Chapter 2. Distribution system strategy

Our Distribution System Plan strategy aims to transform how we deliver and manage energy across our service territory while prioritizing customer affordability. We are adapting to a rapidly evolving customer landscape driven by increased electrification, technological adoption, and surging industrial demand from manufacturing reshoring and AI advancement. Our long-standing commitment to decarbonization, demonstrated through our transition away from coal and leadership in renewable resource integration, guides and necessitates the development of a reliable, modern, customer-centered grid that delivers affordable energy for all customers.

This chapter outlines our three-prong strategy for distribution system planning

Strategy Components

- Grid modernization
- Accelerated DER deployment
- Virtual Power Plant (VPP) development

These strategic elements work together to deliver value to customers and reduce long-term operating costs.

Figure 4 shows our distribution system strategy is built on three interconnected pillars, each contributing distinct but complementary actions. The first pillar, Grid Modernization, provides the foundation through advanced grid technologies that enhance system reliability and flexibility, including digital technologies like ADMS/DERMS that orchestrate bi-directional power flow. The second pillar focuses on accelerating the adoption of distributed technologies like solar panels, batteries, and smart devices, leveraging partnerships with Energy Trust of Oregon (ETO) and Northwest Energy Efficiency Alliance (NEEA) to maximize deployment and deliver value through customer programs. The third pillar encompasses our Virtual Power Plant platform, which integrates and optimizes these customer-owned resources to provide essential grid services while reducing operational costs for the benefits of all customers.

These strategic pillars, driven by a long-term commitment to least-cost planning, represent our comprehensive approach to delivering energy solutions that reduce customers' energy cost burden while creating a more resilient clean energy future. As outlined in **Chapter 1 Distribution system vision,** this strategy unifies our efforts through collaborations that align with community goals, promote sustainability, and deliver essential benefits to all customers.

Figure 4. Strategic pillars and actions[14]

2.1 Pillar One - Grid modernization investments

Grid modernization represents our foundational strategy pillar, focused on transforming our traditional infrastructure into an intelligent, flexible system capable of managing two-way power flows and integrating customer resources. This comprehensive approach integrates advanced technologies with traditional upgrades in support of VPP operations that deliver grid resilience and maximize the use of existing infrastructure (see **Chapter 5 Virtual Power Plant (VPP)**).

As our system is able to deliver higher and higher percentages of clean energy and DER adoption increases, grid operations become more complex. Grid modernization is necessary to achieve reliability, safety and security. As these investments are co-optimized with incremental grid modernization investments that enhance our ability to incorporate and optimize more DERs, benefits increase. PGE's 2023 CEP/IRP has set a goal by 2030 of being able to meet as much as 25 percent of peak demand with power coming from customers and DERs.[15] Visibility and operational optimization of those DERs is necessary to maintain a reliable, clean, affordable, safe system at least cost.

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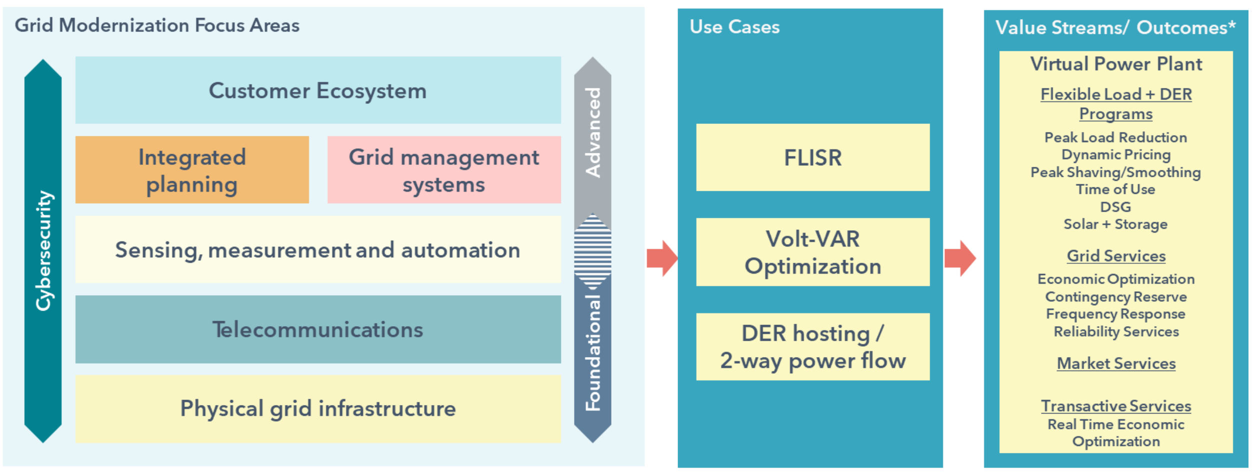
[14] Icons appearing throughout this document align with the strategic pillars shown in **Figure 4** to visually connect key activities with their corresponding strategic elements.
[15] See Section 1.4.2 of PGE's 2023 CEP/IRP. Available at https://downloads.ctfassets.net/416ywc1laqmd/6B6HLox3jBzYLXOBgskor5/63f5c6a615c6f2bc9e5df78ca27472bd/PGE_2023_CEP-IRP_REVISED_2023-06-30.pdf

