



RELIABLE
power
secures
the clean
energy
future





Our communities depend on Portland General Electric's reliable, integrated electric system to deliver the power needed to live, work and play safely. Electricity from PGE powers our communities at all levels: schools, hospitals, fire stations and countless other services we all depend on. PGE remains committed to providing this essential service reliably, for all customers, as we have for 130 years.



Since 1889, PGE has been trusted with the mission of powering Oregon and ensuring electricity is available for all customers. Our integrated system is designed to deliver reliable and affordable power to customers 24/7 — whether it's a blue-sky day or an extreme event that threatens our region. From power generation to transmission to delivery, our coordinated real-time operations, which encompass hundreds of facilities, thousands of miles of lines and an ever-increasing amount of data, keep our customers' power flowing. Our field operations team members are in neighborhoods every day making sure infrastructure is safe and reliable. Our commitment to cyber- and physical security helps ensure data is protected and systems are secure.

Oregon is growing. Technology is increasingly ingrained in our way of life. The power to connect affects the lives of customers and the overall economy more than ever before. At PGE, we have continuously delivered power for 130 years, and we are dedicated to providing it safely and reliably across our integrated system.

The collaborative fabric created by our regulated industry tightly knits us together with other utilities. This has served customers well and is essential to a reliable clean energy future. Our partnerships and collaboration through regional entities, such as the Northwest Power Pool and mutual assistance programs, assure that electricity is available during critical times and that shared resources help save customers millions of dollars.

Enhanced collaboration is even more essential as the need for access to regional resources increases. The retirement of coal-fired resources ushers in an exciting new era, pushing system operations closer to the razor's edge of reliability. Optimizing the transmission system is vital for integrating solar from California and the desert Southwest, wind from Montana and Wyoming, and wind and hydro from the Northwest and Canada. We were one of the first utilities to join the Western Energy Imbalance Market and our leadership in regional power operation coordination gives us greater flexibility. This allows us to generate resources to reliably meet customer needs at the lowest cost while optimizing our use of renewable energy.

This philosophy of teamwork includes not only our facilities, but our people as well. On those rare occasions when Mother Nature hits hard, we pull together to accelerate system restoration and get customers back online quickly.



PORTLAND GENERAL ELECTRIC'S ENHANCED COLLABORATION ACROSS THE WEST IS ESSENTIAL TO DELIVERING RENEWABLE ENERGY SO CUSTOMERS IN OREGON CAN THRIVE

A national leader for clean energy transformation

Innovation is at our core. In 1889, we were the first in the nation to light a city with clean hydro power. Today, 130 years later, we were the first to introduce at-scale combined solar, wind and energy storage to reliably power customers' lives with renewable energy. Throughout our history, we've leveraged our experience and know-how to ensure that the lights stay on, no matter what.

PGE's 30,000 miles of power lines bring energy to our customers from diverse resources across the West. In the past, an issue on a line would not be known until the power was out. Today, PGE uses automated sensing technology to continuously monitor the lines. Pairing this capability with machine learning and data science, we predict failures before they occur and proactively maintain the system to minimize outages. It is our experience and capabilities as a vertically integrated company supplying and delivering power that allows us to couple a smarter grid with clean and renewable resources. This allows us to serve all customers without compromising system reliability.

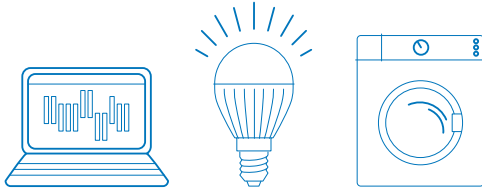
PGE operates the nation's largest virtual power plant by aggregating customer-sited resources and connecting them with regional power plants through our integrated grid. Known as Dispatchable Standby Generation, this system provides local capacity when access to other resources may be constrained. We are expanding our virtual power plant to include even more solar and storage resources.

