligence to improve wildfire response with Pano AI

PGE's groundbreaking partnership with Pano on ignition detection technology exemplifies how we collaborate to address critical challenges. In response to the increasing wildfire risks posed by climate change, and in partnership with Incubatenergy Labs (IEL) as part of the Electric Power Research Institute (EPRI), PGE has deployed Pano's advanced AI-powered camera systems across the area we serve, following a successful demonstration through the 2021 cohort of EPRI's Incubatenergy Labs.

This technology has modernized PGE's and our local firefighting partners' ability to quickly detect and respond to fires, demonstrating tangible benefits in public safety and infrastructure protection. In August 2023, the Pano AI fire detection camera network played an important role supporting first responders during a lightning-caused wildfire in the Bull Run Watershed, a critical water source for over one million people in the greater Portland metro area. At night, the cameras pinpointed the ignition location of what would become the Camp Creek Fire, and provided high-definition, live-streaming video of the fire to PGE and key emergency response agencies. The cameras showed the fire area's fuel type, behavior, and rate-of-spread, and gave the local fire incident management team more than four hours of advanced planning time than if the fire had been reported at daybreak by traditional detection methods. Since deploying Pano AI cameras across our system, the technology's application has expanded to several use cases beyond what was originally intended, including improved situational awareness during winter storm response and providing first responders with data to inform planning evacuation routes.

The success of this initiative underscores the value of embracing external partnerships and cutting-edge technologies to tackle evolving industry challenges. As PGE navigates the energy transition, Strategic Innovation creates an environment where all PGE team members are encouraged to actively participate in innovation efforts, seek out collaborative opportunities, and contribute to shaping a safe, affordable, resilient, and sustainable energy future for our customers.

How PGE innovates

PGE's workflow

The Pano AI case study illustrates the transformative impact of new technologies on our business, customers, and communities when deployed at scale after a successful demonstration. Innovation drives the execution of PGE's strategy: Decarbonize, Electrify, Perform. The Strategic Innovation process aligns with PGE's corporate 5-year roadmaps and categorizes innovation projects into four focus areas. Our approach aligns near-term technology investments, long-term customer needs, and PGE's vision of the future grid.

PGE's innovation projects follow a multi-stage process that often requires collaboration from employees and teams who may be unfamiliar with the innovation process; we use an air traffic control system analogy to describe the stages. A more detailed overview of milestones and key roles and responsibilities associated with the innovation process can be found in Appendix C.

STEP 00 In the hangar

When an employee submits an idea, it enters the hangar. The idea submitter then pitches the concept to a cross-functional group at a meeting called PGE Spark Tank. During this meeting, attendees ask questions to help the presenter think through the idea more critically. After the presentation and Q&A, the group evaluates the idea based on its potential to deliver customer value and its alignment to PGE's strategy. Ideas with low potential are shelved, while those with high potential receive a green light for further development and preparation for the Runway.

We use an **air traffic control system** analogy to describe the stages of PGE's innovation projects

STEP 01 On the runway

After receiving the green light at Spark Tank, the project lead (captain) defines the challenge statement and potential solution. This exercise grounds the captain in the problem and helps them build the case for the proposed solution.

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The captain then identifies key stakeholders who will either be impacted by the demonstration or downstream if the solution is ultimately deployed at scale and facilitates a scoring session with them. This session allows attendees to learn about the problem scope and the proposed solution. Scorers provide feedback and ask questions to help the captain refine the idea before drafting a test plan. This scoring session serves as another stage gate to assess the use cases' alignment with customer and business value.

STEP 02 Cleared for takeoff

Before being cleared for takeoff, each use case must finalize its test and procurement plan. These plans are reviewed by the innovation manager and the cyber and risk teams. Once reviewers have approved the plans for the demonstration, the use case is cleared for takeoff and scheduled for its in-flight date.

STEP 03 In flight

During the flight, the project team tests the idea through a small-scale demonstration as outlined in the test plan and documents key findings. Once the project team collects sufficient data to address the objectives, the flight lands.

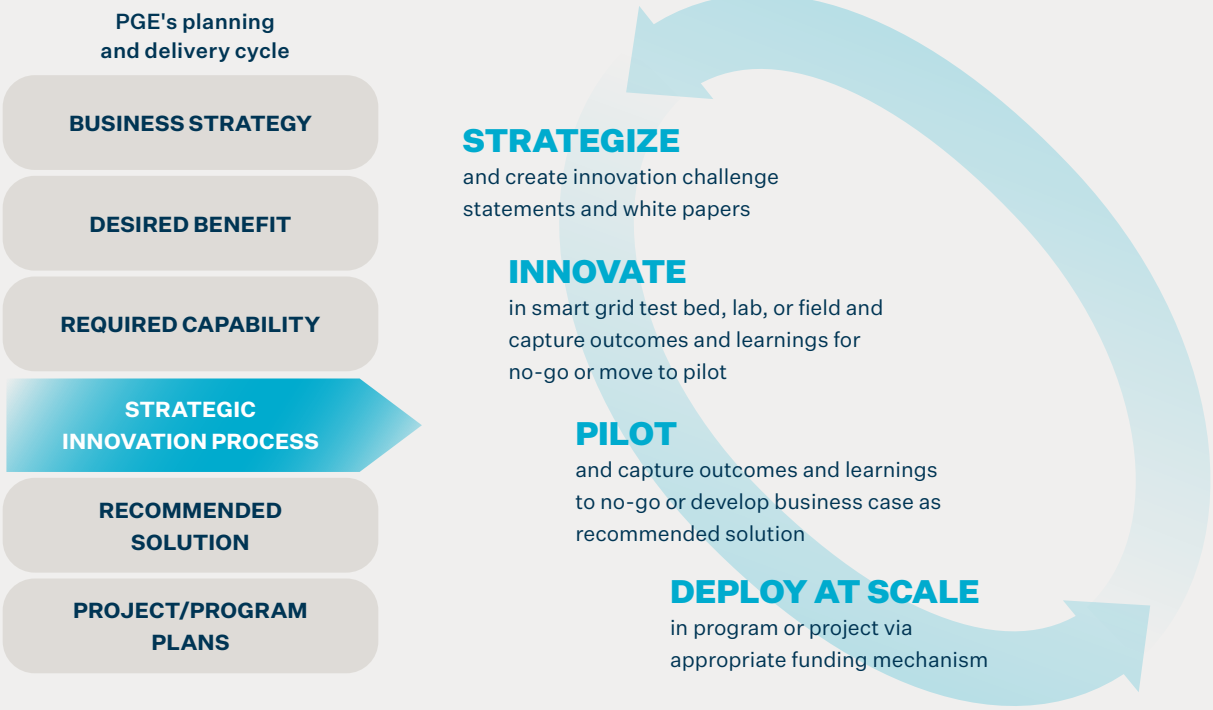
STEP 04 Landing

Once a flight has landed, the innovation manager conducts "day-in-the-life" interviews with key stakeholders who were involved in the demonstration. These interviews capture candid feedback from the demonstration and allow us to document key findings. The innovation manager then works with the captain to capture what worked, what didn't work, any challenges or surprises, and key points of feedback into a post-flight learnings summary. Based on these learnings, the captain, who is the project lead, and the innovation manager, who oversees the portfolio overall, collaborate to determine the best course of action to take to reach a final decision.

STEP 05 At the gate

The innovation manager and captain bring key stakeholders and decision makers together to reach a "Go" or "No-Go" decision. We distribute key learnings and feedback from the flight with those involved in the demonstration, senior leadership, and PGE's innovation ecosystem. For a "Go" decision, the captain drafts a value proposition document and presents their final recommendation to the appropriate Vice President on the Executive Review team. At that point, the business assumes the responsibility to carry the recommendation forward to navigate applicable governance structures, secure funding, and assemble a project team to deploy the solution at scale, should it make sense to do so.

WHERE INNOVATION FITS INTO PGE



Strategic Innovation's impact

Innovation focus areas

Strategic Innovation at PGE focuses on the following four key areas, which we call "airports":

1. **Grid performance**
2. **Decarbonization at scale**
3. **Transportation electrification and load flexibility**
4. **Business enhancements**

These focus areas address the challenges and opportunities within the area PGE serves and the broader energy industry. Our innovation process evaluates and tests ideas across all four airports, covering a wide range of topics and types of innovation. We assess ideas that improve existing business processes, such as using an insulated robotic arm for transmission work, and those that could transform PGE's business model, like technologies to scale our Virtual Power Plant. Below is an overview of each airport. Each section below spotlights one use case that is currently active in each airport to provide an example of projects covered in that focus area.

Grid performance

Building an intelligent, resilient and flexible grid.
Key runways: DER integration and operation, grid management systems, and enterprise DERMS

Decarbonization at scale

Decarbonizing our regional energy supply and assessing emerging, front-of-meter technologies.
Key runways: Energy supply resource investments, regional expansion

Transportation electrification and load flexibility

Scaling PGE's Virtual Power Plant and creating customer value.
Key runways: VPP, customer centric product and program design

Business enhancements

Optimizing workflows to deliver on corporate goals.
Key runways: AI maturity, wildfire risk mitigation, grid hardening

GRID PERFORMANCE

This airport focuses on modernizing the aging grid with cutting-edge technology. For example, we have tested ideas that leverage AI to detect broken conductors and are evaluating technologies that increase existing transmission infrastructure capacity under extreme conditions (dynamic line ratings).

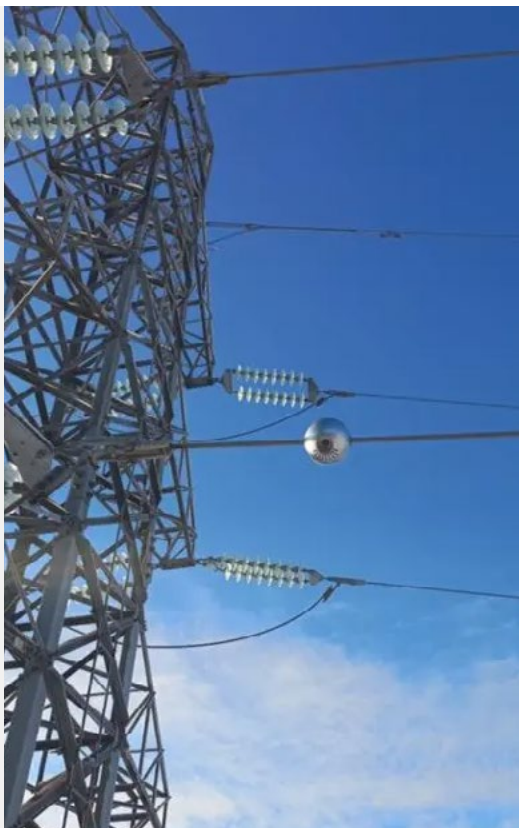
We are also preparing for the growing adoption of distributed resources like rooftop solar and energy storage. For example, within the Grid Performance Airport, PGE is investigating technologies, such as wireless smart sensors and centrally controlled automated switches, that allow us to manage distributed resources efficiently and optimize load on the distribution system. By enhancing grid performance, we aim to accelerate renewable energy deployment, improve customers' experience, and boost overall grid resiliency. Innovations in this airport are crucial for creating a smarter, more responsive, and sustainable energy network at the lowest possible cost for the customers we serve.

Dynamic line rating technology

Why it matters:
DLR technology (sensor-based and Energy Management System-based solutions) can assess wind speed, ambient temperature, and related real-time weather information. This will be used to develop dynamic ratings for transmission lines, which allows for accurate real time ratings compared to static ratings.

Customer value:
To be able to provide an affordable and more reliable clean energy transition, PGE is exploring DLR technology to help reduce congestion costs, improve integration of renewables, and increase capacity and reliability.

Business value:
PGE is experiencing congestion in certain areas of its transmission network during specific operating conditions. DLR solutions have the potential to affordably alleviate some areas of congestion while long-term upgrade projects are being implemented.



KPIs tracked: Does the solution...

- Decrease congestion on flows from South to North?
- Decrease Grid Operations costs?
- Increase accuracy of transmission line loadings?
- Increase our ability to develop operating plans for outage scenarios?

DECARBONIZATION AT SCALE

The Decarbonization at Scale Airport serves as a central hub for capturing insights on emerging technologies that could enable a fully non-emitting energy supply, supporting PGE's goal of 100% decarbonization by 2040. By focusing on innovation in this area, we are paving the way for a cleaner, more sustainable energy future while maintaining reliability and affordability for the customers we serve.

