



THE PATH TO A decarbonized energy economy



Today, carbon dioxide and other greenhouse gases (GHGs) are causing global temperatures to rise, leading to potentially devastating effects for the entire planet. To help prevent the most destructive impacts to our environment, the Intergovernmental Panel on Climate Change has proposed a limit for global temperature rise of 2 degrees Celsius above pre-industrial levels.¹ We know that to make meaningful change, everyone — consumers, businesses, industries and governments — must play an active role in reducing GHG emissions.

As Oregon's largest electric utility, Portland General Electric is leading an energy transformation that will harness the power of clean and renewable resources on behalf of all customers. For more than 125 years, we have powered customers' lives with energy that is safe, reliable and affordable. Today, we're also ensuring the energy we provide is clean and secure.

As we change the way we produce and deliver energy, PGE will work closely with regulators, policy makers, customers and other stakeholders to keep electricity equitable. It is part of our mission to provide an accessible, affordable clean energy future to customers in all of the communities we serve.

PGE'S COMMITMENT TO GHG REDUCTION

- 2018** PGE sets a goal to reduce GHG emissions by more than 80 percent by 2050.
- 2017** PGE joins 2,500+ businesses and local governments in the #WeAreStillIn pledge to do our part to meet obligations in the Paris Climate Agreement.
- 2016** PGE joins diverse stakeholders in designing the Clean Electricity and Coal Transition Plan to further progress toward Oregon's GHG reduction goals.
- 2015** PGE signs the White House's American Business Act on Climate Pledge, supporting strong regulation of emissions.
- 2010** PGE reaches an agreement with the Oregon Public Utility Commission and the Oregon Department of Environmental Quality to cease burning coal at our Boardman generating station by the end of 2020.
- 2009** PGE supports the American Clean Energy and Security Act (H.R. 2454), another attempt to establish a national cap-and-trade program for GHGs.
- 2007** PGE and a diverse coalition of stakeholders are instrumental in the adoption of the Oregon Renewable Portfolio Standard.
- 2007** PGE supports the Low Carbon Economy Act (S. 1766), which would have established a national cap-and-trade program for GHGs.
- 2006** PGE CEO Peggy Fowler publicly states it's time for a national, market-based mechanism to reduce GHG emissions economy-wide.

A global imperative takes shape locally

In 2007, the Oregon State Legislature set a goal to achieve GHG levels that are at least 75 percent below 1990 levels by 2050.² This reduction target will likely become more stringent as science and policy progress. Recent GHG policy proposals suggest a new 2050 goal of 80 percent below 1990 levels. Additionally, Oregon’s Clean Electricity and Coal Transition Plan, enacted in 2016, set a benchmark for how much electricity must come from renewable sources like wind and solar (50 percent by 2040) and requires the elimination of coal from Oregon utility customers’ energy supply by 2035.³

Local governments are taking actions on clean energy and GHG reductions, too. In June 2017, Oregon’s most populous city, Portland, and most populous county, Multnomah, each announced resolutions to achieve 100 percent clean and renewable electricity by 2035 and 100 percent economy-wide clean and renewable energy by 2050.⁴ Other jurisdictions in PGE’s service area, including the cities of Milwaukie and Hillsboro, are considering similar goals.

These commitments reflect the values held by customers. As an example, PGE has the highest participation in the country, both by percentage and total number of customers, in our voluntary renewable power program. Our research has found the majority of both residential and general business customers expect PGE to provide clean and renewable energy to all customers within 20 years.⁵