Oregon is generating a record-level amount of clean and renewable energy from solar and wind,¹ and PGE is bringing even more to customers. Greater grid flexibility allows us to reliably incorporate more of these renewable sources. We are adding smart technologies to capture energy during hours when renewable resources are plentiful and freeing it for customers to use when they need it. PGE's holistic approach utilizes new technologies for automation, load balancing and intelligent resource management to unlock the full potential of centralized and distributed generation.

RELIABILITY, RESILIENCY AND RECOVERY

Reliability, resiliency and recovery are at our core, and we are investing millions to ensure customers are protected. Our full-service system means all our customers and communities benefit in Oregon's clean energy future and receive continuous reliability. We also provide resiliency during extreme events to keep our customers and communities safe. New threats are emerging in the form of climate change, physical intrusions and cyberattacks. We actively address these risks by integrating purpose-built reliability, resiliency and recovery systems across our integrated grid. We continuously monitor and forecast environmental and system conditions and anticipate power flow impacts to allow quick recovery when events occur.

Customers' EXPECTATION

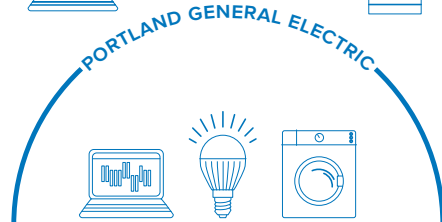


RELIABILITY

"The power comes on when I flip the switch."

Energy LANDSCAPE

THREATS



CUSTOMERS

RESILIENCE

We constantly monitor our systems, track threats, and practice contingency plans to ensure continuous reliability.

Climate resilience

Climate change is increasing the risk and severity of extreme environmental events. An earthquake, storm, wildfire or other natural disaster could happen at any time. The Fukushima disaster in Japan highlighted the importance of an electric grid that is resilient and can recover quickly to keep the community secure, even in the face of unthinkable adversity.² In the Pacific Northwest, we face the very real possibility of a powerful earthquake due to our proximity to the Cascadia subduction zone.³

PGE continuously coordinates with federal and regional agencies to prepare for such events. And when environmental events do occur, we are at the heart of a coordinated industry helping restore power as quickly as possible.

WELL BEFORE AN
EVENT OCCURS, PGE IS
PLANNING FOR RECOVERY
AND WORKING WITH
FIRST RESPONDERS TO BE
READY FOR ANY CRISIS

We respect the natural beauty of our environment. Our responsible vegetation management practices help prevent wildfires and proactive fire preparedness practices will ready us for a rapid response to potential events. PGE has led emergency response drills for decades, both with our internal operations and community partners. Our disaster response simulations are designed to stress test our people and our systems, so that we are prepared for

extreme events and our customers have the confidence that PGE's response will be swift. PGE, emergency services, local governments and community organizations regularly participate in these intense training exercises for disaster preparedness. Practice makes perfect. Well before an event occurs, PGE is planning for recovery and working with first responders to be ready for any crisis.

Our commitment to service and a reliable system deliver peace of mind to customers because they know PGE will be always be there. Integrating technology with our scale and expertise has connected us even more closely with our customers and communities. We are building smart cities, in collaboration with local municipalities, that increase resiliency while using clean energy and new technologies. Smart cities utilize our infrastructure to connect rooftop solar panels, energy efficiency measures, battery storage technologies, secure data monitoring and electric vehicles to increase local resiliency to the level currently found at the regional scale.

Grid hardening

The world is increasingly digital, and Oregon is a digital hub for the United States. We cannot rely on systems from a pre-digital world. The computing needs of data centers and other critical infrastructure must have the 24/7 reliability that PGE provides. PGE's integrated, hardened grid reliably provides high-quality power to ensure the most precious and sensitive aspects of our lives, from family photos to financial information, are safe and secure.

The transmission and distribution system is continuously enhanced to increase resiliency and provide redundancy with a greater ability to self-heal. New artificial intelligence and analytics technology helps us predict and isolate potential problems and prevent their occurrence. Joining physical infrastructure with autonomous technology keeps the system reliable. We detect vulnerabilities in real time and allow for rapid recovery of the grid, making it less susceptible to adverse events.