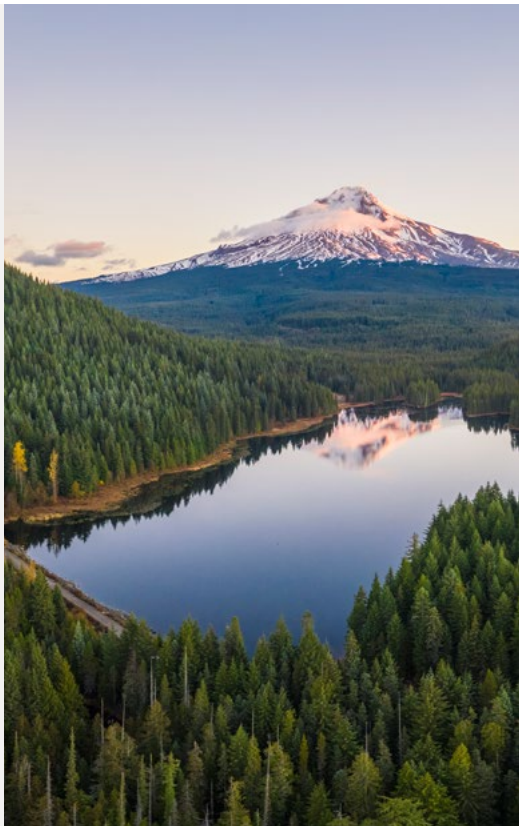
In this airport, we are identifying technologies that save money and rapidly deliver clean energy to customers. PGE is doing this by investing in renewables, energy storage, and front-of-meter technologies that are either distributed and utility-controlled or operating at utility scale. For example, we are testing ideas that expedite the deployment of community-based renewable energy projects. Further, we are testing advanced analytics tools that help us identify ideal locations for new loads and resources to maximize existing infrastructure and reduce costly upgrades (see examples in Appendix A).

Solar microgrid for wildfire mitigation

Why it matters:
Wildfire mitigation planning requires the exploration of all cost-effective alternatives to system hardening and resilience, especially in areas where undergrounding to improve reliability and reduce wildfire risk is cost-prohibitive.

Customer value:
Microgrid technology may allow sites to keep their lights on during a PSPS event and can identify cost-effective project sites. This would result in increased customer value and limit service disruptions.

Business value:
PGE is exploring solar-microgrid solutions targeting remote, rural areas where traditional reliability upgrades may be cost-prohibitive. If viable, we can use this product to defer traditional wires upgrades in remote areas or remote loads, freeing up capital to spend on other high-priority investments, as well as increasing our on-system renewable generation incrementally.



KPIs tracked: Does the solution...

- Enable transmission upgrades to be deferred?
- Improve reliability?
- Defer transmission line undergrounding?

TRANSPORTATION ELECTRIFICATION AND LOAD FLEXIBILITY

At its core, PGE's VPP optimizes load and distributed resources across our system. PGE defines its VPP as "the orchestration of distributed energy resources (DERs) and flexible load, through technology platforms, to provide grid and operations services."[1] This airport focuses on enabling electric vehicles and distributed energy resources connected to the distribution system to participate in the VPP.

In this airport we are testing managed charging programs and vehicle-to-grid (V2G) technology to enable electric vehicles to participate in the VPP. For example, we are researching V2G use cases for electric school buses. When the school bus is plugged in, PGE can discharge energy from the vehicle's battery back to the grid, then charge the battery when demand is lower. The estimated flexible capacity range of each bus is 20 to 53 kW. If this impact were to scale across the approximately 2,700 school buses in the area we serve, the benefit could grow to over 100 MW of grid flexibility through two-way charging while providing reliability and cost-savings benefit to customers.

Fleet EV backup power

Why it matters: As PGE encourages electrification of its fleet and for those of customers, viable options for resiliency are critical in the event of an outage. Mobile options provide a scalable and flexible solution.

Customer value: PGE customers can rely on PGE fleets to mobilize and repair infrastructure during outage events. Customer fleets can remain operational during outage events.

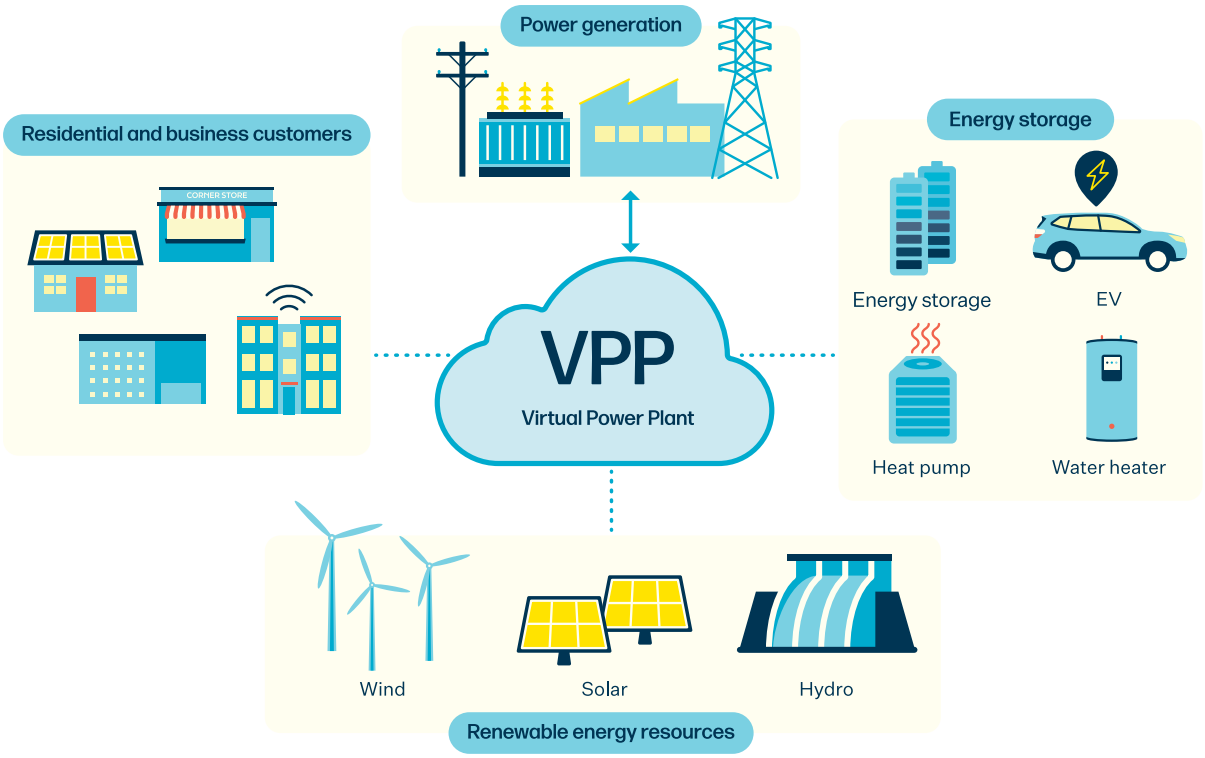
Business value: PGE's fleet requires a resiliency strategy for fleet electrification that does not require costly redundancy at all sites. Mobile EV charging systems could also be installed at generation facilities that are not amenable to electric vehicle charging infrastructure.

KPIs tracked: Does the solution...

- Enable fleets to confidently answer the question of how will fleets continue to operate during power outages?
- Perform as described to charge fleets?
- Make refueling easy for fleets?
- Have mobility benefits that increase its cost effectiveness?

[1] PGE, 2024 Distribution System Plan, Chapter 5. Virtual Power Plant (VPP), December 2024, Available at: DSP Chapter 5.pdf (ctfassets.net)

PGE'S VIRTUAL POWER PLANT



INNOVATION BY THE NUMBERS

62%

Faster time to decision as a result of PGE's Strategic Innovation process

Customer participation via products and programs

Customers are able to participate in the VPP through PGE's work to expand enabling technologies. For example, PGE is testing smart panels that can be installed in customers' homes. These smart panels can support load flexibility by mitigating significant infrastructure upgrades that may otherwise be needed to allow for distributed resources to be sited at homes. We are also testing demand response-capable air conditioning (AC) and heating units that can be installed in renters' homes to manage demand based on renewable energy availability.

Our innovation process tests new products and programs that meet the evolving needs of both our residential and commercial customers at the small-scale demonstration level before additional testing in the Smart Grid Test Bed or deploying at scale across PGE's system. In this airport, PGE proactively explores new technologies and partnerships that can empower customers and communities to ensure a resilient, efficient, and clean energy landscape for generations to come.

BUSINESS ENHANCEMENTS

The Business Enhancement Airport innovates our core business systems to enhance operational efficiency and deliver improved customer value. This airport also serves as a hub for generative AI use cases and other use cases that leverage innovative data solutions to enhance grid hardening and support wildfire risk mitigation efforts. Customers experience additional value as we improve the ways we share timely, accurate information regarding outages, energy usage, and public safety power shutoffs through digital and mobile channels. This airport also enables PGE's network and telecommunications upgrades. By using our cloud and data investments, we can transform raw data into valuable insights to inform optimal decision making in areas like asset management strategies, trading decisions, and demand response events.

INNOVATION BY THE NUMBERS

50%

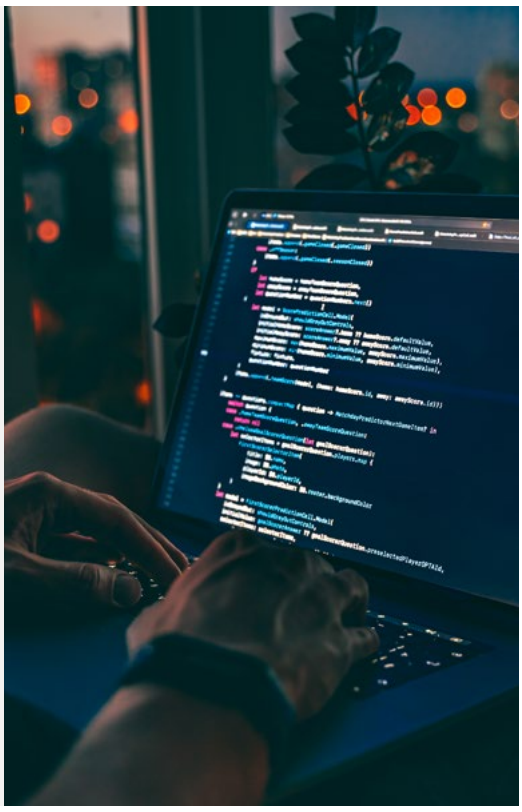
of flights landed with a "Go" decision

Line design review bot

Why it matters: The current manual process is time-consuming (30 minutes per job), prone to errors, and lacks standardization. With an estimated 6,000 jobs in 2024, the potential cost savings by automating the process could be up to $90,000 (from $300,000 to $210,000). Automating this process can significantly reduce cycle time, increase quality and standardization, and improve upstream planning and scheduling.

Customer value: By saving employees time, we are securing cost savings for customers and creating bandwidth for employees to maximize customer dollars.

Business value: Reduces the time and resources required for the job review and approval process to save costs. Mitigates risks associated with non-compliance, such as public and employee safety issues, financial penalties, and crew labor issues.



KPIs tracked: Does the solution...

- Reduce cycle time for job approval?
- Reduce costs per job?
- Increase compliance standards?
- Reduce errors?

Key performance indicators

The Strategic Innovation function evaluates three key performance indicators (KPIs) to monitor the health and performance of the innovation portfolio. Below is a description of the KPIs, how they are measured, and their status.