To deliver maximum customer benefits, PGE proposes a comprehensive grid modernization strategy built on multiple integrated focus areas, from foundational physical infrastructure to advanced customer-facing systems (see **Figure 5**). More detail about these investments is found in **Chapter 4** (Technology foundations for a bi-directional grid) and **Appendix F** (Grid modernization long-term plan and workstreams). This approach optimizes traditional distribution infrastructure upgrades, such as substation or distribution line work, with modern digital systems and DER management capabilities.

Figure 5. Grid modernization focus areas



*Note: Value Streams/Outcomes list is not exhaustive

At the core of these modernization efforts are advanced grid management systems, ADMS and DERMS, that enable intelligent control and optimization of grid operations. These systems create tangible benefits for customers. One use case addresses the response to outages. For example, when power flow is interrupted, ADMS uses automatic fault location, isolation and service restoration (FLISR) capabilities to communicate with line reclosers via communication networks to isolate faults and restore service quickly. Currently 35 of our 695 feeders in the PGE service area have been retrofitted to respond to reliability events, reducing outage durations for about two-thirds of customers on those 35 feeders. This improvement is due to localized enhancements in PGE's system, enabling faster response and restoration for affected areas.

Another use case addresses voltage irregularities. Volt-VAR optimization (VVO) technology fine-tunes voltage and reactive power on the grid, leveraging customer-owned DERs like batteries to maintain optimal power quality.

When ADMS is coupled with DERMS, costs to operate the distribution system to industry standard for reliability and safety are reduced over traditional distribution infrastructure projects.[16]

Together, these investments, coordinated through a VPP, aim to create a flexible and intelligent grid that optimizes existing assets while integrating new technologies and customer resources. These systems work in harmony to enhance reliability, resilience (e.g., shorten outage durations), and improve overall grid efficiency. Further details about these technologies and implementation plans can be found in **Chapter 4** (Technology foundations for a bi-directional grid) and **Appendix F** (Grid modernization long-term plan and workstreams).

2.2 Pillar Two - Accelerating DER deployment

Accelerating distributed energy resource (DER) deployment encompasses a comprehensive strategy to increase customer adoption of technologies like solar panels, batteries, and smart devices through targeted programs, partnerships, and education. This strategic pillar creates pathways for customers to participate in the clean energy transition while ensuring system reliability and equitable access.

2.2.1 Customer engagement and partnership strategy

Our acceleration strategy operates through multiple channels to maximize impact. We partner with established organizations like ETO for co-deployment initiatives and the NEAA for market transformation of demand response programs. These strategic collaborations create a foundation for standardized interconnection requirements and customer support platforms.

