PGE

Distribution System Plan Part 1

OCTOBER 2021

Executive Summary

The last few years, through the ongoing pandemic and increased focus on social justice, have brought to the forefront the importance of having the customer at the center of all that we do. More than ever, customers expect their power to be affordable, reliable and there when they need it. At the same time, customers want clean power options customized to their specific preferences, services delivered with speed and ease.

Background

We applaud the leadership of the Public Utility Commission of Oregon (Commission or OPUC) in creating expectations for a human-centered planning approach to distribution system planning (DSP). Through Order 20-485, the DSP guidelines intend to "foster a developing process that supports a human-centered approach" to the DSP and to utilize this human-centered approach in "identifying grid needs, implemented in partnership with communities and community-based organizations" that "create value-adding investments for communities, and align the energy system with community priorities." Portland General Electric's (PGE's) DSP aims to accelerate a fair and equitable clean energy transition to a modernized grid platform that is customer-inspired and community-centric. We embrace this energy transformation and will empower customers with innovative products and services by designing and modernizing the electric grid for our customers.

The evolution of distribution system planning is a central process within this transformation, providing a proactive pathway to address key drivers such as customer preference, decarbonization, affordability, reliability and resilience. Historically, distribution system planning processes have primarily focused on affordably serving load growth while ensuring safe and reliable operation of the distribution grid. With advances in technology, we are transitioning the distribution system from being a safe and reliable energy delivery system to becoming a safe, reliable, flexible, resilient and human-centered energy exchange platform that integrates seamlessly with the wholesale market. Customers increasingly expect choices and control in the products and services they consume. Ubiquity of low-cost communications and the proliferation of devices and control options mean that customers have unprecedented ability to manage their lives and their consumption. This extends to energy, where there is a growing, critical two-way exchange between customers and the electric grid.

Real-time information and options for flexibility in usage and pricing, combined with digital enablement (mobile, web), will enable customers to use the electric grid as a pathway for meeting their goals, whether those be cost management, sustainable lifestyle, independence, resiliency or other. These options may extend from simple time of use and behavioral demand response solutions all the way to turnkey services that bundle significant energy uses with renewables options (e.g., an electric vehicle paired with rooftop solar and a battery). In all cases, personal or corporate choices for engaging in these programs create the potential for individual customers' needs to be met while also delivering system value and reliability back to all customers.

Solutions are available to enable new capabilities, such as non-wires solutions, automated fault detection and restoration, and photovoltaic (PV) and electric vehicle integration — at scale — without sacrificing safety and reliability. In the following chapters, PGE outlines the vision of how these solutions can be leveraged to accelerate decarbonization and electrification and provide direct benefits to communities — especially environmental justice communities — while improving metrics around safety, reliability, resiliency and security, all at fair and reasonable costs.

PGE's strategy

PGE exists to power the advancement of society. We energize lives, strengthen communities and drive advancements in energy that promote social, economic and environmental progress. We aim to lead the clean energy future and together — with customers, partners and communities — we will lead the energy transformation by decarbonizing, electrifying and performing.

DECARBONIZE

We know our customers and communities want to use clean electricity, which is why we are committed to reducing greenhouse gas (GHG) emissions from the power served to customers by at least 80% by 2030 and 100% by 2040. These ambitious GHG reduction targets are in line with a new Oregon state law (House Bill [HB] 2021) establishing an electric sector decarbonization framework.[1] PGE is excited to have been part of a broad coalition supporting the passage of this important bill during the 2021 legislative session. Our customers want affordable, reliable electricity — and they want their choices to be cleaner than ever before. Right now, more than 90% of our electricity supply is generated right here in the Pacific Northwest, and we will continue to add new clean and renewable resources to the system so all customers can enjoy a clean energy future.

As we advance to a 100% clean energy supply, we are often replacing base-loaded thermal resources with variable energy resources like wind and solar. As a result, we identified that in order to achieve this decarbonized future, we would need to find new sources of flexibility for the supply portfolio. It is estimated that as much as 25% of flexibility could come from customers and distributed energy resources (DERs).[2] It is imperative we find ways to incentivize customers to bring their flexibility and clean resources to the grid to participate in the greater decarbonized energy system.

Doing so is a complex task. It requires that the products and services offered by PGE must be designed to solve real customer needs and must deliver great, end-to-end experiences. Failure to do so will lead customers to seek solutions elsewhere, and the value of a two-way integrated electric system will not be realized. That is why we are also working to help several of our municipal local governments and large customers who want to move faster to achieve their 100% clean energy goals. In addition, we are implementing ways to reduce emissions associated with our own operations, including vehicles and facilities.

ELECTRIFY

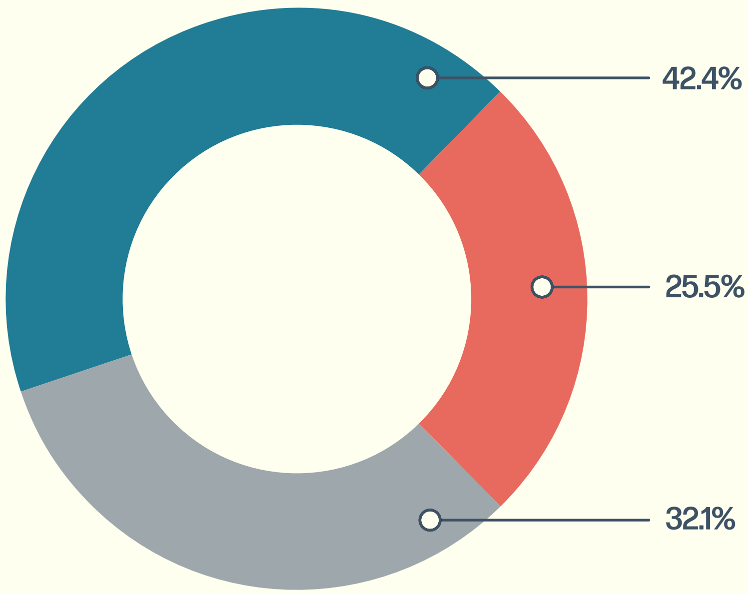
According to the Oregon Department of Energy's 2020 Biennial Energy Report, the majority of Oregon's energy use comes from electricity and the transportation sector, 42% and 32% respectively. Oregon relies on energy from a variety of resources (**Figure 1**) and imports energy like transportation fuels, natural gas, propane and other fuels.[3] Oregon also uses electricity from both in- and out-of-state sources — including coal, natural gas, nuclear, hydropower, wind and other renewable resources.

PGE sees a future in which we double our power served by electricity. We are helping our customers meet their goals of driving decarbonization, electrifying and alleviating energy burden. Our customers and communities are electrifying their vehicles, homes and workplaces and we are powering society in their clean energy journey. In doing so, we will capture the benefits of new technologies such as DERs, leading to an increasingly flexible and reliable grid.

1. House Bill 2021, available at: oregonlegislature.gov.
2. For the purposes of PGE's DSP, we utilize the OPUC's definition of DERs under Order 20-485, which includes distributed generation resources, distributed energy storage, demand response, energy efficiency and electric vehicles that are connected to the electric distribution power grid.
3. This percentage also accounts for source fuels that come from out of state, such as natural gas, but generate electricity in-state.

Figure 1. Oregon Department of Energy: Energy use by source[4]

Percentage of Oregon's 2018 energy consumption



Electricity
This is where most people begin when thinking about energy — the critical resource that powers our day-to-day lives. The electricity Oregonians use comes from facilities across the western United States and in Oregon. This percentage also accounts for source fuels that come from out of state, such as natural gas, but generate electricity in-state.

Direct use fuels
This category includes fuel oil and natural gas used to heat homes and commercial spaces, fuels used for other residential purposes, such as gas stoves, solar thermal heating, and fuels used directly in industrial processes.

Transportation fuels
This includes personal, passenger and commercial vehicles, both on and off the roads, plus airplanes, boats, barges, ships, and trains. Nearly all transportation-related sources of energy are imported from out of state for in-state use.

PERFORM

We know that the heart of our business is keeping the power on safely, reliably and affordably. We power communities, and our customers depend on us to deliver the power they need to live, work and play. Focusing on reliability allows us to bring more flexible and renewable electricity to customers. To keep things running smoothly, we continue to work on increasing efficiency and delivering exceptional customer experiences.

Over the last few years, as noted in our public commitments, such as our Integrated Resource Plan (IRP) filings and recent General Rate Case (GRC) filings, PGE has been shifting its corporate strategy to focus on leading the clean energy transformation by creating a path to zero GHG emissions associated with the power we serve customers.[5]

4. Data according to Oregon Department of Energy (ODOE) 2020 Biennial Energy Report, available at: www.oregon.gov
5. PGE About Us webpage, available at: portlandgeneral.com
PGE's 2019 Integrated Resource Plan, available at: PGE's 2019 Integrated Resource Plan
PGE's request for a General Rate Revision, 2021, available at: PGE's request for a General Rate Revision, 2021

PGE's distribution vision

While most agree that the energy transformation underway should address the threats of climate change, its alignment with social and environmental justice goals is still in its infancy. Oregon has been at the forefront of working to address historical wrongs and breaking down existing systems that discriminate or exacerbate inequities in society. In the utility sector, Oregon is leading the way with policies such as HB 2021 and HB 2475 and regulatory directives such as UM 2005.[6] We embrace the challenge of leveraging the clean energy transformation to address environmental justice.

With the first filing of our Distribution System Plan (DSP), we are excited to share our vision of how the distribution system can help to achieve the shared goals of clean energy transformation and social and environmental justice for our communities.

Our vision is a **21st century community-centered distribution system** that can meet the following goals, detailed in **Chapter 2**.

a. **Advance environmental justice.** We envision the distribution system advancing environmental justice through the strategic deployment and use of grid assets (customer- or utility-owned) to yield more equitable outcomes, especially for those who are most vulnerable.

b. **Accelerate DER adoption.** We have a goal to accelerate DER adoption, which will require a distribution system that can easily enable DERs to not only connect to the grid, but also to deliver societal value through programs.

c. **Maximize grid benefits.** We will plan and operate the distribution system to maximize customer value.

To achieve this vision, we have five strategic initiatives:

- **Empowered communities**
- **Modernized grid**
- **Resilience**
- **Plug and play**
- **Evolved regulatory framework**

As illustrated in **Figure 2**, these strategic initiatives are connected to our vision and goals for the distribution system. These strategic initiatives are discussed in detail in subsequent chapters of the DSP.

Figure 2. PGE's vision, goals and execution approach

Corporate strategy	DSP vision	DSP goals	DSP strategic initiatives
• Decarbonize • Electrify • Perform	• 21st century community-centered distribution system	• Advance environmental justice goals • Accelerate DER adoption • Maximize grid benefits	• Empowered communities • Modernized grid • Resilience • Plug and play • Evolved regulatory framework

6. House Bill 2475, available at: oregonlegislature.gov

PGE's Distribution System Plan (DSP) summary and highlights

PGE is proud to submit our inaugural DSP for consideration by our customers, partners and the Commission. This DSP reinforces our ongoing commitment to the clean energy future and takes the first step to integrate environmental justice goals. We detail in this report the vision, goals and strategic initiatives we plan for the distribution system and the role of the DSP in achieving it. We weave these goals into each section, showing a connection between our long-term vision, current actions and the evolution of the DSP. Additionally, we are committed to transitioning to a human-centered planning approach and have built the DSP on a foundation of engagement with the broader community (partners, customers and communities) and incorporation of their feedback.