Defining PGE’s role

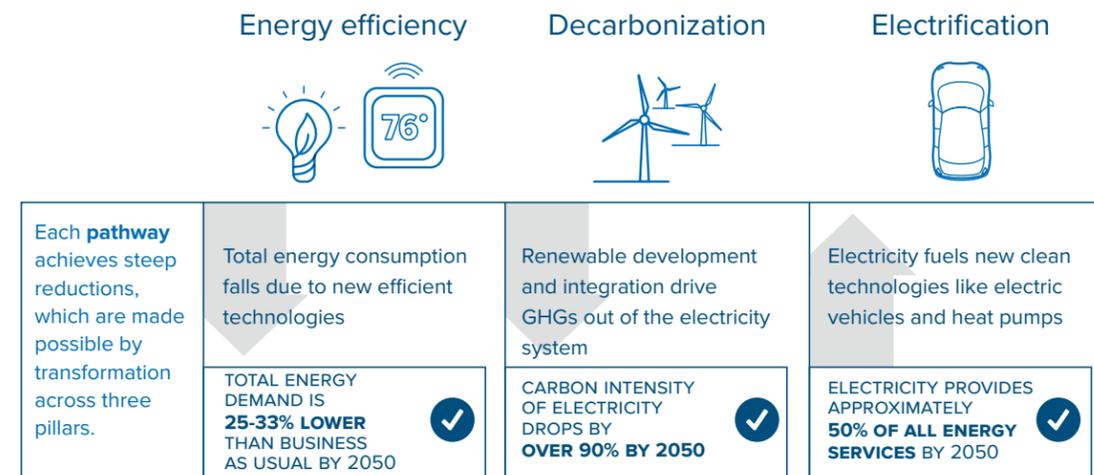
At PGE, we believe addressing climate change is our imperative. Consistent with the recommendations of the world’s leading climate scientists, PGE’s goal is to reduce our GHG emissions by more than 80 percent by 2050⁶ and to be our region’s source for affordable and dependable clean energy now and into the future. By continuing to reduce our emissions through a diverse portfolio of clean and renewable resources — while promoting economy-wide emission reductions through energy efficiency, electrification and smart energy use — we can help other sectors of the economy to decarbonize and help the state meet its GHG reduction goals.

PGE’S DECARBONIZATION STUDY

To help us understand the challenges and opportunities ahead, PGE commissioned a deep decarbonization study. The independent study, conducted by Evolved Energy Research (EER), investigated options to reduce GHG emissions for all energy services by 80 percent across our service area. Because electricity accounts for only a portion of GHG emissions, the study also accounted for energy-related emissions from transportation, industry and buildings.

Our study evaluated three future energy scenarios, also known as deep decarbonization pathways: high electrification, low electrification and high distributed energy. Each pathway achieves the steep GHG reductions required, but does so in a unique way.

Meeting the reduction goal will require dramatic progress across the three tactical pillars: energy efficiency, electricity decarbonization and electrification.



We gained several valuable insights from the study:

- It is possible to meet aggressive GHG reduction goals by 2050 without compromising the services PGE customers expect.
- The work will not be easy. It will require major changes to the way we produce, deliver and use all forms of energy; careful planning by all energy providers in the region; and collaboration across government, industry and businesses, regulators, stakeholders, communities and customers.
- Even with today’s technological outlook, the costs to decarbonize over time could be relatively modest. The higher upfront costs for clean technologies like electric vehicles, smart home appliances and renewable energy, are offset by reducing the amount of money spent on fossil fuels. Smart policies can help manage the costs associated with this transition by prioritizing cost-effective GHG reduction strategies. Technological breakthroughs will likely reduce costs even further.

CRITICAL STRATEGIES

There is no single solution to meeting these deep reduction goals; success will depend on collaboration across a number of technical, policy and regulatory issues. PGE has identified several key focus areas, described below. Critical to all of them is cost. Because electricity will be fundamental to this transition, we must keep costs affordable to make it easier for Oregonians to adopt clean energy technologies. PGE is working with policymakers and stakeholders to advance policies, and identify and work through barriers to ensure all customers will benefit from the clean energy future.

Statewide cap on GHG emissions

An economy-wide mandatory cap on GHG emissions could help Oregon realize its reduction goals if the compliance program is designed to protect Oregonians from unnecessary costs. We believe an effective and affordable program is possible, and we are committed to constructive engagement in the ongoing effort to design a statewide cap-and-trade program that protects our residential and business customers. We support resetting the state's 2050 reduction goal to 80 percent below 1990 levels, or the normalized equivalent if using a base year for which better data is available.