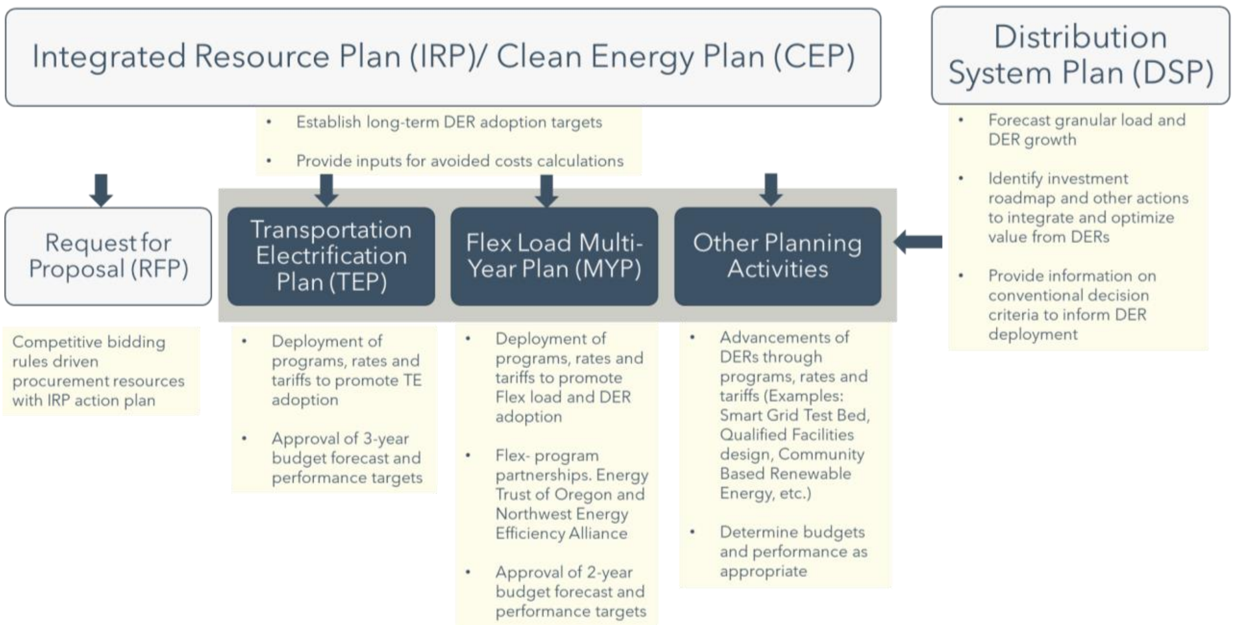
To streamline customer participation, we have developed engagement platforms like Marketplace and PGE+ that provide education, technical support, and streamlined access to DER technologies. Our Smart Grid Test Bed (SGTB) serves as a proving ground for testing and refining these approaches before broader deployment.

2.2.2 Planning framework integration

Our DER acceleration efforts are coordinated through three key planning processes, these relationships are depicted in (**Figure 6**).

[16] This study is referenced in the DOE's commercial liftoff report for Innovative Grid Deployment. Available at: https://liftoff.energy.gov/wp-content/uploads/2024/04/Liftoff_Innovative-Grid-Deployment_Final_4.12.pdf, *citing* Kazempour,F., Hu, K. November 2023. *Utility investment in grid modernization: H2 2023*. Wood Mackenzie.

Figure 6. Overview of planning environment relationships



2.2.2.1 Clean Energy Plan/IRP Integration

The CEP/IRP integration process aligns our DER forecasts with system-wide resource planning. Through our AdopDER model, we develop detailed projections that inform both distribution-level planning and broader system needs, creating a comprehensive view of how distributed resources can best serve our evolving grid.

- Leveraging our AdopDER model to inform system-wide planning
- Ensuring alignment between distribution and resource planning
- Identifying opportunities for distributed resources to meet system needs

2.2.2.2 Multi-Year Plan (MYP) Coordination

The MYP creates a bridge between long-term planning and near-term implementation. By coordinating infrastructure investments with resource development in two-year cycles, we can efficiently deploy flex load programs while maintaining alignment with our broader distribution system goals.

- Aligning infrastructure investment with resource development
- Implementing flex load programs in two-year increments
- Working toward consolidation of DSP and MYP for comprehensive planning

2.2.2.3 Transportation Electrification Integration

Our transportation electrification strategy takes a comprehensive approach through planning, serving, and managing TE load growth. With significant investment focused on underserved communities, we're developing targeted rates and load management solutions to promote equitable access while maintaining grid reliability.

- Executing our Plan, Serve, and Manage strategy for TE load

- PGE's 2023 Transportation Electrification Plan directs nearly $96 million investment. 58 percent of the Monthly Meter Charge dollars supports underserved communities[17]
- Developing TE-specific rates and load management approaches

2.2.3 Advanced forecasting and implementation

Our implementation success relies on sophisticated granular forecasting capabilities that inform both near-term actions and long-term planning. Through integration with our T&D capital planning processes, we develop detailed projections at the feeder and substation levels, allowing us to anticipate and prepare for localized grid impacts. This granular approach is enhanced by our partnership with EPRI on the Wide-Area Distribution Assessment study, which helps us identify electrification opportunities and prioritize grid investments across our service territory.