Our customers are at the center of everything we do. In service to that commitment, we conducted eight partner and community workshops to share perspectives and gather input on key DSP subject areas. In addition to addressing the OPUC's UM 2005 requirements, these workshops created a community of DSP partners committed to building a better understanding of both our work and partners' needs and expectations. Our goal for the workshops was to initiate a dialogue that contributed to our DSP while also creating a platform for collaboration. **We thank the participants for joining us on this journey and are grateful for their partnership and insights**.

We believe this report is robust and meaningful and provides substantial transparency into our company and distribution system planning functions. To highlight some of the key aspects of our report, we summarize below the main points in each of the DSP's chapters.

CHAPTER 1
DISTRIBUTION SYSTEM OVERVIEW

The DSP is in its first stage and is an evolving, multi-stage process. We anticipate that the forming, filing and acceptance of the initial plans will educate all parties and identify areas for continuous improvement. This evolution will be informed by DSPs filed by all investor-owned utilities (IOUs) and help advance how the distribution system is defined, how investments can maximize customer value and even how investment costs are recovered.

In this chapter, PGE provides an overview of the distribution system in context to the overall electric grid. The grid is evolving from a paradigm of one-way power flow with centralized generation to customers, to a bi-directional grid with growing demands for DER interconnection. The distribution grid plays a critical role in enabling this future state, and it is important to understand the current state of system planning and asset replacement so that forward-looking investments can be contextualized and understood from the perspective of reliability, safety and affordability.

> The distribution system is defined as load-serving, PGE-owned equipment and lines at nominal voltage levels below 35 kV.[7] The distribution system starts at the circuit breaker and high-side disconnect of the substation distribution transformer.[8]

Our asset management practices ensure that we prioritize investments across a portfolio of distribution system assets in a manner that balances costs and maximizes improvements for reliability. Our distribution planning team maintains network models (in our power flow modeling software, CYME) of our distribution system and studies the impacts of changing loads to the projected needs of the distribution system in a near- and long-term planning horizon (five to 10 years). The key functions of PGE's distribution planning team are to:

- Perform system analysis and develop plans that ensure the distribution system will be operable and able to maintain functionality and flexibility in both the near and long term
- Provide support and guidance on distribution-related investment decisions
- Support grid modernization efforts and initiatives

The current adoption of DERs is critical to understand and informs what types of investments are needed to drive further adoption. We currently have 125 MW of net metered generation connected to our system, with another 35 MW in the queue. We continue to grow our flexible load resource, with 63 MW of enrolled summer demand response (DR) capacity as of 2020. We also have approximately 20,000 electric vehicles throughout our service area.

We invested an average of approximately $300 million per year on distribution system upgrades from 2016 to 2020, with the relative focus of investments changing each year to support new customer projects, upgrades for reliability and power quality, and capacity-related expansions. Increasing DER adoption will continue to change the nature and type of distribution-related investments required to maintain a safe, reliable system, while also ensuring the flexibility, resilience and security of the system.

MAIN POINTS

- The distribution system is a key part of the energy grid backbone.
- PGE's asset management practices maximize the impact of investments for reliability and resilience and to meet changing customer expectations.
- The changing nature of the grid, including more DER adoption, will require changes in future investments.

7. PGE functionally treats its 57 kVA lines as sub-transmission.
8. Substation circuit breakers are equipped with disconnects, which open a circuit quickly in the event of an overload. For more distribution system asset definitions, see Appendix B, section B.3.1.

CHAPTER 2
DISTRIBUTION SYSTEM VISION

PGE's corporate vision, its intersection with policy and how that informs the distribution system vision is a critical component to our vision for the distribution system. As we lead the clean energy future together — with customers, partners and communities — we will lead with action.

In this chapter we describe our vision of a **21st century community-centered distribution system**, which is needed to take advantage of DERs and accelerate decarbonization and electrification. The system must provide direct benefits to communities (especially environmental justice communities), while improving metrics around safety, reliability, resilience and security — all at fair and reasonable costs. To achieve this vision, we describe five key strategic initiatives: **Empowered communities, modernized grid, resilience, plug and play, and evolved regulatory framework**. These initiatives help realize the vision and goals by aligning critical activities and address gaps in capabilities within the company while addressing market barriers for DER adoption.

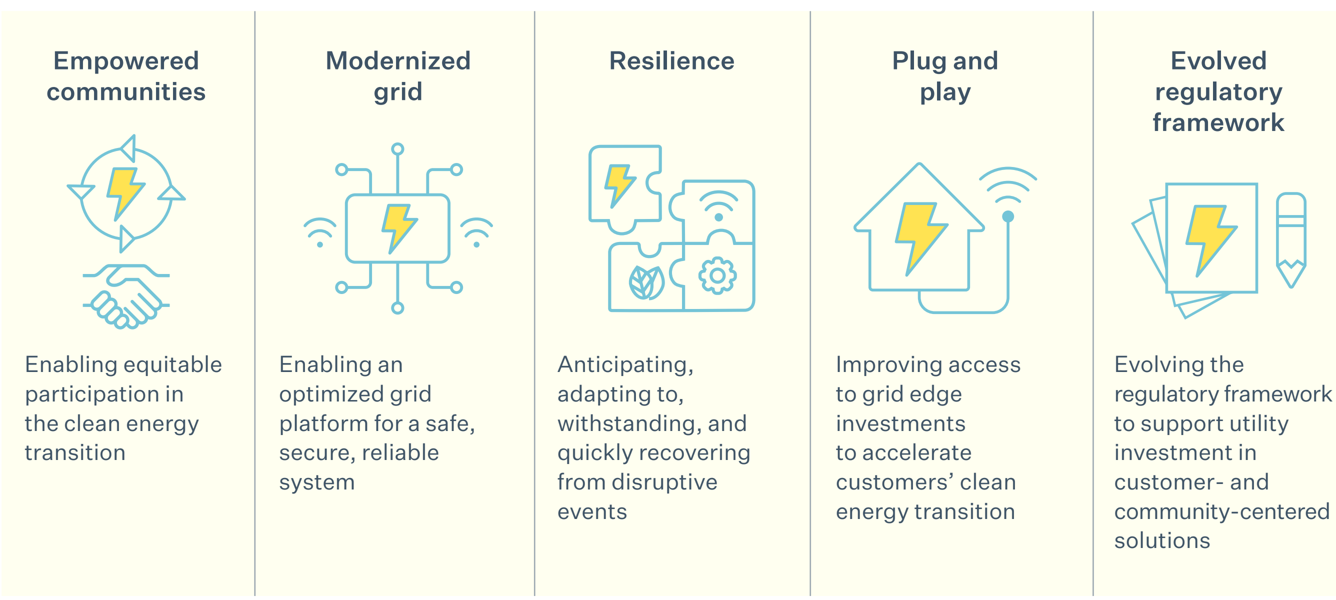
Our empowered communities initiative enables equitable participation in the clean energy transition through human-centered planning and community engagement. Our modernized grid initiative aims to enable an optimized grid platform that is safe, secure and reliable through current and future grid capabilities. The resilience initiative focuses on how we can strengthen the grid's ability to anticipate, adapt to, withstand and quickly recover from disruptive events. Our plug and play initiative discusses how we can improve access to grid edge investments needed to accelerate customers' clean energy transitions through such activities as hosting capacity analysis and developing the capability to connect dynamic devices (e.g., batteries). Lastly, our evolved regulatory framework initiative speaks to the need to support utility investment in customer- and community-centered solutions.

Figure 3 illustrates these key strategic initiatives.

MAIN POINTS

- Federal and state clean energy policies are aligning the clean energy transition with social and environmental justice.
- PGE's vision for a 21st century community-centered distribution system is one that accelerates adoption of grid-integrated DERs while balancing grid, social and environmental justice goals.
- PGE has launched five strategic initiatives: Empowered communities, modernized grid, resilience, plug and play, and evolved regulatory framework.

Figure 3. PGE's five strategic initiatives



CHAPTER 3

EMPOWERED COMMUNITIES: EQUITABLE PARTICIPATION IN DISTRIBUTION DECISIONS

As an essential service provider, PGE must both engage and understand where and how customers live, work, learn and play. The work requires us to co-develop solutions with communities and develop solutions that deliver value to both them and the grid. We see it as imperative to pursue the twin goals of social justice, including racial equity, and decarbonization. These goals are needed to ensure that we address and redress disparities and impacts within the environmental justice communities PGE serves.

In this chapter, we outline the outreach and engagement done to date, including workshops for both traditional stakeholders as well the community workshops that were developed in partnership with, but delivered by, community-based organizations (CBOs). Additionally, the core tenets of environmental justice are introduced, as well as the Government Alliance on Race and Equity's (GARE's) racial equity toolkit that PGE is applying to this human-centered work.[9]

Finally, we have included our first Community Engagement Plan that is informed by recommendations and learnings that resulted from the community workshops and includes best practices provided by our CBO partners. This plan provides a framework for community engagement as well as planning strategies to inform the work we do in the second part of our DSP, as well as be a guide for how PGE intends to do community engagement more generally going forward.

There's much work to do, especially as new technologies — rooftop solar, battery storage, smart thermostats and electric vehicles — can amplify existing disparities in how we generate, access and conserve energy if not deployed strategically. The goal is not to just eliminate the disparities, but also to increase success for all groups. Systems that are failing communities of color are failing all of us. Solving problems for everyone while paying special attention to communities suffering disproportionate burdens will increase our collective success. Societal inequities make it harder for some people to access energy-saving and clean energy programs, technologies and jobs. For everyone to benefit from a clean energy future, PGE must break through economic, cultural and linguistic barriers to give everyone a seat at the table when making decisions that define our path forward.

As we continue our work, we will focus on the equitable implementation of our DSP Action Plan that will be filed on August 15, 2022. The DSP will serve to support and complement the empowering communities pillar as well as other pillars, namely in improving community resilience and evolving the regulatory framework to provide flexibility in solutions that meet identified community needs.

MAIN POINTS

- We have learned that creating a collaborative environment requires building trust first.
- Designing programs and solutions with affected communities (instead of for them) produces better outcomes.
- We should collaborate and defer to our communities, where and whenever possible.
- PGE's Community Engagement Plan is informed by best practices, learnings and the recommendations of **Unite Oregon, Community Energy Project** and the **Coalition of Communities of Color** based on their engagement in the first phase of the DSP.