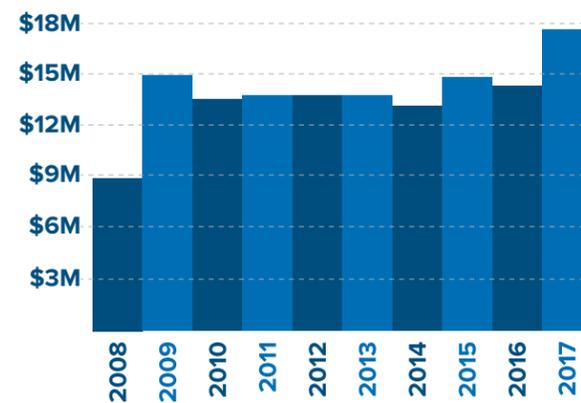
Energy efficiency

Energy efficiency will continue to be key in reducing GHG emissions. To reach the goals envisioned in PGE's study, the research found total energy consumption across the energy economy will need to drop by about one-quarter to one-third. This will be accomplished through traditional forms of energy efficiency, such as LED lighting and energy-efficient appliances, as well as the adoption of new highly efficient technologies like electric vehicles and heat pumps.

POWER FOR ALL PEOPLE

As we make the transition to a decarbonized future, we are keenly aware of our responsibility to provide affordable access across PGE's service area. We provide an essential service that customers rely on to power their lives and businesses. We have, for many years, worked closely with local Community Action Program agencies, customer advocates, counties, policymakers and other stakeholders to increase resources and improve services for our low income, medically fragile and non-english-speaking customers. But, there's more work to do here. We must partner with others to break through economic, cultural and linguistic barriers. We are committed to working with stakeholders to ensure all customers — including low-income people, people of color, seniors and people living with disabilities — have the opportunity to participate in the evolving energy landscape and benefit from new technologies and opportunities.

Energy Assistance Payments to PGE Customers from LIHEAP* and OEAP** Funds
Covers 20% of estimated customer need



*Low Income Home Energy Assistance Program
**Oregon Energy Assistance Program

Keep electricity as affordable as possible. We are working with policymakers and our regulators to keep affordability at the forefront of discussions around the clean energy transition. The transition will require dramatic changes in the way we produce, deliver and consume energy. Careful planning and policy design can reduce the incremental costs of the transition, protecting customers from unnecessary cost impacts. Despite efforts to keep electricity broadly affordable, we recognize that some customers are disproportionately impacted by the cost of their energy bills and need additional assistance to reduce their overall energy burden. Existing assistance programs are effective but insufficient in meeting current needs. It is time for a holistic review of existing weatherization and bill-assistance policies and programs with a focus on identifying barriers for participation and how we can better serve the needs of the most vulnerable members of our community.

Focus on policies, programs and technologies that deliver the biggest GHG reduction “bang for the buck.” Utility customers’ ability to absorb new costs is limited. It is essential that state policies align with the greater goal of cost-efficient decarbonization, freeing capacity to provide additional support to traditionally underserved communities so they too have meaningful access to weatherization, renewables, electric vehicles and smart grid enabled efficient technologies and appliances.

Offer multiple solutions. When rolling out clean energy options, we will ensure our most vulnerable communities are not left behind. We recognize that customers have differing needs and that “one size fits all” solutions are far from ideal. We’ll work to understand the unique needs of the communities we serve and explore how we can expand and refresh existing policies and programs. To increase access for all customers, PGE will also work to identify and remove barriers to program participation.

Protect our most vulnerable customers. We must protect vulnerable customers from predatory situations in which businesses promise benefits that don’t manifest.

Be the green energy employer of choice with a workforce that reflects the communities we serve. At PGE, diversity, equity and inclusion are part of our core values — both in how we develop and support our workforce and in how we serve our community. As one of the state’s largest employers and as an energy company at the center of the region’s clean energy transition, PGE has the opportunity to ensure the clean energy job revolution provides opportunities for all.

Efficient energy use is also critical to managing the individual and collective costs of the transition to a low-carbon future. We, along with our partners, must remain diligent and creative in engaging as many customers as possible in cost-effective energy efficiency. To do this, we must address the access and equity issues that impede some customers from taking advantage of services like free weatherization or rebates for energy-efficient purchases. Working with policymakers and stakeholders, we must also create solutions for multifamily housing and rentals, so the 44 percent of our customers who rent can also enjoy the cost and comfort benefits of energy efficiency.

Renewable development

In the near term, PGE is pursuing renewable resources to meet customers' needs, affordably and reliably. We're on track to serve about 50 percent of customers' energy needs with clean and renewable power by 2021. That's a good start, but we have to do more to meet our 2050 GHG reduction goal and enable the state and local jurisdictions we serve to meet their clean energy goals.