Building on these capabilities, we conduct comprehensive load modeling across various scenarios, particularly focusing on heavy-duty vehicle charging profiles and their grid impacts. This modeling includes both reference and high adoption scenarios for electric vehicles, helping us understand potential system impacts and investment needs. Through regular assessment of demand patterns and proactive infrastructure planning, we can better anticipate and address emerging grid needs while ensuring efficient use of existing assets. This data-driven approach enables us to make targeted investments that support accelerated DER adoption while maintaining system reliability and cost-effectiveness.

Our implementation success is informed by sophisticated forecasting and planning activities:

- Granular load growth projections at feeder and substation levels
- Integration with T&D capital planning processes
- Regular assessment of demand patterns
- Partnership with Electric Power Resource Institute (EPRI) for Wide-Area Distribution Assessment[18]
- **Key outcomes include:**
    - Assessment of electrification opportunities
    - Identification of high-priority feeders
    - Proactive infrastructure investment planning
    - Comprehensive load modeling scenarios

Through this coordinated approach, we are building a foundation for accelerated DER adoption while ensuring system reliability and equitable access. This pillar integrates with

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[17] PGE's 2023 Transportation Electrification Plan is available at: https://assets.ctfassets.net/416ywc1laqmd/2xv3CdVdbyaZuYVy3UFWkR/65122d294f36a14ee6514cab2cf6fb74/TEP_2023-08-25_Full_Report.pdf

[18] Wide Area Assessment is related more closely to reliability but produces data that may be used by the planning team. EPRI's product description for these assessments. Available at: https://www.epri.com/research/products/000000003002031146

our broader planning framework, bringing together elements of infrastructure investment, customer programs, and resource acquisition. While the infrastructure components are detailed in this DSP, specific program elements are further developed in the Multi-year Plan and Transportation Electrification Plan. Additional technical details can be found in **Chapter 4** (Technology foundations for a bi-directional grid) and **Appendix F** (Grid modernization long-term plan and workstreams).

PGE's distribution system plan strategy brings together elements of infrastructure investment, customer programs and resource acquisition. The infrastructure required to follow through on this strategy is discussed in this DSP. Elements of resource acquisition and customer programs are discussed in the Multi-year Plan and Transportation Electrification Plan.

2.3 Pillar Three - Virtual Power Plant

A Virtual Power Plant (VPP) is a sophisticated system that coordinates distributed energy resources - such as rooftop solar, batteries, electric vehicles, and flexible loads - to function like a traditional power plant. By integrating and orchestrating these resources through advanced technology platforms, a VPP provides essential grid services while optimizing costs and reliability. This approach transforms individual customer resources into a collective asset that benefits the entire energy system.

PGE's Virtual Power Plant (VPP) strategy creates a framework for customers to actively participate in a clean, reliable, and affordable energy system. Through the VPP, we will harness the power of distributed energy resources to optimize grid operations, reduce reliance on traditional power plants, and accelerate the transition to a non-emitting energy future.

This approach aligns with broader industry direction, as the United States Department of Energy (US DOE) has documented the importance of these objectives through several white papers and reports on the topics of grid modernization, virtual power plants (VPPs) and related concepts.[19] The federal government has identified VPPs as necessary to provide safe, reliable clean power at least cost, and has provided funding and support for VPP initiatives and DER integration.[20]

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[19] See generally, The "Pathways to Commercial Liftoff" reports, available at: https://liftoff.energy.gov/ .
[20] Some of the key pieces of legislation include:

1. **Inflation Reduction Act (IRA)**: Passed in 2022, this act includes various provisions for clean energy technologies, tax credits for renewable energy development, and incentives that can support the integration of VPPs by promoting energy efficiency, renewable generation, and storage solutions.
2. **Infrastructure Investment and Jobs Act (IIJA)**: Enacted in late 2021, this legislation allocates funding for infrastructure improvements that can enhance grid reliability and

To execute this strategy effectively, we must create a platform that brings together resources distributed across the system to optimize their operation.