9. GARE's racial equity toolkit is available at: racialequityalliance.org

CHAPTER 4
MODERNIZED GRID: BUILDING A PLATFORM FOR PARTICIPATION

The modernized grid represents a key element to transforming the grid and enabling large-scale integration of DERs —especially solar PV, batteries and electric vehicles — in a manner that can improve grid flexibility and reduce the need for supply-side resources to address the grid goals outlined in PGE's vision. However, modernizing the grid is a complex undertaking with large investments focused on augmenting and improving the electrical grid. PGE is aware of the impact of these investments on customer prices, especially on our must vulnerable communities, and takes a pragmatic, needs-based approach to balance the different goals and maximize customer and/or societal value of investments once in service.

In this chapter, we focus on informing PGE's modernized grid framework, the capabilities that underpin that framework, and PGE's roadmap at the capability level using the US Department of Energy's modernized distribution grid (DSPx) framework.[10] The chapter also details PGE's key planned investments and their expected evolution in the one- through five-year timeframe for each of the following capabilities.

- Virtual power plant
- Planning and engineering
- Grid management systems
- Sensing, measurement and control
- Telecommunications
- Physical grid

Grid modernization refers to the evolution of the grid through the integration of different technologies and computing solutions. This transformation has been underway for several years, with its scope evolving with time. Today, as we think about grid modernization on the operations side, we think both about operator awareness and also operator control, specifically focused on the interaction between DERs and the grid. On the planning side, planning needs have also evolved to focus on improving the ability to holistically interconnect DERs to deliver the maximum grid and community benefit. As more technologies and computation solutions mature, it is likely that the scope of grid modernization will continue to evolve as well.

We have adopted a platform-based architecture with modular elements as our approach to modernizing the grid. Certain capabilities of the platform remain relatively stable throughout the platform's evolution over time — these are known as core platform capabilities or foundational capabilities. Other capabilities and layers are complementary to these core capabilities and work in an integrated manner to deliver customer value. In other words, a modernized grid is equivalent to a platform with layers of digital capabilities upon layers of physical assets that work together in various combinations to improve and enable system capabilities. Over time, as different technologies mature, capabilities and layers can be added or replaced as needed.

MAIN POINTS

- A modernized grid is a platform that layers digital capabilities on a network of physical assets, all working together in various combinations to improve system capabilities.
- PGE has adopted the U.S. Department of Energy's modernized distribution grid (DSPx) framework.
- The evolving grid holds implications for workforce planning and cybersecurity.

10. DOE's DPSx is available at: gridarchitecture.pnnl.gov

CHAPTER 5
RESILIENCE: MANAGING DISRUPTIVE EVENTS

Resilience is top of mind for PGE as climate change and extreme weather present new challenges. In 2021, a once-in-40-years ice storm caused unprecedented power outages for approximately 740,000 customers, and the Bootleg wildfire interrupted Oregon's transmission of power to and from California. Our customers are feeling urgency to take action to prepare for the unexpected, as does PGE.

This chapter details the work of our Resilience Accelerated Response Coordination (Resilience ARC) initiative that focuses on improving our ability to meet customer and community expectations for resilient power delivery. Below are the three areas of focus for this initiative.

- **Customer infrastructure resilience** — Investigation into customer-sited solutions, such as microgrids, batteries and other DERs, that enable customers to ride through events and, during normal conditions, provide services to the grid.
- **PGE infrastructure resilience** — Investment in infrastructure, such as grid hardening, integrated grid and energy supply hardening, that mitigates the occurrence of outages during an event such as a wildfire or wind or ice storm.
- **Operational resilience** — Improvements in PGE's ability to meet customers' needs during events and accelerate the restoration of service through emergency preparedness, outage response and customer support.

Due to increasing levels of variable energy resources (e.g., solar and wind), we also are looking to develop solutions that offset those sources of energy.

Safety, reliability and resilience always have been core to our mission. Shifts in the climate as well as a shift toward electrification put a spotlight on the importance of resilience and resilience measures that are closer to the customer. We are using new technology and building new relationships with customers and municipalities. These investments not only enable a stronger, more resilient infrastructure, but also ties to our communities by enabling an accelerated, robust response to the challenges we face together.

MAIN POINTS

- Increasing fire and storm risk, coupled with increasing electrification, requires enhanced resilience measures.
- Our Resilience Accelerated Response Coordination (Resilience ARC) initiative will bring focus to resilience efforts.
- Investing in resilience measures that are closer to communities and customers is essential.

CHAPTER 6
PLUG AND PLAY: ENABLING DER ADOPTION

Growth in the adoption of DERs implies ease of access to and integration of those DERs into the distribution system. Our plug and play initiative focuses on enabling that access and integration — removing barriers and streamlining the interconnection process. Hosting capacity analysis (HCA) is a fundamental capability in a high-DER adoption, plug and play future.

PGE uses Electric Power Research Institute's (EPRI's) definition of hosting capacity.[11] According to EPRI:

Hosting capacity in a distribution system is the amount of DERs that can be accommodated without significant upgrades or adversely impacting power quality or reliability under existing feeder design and control configurations.

In this iteration of the DSP, our plan is focused on HCA as it relates to distributed generation (DG) and does not include consideration of DERs such as electric vehicles, as described in EPRI's definition. Flexible loads such as electric vehicles, hot-water heaters and behind-the-meter storage will be considered in future DSP submittals.

PGE's approach to HCA has been shaped by conversations with partners and communities and best practices gleaned from other utilities that have implemented HCA tools and methodologies. We conducted a series of feedback sessions with partners and communities and interviews with peer utilities to gain insight into lessons learned and the most effective approach to delivering value to partners.

In this chapter, we will discuss the common use cases for HCA, which include:

- Preliminary screening for DG proposals
- Guidance in the early phases of the interconnection process
- Enhancing distribution system visibility when determining locations for future DG

HCA may be utilized to identify the potential need for preliminary system upgrades in the early stages (e.g., scoping call, feasibility study) of the interconnection process. Although valuable in informing customer decisions, we do not support using HCA to replace any part of the interconnection process. Additional local studies will need to be performed to determine the viability of adding DG.

While our system modeling and remote sensing capabilities are maturing, we will use distribution system indicators to provide information to identify areas where DG can be accommodated. Moving beyond this level of HCA requires advancements in forecasting, system monitoring and system modeling. We will begin to see these advancements with the implementation of our advanced distribution management system (ADMS) in 2022.

Beginning in 2022, we plan to conduct HCA twice annually at the distribution feeder level. We anticipate that an ideal future state for HCA is:

- Accurate at the time and place of use
- Cost-effective
- User-friendly for both external and internal audiences

We anticipate that, as HCA matures and more datasets become available (e.g., energy burden, socioeconomic indicators, DER adoption), combining these data will enable us and our customers to identify and unlock the value of DERs. As we move toward a 21st century community-centered distribution system through our modernized grid framework and implement our Community Engagement Plan, integration of DERs should be seamless. The ability to seamlessly interconnect to the modernized grid is a key enabler to improved access to DERs, achieving a plug and play future.

MAIN POINTS

- PGE has enhanced its Net Metering map to include Distributed Generation Readiness information and demographic data from the US Census.
- Starting in late 2022, PGE will begin performing HCA twice annually.
- HCA updates should be performed at the line segment level on an as-needed basis rather than monthly or hourly.

11. Defining a Roadmap for Successful Implementation of a Hosting Capacity Method for New York State," EPRI, June 2016, is available at: epri.com

CHAPTER 7

EVOLVED REGULATORY FRAMEWORK: INCENTIVES THAT MOTIVATE EQUITABLE DER ENABLEMENT AND ADOPTION

With communities, partners, Staff and other utilities, we plan to identify regulatory and rulemaking opportunities needed for the safety and reliability of the system, as well as equitably supporting utility investment in customer- and community-centered solutions while keeping pace with the clean energy transition. This evolution aims to ensure the sustained success of this transition while minimizing the impact to those who are marginalized.

The Pacific Northwest's conception of the "smart grid" dates back to the 1990s when the Bonneville Power Administration issued a paper about the "energy web." In 2005, the OPUC began contemplating the benefits of a smart grid.[12] In response to the Energy Policy Act of 2005, PGE proposed in its 2006 Rate Case (UE 189) to make AMI investments. Several years later, that Commission, in Docket UM 1460, issued smart grid guidelines to inform subsequent Commission guidance on smart grid investment. The pace of investment is now accelerating, as is policy. We must match the pace of policy and technical evolution with targeted reform, guidance and new policy. The DSP identifies items to be raised for discussion and possible reform to advance the vision outlined by PGE, the policies and direction of the Commission, the governor and the legislature.

Throughout the UM 2005 proceeding, we noted intersections between the goals of the DSP and current policies, rules, standards and other regulations. In this chapter, we provide a detailed summary touching on policies at the federal level through FERC and the federal government to state policies through the legislature and the Commission. These policies provide a view of the regulatory drivers for change. We then complement this information by identifying downstream regulation that can align with these policies to enable the vision of the DSP. Below are the categories of regulation we focused on in this DSP.

- New regulation that can accelerate DER adoption and our ability to leverage their value
- Current regulation that is inconsistent with policy drivers and thus can act as barriers for us to leverage DERs and their value
- Ongoing updates to policies, rules, standards and other regulations and their relationship with the DSP.

While these regulations impact the DSP, we do not believe the DSP is the appropriate avenue to discuss all of them. While some can be discussed in the DSP, other regulatory recommendations are more suited to their respective dockets, General Rate Cases or other plans.

MAIN POINTS

- PGE has identified an initial set of regulations that can help accelerate DER adoption and PGE's ability to leverage DER value.
- PGE has categorized regulation that can accelerate DER into:
  - New regulation
  - Current regulations
  - Ongoing updates to regulation

12. OPUC Docket UM 1020, Order 05-878 where the Commission considered the advantages of dynamic rates made possible through smart grid technologies such as Advanced Metering Infrastructure

CHAPTER 8
PLAN FOR PART 2 DEVELOPMENT

In the DSP guidelines, the Commission requires PGE to provide a high-level summary of our preparation for Part 2 of the DSP, focusing on planning evolution and interaction with our Integrated Resource Plan (IRP).

In this chapter, we focus on planning practice updates related to DER forecasting and potential non-wires solutions (NWS) and efforts to synchronize IRP activities with requirements of Part 2 of the DSP. Continuously working on advancing DER modeling tools, we recently built a DER forecasting and potential assessment modeling tool, AdopDER. This will increase transparency of the modeling approach (inputs, outputs, algorithms), capture broad resource parameters and key assumptions, advance understanding of flexible load potential needed to achieve a range of grid services, and integrate DERs into the IRP.

As we explore how NWS can replace, defer or be combined with traditional transmission and distribution solutions, this will present an opportunity for us to test new processes, analysis and tools from a planning perspective. Improving our planning capabilities is a critical step in enabling and leveraging DERs for different use cases such as NWS, improved asset utilization and providing community benefits.

MAIN POINTS

- PGE is planning the next steps for DER forecasting and non-wires solutions.
- PGE presents considerations for alignment of the DSP with the IRP.

Chapter 1.

Distribution system overview

Chapter 1. Distribution system overview

"A transition to clean energy is about making an investment in our future."