Quality of intake

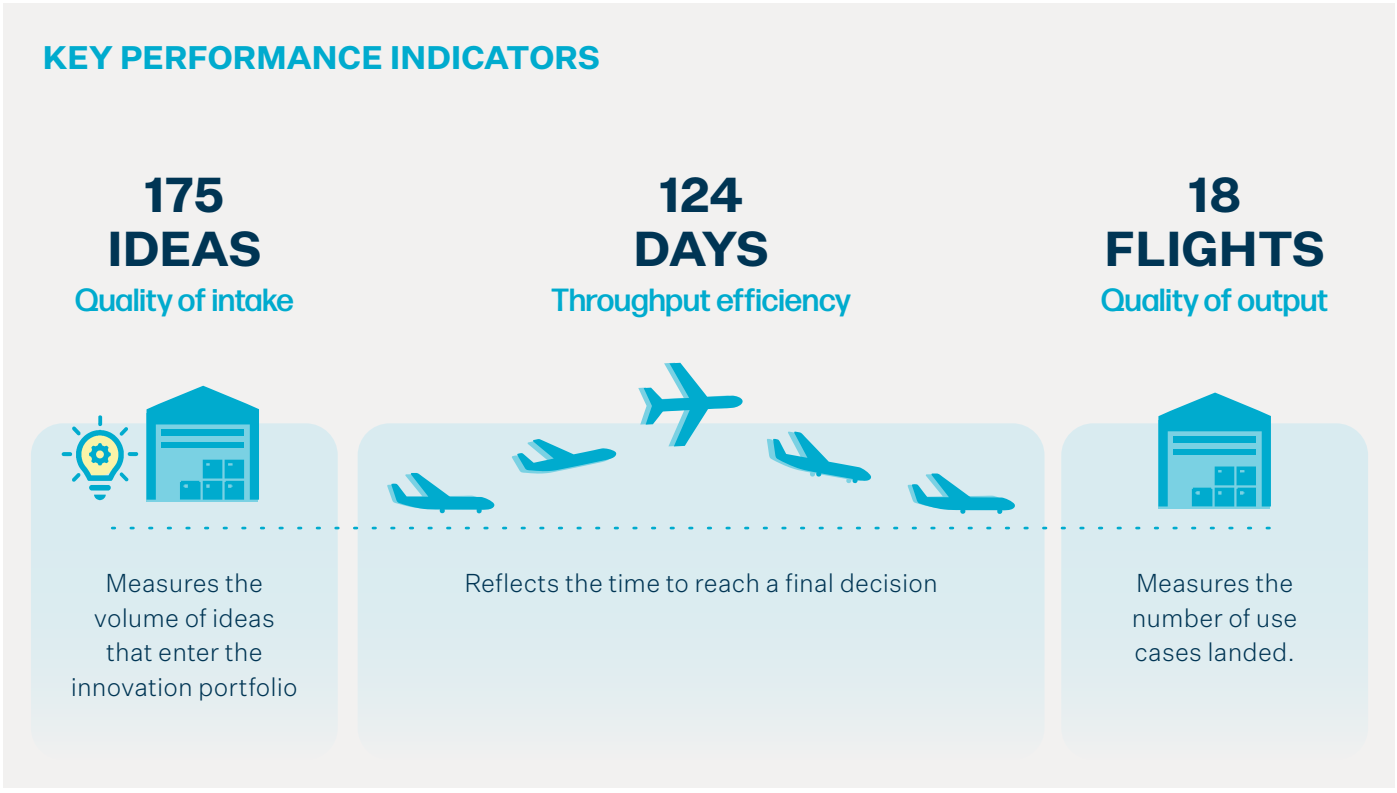
Quality of Intake measures the number of ideas that are submitted into the hangar. Ideas can be submitted by individual contributors, managers, or senior leadership. Ideas often originate from subject matter experts, outreach from vendors, direction from executive leadership, or innovation ecosystem partners, like IEL and Energy Impact Partners. Since October 2022, 175 ideas have been submitted to Strategic Innovation. Many of these ideas have been presented at Spark Tank, a meeting that provides innovators a platform to pitch their idea to employees across the company, get feedback, and reach an initial decision on whether to continue to move the idea forward or press pause.

Throughput efficiency

Throughput Efficiency reflects the time to reach a final decision. It is defined as the number of days spent between the runway and takeoff plus the time spent between landing and reaching a final recommendation (Go/No-Go decision). This measurement does not include the time spent testing the idea. Since October 2022, the Strategic Innovation portfolio has reached a decision in an average of 124 days compared to the 325 days that were typically spent before Strategic Innovation introduced the ideation to decision making process.

Quality of output

Strategic Innovation measures quality of output to reflect the quality of ideas in the portfolio. Quality of Output measures the number of use cases that have landed and have had learnings captured. The Strategic Innovation process' standardized documentation and governance enables quicker time to decision and provides strategic alignment between ideas that are pursued and PGE's goals. Since October 2022, 18 flights have landed, of which nine reached a "Go" decision.[2]



[2] Flights that have landed and reached a "Go" decision are summarized in Appendix A, Section 1

Since October 2022, The Strategic Innovation Portfolio has grown by

343%

INNOVATION BY THE NUMBERS

Other indicators of program maturity and success

Portfolio growth

Since October 2022, the Strategic Innovation portfolio has grown by 343%. This growth reflects the total count of projects that have entered the Hangar. This growth indicates that Strategic Innovation has successfully encouraged employees to identify new solutions to deliver customer value in the most cost-effective way.

Expedited decision-making

Since October 2022, PGE's structured and focused approach to innovation has resulted in expedited time to decision that is 62% faster than before the Strategic Innovation process was established. This improvement in decision-making efficiency demonstrates the positive impact of the company's renewed emphasis on innovation process.

EPRI global innovation effectiveness 2024 assessment results

OVERVIEW OF ASSESSMENT

In June 2024, PGE participated in the Global Innovation Effectiveness (GIE) Assessment facilitated by EPRI. The assessment is intended to characterize PGE's current state of innovation to catalyze continuous improvement and measures various characteristics of PGE's innovation strategy, structure, and culture. The results were combined and benchmarked alongside GIE's industry research to inform takeaways and next steps for PGE. This assessment also allowed us to compare 2024 results with those from previous participation in 2021.[3]

OBJECTIVES

GIE Assessment goals:

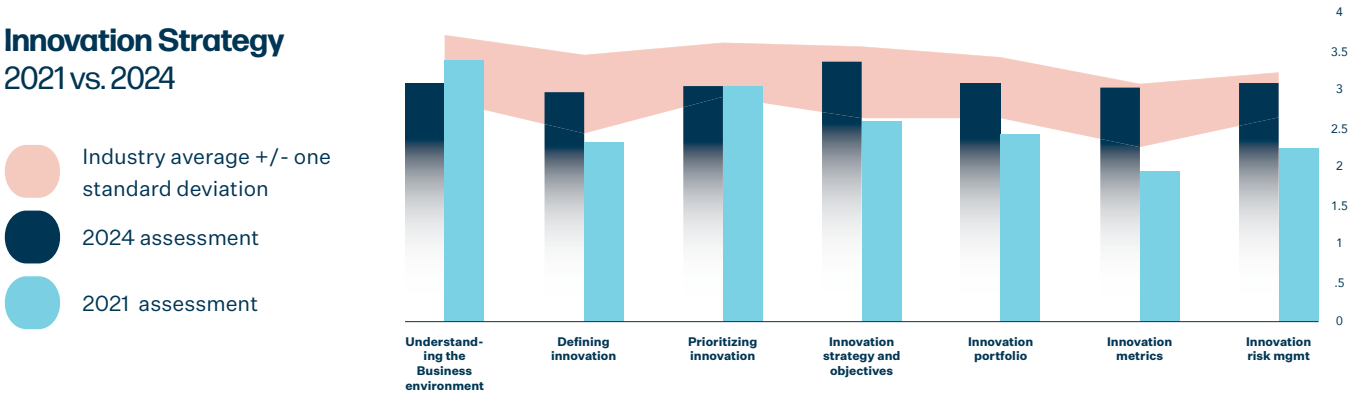
- Identify areas where the innovation program has progressed.
- Identify opportunities to engage employees in the innovation process.
- Identify opportunities for improvement to inform action planning and goal setting.

RESULTS

Overall improvements

The GIE results showed overall improvements in innovation strategy and structure between 2021 and 2024, while innovation culture results showed some regression between 2021 and 2024. Please see Appendix B for a full list of each innovation category and how they are defined. PGE demonstrated improvements in organizational values, leadership, idea generation, collaboration, and networking. Meanwhile, the results highlighted opportunities for improvement in fostering an innovative environment, communication, incentivizing success, and innovation learning.

Innovation Strategy
2021 vs. 2024



[3] The full GIE Assessment Report from 2021 that describes the assessment's methodology can be accessed at https://www.epri.com/research/products/000000003002022727

Innovation strategy

The 2024 assessment indicated room for improvement in Strategic Innovation's "understanding of the business environment." The Strategic Innovation roadmap that has been developed in the second half of 2024 is intended to identify business needs and characterize the landscape that PGE is navigating. The roadmap also serves as a tool to clearly align innovation use cases to our established priorities.

Innovation structure

While the characteristics that provide necessary resources, measured by EPRI, scored below the industry average, other aspects of innovation structure showed positive results. Innovation process, central coordination, and implementation all scored above the industry average.

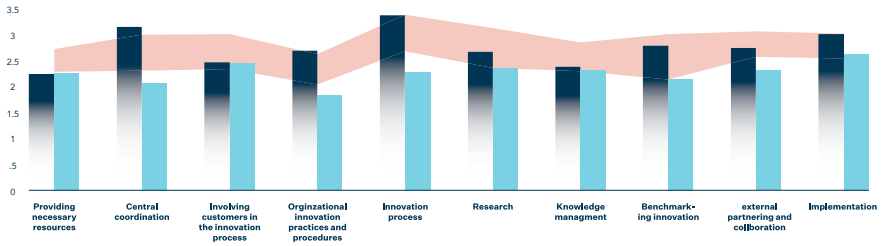
Innovation culture

Between the 2021 and 2024 assessment, innovation strategy and structure saw significant improvements. Culture often can take longer to show improvements after other components of innovation have progressed. It was noted that over the past three years, the emphasis on building new processes and a lack of communication may have made some employees feel uncertain about navigating the process or left out. To address these issues, PGE plans to seek best practices from EPRI and other utilities.

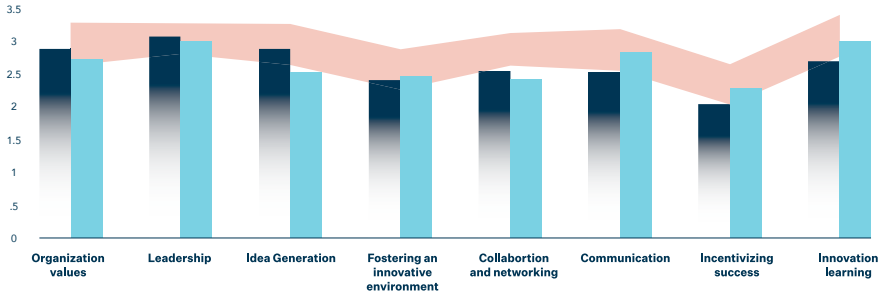
The assessment revealed a regression in innovation culture from 2021 to 2024. Areas needing improvement include:

- Fostering an innovative environment
- Communication
- Incentivizing success
- Innovation learning

Innovation Structure
2021 vs. 2024



Innovation Culture
2021 vs. 2024



In 2025, Strategic Innovation will focus on sharing innovation learnings, as well as improving communications around the innovation process and how employees can navigate it. In the future state, insights from innovation efforts will be shared in an organized and candid way. The learnings will also be accessible to interested employees.

Over the past three years, PGE has developed a robust process around innovation. However, there has been less concerted effort around educating a broad set of employees on how to get involved with the process, which may have caused some employees to feel left out. To address this, Strategic Innovation will have a robust PGE-wide communications campaign in 2025 to increase employee engagement with the innovation process and purpose.

In conclusion, PGE has made significant strides in certain areas of innovation management and is now performing one to two standard deviations above industry average on structure and strategy metrics. Nevertheless, there are still opportunities for improvement, particularly in fostering an innovative culture by increasing internal awareness around the process and sharing learnings from demonstrations with employees. The company's commitment to continuous improvement and willingness to benchmark against industry standards positions it well for future growth and success in innovation.

Pachwáywit Fields

Strategic Innovation's direction

Where we're headed, innovating is imperative.

Vision of PGE's future grid

PGE is operating through a historic energy transition, while navigating the shift in how we serve load. Historically, utilities have viewed demand as fixed—meeting load with dispatchable (mostly thermal) resources. As our energy portfolio becomes more reliant on variable energy resources like wind and solar, PGE looks to optimize both supply (energy resources) and demand (customer load) to maintain system reliability. Harnessing flexibility on both the supply and demand side requires enhanced focus on scaling the collective power of distributed energy resources.

Building a robust and adaptable grid is essential in an era of extreme weather events. PGE's Virtual Power Plant represents a transformative approach to energy management, enhancing grid stability and creating new value streams for customers and utilities alike. Innovative technologies and strategies that support actions identified in various planning documents, like the Distributed System Plan, can help us mitigate the impacts of severe climate events on our infrastructure and increase system reliability.