Our approach builds on established success. PGE ranks among the top utilities in the country for energy efficiency spending per customer and program offerings.[21] Building on this foundation, PGE's 2024 DSP focuses on how an accelerated deployment of DERs operating within a bi-directional system orchestrated through a VPP provides direct benefit to customers, communities and the system.

According to high-level projections from PGE's Integrated Resource Plan (IRP), long-term forecasts indicate a potential for over 2,000 MW of DERs and flexible loads to come online within PGE's service territory by 2030. This significant growth potential requires sophisticated management, which is why our VPP integrates various distributed energy resources such as solar panels, wind turbines, battery storage systems, and flexible demand-side resources into a unified and manageable network.

Moving forward, VPP operations will expand from our current, event-based responses (like heat waves or cold snaps) to thousands and eventually millions of automated operations for real-time energy management. Through this development, the VPP will harmonize customer participation and system operations to support growth in customer electrification without compromising reliability and keeping costs as low as possible throughout the clean energy transformation.

The integration of distributed energy resources (DERs) and flexible loads through technology systems to deliver grid services and operational benefits. Further detail can be found within **Chapter 5 Virtual Power Plant (VPP)**.

2.3.1 DER platform optimization

Updating the distribution system is necessary to create a platform that brings together resources distributed across the system to optimize their operation in a manner that provides the greatest number of megawatts at the highest system value. The development

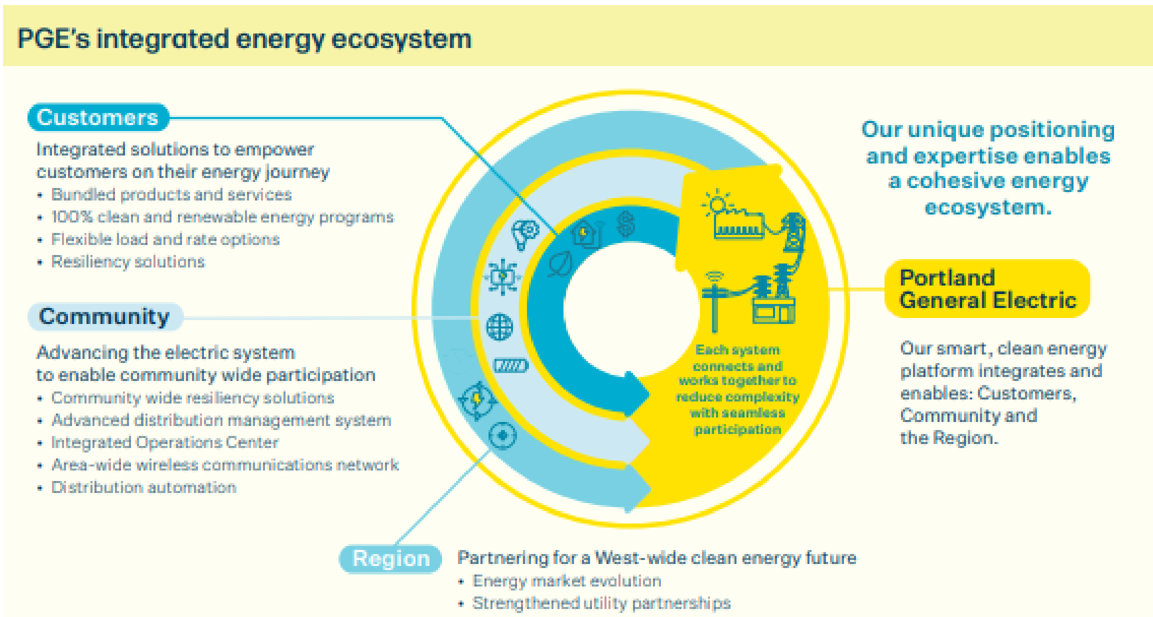
support the deployment of smart grid technologies. It includes provisions for funding research and development initiatives that can benefit VPPs and related technologies.

3. **Energy Policy Act**: This act includes various provisions that promote energy efficiency, renewable energy, and electricity reliability, which indirectly support the development of VPPs by funding programs that encourage the integration of DERs and modern grid technologies.
4. **Grid Modernization Grants**: The DOE administers various grant programs and funding opportunities for states and utilities to modernize the electrical grid. These programs often encourage projects that incorporate technologies like VPPs.
5. **State-Level Initiatives**: Besides federal legislation, various states have also instituted their own programs and funding mechanisms to encourage VPPs and DERs, sometimes in partnership with federal initiatives.