— **Gloria Reuben**, environmental activist and a special advisor to The Alliance for Climate Protection

1.1 Reader's guide

PGE's Distribution System Plan (DSP) takes the first step toward outlining and developing a 21st century community-centered distribution system. This system primarily uses distributed energy resources (DERs) to accelerate decarbonization and electrification and provide direct benefits to communities, especially environmental justice (EJ) communities communities.[13] It's designed to improve safety and reliability, ensure resilience and security, and apply an equity lens when considering fair and reasonable costs.

This chapter describes our current system assessment and planning processes and provides baseline data for distribution system assets, historical investments and DER penetration. It also provides context about the distribution system's function in relation to the overall grid. **Table 1** illustrates how PGE has met the Public Utility Commission of Oregon's (Commission or OPUC) DSP guidelines under Docket UM 2005, Order 20-485.[14]

For more details on how PGE has complied with the requirements under UM 2005, Order 20-485, see **Appendix A: DSP plan guidelines compliance checklist**.

WHAT WE WILL COVER IN THIS CHAPTER

The key components of the electric grid and distribution system

How the grid is changing and why distribution system planning matters

An overview of PGE's distribution system, assets and planning approach

How PGE makes capital investments in our distribution system

The types of distributed energy resources (DERs) joining the grid and the value they offer

13. PGE uses the definition of environmental justice communities under Oregon House Bill 2021, available at: oregonlegislature.gov
14. OPUC UM 2005, Order 20-485 was issued on December 23, 2020, and is available at: puc.state.or.us

Table 1. Distribution system overview: Guideline mapping

DSP guidelines	Chapter section
4.1.a	Section 1.2, 1.3
4.1.b	Section 1.3
4.1.c.i	Section 1.3
4.1.c.ii	Section 1.3
4.1.e	Section 1.4
4.1.f	Section 1.5.1
4.1.g	Section 1.5.3
4.1.i	Section 1.5.4
4.1.j	Section 1.5.4
4.1.l	Section 1.5.2
4.4.b.i.3	Section 1.5
4.4.b.i.4	Section 1.5

1.2 Introduction

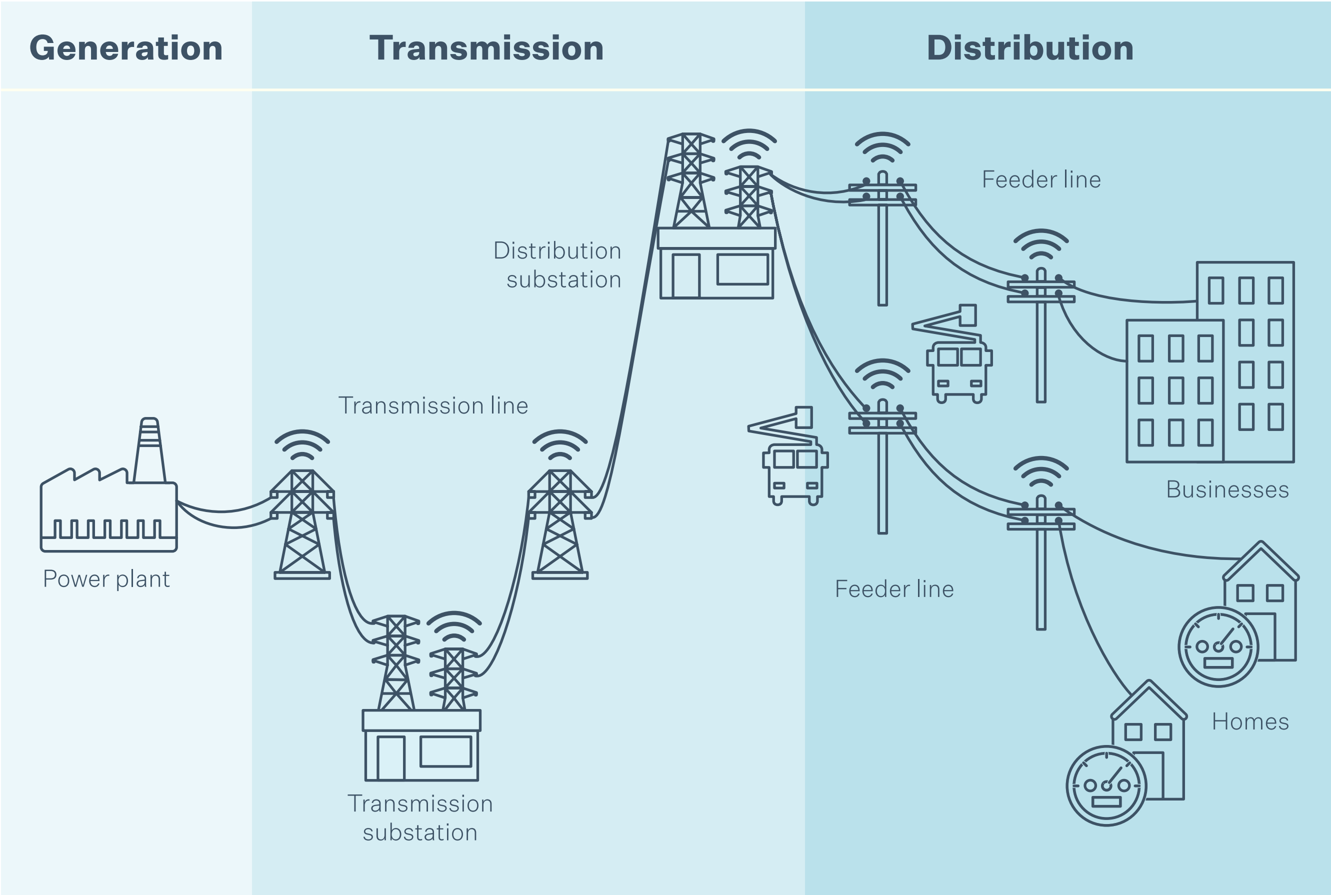
Through Order 20-485, the OPUC required investor-owned utilities (IOUs) to foster transparency and to include an overview of baseline assessments of their distribution system as part of their DSP. This includes an asset inventory, management and monitoring practices, recent investments and DER penetration at the time of filing.

Our inaugural DSP is the first effort in an evolving, multi-stage process. PGE anticipates that the forming, filing and accepting of the initial plans will educate all parties and identify areas for continuous improvement. We expect the evolution from the Order 20-485 guidelines to more advanced stages may change how the distribution system is defined, how investments are made and even how investment costs are recovered.

1.2.1 WHAT IS THE ELECTRIC GRID?

The electric grid's primary purpose is to deliver power to end users. **Figure 4** illustrates a simplified grid network comprised of three main components: generation, transmission and distribution.

Figure 4. The electric grid



System operators must balance the competing demands of the grid using available resources while ensuring the reliable delivery of power within a specified range of voltage and frequency. The functions of the three main grid components are:

- **Generation**: Power plants generate energy from various sources, like hydro or wind. Our energy generation is located both on our system and outside our service territory.
- **Transmission**: Electricity is transported at a high voltage from the large generation resources, which are often centrally located, to the distribution system. Generation is connected to generation step-up transformers. Transmission lines and substations are then used for the transmission of power to distribution substations, where energy voltage is stepped down for safety reasons.
- **Distribution**: Distribution delivers power from transmission to the customer. Transmission lines are connected at a distribution substation, where voltage is stepped down to safer levels for transfer to homes and businesses. Our two most common voltages directly serving customers are 35 kV and 13 kV, which serve industrial, residential and commercial customers across our service territory.

1.2.2 WHAT IS A DISTRIBUTION SYSTEM?

For the purposes of meeting the intent of the DSP guidelines, namely providing understanding and transparency into how PGE plans for and operates its distribution system, PGE defines the distribution system as follows:

1.2.2.1 Engineering definition

> The distribution system is defined as load-serving, PGE-owned equipment and lines at nominal voltage levels below 35 kV.[15] The distribution system starts at the circuit breaker and high-side disconnect of the substation distribution transformer.[16]

Throughout this filing, we use the engineering definition of the distribution system as beginning at the high-side disconnect of the substation distribution transformer, and comprising any load-serving, PGE-owned equipment and lines at nominal voltage levels at or below 35 kV, unless otherwise noted.[17]

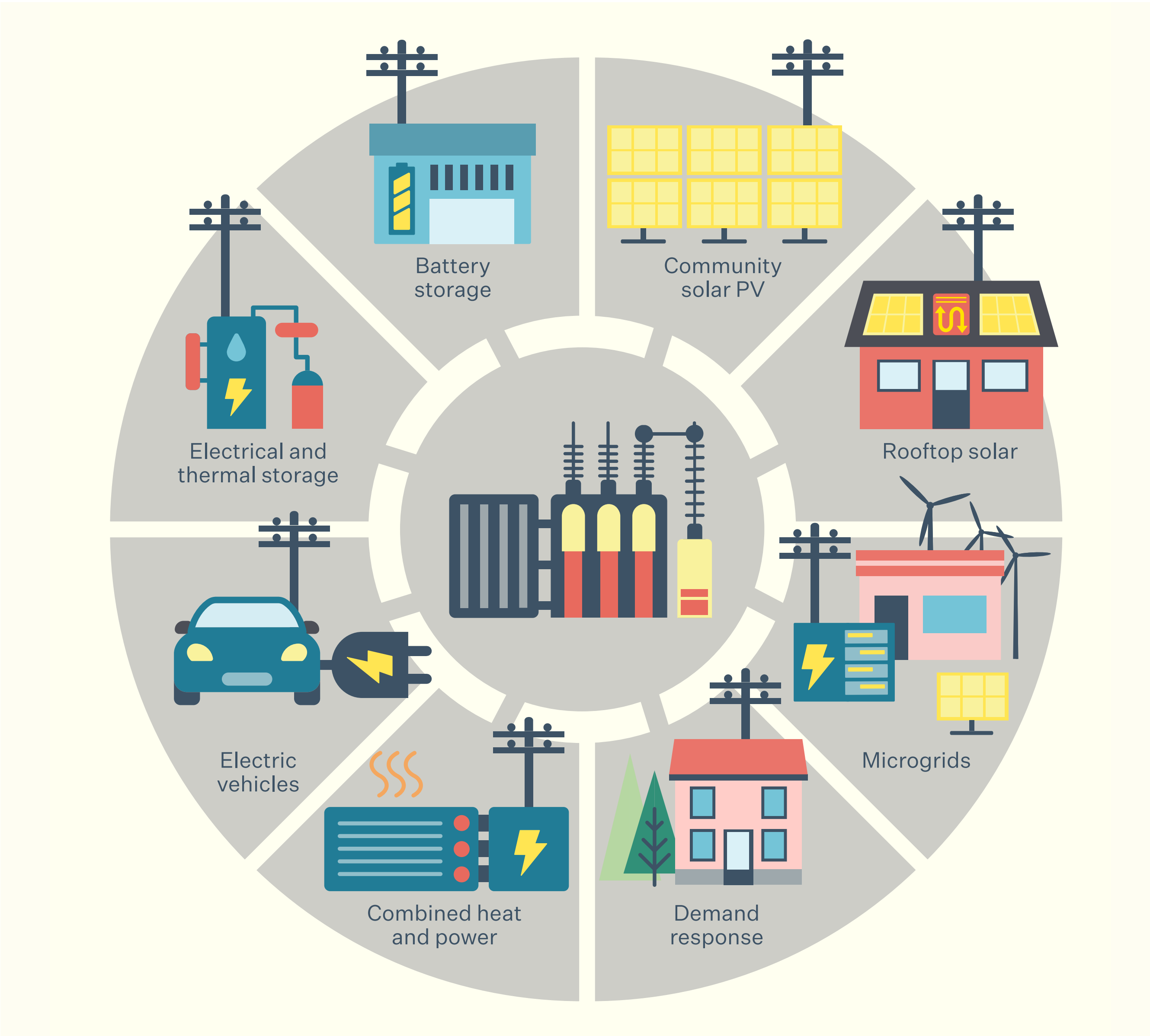
1.2.3 WHAT IS DISTRIBUTION SYSTEM PLANNING?