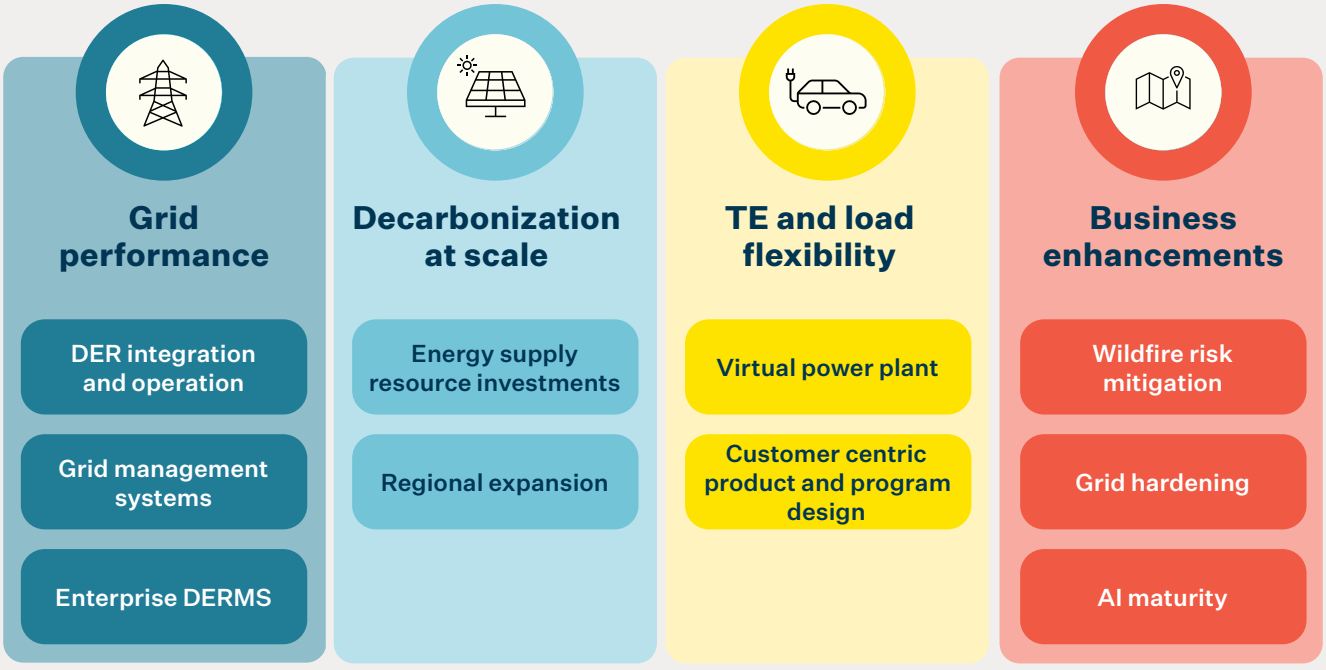
Strategic innovation roadmap

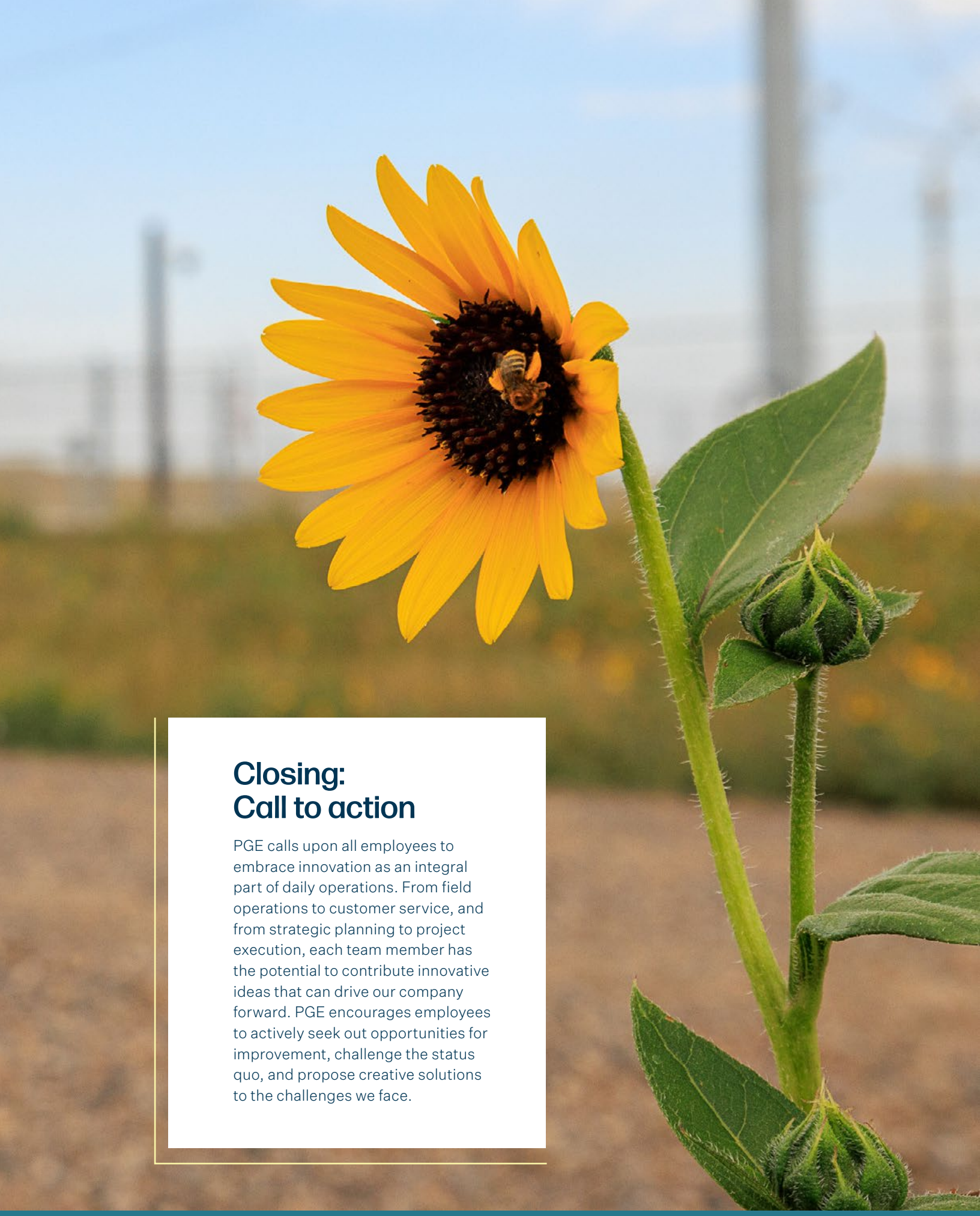
PGE communicates its system plans externally through various publicly filed documents. The Strategic Innovation team has reviewed many of PGE's planning documents including the Distributed System Plan, Integrated Resource Plan and Clean Energy Plan, Wildfire Mitigation Plan, Transportation Electrification Plan, Flex Load Multi Year Plan, amongst others. Strategic Innovation has analyzed these planning documents to compile a roadmap that reflects capabilities identified by various business functions that will enable PGE to reach its goals. This roadmap focuses on testing emerging technologies to prove out capabilities before deploying at scale.

The Strategic Innovation Roadmap is designed to provide a simplified view of PGE's major innovation challenges on the horizon, such as wildfire risk mitigation or scaling up the Virtual Power Plant. Historically ideas have originated from vendors, direction from leadership, or from teams at PGE who have identified an opportunity to innovate. Using this roadmap, the Strategic Innovation team will work with the business to sequence and prioritize innovation prospects to build the business capabilities necessary to achieve our strategic goals. Additionally, the roadmap will help PGE identify compelling opportunities in the pursuit of state and federal grant funding. The table below shows the runways depicted in the Strategic Innovation Roadmap.

As the Strategic Innovation function matures, we are evolving the ideation process to take a more proactive approach in sourcing ideas. Targeted innovation directed by the roadmap will enable PGE to achieve our top priorities.

STRATEGIC INNOVATION RUNWAYS





Closing: Call to action

PGE calls upon all employees to embrace innovation as an integral part of daily operations. From field operations to customer service, and from strategic planning to project execution, each team member has the potential to contribute innovative ideas that can drive our company forward. PGE encourages employees to actively seek out opportunities for improvement, challenge the status quo, and propose creative solutions to the challenges we face.

APPENDICES

Appendix A

Summary of use cases (flights):

1. Landed flights with “go” decisions
2. Active flights by airport (as of December 2024)

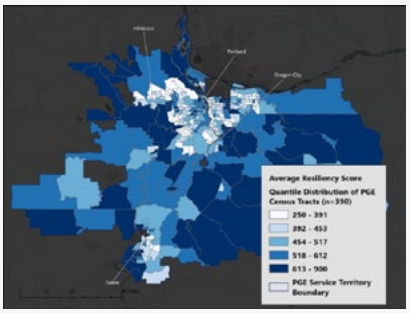
1. Landed flights with “go” decisions

Listed alphabetically

BUSINESS ENHANCEMENTS | LANDED

AdopDER Data Aggregation*

WHY IT MATTERS	The pace of change in the regulatory environment and market landscape for DERs is too rapid to rely on expensive third-party models that have a limited shelf-life.
CUSTOMER VALUE	Customers, community partners, and internal teams care that our forecasting of DERs is as accurate as possible to inform distribution system planning.
BUSINESS VALUE	This enterprise solution feeds into essential workstreams such as load forecasting, as well as the GRC, IRP, DSP, CEP, and various financial and customer planning exercises.
CHALLENGE STATEMENT	Develop a bottom-up forecasting and distributed energy resource (DER) adoption model.
SOURCE	Internal / direct engagement with consultant



DECISION: GO
NEXT STEP: INCORPORATE ADOPDER MODEL INTO ANALYTICAL WORKFLOW

How this Innovation Creates Value for PGE

Advances **DER Generation and Load Forecasting** capabilities

Improves **Planning** capabilities to support **Resource Investments** and **VPP Scaling**

Capabilities

Enables **10-20% time savings** per run time (2-4 hours)

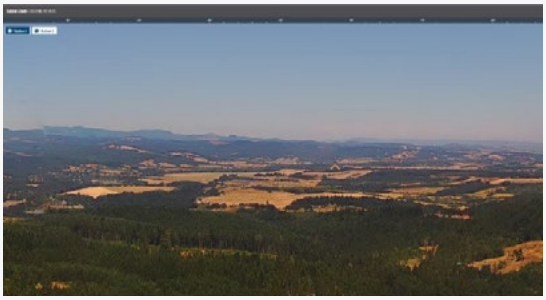
Potential to **expand to all 600 feeders**

Benefits

*This slide reports on a legacy flight that does not count towards reported KPIs.

AI Camera Wildfire Detection*

WHY IT MATTERS	PGE anticipates fire risk to increase 500-900% in some parts of our service area and has developed a 4-year plan to harden the system against wildfires that are growing in frequency and severity.
CUSTOMER VALUE	Customers and fire agencies expect PGE to quicky identify wildfire ignition and prevent wildfire damage.
BUSINESS VALUE	AI technology is more proactive, drives a faster response, and reduces resources needed to monitor fire prone areas.
CHALLENGE STATEMENT	Ability to leverage AI & ML technology to enable real-time ignition detection and location triangulation within 100 miles.
SOURCE	EPRI Incubatenergy Labs



DECISION: GO
NEXT STEP: DEPLOY CAMERAS AT SCALE

How this Innovation Creates Value for PGE

Capabilities

- Leverages **AI** for **Risk Assessment and Mapping**
- Improves **Situational Awareness and Forecasting**

Benefits

- During one ignition, **the camera system alerted crews 4+ hours sooner** compared to traditional technology
- **Minimizes ignition risk** through faster response time

*This slide reports on a legacy flight that does not count towards reported KPIs.