OFF-GRID DISASTER SERVICES

PREPHub provides crucial services during a disaster

PGE, the City of Portland, Portland State University and the Massachusetts Institute of Technology have partnered to install a new kind of infrastructure for use during natural disasters and extreme events.

PREPHubs are designed to operate entirely off-grid during a disaster, providing crucial services like power, communication and emergency first aid supplies. The hubs will be able to recharge emergency communications and cell phones during and after a disaster. They also provide secure storage for Basic Earthquake Emergency Communication Node cache equipment, which helps residents ask for emergency assistance and get information. PGE will provide power to the PREPHubs from the electric grid and energy storage devices, supplemented by solar arrays and pedal power.

PGE is increasing system capability for two-way power flow by connecting regional and local resources. Deploying system-connected autonomous microgrids — a combination of distributed generation, storage and the ability to monitor and control power — gives customers safe access to critical services shortly after a major event. This allows us to partner with customers, community leaders and first responders to build and manage resilient connected microgrids and limit widespread outages during major storms or other disasters.

Microgrids are integrated with our regional grid and power essential services during emergencies. They also enable greater efficiency during normal operations. PGE and the City of Portland have partnered to install a solar-plus-storage microgrid at the Portland Fire and Rescue Station 1. The site is home to the fire department's incident command center and will be a crucial part of the city's ability to respond to a hazardous event.^{4,5} The facility can island from the grid in case of emergency and PGE will ensure that the fire station recovers quickly from any event interrupting power supply. Solar panels, coupled with energy storage, will keep the facility powered and critical emergency response systems running. This innovative microgrid is one of the first tailored specifically to a critical infrastructure location, and the ability to power its operations from either solar or storage further ensures its resiliency. Microgrids can also help in neighborhoods during an emergency and allow distributed energy resources paired with autonomous technology to keep the lights on while recovery efforts outside the neighborhood continue.

Cybersecurity

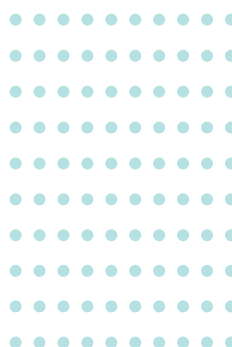
Cyberattacks are continuous, sophisticated attempts to breach a system. These attacks are like someone constantly checking a door to see if it's unlocked. PGE is vigilant in making sure the door is locked to would-be attackers and is also increasingly secure.

Cyberattacks can originate from almost anywhere and have the potential to disrupt power plants, transmission and distribution systems, and customer devices. They can even spread across systems. PGE protects customers by providing energy through connected parts of a vertically integrated system. From homes and businesses, all the way through to regional generation facilities, equipment is connected and set up with the technology to detect and isolate these attacks and prevent their access to our system.

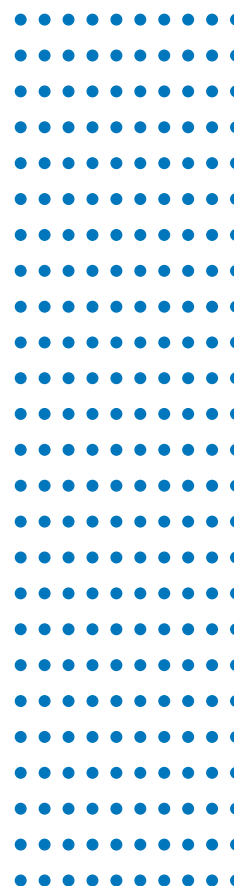
Renewables & reliability

To reach Oregon's clean energy goals, more energy will come from wind and solar. By 2030, PGE will add more than 2.5 times the wind and solar we have today.

RENEWABLES IN 2019



RENEWABLES IN 2030



Integrated physical and cybersecurity

At PGE, a comprehensive security system protects electricity, information, infrastructure and people from both physical and cyberthreats. Our Integrated Security Program focuses on the early detection of threats to achieve the highest possible safety and reliability. PGE's capabilities for data and systems interoperability enable us to securely manage the large volumes of information from all parts of our system.