Distribution system planning is the process of analyzing the distribution grid to ensure it is capable of serving existing and future load (power demand) under normal operating conditions and in the face of contingencies, such as failure of a component. This process is vital, allowing us to ensure reliable, safe and affordable power for our customers. Historically, the primary planning concerns have been around managing current and future peak loads under one-way power flow, as shown in **Figure 4**.

These objectives are changing as technologies, policies and our capabilities continue to evolve. The grid has become more nuanced and requires more considerations in planning. **Figure 5** shows the dynamic, two-way nature of the modern distribution grid.

15. PGE functionally treats its 57 kVA lines as sub-transmission.
16. Substation circuit breakers are equipped with disconnects, which open a circuit quickly in the event of an overload. For more distribution system asset definitions, see Appendix B, section B.3.1.
17. Alternative categorizations of discrete transmission and distribution (T&D) system elements may be applicable depending on the stated purpose. The above definition was deemed most suitable for the DSP filing based on the stated policy goals of UM 2005 and associated guidelines. For more information on alternative T&D classifications, see OPUC Order 19-400, available at: puc.state.or.us

Figure 5. Examples of distributed energy resources connected to the distribution grid



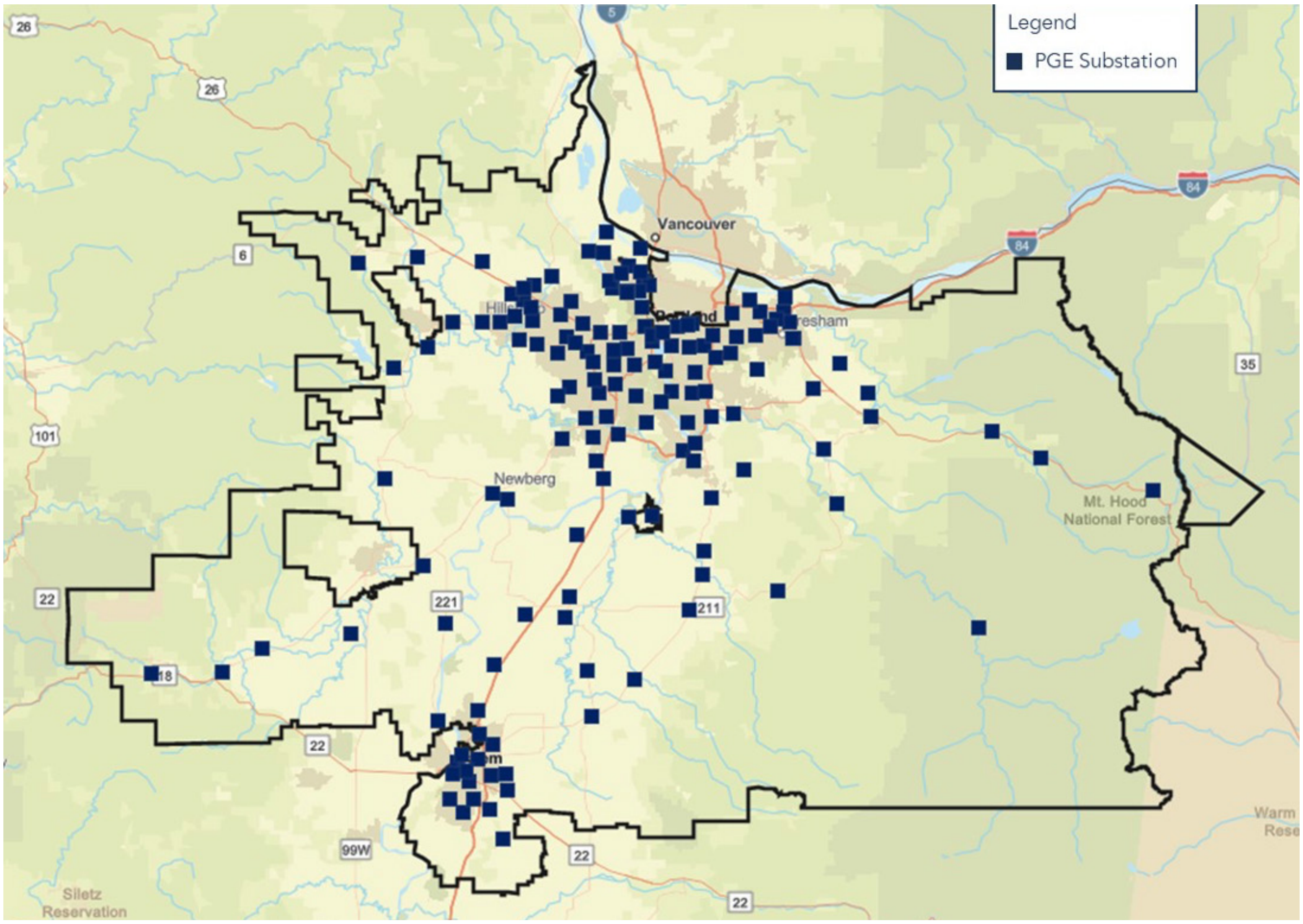
This brief timeline shows how technology has impacted distribution system planning:

- Historically, the distribution system has been optimized for one-way flow with a relatively low granularity and visibility of the system's real-time state.
- Over the last 10-15 years, more advanced and lower-cost sensor and control technologies have increased the level of detail received about the distribution system. This has enabled new functionalities that lead to improvements such as reduced outage response times. System planners can also improve the accuracy of forward-looking studies, facilitating better decision-making.
- In the last 5-10 years, technology improvements and lower-cost DERs have expanded the amount of clean energy resources on the grid. Utilities have taken several steps to accommodate this growth, including improving protection at substations.
- Today, with new digital capabilities that can optimize DERs, we are entering a new age in which planning can help the distribution system accelerate decarbonization, provide community benefits and more. The future state of the distribution system is discussed further in **Chapter 2** and **Chapter 4**.

1.3 System baseline and assessment practices at PGE

PGE serves a population of 1.9 million people, representing about 900,000 customers over 4,000 square miles. Our distribution system is composed of 153 distribution substations, 270 distribution power transformers and 695 distribution feeders (**Figure 6**).

Figure 6. PGE's service area



The safe operation of the distribution grid requires continuous tracking, assessment and maintenance of all the various pieces of electrical equipment dispersed across the network. We implement strategic asset management to ensure we are adequately addressing cost and risk considerations across our portfolio when making investment decisions. This requires maintaining a risk assessment model that combines asset-specific information (such as equipment age, nameplate and emergency ratings and average load) with expected consequences (e.g., customer costs) resulting from service interruptions.

Poles are physically inspected through PGE's Facilities Inspection and Treatment to National Electrical Safety code (FITNES). Oregon Admin Rule 860-024-0011 requires a detailed visual inspection as well as wood utility pole testing and treating.[18] It works on a 10-year cycle and covers 10% of PGE's system per year. The rule recommends a pole be replaced if the inspection finds that insufficient pole strength or pole height exists (Note: Pole age varies depending on wood product quality).

18. Oregon Admin Rule 860-024-001, available at: oregon.public.law

We classify our distribution assets into 13 categories. **Table 2** shows the average age and average service life of each asset category. Definitions of each category and further details about asset age ranges can be found in **Appendix B, Section B.3.1**.

Table 2. Summary of distribution assets as of Q1 2021

Asset classes	Number of assets	Average age of assets[1]	Average service life[2]
Substation structures	N/A	N/A	65
Substation transformers	407	38	55
Circuit breakers	1,617	21	55
Other substation equipment	9,967	30	65
Distribution poles	203,615	41	48
Overhead transformers	108,500	29	50
Reclosers and sectionalizers	422	8	50
Voltage regulators	55	9	50
Capacitor banks	689	27	50
Other open hole (OH) conductor devices	175,492	21	48
Underground (UG) transformers	71,153	28	55
UG conduit	243,273	12	80
Other UG conductor devices	3,411	19	55

1. Average age is the actual average age of all in-service assets within each group as of Q1 2021.
2. Average service life is derived from a five-year depreciation study and used for cost-recovery purposes.

In addition to monitoring asset health and conditions, we maintain detailed network models of the distribution grid in CYME (our power flow modeling software) that factor into nearly all aspects of system planning. Our distribution planning engineering team uses these models to support the following key functions:

- To perform system analysis and develop plans that ensure the distribution system will be operable and maintain functionality and flexibility in both the near and long term (5-10 years)
- To provide support and guidance on distribution-related investment decisions
- To support grid modernization plans

When conducting distribution system planning, we look at how we will meet customer needs, enhance safety, increase reliability, meet new standards and requirements and reduce risk. We also optimize the configuration of the distribution system to improve customer experiences and reliability.

1.3.1 DISTRIBUTION SYSTEM PLANNING DRIVERS

Distribution planning is informed by key drivers such as load growth forecasts, economic development, new large single loads, grid modernization, regulatory requirements, safety, reliability performance of the system, urban growth boundary expansion and zoning changes. DERs are newer drivers, and different DERs have different impacts. For example, electric vehicle charging is an intermittent load addition, photovoltaic installations provide distributed generation and flexible loads offer opportunities for capacity relief by shifting energy use to more optimal times of day.

At PGE, we see the distribution grid as an evolving system at different stages of modernization. By proactively responding to the changes in the communities we serve, we can advance and improve distribution operations and customer service. For example, we work hand in hand with our business development team by providing them with up-to-date information on our current system capacity to serve potential new customers. When a potential customer becomes an actual customer by signing a service agreement, we anticipate their future energy growth needs by incorporating their home or business into our load growth forecast and exploring whether upgrades to the system are needed.

1.3.2 PGE DISTRIBUTION LOAD GROWTH FORECASTING METHODOLOGY

For load forecasting purposes, PGE's distribution system is evaluated for a 1-in-3 peak load condition during the summer and winter seasons for near-term (years 1 through 5) and longer-term (years 6 through 10) studies. The 1-in-3 peak system load is calculated based on weather conditions that PGE can anticipate experiencing once every three years. The summer (June 1 through October 31) and winter (November 1 through March 31) load seasons are considered the most critical study seasons due to heavier peak loads and high-power transfers over PGE's transmission and distribution system to its customers.