GRID PERFORMANCE | LANDED

Backup Power for Wells in PSPS Zones

WHY IT MATTERS	As a part of the Wildfire Mitigation Plan, PGE has committed to research ways to mitigate the impact of PSPS events on customers. A customer survey revealed access to water was a top priority for those who may be impacted by a PSPS event.
CUSTOMER VALUE	Many of these customers rely on well water, which requires electricity to power the well pump, and are without water during power outages.
BUSINESS VALUE	By providing customers with solutions to ensure they retain access to water during PSPS events, PGE can continue to call PSPS events as needed to mitigate wildfire risk.
CHALLENGE STATEMENT	PGE needs to test multiple solutions to provide access to water in order to identify which methods are truly feasible and worth recommending to customers.
SOURCE	Internal

DECISION: GO
NEXT STEP: CREATE RESOURCE HUB TO CONNECT CUSTOMERS WITH SOLUTIONS PROVIDERS

How this Innovation Creates Value for PGE

Capabilities

- Supports **Stakeholder Cooperation and Community Engagement**
- Improves **Emergency Planning and Preparedness**

Benefits

- Identifies **cost effective** backup water **solutions for customers**
- Enables PGE to **continue to effectively call PSPS events**

DER/IOT Gateway

WHY IT MATTERS	Scaling PGE's VPP requires DER visibility and control through its centralized VPP (DERMs) platform. Today, interfaces and physical protocol devices need to be standardized.
CUSTOMER VALUE	Supports renewable integration by standardizing equipment options for gateways as part of PGE's VPP. Long-term, this can reduce peak demand by optimizing DER at customer locations.
BUSINESS VALUE	Accelerates PGE's efforts to define comprehensive requirements based on existing work to include requirements in PGE's VPP planning and verifies PGE strategy for which vendors to pursue.
CHALLENGE STATEMENT	PGE needs standard protocols, system architecture, and physical gateways in order to have effective VPP visibility and management of DERs at the grid edge.
SOURCE	Internal / direct contact with vendor

DECISION: GO
NEXT STEP: INSTALL TWO GATEWAYS INTO FIELD TESTING

How this Innovation Creates Value for PGE

Supports **Advanced Monitoring and Control** of VPP

Improves **Standardization, Planning, and Engineering** capabilities to integrate DERs

Capabilities

Furthers PGE's awareness of technological capabilities and future requirements to **enable VPP integration**

Demonstrates **DER optimization** to inform **dispatch decisions**

Benefits

DECARBONIZATION AT SCALE | LANDED

DOE – EPRI Net Load Forecast

WHY IT MATTERS	Fundamentals that underpin PGE's planning models require updates that take extreme weather patterns, changing customer load and occupancy, and DER penetration and electrification into account.
CUSTOMER VALUE	More accurate forecasting capabilities enable PGE to make better informed investment decisions on behalf of customers.
BUSINESS VALUE	PGE can improve performance by bolstering bottom-up forecasting capabilities by collaborating with vendors, the DOE, and EPRI to receive probabilistic net-load forecasting.
CHALLENGE STATEMENT	Incorporate updated assumptions into load forecasting models.
SOURCE	Energy Impact Partners

DECISION: GO
NEXT STEP: PROCEED TO A FOLLOW-UP FLIGHT WITH TECHNOLOGY VENDOR

How this Innovation Creates Value for PGE

Improves **Data Governance**

DER Aggregation and Optimization

Capabilities

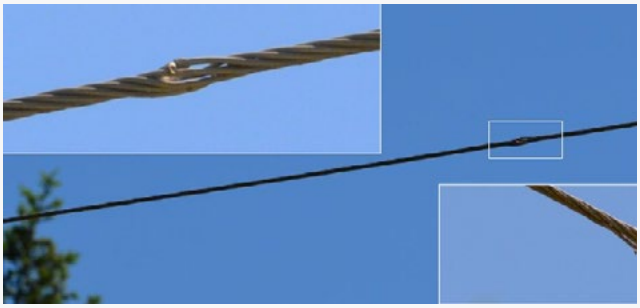
Removes barriers to use **data to improve model workflow**

Increases **forecasting accuracy of distributed resources**

Benefits

Early Fault Detection*

WHY IT MATTERS	Equipment failures and faulted circuits can lead to increased wildfire risk. This technology can scale across our 4,000 square mile service area to reduce the likelihood of outages and wildfire.
CUSTOMER VALUE	PGE can proactively maintain infrastructure to improve reliability and safety by reducing wildfire risk and outage time.
BUSINESS VALUE	PGE could realize an ROI greater than 10:1 by reducing O&M expenses while improving reliability metrics and an ROI of 25:1 with proactive identification of wildfire incident reduction proven in field trials.
CHALLENGE STATEMENT	Reduce O&M costs by improving capability to detect equipment failures and faulted circuits to decrease risk.
SOURCE	Internal / direct contact with vendor



DECISION: GO
NEXT STEP: DEPLOY AT SCALE

How this Innovation Creates Value for PGE

Proactive wildfire **Risk Assessment and Mapping**

Augments **Asset Management and Inspection** capabilities

Capabilities

10:1 ROI by reducing O&M

25:1 ROI by proactively identifying wildfire

Benefits

*This slide reports on a legacy flight that does not count towards reported KPIs.

Expense Bot

WHY IT MATTERS	90% of discretionary spend at PGE is from expense submittals. The current manual review process is time-consuming and can contribute to long processing times. Automating the review process can significantly reduce the time and effort required, while ensuring compliance with company policies.
CUSTOMER VALUE	By saving employees time, we are securing cost savings for customers and creating bandwidth for employees to maximize customer dollars.
BUSINESS VALUE	The solution can lead to insurance that all expenses follow company expense policies and reduction of non-compliant expenses and reduce PGE's monthly expense payout
CHALLENGE STATEMENT	An AI-powered bot capable of evaluating expense reports against PGE's expense policies, flagging non-compliant submittals, and assisting with non-compliance emails and training enrollment.
SOURCE	Internal / ChatPGE Generative AI Innovation Roadmap

DECISION: GO
NEXT STEP: DEPLOY AT SCALE

How this Innovation Creates Value for PGE

Leverages **Partnership with Business Units**

Applies **Generative AI and Machine Learning** to business operations

Capabilities

Reduces time and labor hours for reviews

Reduces non-compliant cost payouts

Benefits

Innovation Management Platform Demonstration

WHY IT MATTERS	To achieve decarbonization goals, it is important that PGE finds innovative ideas and rapidly completes field trials and projects to determine what new technologies would be best deployed at scale.
CUSTOMER VALUE	To drive the clean energy transition safely, reliably, and affordably, new innovations must be thoroughly tested.
BUSINESS VALUE	Reduce time (OPEX) spent in innovation process while increasing the impact of the innovation program. Identified $563k of savings per idea.
CHALLENGE STATEMENT	Reduce administrative time in managing the innovation portfolio.
SOURCE	EPRI Incubatenergy Labs

DECISION: GO
NEXT STEP: INTEGRATE INTO INNOVATION MANAGEMENT WORKFLOW

How this Innovation Creates Value for PGE

Enables **Partnerships across Business Units**

Improves **Resource Allocation** and creates **time savings**

Capabilities

Improves **management capabilities of scaling portfolio**

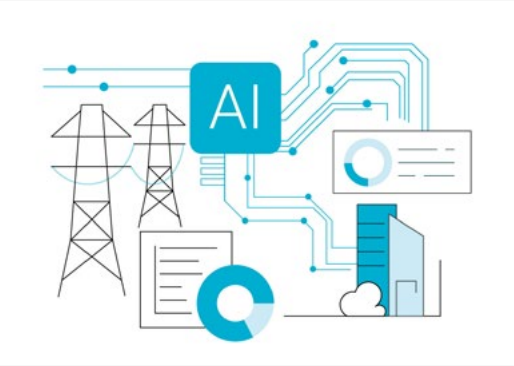
Cost savings of $563,000 per idea

Benefits

BUSINESS ENHANCEMENTS | LANDED

Line Design Review Bot

WHY IT MATTERS	The current manual process is time-consuming (30 minutes per job), prone to errors, and lacks standardization. With an estimated 6,000 jobs in 2024, the potential cost savings by automating the process could be up to $90,000 (from $300,000 to $210,000). Automating this process can significantly reduce cycle time, increase quality and standardization, and improve upstream planning and scheduling.
CUSTOMER VALUE	By saving employees time, we are securing cost savings for customers and creating bandwidth for employees to maximize customer dollars.
BUSINESS VALUE	Significant cost savings by reducing the time and resources required for the job review and approval process. Helps mitigate risks associated with non-compliance, such as public and employee safety issues, financial penalties, and crew labor issues.
CHALLENGE STATEMENT	PGE needs a generative AI solution to automate the job review and approval process for design standards compliance. The bot leverages image segmentation, Optical Character Recognition (OCR), text extraction, and Generative AI to identify potential violations and streamline the approval process.
SOURCE	Internal / ChatPGE Generative AI Innovation Roadmap



DECISION: GO
NEXT STEP: DEPLOY AT SCALE

How this Innovation Creates Value for PGE

Leverages **Partnership with Business Units**

Applies **Generative AI and Machine Learning** to business operations

Capabilities

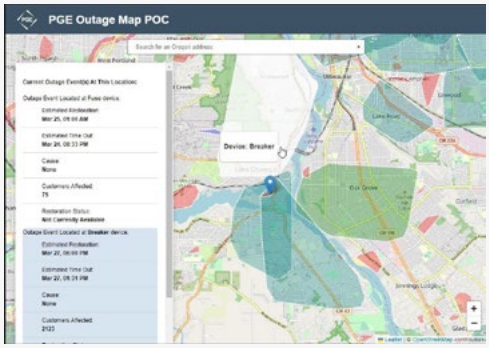
Reduces cycle time for job approval **from 12 days to less than one day**

Saves approximately $90k per job

Benefits

Outage Communications

WHY IT MATTERS	Grid Ops identified the opportunity to provide customers with more user-friendly information and notifications regarding outages, both planned and unplanned.
CUSTOMER VALUE	80% of customers want text notifications regarding outages. Customers want a user-friendly map to identify the outage impacting them.
BUSINESS VALUE	Minimize cancelations of jobs requiring planned outages and bring automation and process to manual, cost-intensive notifications.
CHALLENGE STATEMENT	PGE needs to identify impacted customers, show impacted customers by device on a map, and send text notifications to impacted customers.
SOURCE	Internal / direct contact with vendor



DECISION: GO
NEXT STEP: DEPLOY AT SCALE

How this Innovation Creates Value for PGE

Improvements to **Outage Management Systems**

Customer-Centric Product Design

Capabilities

Minimizes job cancellations to **reduce OPEX costs**

80% of customers wanted this capability

Benefits

BUSINESS ENHANCEMENTS | LANDED

Risk Damage Prevention

WHY IT MATTERS	Over a two-year timespan, PGE absorbed nearly 60% of dig-ins, costing $1.8M to repair.
CUSTOMER VALUE	Limit O&M spend and reallocate time spent to increase customer value.
BUSINESS VALUE	Assigns a calculated risk associated with each locate ticket. With this tailored risk, PGE can make the best decision about how to best assign the locate ticket (ex. internal, to contractor).
CHALLENGE STATEMENT	Minimize dig-ins that are not externally liable.
SOURCE	Energy Impact Partners

DECISION: GO
NEXT STEP: DEPLOY AT SCALE

How this Innovation Creates Value for PGE

Leverages **AI & Machine Learning**

Improves awareness of **Physical Grid Infrastructure**

Capabilities

Limit O&M and reallocate time to **increase customer value**

20% cost reduction for dig-ins; **$286,000 saving**s in first year

Benefits

Renter Heating and Cooling Employee Demonstration

WHY IT MATTERS	Many renters in our service area do not have permanent cooling in their homes. These demand response capable units could meet customers' needs for both efficient cooling and heating, reducing the energy required to support these customers in the winter and summer.
CUSTOMER VALUE	Renters are increasingly searching for cooling options that bring comfort, reliability, lower costs, and easy installation to their apartment.
BUSINESS VALUE	The vendor claims their product is grid enabled. In this demonstration, PGE is interested in testing the reliability of the demand response capabilities in an effort to expand technologies that can participate in the VPP.
CHALLENGE STATEMENT	PGE needs renters to participate in flexible load in order to reach our 2030 decarbonization goals.
SOURCE	PGE Marketplace vendor intro to technology vendor

DECISION: GO
NEXT STEP: CONDUCT A FOLLOW-UP FLIGHT IN A CLIMATE CONTROLLED LAB

How this Innovation Creates Value for PGE

Increases accessibility of **Demand Response** capable devices to renters

Increases **Scalability and Flexibility** of VPP

Capabilities

Reliably shift load during events

Compliments **customer behaviors**

Benefits

Residential Managed Charging – Direct to Charger

WHY IT MATTERS	PGE provides up to $1,000 in rebates for customers who purchase a qualified level 2 charger. Customers who require a panel upgrade are eligible for up to $5,000 in rebates.
CUSTOMER VALUE	Customers can receive rebates and participate in seasonable incentives to increase incentives to install EV infrastructure that has higher potential value for the grid.
BUSINESS VALUE	This pilot is an attempt to shift EV charging away from times of high system energy demand or when energy prices are highest in exchange for rebates for electric vehicle supply equipment (EVSE/chargers) and allows PGE to control their EV charging during defined event hours.
CHALLENGE STATEMENT	PGE would like to offer an incentive program to EV owners in order to shift EV charging away from high system demand.
SOURCE	Internal