DEVELOPMENT OPPORTUNITIES AND CHALLENGES

Between now and 2050, we anticipate that a significant amount of new carbon-free resources will need to be added to the system to transition to the clean energy economy envisioned in PGE's decarbonization study. While the amount projected in our decarbonization study is well within the renewable resource potential of our region, it represents a ten-fold increase compared to the renewables we have today.

The scale of development required in the coming decades will call for a coordinated effort to develop and integrate renewable resources. This effort would benefit from streamlined permitting, transmission coordination and planning and the timely deployment of capital. PGE will continue to work with stakeholders at the local, state and federal levels to ensure barriers to cost-effective renewable development and access to transmission in the West are reduced. We will also work with stakeholders and regulators through our Integrated Resource Planning process to plan for cost-effective renewable resource procurement as clean technology costs continue to decline.

GREEN OPTIONS FOR CUSTOMERS

Customers' desire to decarbonize their personal energy use provides a valuable boost for reaching GHG goals. PGE is taking steps to ensure all customers can meet their clean energy goals, including a new green tariff option.

THE ROLE OF DISTRIBUTED GENERATION

While research suggests large-scale renewable resource development will be critical to meeting long-term GHG reduction goals, we also know distributed generation, like rooftop solar, empowers customers to participate in the clean energy economy and accelerates decarbonization of our energy system. We're working to help

customers adopt clean distributed technologies while integrating them onto the grid, so distributed resources can benefit all customers. To make the most of distributed technologies, we are evolving our processes, from long-term planning to real-time power management operations. Our goal is to provide an integrated platform to connect customers and their clean energy technologies to the community and to the broader Western energy markets. To learn more about what we're doing to support clean technologies on our distribution system, see our paper on grid modernization.

Transportation electrification

Today, about 40 percent of Oregon's GHG emissions come from transportation — and these emissions are expected to grow⁷. If Oregon is to achieve its GHG reduction goals, that trend must reverse. Switching vehicles from running on fossil fuels to electricity is an essential step toward a clean energy future. In addition to reducing emissions and improving air quality along major corridors, transportation electrification can help us use clean energy resources more efficiently and improve the

resilience of our grid by tapping electric vehicles (EVs) for power storage.

PGE's decarbonization study projected that charging EVs on a low-carbon grid could decrease overall passenger transportation GHG emissions by 95 percent. Our communities can realize additional reductions by electrifying buses, delivery vehicles and intermodal freight trucks — giving customers the ability to choose electric and clean regardless of their mode of transportation or need. Keeping electricity affordable is an important part of helping Oregon families, businesses, school systems and local governments to make this transition.

PGE is working to increase the adoption of EVs and expand access to electricity as a transportation fuel for all customers. We are also focused on efficiently integrating vehicle charging to realize the grid benefits that flexible battery loads can provide. Today, we're deploying charging infrastructure, streamlining processes for customers to add their own chargers and creating rates that support EV adoption. Looking forward, we're evaluating programs to make it easier for customers to install smart and connected charging in their homes and businesses to support flexible loads.

In the future, consumers will have a larger selection of vehicle types that will all be supported by a ubiquitous network of smart chargers living at the intersection of the transportation sector and the electric utility. To be ready for this future, we'll need policies that support common industry standards, ensure equitable access and reduce deployment costs.

SWITCHING VEHICLES FROM RUNNING ON FOSSIL FUELS TO ELECTRICITY IS AN ESSENTIAL STEP TOWARD A CLEAN ENERGY FUTURE

Flexible operations

In the Pacific Northwest, we benefit from investments made over the last century in clean and flexible hydropower. In a deeply decarbonized future, the regional electricity system will need to complement the hydropower system with new approaches to improving flexibility, both across the West and here in Oregon.

REGIONAL COORDINATION

The development and integration of renewable resources at the scale required in the coming decades will depend on improved coordination across the West. PGE took an important step in this direction in 2017 by joining the Western

Energy Imbalance Market — a real-time energy wholesale market that automatically dispatches the lowest-cost electricity generating resources available to customer needs within the hour, while optimizing use of renewable energy over a seven-state region (plus a Canadian province). Going forward, we'll identify and evaluate opportunities to improve regional coordination, with the goal of joining a broader organized market when it is in the best interest of customers and Oregon.