We enhanced substations with electronic protection systems that enable better tracking and require continuous access verification. We've also strengthened physical security at our headquarters and field offices to better protect our people, operations and data. In addition, PGE is enhancing cybersecurity protection as we integrate more distributed energy resources through our full-service system. This keeps the system reliable and provides resiliency to keep the lights on in the event of a cyberattack.

INTEGRATING RENEWABLES, RELIABLY

To reach Oregon's clean energy goals, more energy will come from wind farms and solar power plants, as well as from distributed solar around the community and on our customers' homes and businesses. By 2030, PGE will add more than 2.5 times the wind and solar we have today to meet customer needs with renewable energy.⁶ PGE's integrated planning activities determine the right "what, where and when" of resources and drive complementary actions that deliver value for customers.

At certain times, renewable sources will generate more electricity than our customers need. PGE is integrating technology to store the extra power and help customers shift usage so renewable energy can be used when needed, not just when the wind is blowing and the sun is

PGE IS INTEGRATING
TECHNOLOGY TO STORE
THE EXTRA POWER AND
HELP CUSTOMERS SHIFT
USAGE SO RENEWABLE
ENERGY CAN BE USED
WHEN NEEDED

shining. Our vertically integrated technology advancements have removed the traditional lines between generation, transmission, distribution and customers. This makes our system smarter, more flexible and able to continue delivering electricity with the reliability we all expect.

Enhanced data analytics and communication systems increase two-way power flow and allow distributed resources to pair safely and seamlessly with the large-scale renewable energy customers already receive from PGE. Energy storage provides necessary grid services to keep energy supply and demand in continuous balance. These systems can be large and centralized — like the battery array at the Salem Smart Power Center — or small and distributed, like the batteries in customer homes and businesses. To maximize the benefits to all customers, PGE's system also connects rooftop solar, in-home batteries and electric vehicles so they can serve as valuable energy resources along with centralized generation and regional collaboration.

SUMMARY

Delivering a clean energy future means we need to add more clean renewable resources to our system. At PGE, we understand our critical role continues to be providing this clean energy in a reliable and resilient fashion every day, during extreme events, for the long term and for all customers. When extreme events happen, our customers rely on PGE to keep the power flowing. That's why we're focused on reliability — hardening our physical system and increasing cybersecurity — while bringing more renewable energy to customers through our integrated grid. PGE is committed to providing safe, reliable, affordable service for all. Just like we have been doing for 130 years.

-
1. Electricity Mix in Oregon, Oregon Department of Energy, www.oregon.gov/energy/energy-oregon/Pages/Electricity-Mix-in-Oregon.aspx.
 2. "Getting Smart in the Suburbs of Tokyo," The New York Times, Nov. 27, 2011, www.nytimes.com/2011/11/28/business/global/28iht-RBOG-SOLAR28.html.
 3. "New Cascadia subduction zone earthquake study 'is worse news for Portland northward to Seattle,'" The Oregonian, July 30, 2018, www.oregonlive.com/trending/2018/07/new_cascadia_subduction_zone_e.html.
 4. Source: Deputy Chief of Logistics Marco Benetti.
 5. "Tapping the Sun's Energy Around the Clock," Pamplin Media Group, March 21, 2017 <https://pamplinmedia.com/si/350090-228627-tapping-the-suns-energy-around-the-clock->
 6. A modernized grid platform for a clean energy future, PGE, www.portlandgeneral.com/-/media/public/our-company/energy-strategy/documents/pge-smart-grid-white-paper.pdf.

ADDITIONAL RESOURCES

PGE Clean Energy Vision

portlandgeneral.com/energyvisionpdf

PGE energy strategy

portlandgeneral.com/energystrategy

PGE Integrated Resource Plan

portlandgeneral.com/resourceplanning

PGE strategy papers

The path to a decarbonized energy economy,
portlandgeneral.com/decarbonizationpdf

A modernized grid platform for a clean energy future,
portlandgeneral.com/modernizedgridpdf





portlandgeneral.com/cleanvision