DECISION: GO
NEXT STEP: EMBED IN SMART CHARG PROGRAM AND LIFT ENROLLMENT CAPACITY LIMIT

How this Innovation Creates Value for PGE

Increases scale of **Serving TE Load**

Improves capabilities to **Manage TE Load**

Capabilities

Optimizes impacts of **energy demand per vehicle**

Manage EV charging and **shift charging behavior away from peak demand times**

Benefits

Residential Managed Charging – Direct to Vehicle

WHY IT MATTERS	Electric vehicles present substantial load growth. Unmanaged, EV load is expected to contribute 200 MW toward system peak load, placing additional burden on utility infrastructure. There is opportunity to optimize the charge cycle of vehicle batteries to provide congestion relief and deliver other services back to the grid.
CUSTOMER VALUE	Customers can benefit from managed charging, to mitigate their energy bill and unlock new value streams as a customer and EV owner, without impacts to their vehicle's performance.
BUSINESS VALUE	This demonstration employs on-board telematics to optimize charging around grid considerations, such as wholesale prices, bulk capacity, distribution congestion, and equipment health (e.g., keeping transformer loading with equipment rating).
CHALLENGE STATEMENT	PGE needs to assess the capability of telematics-based EV charge management to provide value in grid operations while testing the customer acceptance of these tools.
SOURCE	Internal

DECISION: GO
NEXT STEP: EMBED IN SMART CHARG PROGRAM AND LIFT ENROLLMENT CAPACITY LIMIT

How this Innovation Creates Value for PGE

Increases scale of **Serving TE Load**

Improves capabilities to **Manage TE Load**

Capabilities

Optimizes **energy demand from electric vehicle charging**

Incentivizes customer expectations to scale participation

Benefits

TRANSPORTATION ELECTRIFICATION & LOAD FLEXIBILITY

Satellite Imagery Analysis for Vegetation Management

WHY IT MATTERS	Vegetation is the single greatest contributor to power outages and wildfires caused by the grid. PGE manages approximately 2.4 million trees over a 12,000 line-mile overhead network. In the past, PGE has used LiDAR to analyze vegetation inventories which can be expensive to collect frequently. This solution offers satellite imagery data collection on short time scales and is less expensive but can be less precise than LiDAR.
CUSTOMER VALUE	If deployed at scale, it would be a transformational change that aids in lessening customer interruptions, reducing costs, increasing grid reliability and resiliency, as well as establishing data-driven trim plans to improve SAIFI and SAIDI reliability indexes, while ensuring we are targeting the right work.
BUSINESS VALUE	Satellite imagery could cost-effectively supplement outdated LiDAR data to optimize work plans for vegetation management and reduce wildfire risk.
CHALLENGE STATEMENT	PGE needs a solution that provides accurate, data-driven decision making for vegetation management at scale that is cost effective in order to manage risk and decrease power outages.
SOURCE	Internal / direct contact with vendor

DECISION: GO
NEXT STEP: INTEGRATE SATELLITE IMAGERY INTO REMOTE SENSING STRATEGY

How this Innovation Creates Value for PGE

Supports **Vegetation and Asset Management and Inspections**

Improves **Situational Awareness and Forecasting**

Capabilities

Cost-effectively supplements LiDAR **data** of vegetation near transmission and distribution lines

Successfully **assesses tree health**

Benefits

School Bus Vehicle to Grid Phase 2

WHY IT MATTERS	Bidirectional charging technology is new and unproven, yet it appears to have a lot of potential to benefit the grid and customers through Vehicle-to-Grid (V2G) capabilities. Electric school buses are commonly V2G-capable, but without a clear business case, the technology will not be heavily adopted.
CUSTOMER VALUE	Customers need to understand how they can be compensated for V2G services to determine whether the investment in V2G equipment pencils.
BUSINESS VALUE	PGE must better understand how to manage EV charging load at scale to reduce system peaks, maintain grid reliability, and keep energy costs low.
CHALLENGE STATEMENT	Document substantive learnings on V2G as a potential grid benefit to inform PGE's next steps.
SOURCE	Internal / Transportation Electrification Plan Roadmap

DECISION: GO
NEXT STEP: CONDUCT A FOLLOW-UP FLIGHT TO FURTHER TEST TECHNICAL CAPABILITIES OF V2G

How this Innovation Creates Value for PGE

Supports the VPP's ability to provide **Grid Services**

Improves capabilities to **Manage TE Load**

Capabilities

Reduces load by 46 kW per bus

Maximizes energy and capacity contributions to the grid from transportation electrification

Benefits

Using an Insulated Robotic Arm for Energized Transmission Work

WHY IT MATTERS	It is becoming increasingly complicated to plan and schedule transmission outages, and each transmission element out of service adds risk to the system. The switching process needed to deenergize also requires field support and control center support to take the line out of service and return the line to service.
CUSTOMER VALUE	This technology should improve schedule adherence, create efficiencies, help lower the capital cost per pole change, and keep the transmission system energized to support reliability and resiliency.
BUSINESS VALUE	Energized transmission work has been an industry practice for over 20 years. There is proven technology within the industry to safely perform the work while minimizing outages.
CHALLENGE STATEMENT	Transmission shutdowns are becoming increasingly hard to obtain due to grid demands.
SOURCE	Internal

DECISION: GO
NEXT STEP: UPDATE AGREEMENTS TO ENABLE USE OF TECHNOLOGY

How this Innovation Creates Value for PGE

Enables **work to be done safely**

Augments **Physical Grid Infrastructure**

Capabilities

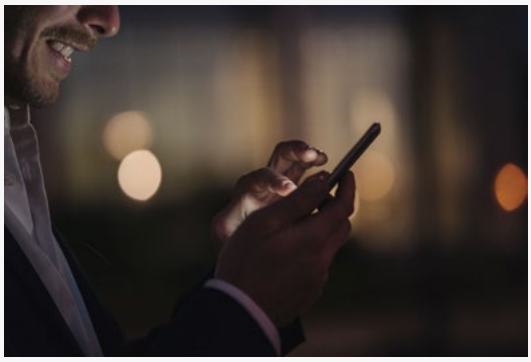
Improves scheduling work compared to current practices

Reduces the total cost of the job by not having to deenergize and reenergize lines

Benefits

Wireless Integrated Network (WIN)*

WHY IT MATTERS	With PGE's VPP strategy, millions of devices will be connected over 5G networks which would be expensive to build and maintain. The solution allows PGE to connect devices using a multi-carrier approach without building new telecom infrastructure.
CUSTOMER VALUE	This solution allows PGE to offer services to a new class of customer devices over cellular more affordably and enables the megawatts of distributed energy resources to meet the 2030 decarbonization targets to be connected to the VPP.
BUSINESS VALUE	Avoids capex investment and opex spending and avoids building cell towers to maintain the telecom infrastructure. PGE can now reallocate that capital to invest back into the core grid services customers need.
CHALLENGE STATEMENT	Deliver a 20X savings in cost and time to deliver the 5G cellular network.
SOURCE	PGE 5G Innovation Lab



DECISION: GO
NEXT STEP: SET UP PRODUCTION ENVIRONMENT

How this Innovation Creates Value for PGE

Capabilities

Telecommunications and **5G** capabilities

Enables PGE's **Virtual Power Plant to scale** through **DER integration**

Benefits

9 years faster to deploy than cell towers

Avoids capex investment and opex in cell tower infrastructure.

*This slide reports on all landed WIN-related use cases, which consists of one non-legacy flight (counts toward KPIs): PGE OmniCarrier SIM & WIN and three legacy flights (do not count towards KPIs): Connected Weather Stations, Connected Electric Avenue and Connected Electric Island.

2. Active flights by airport

As of December 2024

TRANSPORTATION ELECTRIFICATION AND LOAD FLEXIBILITY

Ductless Heat Pump Flex Load Demonstration

WHY IT MATTERS	Customers with ductless heat pumps are not able to participate in an automated demand response or direct load control program such as Smart Thermostat. Currently, these customers can only participate in behavioral programs like Peak Time Rebates or rate such as Time of Day.
CUSTOMER VALUE	Ability to participate in automated demand response and load control programs like Smart Thermostat.
BUSINESS VALUE	This technology presents an opportunity to increase market responsive products that share financial value with customers, offsetting price increases and increasing customer trust.
CHALLENGE STATEMENT	PGE needs to include customers with ductless heat pumps in direct load control programs to help meet our flexible load and VPP goals and to help customer access programs to help them save money.
SOURCE	Energy Impact Partners

KPIs tracked:
Does the solution...

Work as advertised?	Able to **integrate with a major DRMS** provider in order to develop a pilot?	Respond to demand response dispatch signals?

Residential EV Telematics Expansion

WHY IT MATTERS	The Residential EV Smart Charging Program has limited qualified chargers and one qualified vehicle that can join through the telematics pathway. These limitations prevent many EV drivers from joining our program. With expanded telematics options, we can access more vehicles to manage the charging load during peak times.
CUSTOMER VALUE	Over 10,000 EVs in our service area are not a part of the Residential EV Smart Charging Program.
BUSINESS VALUE	Currently, the charging for many vehicles in our service area is going unmanaged and many customers are unable to qualify for rebates and incentives.
CHALLENGE STATEMENT	PGE needs to expand the qualified vehicle telematics options in order to grow the Residential EV Smart Charging Program to contribute to the Virtual Power Plant.
SOURCE	Internal

KPIs tracked: Does the solution...

Expand qualified chargers and vehicle OEMs?

Allow us to **compare EV telematics** solutions?

Increase eligible vehicles to **increase customer participation**?

Fleet EV Backup Power

WHY IT MATTERS	As PGE encourages electrification of its fleet and for those of customers, viable options for resiliency are critical in the event of an outage. Mobile options provide a scalable and flexible solution.
CUSTOMER VALUE	PGE customers can rely on PGE fleets to mobilize and repair infrastructure during outage events. Customer fleets can remain operational during outage events.
BUSINESS VALUE	PGE's fleet requires a resiliency strategy for fleet electrification that does not require costly redundancy at all sites. Mobile EV charging systems could also be installed at generation facilities that are not amenable to electric vehicle charging infrastructure.
CHALLENGE STATEMENT	As mobile EV charging investments, do the available technologies present a cost-effective resiliency solution for fleets?
SOURCE	Energy Impact Partners and PGE interest from conference

KPIs tracked: Does the solution...

Perform as described to charge fleets?

Make **refueling easy** for fleets?

Enable fleets to confidently answer the question of **how will fleets continue to operate during power outages**?

Have **mobility benefits** that increase its cost effectiveness?

Managed Charging Demonstrations

WHY IT MATTERS	PGE scoped several managed charging demonstrations to experiment with various load management approaches with our commercial EV customers.
CUSTOMER VALUE	PGE could offer incentive programs for residential and C&I customers that would yield cost savings and grid stability.
BUSINESS VALUE	Managed charging will help PGE reduce the need for expensive peaker plants and minimize demand charges. At the pilot scale and larger, it would be part of our VPP, providing valuable peak load reduction and other grid benefits that reduce PGE's cost to operate the grid. It can also reduce or defer the need for investments in new grid infrastructure.
CHALLENGE STATEMENT	PGE needs managed charging programs that reduce demand and costs, and increase participation, ensuring reliability of controls and customer satisfaction.
SOURCE	Internal / Transportation Electrification Roadmap / B&V Fleet Managed Charging Study

KPIs tracked: Does the solution...

- **Effectively shift charging** among residential and C&I EV customers?
- Compliment current rates to shift customer charging behavior **or is there a need for an EV-specific TOU rate**?
- Work with existing Residential Smart Charging Pilot to **manage charging in multifamily sites** with dedicated parking and charging?
- Provide noticeable differences **in peak load reduction**?