FLEXIBLE LOADS

We recognize that as customers adopt new clean technologies like electric vehicles, water heaters and heat pumps, the flexibility of these resources will be increasingly valuable in integrating renewable energy efficiently and affordably. We will develop programs and implement the technologies needed to enhance grid flexibility through the participation of these new electric loads. This will help us make the best use of variable renewable resources, like wind and solar, when they are available, and to reduce costs when they are not. In PGE's decarbonization study, we found that operating these new electric loads flexibly will be critical to ensuring the transition to a low-carbon economy is as efficient and affordable as possible.

Today, we're implementing pilot programs to test flexible load technologies and programs with customers. We'll also work with policymakers to encourage updated codes and standards that advance the use of smart electric appliances and incentives that support the adoption of smart technologies as appliances are replaced.

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ENERGY STORAGE

Energy storage technologies can help us integrate renewables and better support our grid. By 2020, we will expand upon our pioneering work on battery storage at the Salem Smart Power Center with new pilot programs and projects. These will focus on enabling customer adoption, improving flexibility, contributing to reliability and resiliency and supporting our grid.

GRID MODERNIZATION

At the core of our transformation will be the development of a modernized smart grid that is flexible, reliable and highly integrated. As outlined in our grid modernization paper, PGE will be transforming the grid to integrate new technologies, improve real-time power management operations and better coordinate with the rest of the West to ensure customers have the most reliable and affordable access to the clean power they expect.

NEXT STEPS

PGE is proud to partner with local, state and federal policy makers, municipalities, regulators, customers and stakeholders to advance a clean energy future that will help address climate change, promote healthy communities and deliver affordable, reliable power. As our region's population and industries grow, PGE is examining options through our Integrated Resource Planning process to meet the demand for energy with cost effective energy efficiency and clean and renewable resources. We're also developing new capabilities around distributed and flexible resources, like energy storage and flexible loads, to more efficiently integrate these resources into our portfolio to lower costs and maintain reliability. Furthermore, we're working with all of our stakeholders to ensure this transition is affordable, accessible and equitable for all customers and communities. By partnering with customers and communities, we can realize a more sustainable future for all Oregonians.

1. "Understanding the IPCC Reports." World Resources Institute, accessed March 15, 2018, <http://www.wri.org/ipcc-infographics>.
2. "Chapter 468A — Air Quality." 2017 Edition, Oregon State Legislature, 2017, https://www.oregonlegislature.gov/bills_laws/ors/ors468A.html.
3. "Renewable Portfolio Standard." Oregon Department of Energy, accessed March 15, 2018, <http://www.oregon.gov/energy/energy-oregon/Pages/Renewable-Portfolio-Standard.aspx>.
4. "Portland, Multnomah County set 100% renewable energy goal." The Oregonian, June 1, 2017, http://www.oregonlive.com/portland/index.ssf/2017/06/portland_multnomah_county_set.html.
5. PGE's Customer Insights Survey, presented at the February 14th 2018 IRP Roundtable Meeting. Available at: <https://www.portlandgeneral.com/-/media/public/our-company/energy-strategy/documents/2018-02-14-pge-presentation.pdf?la=en>.
6. PGE's 2050 goal is based on its proportionate share of Oregon's proposed mandatory economy-wide goal, using 2010 as the base year.
7. "Oregon Clean Fuels Program." Oregon Department of Environmental Quality, accessed March 15, 2018, <http://www.oregon.gov/deq/aaq/programs/Pages/Clean-Fuels.aspx>.

ADDITIONAL RESOURCES

PGE Clean Energy Vision

[portlandgeneral.com/
cleanvisionpdf](http://portlandgeneral.com/cleanvisionpdf)

PGE energy storage proposal

[portlandgeneral.com/
2018storagepotential](http://portlandgeneral.com/2018storagepotential)

PGE Green FutureSM program

portlandgeneral.com/greenfuture

PGE Decarbonization Study report

[portlandgeneral.com/
deepdecarbstudy](http://portlandgeneral.com/deepdecarbstudy)

PGE energy strategy

[portlandgeneral.com/
energystrategy](http://portlandgeneral.com/energystrategy)

Electric vehicles and charging stations

portlandgeneral.com/ev

PGE green tariff program

portlandgeneral.com/greentarriff

PGE Integrated Resource Plan

[portlandgeneral.com/
resourceplanning](http://portlandgeneral.com/resourceplanning)

PGE strategy paper

A modernized grid platform
for a clean energy future



portlandgeneral.com/cleanvision