PGE calculates the seasonal peak load forecasts for each distribution power transformer via an in-house program using a "top-down" approach for predicting loads for each of our 270 distribution power transformers. Inputs to this forecasting tool include:

- Our corporate forecast for 1-in-3 peak summer and winter loading
- Historical loading information (most recent five-year period) for each distribution power transformer
- Compensated power factor (PF) for each distribution power transformer during the designated peak period

This program factors in historical load growth and "bottom-up" known load additions to scale forecasted, individual, distribution power transformer loading to the aggregate load level provided by our corporate forecast. It also factors in internal and external losses and uses scaling factors to approximate non-coincidental loading that is provided in historical loading information. Outputs from the program include:

- Peak annual seasonal megawatt (MW) and megavolt-amp reactive (MVAR) output for each distribution power transformer for each year of the forecast horizon
- Peak annual seasonal megavolt amp (MVA) and PF for each distribution power transformer for each year of the forecast horizon

When a feeder or substation power transformer is forecasted to increase beyond its planning design criteria, we continue to monitor the loads and may conduct a detailed planning study to inform investments on needed system upgrades. See **Appendix B** for details on the planning design criteria for specific distribution assets, as well as an overview of our modeling approach using CYME. We now turn to a summary of recent capital investments made on the distribution system.

1.4 Distribution system historical capital investments

Our electric grid is the mechanism by which we bring our customers safe, reliable, affordable energy, and the distribution system is a significant part of it. In one form or another, the investments described in this section allow us to maintain a reliable distribution infrastructure and keep outages low. For details about system reliability key performance metrics and outages, see **Appendix B**.

Budgeting and investing are done for our distribution system on a yearly basis. **Table 3** shows our historical spend on the distribution system for the last five years for the categories outlined in the guidelines (defined below), as well as average budgeted amount in the same period.

- **New customer projects** are new connects, minimum load agreements (MLAs) tied to specific customer base and interconnections. These cover any customer coming online with a contract agreement.
- **Age-related replacements and asset renewals** are like-for-like replacements due to age or reactive failure.
- **System expansion or upgrades for reliability and power quality** are proactive upgrades to improve reliability and reduce risk. Examples include our distribution protection unit (DPU) relay replacement program, tree wire program (installs insulation on overhead wires to reduce outages), underground cable replacements and substation upgrades. These projects aim to reduce outages and improve the customer experience.
- **System expansion or upgrades for capacity** are driven by load growth per our Distribution Planning Department's load forecast.
- **Metering** involves meter installs and purchases to enhance metering capabilities for our customers.
- **Preventative maintenance** is operation and maintenance (O&M) spending to ensure grid components are up to standards and operating efficiently.
- **Grid modernization projects** involve new technologies such as energy storage, distribution automation, communications via field area network (FAN) or multi-protocol label switching (MPLS), and software, such as advanced distribution management system (ADMS) platforms, to modernize the grid.

Table 3. Distribution of yearly spending by expenditure category[19]

Spending category	Yearly spending (million USD)					Budget average 2016-2020
	2016	2017	2018	2019	2020	
New customer projects	$49	$84	$86	$87	$86	$78
Age-related replacements and asset renewal	$50	$52	$60	$86	$175	$85
System expansion or upgrades for reliability and power quality	$39	$51	$76	$122	$84	$74
System expansion or upgrades for capacity	$32	$67	$82	$37	$30	$50
Metering	$9	$7	$7	$12	$9	$9
Preventive maintenance	$0.4	$4	$8	$5	$2	$4
Grid modernization projects	$0.01	$2	$3	$4	$5	$3
Total	**$180**	**$268**	**$322**	**$352**	**$390**	**$302**

As discussed throughout this chapter, the distribution system is facing tremendous change as a result of evolving customer demands and advancing DER technologies. In the next section, we provide a summary of current DER adoption as laid out in the baseline requirements section of the guidelines. In **Chapter 2**, we discuss how forecasted growth in DERs is driving the need for continued investments in the distribution grid.

19. Totals may not add up due to rounding.
The investment figures presented in Table 3 reflect the stipulation reached by parties and reflected in Order 19-400, available at: apps.puc.state.or.us
PGE may revisit this definition in future DSP filings.
A. Radial lines both to distribution and to customers tend to be classified as distribution.
B. Radial generation tie facilities tend to be classified as transmission for accounting purposes, but should be classified as production for ratemaking purposes.
C. Non-radial line segments of 100 kV or higher voltage tend to be classified as transmission.
D. Transformers with a secondary voltage under 100 kV tend to be classified as distribution.
E. Substation assets (e.g., circuit breakers) that are part of the path that connects the transmission line segments, or equipment associated with transformers with a secondary voltage higher than 100 kV, are classified as transmission.

1.5 DERs currently integrated in PGE's distribution system

Understanding how many DERs are connected to our system is foundational to understanding the associated challenges and opportunities. For the purposes of the UM 2005 guidelines, "distributed energy resource" includes the following resources that are connected to the distribution power grid:

- Distributed generation resources, either net metering (NM) or qualifying facilities (QFs) connected to distribution[20]
- Distributed energy storage
- Demand response
- Energy efficiency programs
- Electric vehicles

The following sections provide a brief introduction to each DER type and a summary of how many DERs are currently connected to our distribution system.

1.5.1 NET METERING AND DISTRIBUTED GENERATION

For customers who install their own renewable generation sources, net metering rules allow for the flow of electricity both to and from the customer — typically through a single, bi-directional meter. When a customer's on-site generation exceeds their individual use, electricity flows back to the grid, generating bill credits that can be used to offset electricity consumed by the customer at a different time during the same 12-month period. In effect, the customer uses excess generation to offset electricity that they otherwise would have to purchase from the utility.[21]

QFs can encompass both large-scale, transmission-connected generators and smaller facilities connected to the distribution system. Based on the final DSP guidelines, the following information for QFs pertains only to those connected to the distribution system.

1.5.1.1 In-service facilities

In-service facilities are integrated with the grid and producing energy. **Table 4** shows that net metering facilities in our territory as of September 2021 have the capacity to produce close to 126 MW, and that approximately 96% of that capacity comes from rooftop solar facilities.

Table 4. In-service net metering facilities by generator type, number and capacity

In-service net metering facilities				
	Generator		Capacity	
Generator type	Number	Percent of total	kW	Percent of total[22]
Solar	13,454	99.59%	121,170	96.28%
Methane gas	4	0.03%	3,801	3.02%
Wind	40	0.30%	650	0.52%
Hydro	6	0.04%	185	0.15%
Solar + wind	2	0.01%	22	0.02%
Fuel cell	3	0.02%	21	0.02%
Total	**13,509**	**100%**	**125,848**	**100%**

20. Qualified facilities (QFs) fall into two categories: qualifying small power production facilities and qualifying cogeneration facilities. QFs are reported on annual bases in the Annual Small Generator report found in Appendix D.
21. Oregon's net metering rules can be found in OAR 860-039-0010 through 860-039-0080, available at: secure.sos.state.or.us
22. Totals may not add up due to rounding.

We currently have 54 in-service QFs with an estimated nameplate capacity of 118 MW (**Table 5**).

Table 5. In-service qualifying facilities by generator type, number and capacity

In-service qualifying facilities				
Generator type	**Generator**		**Capacity**	
	Number	**Percent of total**	**kW**	**Percent of total**[23]
Solar	51	94%	117,921	99.85%
Diesel	2	4%	175	0.15%
Storage only	1	2%	1.20	0.001%
Total	**54**	**100%**	**118,097**	**100%**

1.5.1.2 In-queue facilities

In-queue facilities have applied to be permitted to integrate with the grid and are not producing power yet. **Table 6** and **Table 7** show the number of in-queue net-metering and QF applications as of September 2021.

We have created an electronic map showing all in-service and in-queue distributed generation summarized by feeder, available on our DSP website.[24]

Table 6. In-queue net metering facilities by generator type, number and capacity (September 2021)

In-service net metering facilities				
Generator type	**Generator**		**Capacity**	
	Number	**Percent of total**	**kW**	**Percent of total**[25]
Solar	1,698	99.71%	33,911	94.82%
Methane gas	2	0.12%	1,833	5.13%
Storage	3	0.18%	21	0.06%
Total	**1,703**	**100%**	**35,765**	**100%**

Table 7. In-queue qualifying facilities by generator type, number and capacity (September 2021)

In-queue qualifying facilities				
Generator type	**Generator**		**Capacity**	
	Number	**Percent of total**	**kW**	**Percent of total**[26]
Solar	37	97%	82,965	98%
Storage only	1	3%	1830	2%
Total	**38**	**100%**	**84,795**	**100%**

23. Totals may not add up due to rounding.
24. PGE map is available at: arcgis.com
25. Totals may not add up due to rounding.
26. Totals may not add up due to rounding.

1.5.2 DEMAND RESPONSE

In June 2021, the Commission accepted PGE's Flexible Load Plan, which laid out a holistic vision for how we plan to accelerate flexible load development through streamlined budget planning and improvements to cost-effectiveness and greater integration with our system operations.[27] As we continue to build on the transparency provided in our Flexible Load Plan, we will work with participants to ensure the appropriate level of information is being shared between Flexible Load Plan activity and DSP filings.

In 2020, we had successfully enrolled 63 MW of available summer demand response (DR) capacity and 39 MW of available winter DR capacity. **Table 8** and **Table 9** provide historic achievements of our DR pilots by customer segment, as of the end of 2020. More detail about each product offering, as well as future plans, are available in the Flexible Load Plan.[28]

Table 8. Number of customers participating in demand response (2016-2020)

	2016	2017	2018	2019	2020
Residential	16,409	16,370	26,552	107,876	116,835
Business	42	18	43	95	509
Total	**16,467**	**16,388**	**26,595**	**107,971**	**117,344**

Table 9. Demand response capacity by season (2016-2020)

2016		2016	2017	2018	2019	2020
Maximum available capacity of DR (MW)	Residential	1.4	0.5	5.3	17.1	17.9
	Business	14.9	3.0	15.2	18.6	21
	Total	**16.3**	**3.5**	**20.5**	**35.7**	**38.6**
PGE's Season Peak (MW)		3,716	3,727	3,399	3,422	3,330
Available capacity of DR (percent of season system peak)		0.44%	0.10%	0.60%	1.04%	1.16%
Winter						
Maximum available capacity of DR (MW)	Residential	5.8	4.5	13.0	32.3	39.0
	Business	12.9	3.0	15.2	20.6	23.7
	Total	**18.7**	**7.5**	**28.2**	**52.9**	**62.7**
PGE's Season Peak (MW)		3,726	3,976	3,816	3,764	3,771
Available capacity of DR (percent of season system peak)		0.50%	0.19%	0.74%	1.41%	1.66%
Summer						

27. Order No. 21-158 is available at: apps.puc.state.or.us
28. PGE Flexible Load Plan is available at: edocs.puc.state.or.us

1.5.3 ELECTRIC VEHICLES (EVS)

EV growth is accelerating around the country, and Oregon is a leader in the space. State policies and supporting legislation are driving this adoption, and with increasing EV model availability, this trend is projected to continue accelerating as more diverse segments of the vehicle consumer market have viable EV options from which to choose.