Pole Charging EVSE

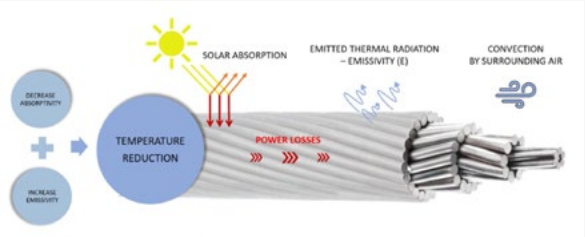
WHY IT MATTERS	Roughly 50% of PGE's customers are renters and likely do not have the ability to install charging at their place of residence given current program offerings and infrastructure.
CUSTOMER VALUE	PGE's customer surveys suggest that access to charging is a "must-have" before purchasing an EV. This demonstration aims to provide customers living in multi-family housing with access to DC fast charging in public spaces.
BUSINESS VALUE	As more vehicles are electrified, PGE is able to support transportation electrification and the load it requires.
CHALLENGE STATEMENT	PGE needs charging infrastructure that can provide multi-family residents with access to EV charging in public spaces.
SOURCE	Internal

KPIs tracked: Does the solution...

- **Identify EV charging sites** in locations that will increase use and EV adoption?
- **Impact feeder performance** in a material way?
- Offer a **safe and fast** charging solution to customers?
- **Address access to charging** needs to increase EV adoption?

Technology for Transmission Conductor Ampacity Increase

WHY IT MATTERS	This technology allows PGE to increase the facility rating of critical transmission paths.
CUSTOMER VALUE	Explores a cost-effective solution to meet growing customer load while maintaining reliability.
BUSINESS VALUE	Allows PGE to meet the needs of our customers and increase facility ratings without investing in expensive substation upgrade equipment.
CHALLENGE STATEMENT	PGE needs a solution that could provide a coating to increase emissivity and reduce absorptivity to support 4000A for substations on 2156 ACSS conductors in order to support load growth without an equipment upgrade.
SOURCE	Internal

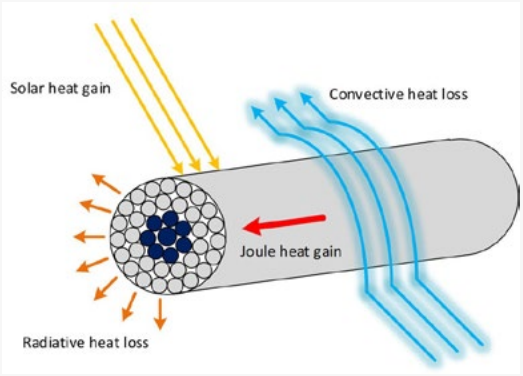


KPIs tracked: Does the solution...

- **Increase conductor ampacity** to 4000A from 2156 ACSS conductors?
- **Support increased load growth** without an equipment upgrade?
- **Reduce** costs to meet load growth?
- **Reduce** time to meet load growth?

Dynamic Line Rating Technology

WHY IT MATTERS	DLR technology (sensor-based and Energy Management System-based solutions) can assess wind speed, ambient temperature, and related real-time weather information. This will be used to develop dynamic ratings for transmission lines, which allows for accurate real time ratings compared to static ratings.
CUSTOMER VALUE	To be able to provide an affordable and more reliable clean energy transition, PGE is exploring DLR technology to help reduce congestion costs, improve integration of renewables, and increase capacity and reliability.
BUSINESS VALUE	PGE is experiencing congestion in certain areas of its transmission network during specific operating conditions. DLR solutions have the potential to affordably alleviate some areas of congestion while long-term upgrade projects are being implemented.
CHALLENGE STATEMENT	Explore two DLR solutions that factor in variable weather data impacting the ampacity of lines (sensor-based, EMS-based) on a 230 kV line to determine value proposition at scale for operational flexibility and cost reduction.
SOURCE	Internal / direct contact with vendor



KPIs tracked: Does the solution...

- **Decrease congestion** on flows from South to North?
- **Decrease Grid Operations costs**?
- **Increase accuracy** of transmission line loadings?
- Increase ability to **develop operating plans for outage scenarios**?

Forecasting Grid Hardening and Resilience

WHY IT MATTERS	Due to regulatory environments, equity considerations, and nascent data and methodologies, understanding the economic and social resilience benefits to infrastructure investment to meet climate resiliency is a complex and crucial challenge.
CUSTOMER VALUE	Informs grid hardening investments to reduce infrastructure costs and mitigate outage time.
BUSINESS VALUE	Rather than develop our own model internally, PGE is exploring a resilience modeling solution based on research already developed by frameworks being used by national labs to make the right investments.
CHALLENGE STATEMENT	PGE needs to quantify the economic and social benefits to support infrastructure investments that would need to be made in order to address improved resiliency in the face of climate risks.
SOURCE	Internal

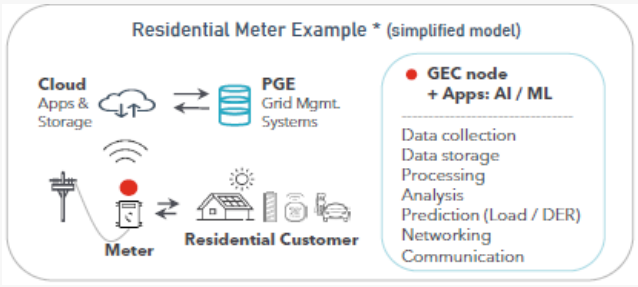
KPIs tracked: Does the solution...

Improve data to address economic and social resilience benefits?	**Reduce time and costs** compared to building the solution internally?	**Deliver data to improve resiliency** in the face of climate risks?	Provide **regulatory justification** for infrastructure resilience projects?

GRID PERFORMANCE | IN FLIGHT

Grid Edge Computing – AMI 2.0

WHY IT MATTERS	PGE is expanding its focus at the grid edge to support real-time grid visibility, including: meter to transformer mapping, Distributed Energy Resource (DER) capacity insights, DER disaggregation, and identification of power quality issues. These features will produce large amounts of data that will be analyzed and reported on using AI/ML and data analytics apps. These tools both on premise and in the cloud provide actionable grid intelligence for PGE to use to optimize grid services.
CUSTOMER VALUE	This evaluation and demonstration is supported by a $50M DOE grant that enables PGE to explore AI capabilities that enable customers' distributed devices/DERs to support grid capacity and resilience.
BUSINESS VALUE	This project supports PGE's long-term imperatives to decarbonize, electrify, and perform by providing real-time, granular visibility of the distribution system and DERs, not otherwise available today.
CHALLENGE STATEMENT	To better serve customers, improve grid resiliency, and meet 2030 goals PGE must increase predictive capabilities where we have traditionally had the least visibility – at the edge of the distribution network.
SOURCE	Internal / DOE Grant

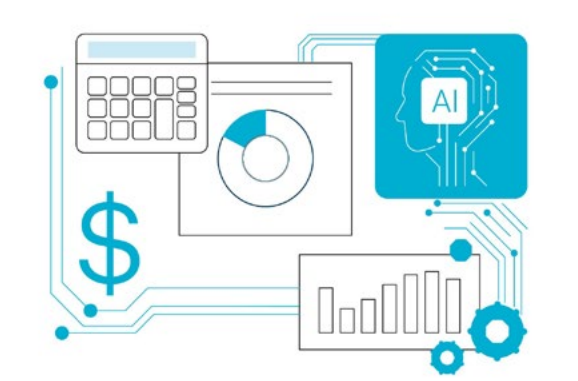


KPIs tracked: Does the solution...

Provide **Real-Time Grid Visibility**?	Provide near-real-time **DER local hosting capacity insights** that leverage **advanced analytical models and AI**?	Validate **DER responses** as grid assets for **dynamic performance**?	Assess the impact of **DERs, integrate them into real-time operations,** and execute local, **autonomous signals to rebalance the system**?

Expense Bot

WHY IT MATTERS	90% of discretionary spend at PGE is from expense submittals. The current manual review process is time-consuming and can contribute to long processing times. Automating the review process can significantly reduce the time and effort required, while ensuring compliance with company policies.
CUSTOMER VALUE	By saving employees time, we are securing cost savings for customers and creating bandwidth for employees to maximize customer dollars.
BUSINESS VALUE	The solution can lead to insurance that all expenses follow company expense policies and reduction of non-compliant expenses and reduce PGE's monthly expense payout.
CHALLENGE STATEMENT	An AI-powered bot capable of evaluating expense reports against PGE's expense policies, flagging non-compliant submittals, and assisting with non-compliance emails and training enrollment.
SOURCE	Internal / ChatPGE Generative AI Innovation Roadmap



KPIs tracked: Does the solution...

Improve efficiency and increase number of expense reviews?

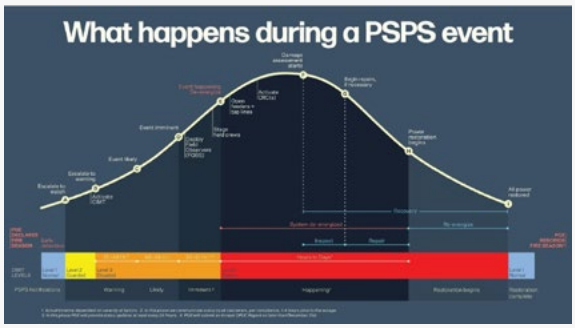
Reduce time and labor hours for reviews?

Reduce non-compliant **cost payouts**?

Increase number of users enrolled in **expense training**?

PSPS Outage Smart Board

WHY IT MATTERS	The current system to track crews and progress made during PSPS events is very manual and does not provide real time visibility of where crews are working.
CUSTOMER VALUE	Reduces outage time by enabling line center operations to run smoothly and efficiently.
BUSINESS VALUE	Provides visibility into where crews are operating in real-time and automates what is currently a manual process to track crews in the field.
CHALLENGE STATEMENT	PGE needs a digital technology with automated workflows to get real-time data to crews and customers during PSPS events to reduce OPEX cost, improve response times, and improve customer satisfaction.
SOURCE	Internal



KPIs tracked: Does the solution...

Accurately **track crews in real-time**?

Reduce labor **costs and outage time**?

Improve **Emergency Planning and Preparedness**?

Improve Resource Allocation Methodology during PSPS events?

Wireless Integrated Network (WIN) for PGE Flex Load Water Heaters

WHY IT MATTERS	PGE has historically utilized third party vendors for connecting, communicating, and dispatching DERs. Ongoing data costs negatively impact program cost effectiveness. PGE has no ability to control these costs by changing carriers.
CUSTOMER VALUE	Improved costs of the flexible load program.
BUSINESS VALUE	Ability to lower costs and offer a better flexible load program. This could potentially improve resiliency and security of the communications network.
CHALLENGE STATEMENT	PGE needs a SIM that can be installed into water heater Universal Communication Modules offering a multi-carrier cellular solution to control and reduce cellular data costs.
SOURCE	Internal

KPIs tracked:
Does the solution...

Enable a **multi-cellular solution** through a single SIM?

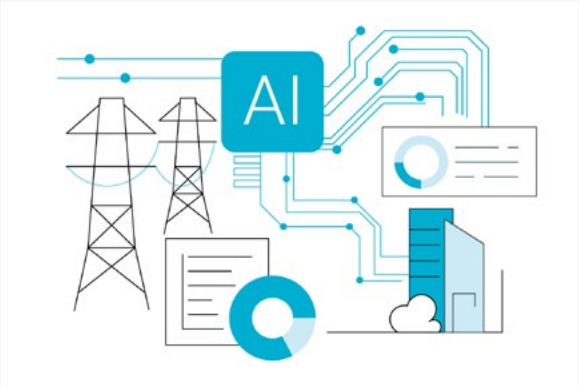
Reduce data costs?

Install inside a **Universal Communication Module**?

Deliver the ability for PGE to **control** and select cellular networks **without a truck roll**?

Line Design Review Bot

WHY IT MATTERS	The current manual process is time-consuming (30 minutes per job), prone to errors, and lacks standardization. With an estimated 6,000 jobs in 2024, the potential cost savings by automating the process could be up to $90,000 (from $300,000 to $210,000). Automating this process can significantly reduce cycle time, increase quality and standardization, and improve upstream planning and scheduling.
CUSTOMER VALUE	By saving employees time, we are securing cost savings for customers and creating bandwidth for employees to maximize customer dollars.
BUSINESS VALUE	Reduces the time and resources required for the job review and approval process to save costs. Mitigates risks associated with non-compliance, such as public and employee safety issues, financial penalties, and crew labor issues.
CHALLENGE STATEMENT	PGE needs a generative AI solution to automate the job review and approval process for design standards compliance. The bot leverages image segmentation, Optical Character Recognition (OCR), text extraction, and Generative AI to identify potential violations and streamline the approval process.
SOURCE	Internal / ChatPGE Generative AI Innovation Roadmap



KPIs tracked:
Does the solution...

Reduce cycle time for job approval?

Reduce costs per job?

Increase compliance standards?

Reduce errors?