[21] ACEEE 2023 Utility Energy Efficiency Score Card. Available at https://www.aceee.org/research-report/u2304

of the resources can be done in myriad ways, but PGE holds that it has a significant role in building, operating and optimizing DERs that are least cost, transparent in its customer relations, transparent in cost and benefits and equitable in service and participation (see **Figure 7**).

Figure 7. PGE's integrated energy ecosystem

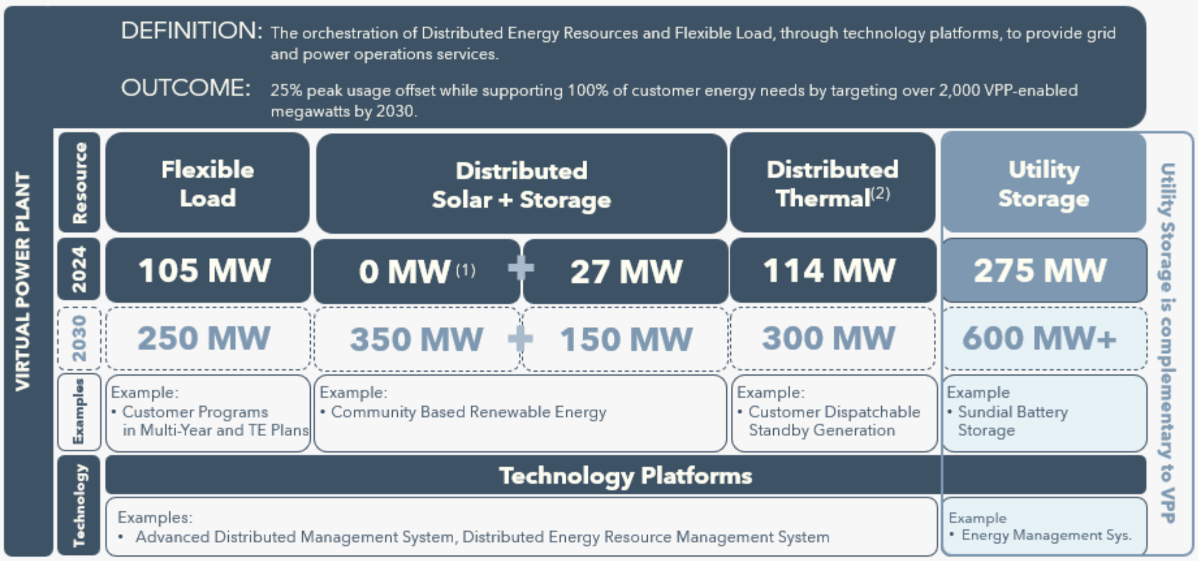


2.3.2 Distributed energy resources (DERs) integration

PGE's Virtual Power Plant (VPP), illustrated in **Figure 8**, integrates distributed energy resources (DERs) and flexible loads through advanced technology platforms, optimizing them to provide essential grid and power operation services (see **Section 5.1 Virtual Power Plant**). The continuous evolution of VPP capabilities is crucial for identifying and harmonizing these resources, benefiting our customers and community partners with equitable, local, clean, affordable, and resilient energy.

PGE VPP Operations, enabled with real-time visibility, will dispatch DERs and flexible loads within our distribution network to harmonize customer participation and system operations and support growth in customer electrification without compromising reliability. This will help keep costs as low as possible throughout the clean energy transformation, guiding customer participation and realizing value through market integration.

Figure 8. Components of PGE's VPP



(1) Distributed Solar interconnected capacity from the Net Energy Metering Program is approximately 286 MW in Sep 2024; excluded from VPP because it is not integrated with PGE's VPP technology platforms.
(2) Distributed Thermal represents the customer back-up engines in the Dispatchable Standby Generation (DSG) program.

The VPP integrates various distributed energy resources (DERs) such as solar panels, battery storage systems, and flexible demand-side resources into a unified and manageable network. Key capabilities and features of the VPP are discussed in **Appendix F** (**Grid modernization long-term** plan and workstreams**, Distributed energy management system (DERMS)** and **Technology foundations for a bi-directional grid**. The VPP represents a significant advancement in the way PGE manages and utilizes distributed energy resources.