At the same time, EV range has increased dramatically with improvements in battery technologies and overall EV efficiency. The median range of an EV in 2011 was 68 miles, while for model year 2020 EVs, the median range was 259 miles with the top models surpassing 400 miles of maximum range.[29]

The Oregon Department of Energy has launched an EV dashboard that provides an easy way to track electric vehicle adoption by powertrain (battery electric vehicle or plug-in hybrid) and can easily be filtered by county or utility provider.

At the time of this filing, the number of EVs in our service area as reported by the Oregon Electric Vehicle Dashboard was 19,545.[30] **Table 10** shows the number of EVs added to our service area over the last five years.

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Table 10. Electric vehicle (EV) growth in PGE service area by powertrain (additional EVs by year)

EV powertrain	2016	2017	2018	2019	2020[31]
Battery electric vehicle (BEV)	900	1,189	2,307	3,634	3,729
Plug-in hybrid electrical vehicle (PHEV)	636	873	1,379	1,344	1,230
Total EVs	**1,536**	**2,062**	**3,686**	**4,978**	**4,959**

We performed additional analysis on the existing vehicle stock, both EVs and internal combustion engine (ICE) vehicles, to inform the DER and Flexible Load Study for our upcoming Integrated Resource Planning. **Table 11** shows all vehicles by weight class and fuel type in our service area as of the fourth quarter of 2020.

Table 11. Existing vehicle summary in PGE service area by vehicle class and powertrain

Vehicle class	Total vehicles	Percent of total
Light-duty vehicles	1,552,891	87%
Medium-duty vehicles	215,743	12%
Heavy-duty vehicles	13,102	1%
Total	**1,781,736**	**100%**

We used the fuel type, vehicle weight class and vehicle model year information from our analysis to inform our stock turnover model, which captures the changing nature of vehicle ownership over time as older models are retired and more EVs are introduced into the service area. We will present the results of this work and a description of how the EV stock is forecasted to change over time in Part 2 of our DSP filing (**Appendix G**).

29. Source: US Department of Energy. energy.gov
30. Source: oregon.gov
31. In 2020 there was a pandemic-related slowdown.

1.5.4 CHARGING STATIONS

In our 2019 Transportation Electrification Plan, we highlighted the role that public charging infrastructure plays in accelerating transportation electrification.[32] While currently many EV drivers prefer to charge at home, as more and more drivers adopt EVs there will be a growing need to provide quick and convenient access to public charging. This is especially true of EV drivers who may face hurdles to home charging, such as renters or those without a garage or driveway.

We have since updated our tracking of charging infrastructure installed in our service area. We have also gained new insights into charging station usage patterns and information about newly launched PGE initiatives.

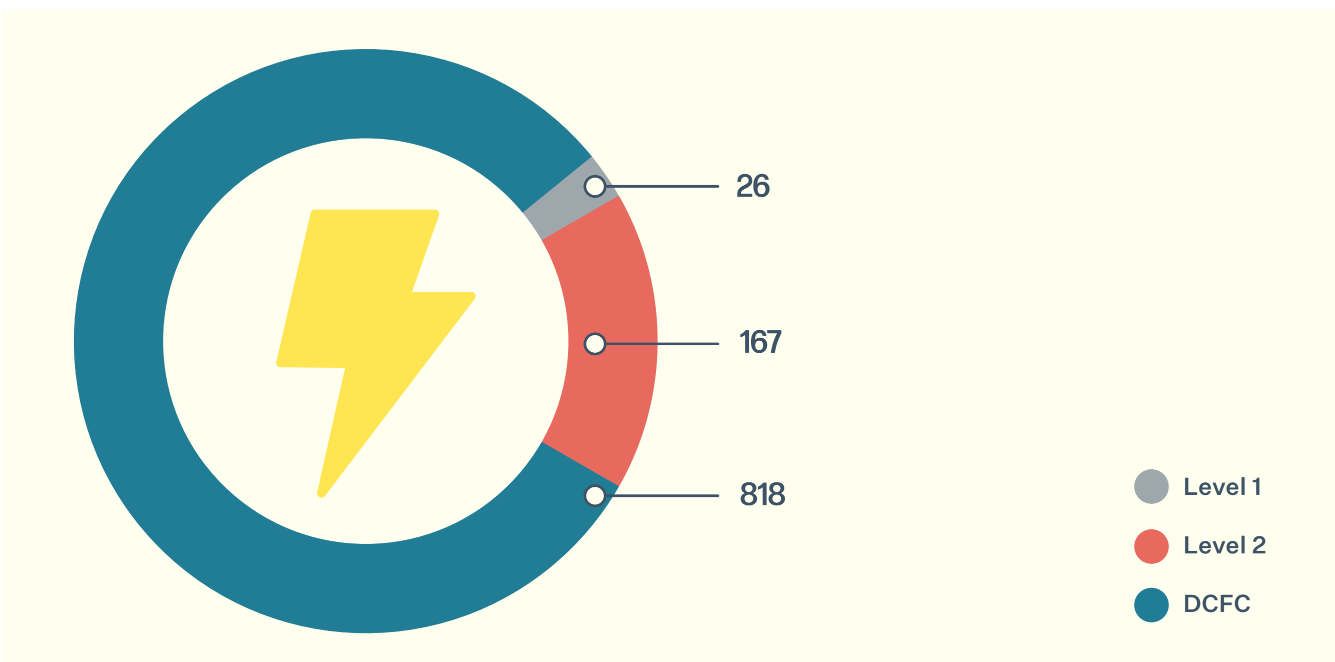
1.5.4.1 Charging stations in our territory

Nationwide, there are several efforts to collect and disseminate data on the availability of charging stations to support EV drivers (e.g., PlugShare, Electrify America and the U.S. Department of Energy [DOE] Alternative Fuels Data Center). As useful as these sources are, each are bound to be incomplete as a standalone source because of the decentralized nature of infrastructure development in both public and private locations across the grid.

For this reason, we decided to rely on the U.S. DOE Alternative Fuels Data Center (AFDC) as a single, trusted external source that we supplement with existing information about our network of EV chargers.[33] We will continue to evaluate the landscape of EV charging databases available in the industry and may modify this decision if more resources become available.

Figure 7 and **Figure 8** summarize the existing charging stations in our service area by charging speed, network type and accessibility. **Figure 9** summarizes the charging stations added to PGE service area by year and type.[34]

Figure 7. Electric vehicle supply equipment (EVSE) counts in PGE service area



Direct Current Fast Charge (DCFC)

32. PGE Transportation Electrification Plan, September 2019, is available at: edocs.puc.state.or.us
33. U.S. DOE AFDC is available at: afdc.energy.gov
34. The U.S. DOE AFDC dataset has many gaps in the installation year, making it difficult to compare the historical trend of EVSE installation by type with the present snapshot presented in Figure 9.

Figure 8. Charging stations by ownership and type

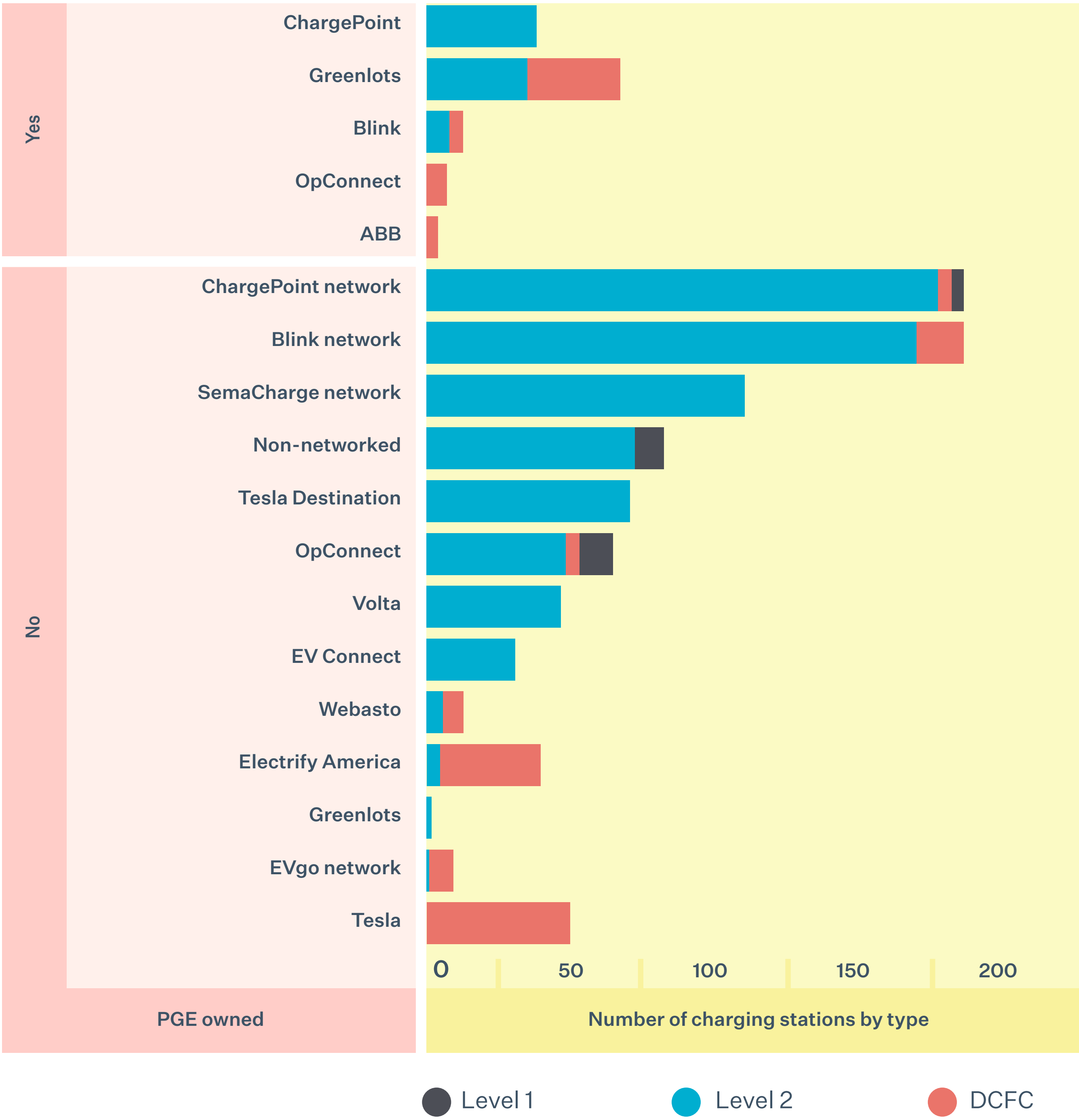
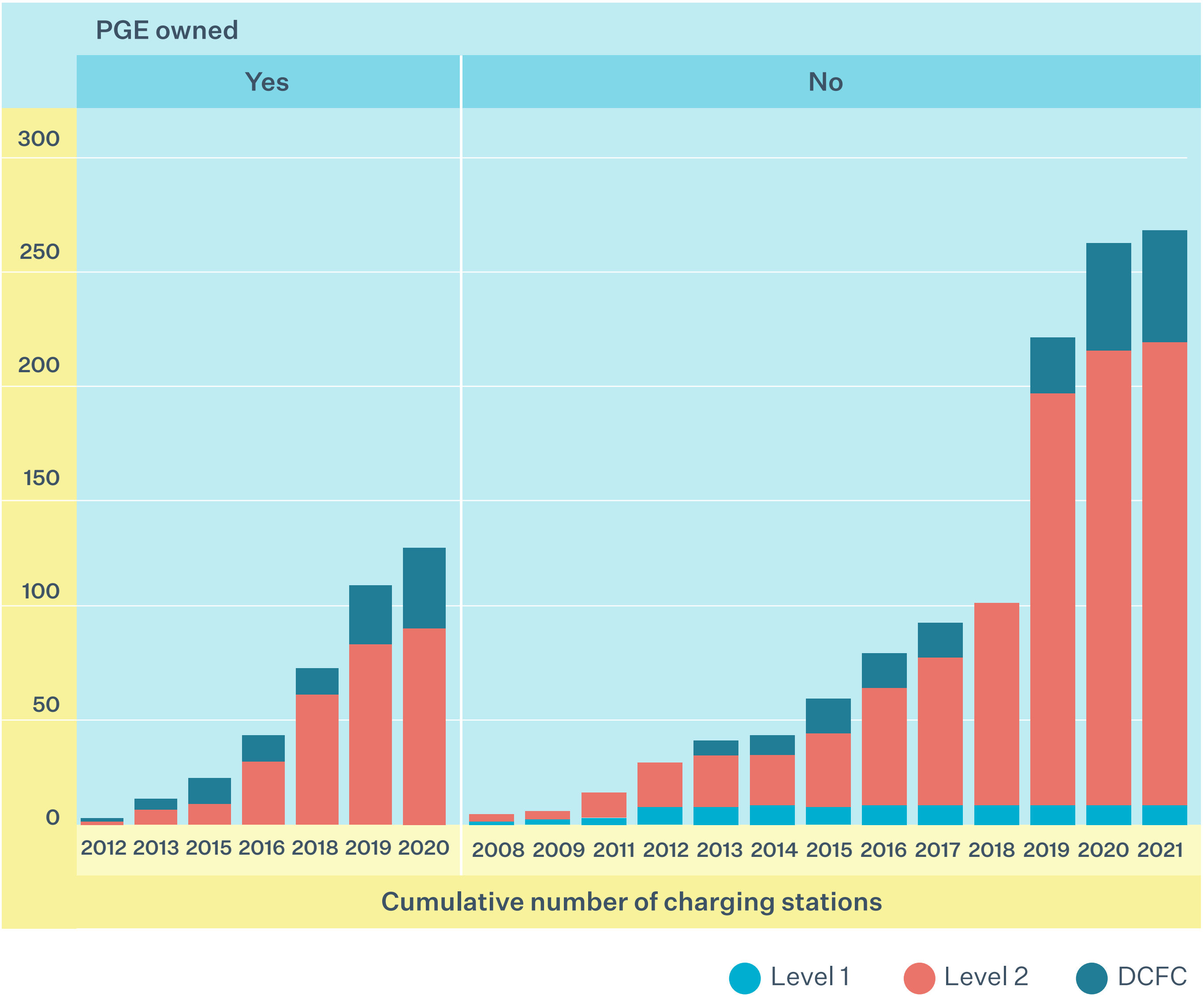