DOE Wind and Solar Grid Services Demo

WHY IT MATTERS	On the path to a future system with high penetration of inverter-based resources, grid forming technologies have the capability to provide cost-effective grid services (voltage control, frequency control) in conjunction with intermittent resources.
CUSTOMER VALUE	Pursues research around grid service capabilities of non-emitting resources through DOE funding to mitigate customer costs.
BUSINESS VALUE	If successful, this will be the first bulk power system connected grid forming inverter power plant in the country.
CHALLENGE STATEMENT	PGE is pursuing a grant funding opportunity to demonstrate grid services using mixed grid-forming and grid-following technologies at the Wheatridge Renewable Energy Facility by engaging with industry partners.
SOURCE	Internal / DOE Grant

KPIs tracked: Does the solution...

Identify the optimal combination of existing **installed power systems controls and newer innovative technology of dynamic**?

Offer a **cost-effective alternative** to grid following power system controls?

Compliment PGE's **renewable resource** portfolio?

DECARBONIZATION AT SCALE | RUNWAY

Genset Starting System

WHY IT MATTERS	There's a need to replace lead acid batteries for DSG genset starting systems. The type of battery that we are exploring has an integrated charger, smaller footprint and lower O&M compared to lead acid batteries.
CUSTOMER VALUE	These genset starting systems have a lower total cost of ownership resulting in O&M savings to the DSG program and savings for customers.
BUSINESS VALUE	Current genset starting systems need to be replaced every 3 years, are the leading cause of failures, and contain lead and other harmful materials. PGE is exploring a technology that is 75% smaller, does not contain hazardous materials, and has a lower total cost of ownership.
CHALLENGE STATEMENT	Test technology to assess if it is capable of necessary genset starting system criteria to select best technology solution.
SOURCE	Internal / direct contact with vendor

KPIs tracked: Does the solution...

Map a **path away from lead acid batteries**?

Decrease **total cost of ownership**?

Provide **comparable reliability** to lead acid batteries?

Smart Battery Demonstration

WHY IT MATTERS	This is a low barrier, low risk demonstration to test the functionality of new devices entering the Smart Battery pilot, an important component to PGE's continued VPP efforts. Though batteries are a nascent technology they are growing quickly and have the potential to perform far more grid services than other residential appliances.
CUSTOMER VALUE	PGE has been approached for a VPP grid services partnership where the partner will offer a discount to customers.
BUSINESS VALUE	To qualify batteries for this program, PGE would like to test the quality and accuracy of the battery and its ability to offer grid services.
CHALLENGE STATEMENT	PGE needs to test new devices seeking to join the Smart Battery pilot in order to vet their quality and validate the capabilities that these new devices are promising.
SOURCE	Vendor

KPIs tracked: Does the solution...

Meet our **customer experience** expectations for **device quality, installation, reliability and performance**?	Offer **DERMs interoperability**?	Meet our **demand response performance requirements**?	Contribute to advanced grid services **like frequency response and regulation**?

DECARBONIZATION AT SCALE | RUNWAY

Solar Microgrid for Wildfire Mitigation

WHY IT MATTERS	Wildfire mitigation planning requires the exploration of all cost-effective alternatives to system hardening and resilience, especially in areas where undergrounding to improve reliability and reduce wildfire risk is cost-prohibitive.
CUSTOMER VALUE	Microgrid technology may allow sites to keep their lights on during a PSPS event and can identify cost-effective project sites. This would result in increased customer value and limit service disruptions.
BUSINESS VALUE	PGE is exploring solar-microgrid solutions targeting remote, rural areas where traditional reliability upgrades may be cost-prohibitive. If viable, we can use this product to defer traditional wires upgrades in remote areas or remote loads, freeing up capital to spend on other high-priority investments, as well as increasing our on-system renewable generation incrementally.
CHALLENGE STATEMENT	In addition to conducting an analysis of the microgrid alternative as a wildfire mitigation approach for Mt. Hood Meadows, the team is also conducting an in-depth assessment of additional cost-effective opportunities on the PGE system.
SOURCE	EPRI Incubatenergy Labs

KPIs tracked: Does the solution...

Enable **transmission upgrades to be deferred**?	**Improve reliability**?	Defer transmission line **undergrounding**?

Grid Edge Computing – DER/IOT Gateways – EPRI Study Phase 2

WHY IT MATTERS	Today, local smart inverter gateways do not follow specific protocol standards. As PGE scales its VPP platform, standardized interfaces and/or physical protocol devices are needed that will link PGE's communications network with DERs.
CUSTOMER VALUE	Standardizing plug and play equipment options for gateways could reduce peak demand by optimizing DER management through specific gateways protocols at customer locations throughout the distribution system.
BUSINESS VALUE	DER gateways are required for PGE to meet its goal of 25% of peak load being served by DERs, and this project provides support for increased DER penetration by enabling added visibility through grid-edge logic.
CHALLENGE STATEMENT	PGE requires increased grid-edge logic and "plug and play" interoperability for gateways to support the DERs required to reduce 25% of peak load served by these renewables.
SOURCE	EPRI

KPIs tracked: Does the solution...

Meet documented **gateway requirements**?

Allow us to **document DER integration needs** that can be met by DER network gateways?

Deliver intelligence and logic for **grid edge applications**?

Drive industry standards for gateway capabilities and requirements?

DECARBONIZATION AT SCALE | IN FLIGHT

Low Cost Wireless Carrier DTT

WHY IT MATTERS	DERs with capacity greater than 33% of a feeder's minimum load normally require DTT, a fiber optic cable from a substation to a customer's site. This can cost hundreds of thousands of dollars and can also take as long as two years due to supply chain constraints.
CUSTOMER VALUE	Often this cost negates the customer's financial benefit of enrolling their DER into one of PGE's programs.
BUSINESS VALUE	This use case will help us find alternatives to fiber that are more affordable and faster to deploy to improve customer satisfaction and improve access to DER programs.
CHALLENGE STATEMENT	PGE needs to develop one or more satisfactory alternatives to our current DTT communication methods to reduce costs and enable a faster pace of DER integration.
SOURCE	Internal

KPIs tracked: Does the solution...

Log errors and exceptions effectively, facilitating troubleshooting and post-event analysis?

Accurately identify fault types?

Meet or exceed specified requirements?

Support **reliable wireless communications channels** without loss or corruption?

Appendix B

This appendix covers the characteristics under each section of innovation (strategy, structure, and culture) and describes how EPRI characterizes them in the GIE Assessment.

INNOVATION STRATEGY

The mission and vision of an organization that govern how it operates to create value and thrive in the future.

Understanding the Business Environment: How future business risks and opportunities in the market are identified.

Defining Innovation: How the organization defines innovation.

Prioritizing Innovation: How well the company's innovation priorities—its objectives, commitments, and resources—are incorporated into its overall corporate strategy.

Innovation Strategy and Objectives: The extent to which the organization has an explicit innovation strategy and set of objectives.

Innovation Portfolio: Whether the organization has a portfolio of innovation projects/initiatives.

Innovation Metrics: How innovation performance is measured and managed.

Innovation Risk Management: The extent to which the organization uses a risk management framework for innovation decisions.

INNOVATION STRUCTURE

The activation of strategy through operating models, defined processes, business activities, and resource support.

Providing Necessary Resources: The extent to which sufficient resources are made available to support innovation.

Central Coordination: How innovation activities are coordinated via a central function.

Involving Customers in the Innovation Process: How effectively customers and other stakeholders are involved.

Organizational Practices and Procedures: How organizational practices and procedures support innovation.

Innovation Process: The processes, tools, and/or methods that govern the practice of innovation.

Research: How research related to innovation (R&D, market research, ideation) is conducted.

Knowledge Management: The extent to which employees share and access knowledge gained through innovation practices.

Benchmarking Innovation: How innovation processes and management practices are benchmarked.

External Partnering and Collaboration: The state of collaboration and networking with external parties.

Implementation: How well innovation efforts are implemented into existing business practices and/or the marketplace.

INNOVATION CULTURE

The shared values, beliefs, and behaviors of leaders and individuals in pursuit of common goals.

Organizational Values: The extent to which values around innovation contribute to the corporate environment.

Leadership: The extent to which leadership drives, encourages, and supports innovation.

Idea Generation: How ideas for future actions/ improvements are surfaced.

Fostering an Innovative Environment: The extent to which employees are encouraged to take initiative and be entrepreneurial.

Collaboration and Networking: The state of collaboration and networking internally.

Communication: The state of communication about innovation activities inside the organization.

Incentivizing Success: The extent to which individuals and teams are motivated and rewarded.

Innovation Learning: The extent to which insights and lessons learned from successful (and unsuccessful) innovation efforts are shared throughout the organization.

Appendix C

Strategic Innovation process roles, responsibilities, meetings

PORTFOLIO

Below is a list of roles participating in the innovation process.

Roles	Responsibilities
Executive Review Team (“FAA”)	Executive champions supporting the innovation process. They receive updates and reporting on performance. They are invited to review the Value Proposition for any use cases deemed a “Go”
Strategic Innovation Manager	The “Approver” for all use case stage gates in the Strategic innovation process
Strategic Innovation Team	Innovation core team supporting all captains and flights as the make their way from runway to landing
Captain	Business Unit leader owning the execution of the innovation sprint
First Officer	The SME supporting the Captain in the execution of the innovation sprint
Airport Manager	Innovation champions that support the portfolio of use cases in their Strategic Innovation focus areas (airports), serving as a liaison between the Strategic Innovation team and the business units
Crew	Extended team of resources supporting a use case test flight

OVERVIEW OF STRATEGIC INNOVATION PROCESS AND DELIVERABLES

Hangar	Taxi to runway	Runway	In-flight	Landed	Final decision
• Intake form completed • Idea cataloged • Idea assigned to capt. • Idea assigned to airport • Idea pitched at Spark Tank • **Decision Point:** Proceeds to next step or remains in hangar	• Complete taxi to runway checklist • Use case is formally scored using EPRI methodology in a hole-punching session with SMEs • **Decision Point:** Proceeds to runway or go back into hangar	• Captain determines procurement strategy and package • Complete solution framing • Complete cyber/risk review • Complete test plan • Complete project plan • Submit package to innovation manager, cyber, risk, procurement and IT to be cleared for takeoff!	• Field testing starts • Field testing completed • Field testing accepted	• Field testing accepted • Day-in-the-life learnings captured • Post-flight learnings template completed • **Decision point:** Innovation manager reviews learnings and determines how to progress to decisions	• Captain shares learnings • Final "hole punching" session with executive is scheduled if needed • **Decision point:** Final decision is made • If "go", captain creates value prop 1 pager to hand off to business

MILESTONE MEETINGS

Below is a list of the meetings the Strategic Innovation Team schedules to bring innovators together and advance use cases. These are meetings where decisions are made or updates are provided to the organization on a regular cadence.

Meeting	Description	When is it?	Participants
Spark Tank Innovation Hour	Meeting where initial ideas are presented to a set of cross-functional SMEs team for initial feedback	Monthly	Captains, Airport Managers, Cross-functional SMEs
Use Case Prioritization Scoring	Meeting where ideas are presented for more detailed scoring using the EPRI ranking methodology.	Before each plane enters the Runway	Captains, Airport Managers, First Officers and any additional SME Scorers
Prioritization and Governance Team Meeting	Ideas (test flights) progressing to new stages are presented to the extended team for awareness and support.	Quarterly	Prioritization and Governance Team, Captains, Airport Managers
Cyber / Risk Review Team Meeting	Test flights are reviewed by the cyber/risk review team to review approach for test flights on the runway, define path to take-off	Quarterly	Captains, Cyber representatives, Procurement representative, Legal representative
Executive Review Team Meeting	Final meeting where the recommendation to scale for any use cases deemed a “go” is made. This meeting serves as the baton handoff to the business to take ideas into decision venues (e.g., BSGs)	After each flight Landing	Captains of “Go” Use cases, Airport Managers, Executive Review Team

REGULAR CADENCE MEETINGS

These meetings that help drive and support the innovation process.

Meeting	Description	Participants
Airport Managers Weekly	Opportunity to review test flights progressing into new stages. Allows Airport Managers to offer guidance, get updated and offer support to the planes in their airport.	Strategic Innovation Team, Airport Managers
Air Traffic Control Weekly	Weekly meeting with Strategic Innovation to discuss what is needed to help support the entire innovation process, dashboard reporting, etc.	Strategic Innovation Team
1:1 Meetings with Captains	Opportunities for Captains to meet when needed with the innovation core team to get help, training or coaching through the innovation process.	Captains and core innovation team

Pachwáywit Fields