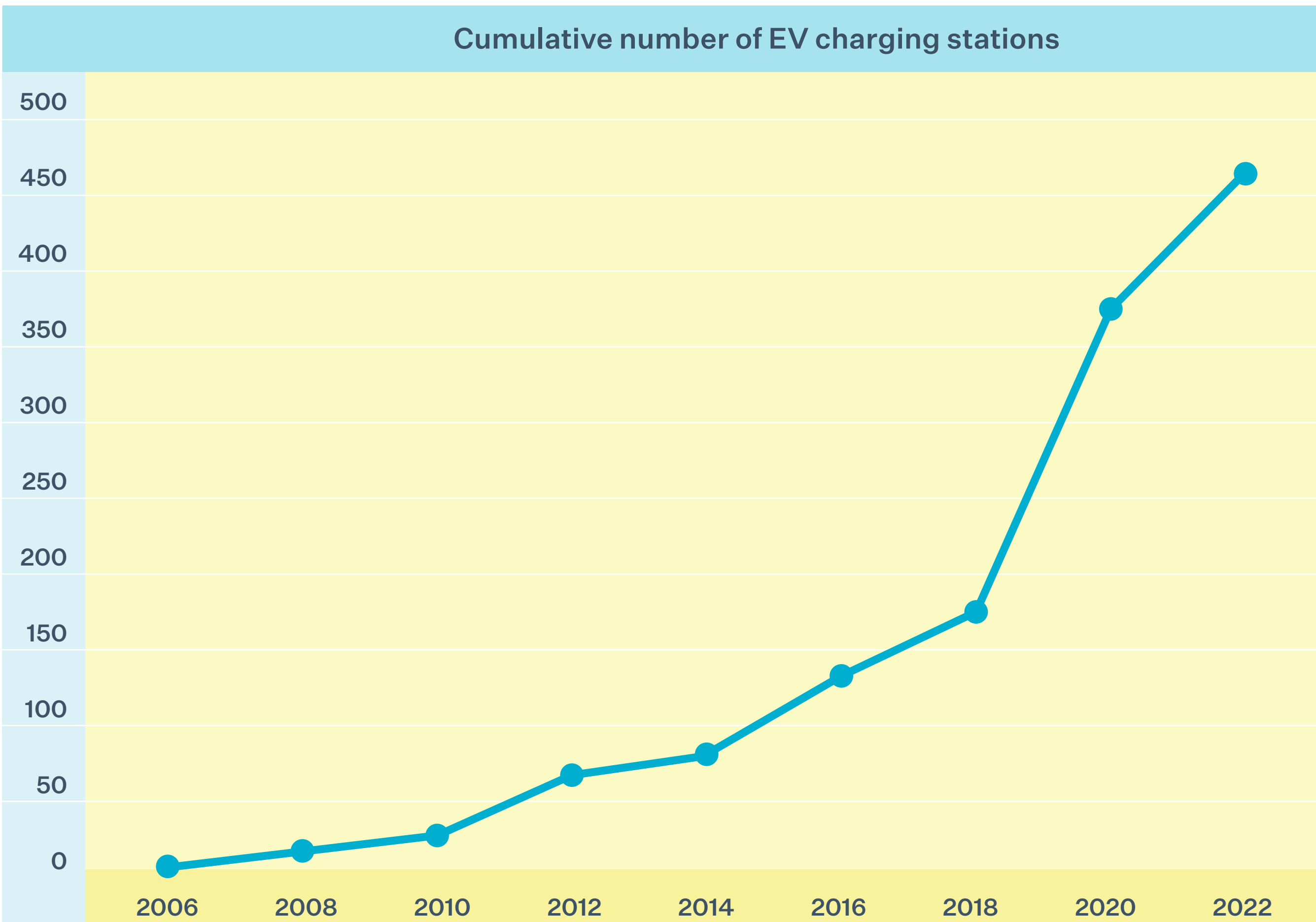
Figure 9. Cumulative number of charging stations by ownership and type



We gathered data on the year charging stations went into service ("in-service year") from the AFDC database and combined this with data on PGE-owned sites. **Figure 10** shows the number of charging stations added by year.[35] One caveat is that many of the entries in the AFDC are missing an in-service year and are therefore not pictured in the chart. We are investigating other data sources to supplement this figure and will update as more information is available.

For additional details on our transportation electrification activities, including usage patterns of charging stations, see **Appendix B**.

Figure 10. Historical growth of EV charging stations in our territory



35. Source: AFDC dataset and PGE internal analysis. AFDC data regarding installation is incomplete and those sites are not reflected in this chart.

1.5.5 RESILIENCE ENERGY STORAGE/ MICROGRIDS

We are developing five energy storage projects totaling 30 MW/102 MWh, including two microgrids at critical facilities, across multiple end-use applications.[36] These projects are providing early insights for how to successfully develop and execute on these technically challenging projects. The following sections provide more detail about residential and commercial mass market products and how they might be used for increased resiliency of the distribution system.

1.5.5.1 Residential storage

Our Residential and Energy Storage Product Management team is responsible for our residential Smart Battery Pilot.[37] Since its launch, the pilot has been helping customers afford whole-home back-up power through on-bill rewards, plus up-front incentives for select customers. In turn, PGE may dispatch the batteries for grid services. This not only increases the resilience of PGE's customers, but also lays the groundwork for expanding PGE's energy storage capabilities across the service territory.

As the pilot matures, we will continue to watch the evolution of energy storage technology and consider how we can continue to innovate and partner with our customers to meet their resilience and clean energy needs. This might mean developing innovative ways to help customers afford home energy storage, like financing options for interconnected devices, or enhanced resilience options on the utility side that can pair energy storage as a grid resource, such as a neighborhood-level microgrid. The pilot will also explore whether letting customers control their own dispatch of the battery during a peak event, as with our Peak Time Rebates program, will yield comparable savings to PGE-dispatched energy.

We are enrolling 525 residential customers into a bring-your-own-battery program that will compensate customers for allowing us to manage the charging and discharging of batteries for a variety of uses. We have also been watching the emerging market of vehicle-to-grid and vehicle-to-home, wherein electric vehicles that have the capability to provide two-way flow could potentially be used in the event of an outage or to export to the grid. Further study is needed to test the safety and reliability of this new technology, as well as customer acceptance and willingness to use vehicle batteries for this purpose. Nevertheless, were this technology to scale, this could be a large change to the resilient home backup market.

1.5.5.2 Commercial and industrial storage

We have been conducting research among customers who have medical equipment powered by electricity or who are otherwise more vulnerable from a health and safety standpoint during a power outage. We want to understand the diversity of this population and consider what products or services may be offered to protect against negative health outcomes in the event of an outage.

Recent power outages have hit our non-residential customers hard during an already challenging economic climate. Customers are asking how we can provide them with solutions to prevent the loss of inventory, keep patients safe and allow businesses and institutions to remain open when they are needed most.

We are exploring a range of solutions, such as custom-engineered microgrids at customer locations that can provide resilience to the customer and flexible load to the utility. With this approach, we would share the costs and benefits with our customers, with PGE paying for the cost-effective portion of the grid resource and the customer paying for their share of the resiliency backup power benefit over time. This structure could potentially be applied to other transformational energy solutions, such as grid-connected heavy-duty fleet charging, pairing energy storage with vehicle charging and multi-family dwellings.

36. Docket UM 1856 and the state law directing Investor-Owned Utilities to invest a minimum of 5 MWh storage
37. Tariff schedule 14