Distributed Energy Resources as Virtual Power Plants

DOE Clean Energy Innovator Fellows Training

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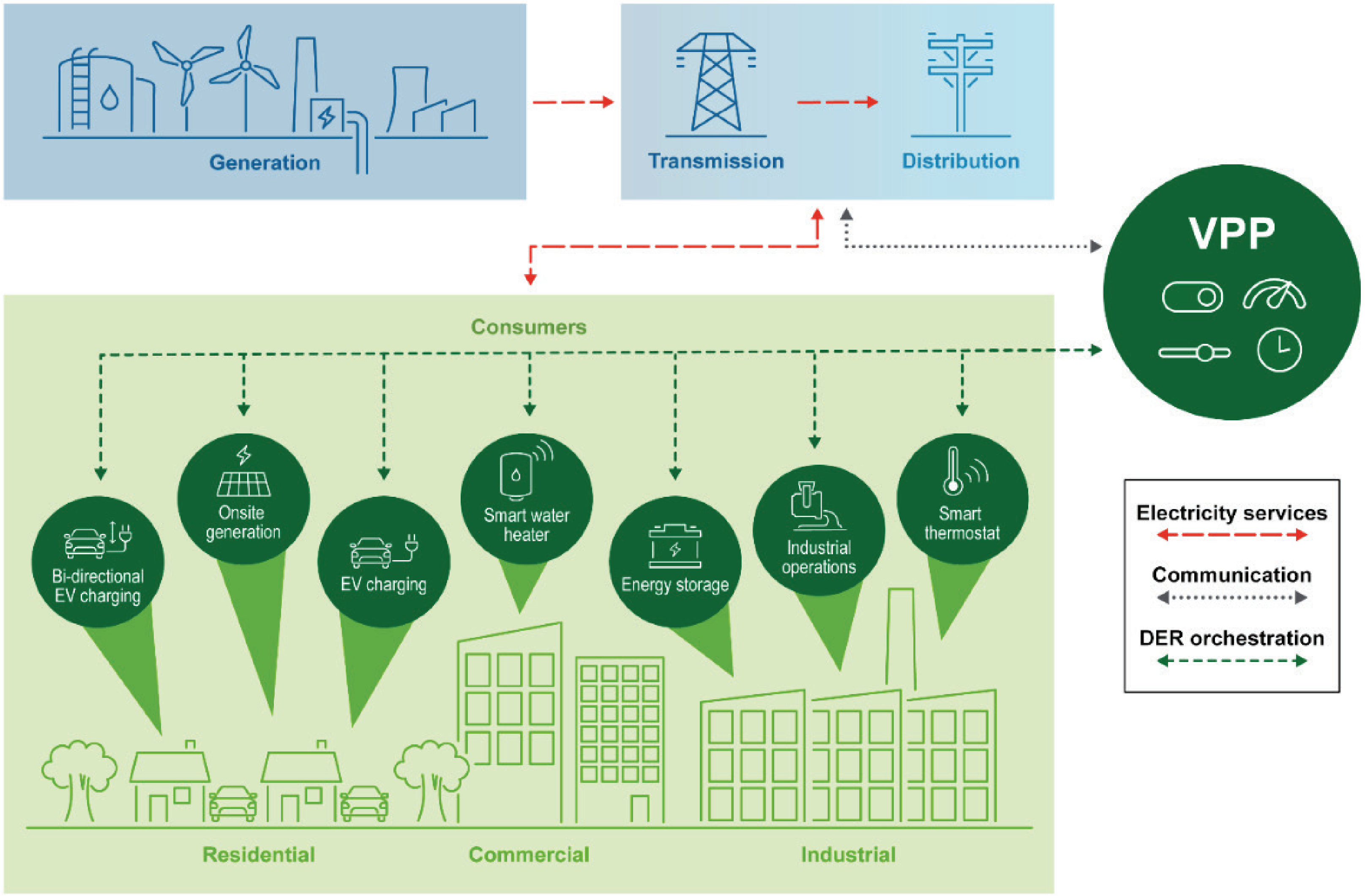
Poll

- Virtual power plants are solutions composed of:
  - Existing energy efficiency programs
  - Front-of-the-meter batteries
  - Demand response programs
  - Solar+storage
  - All of the above

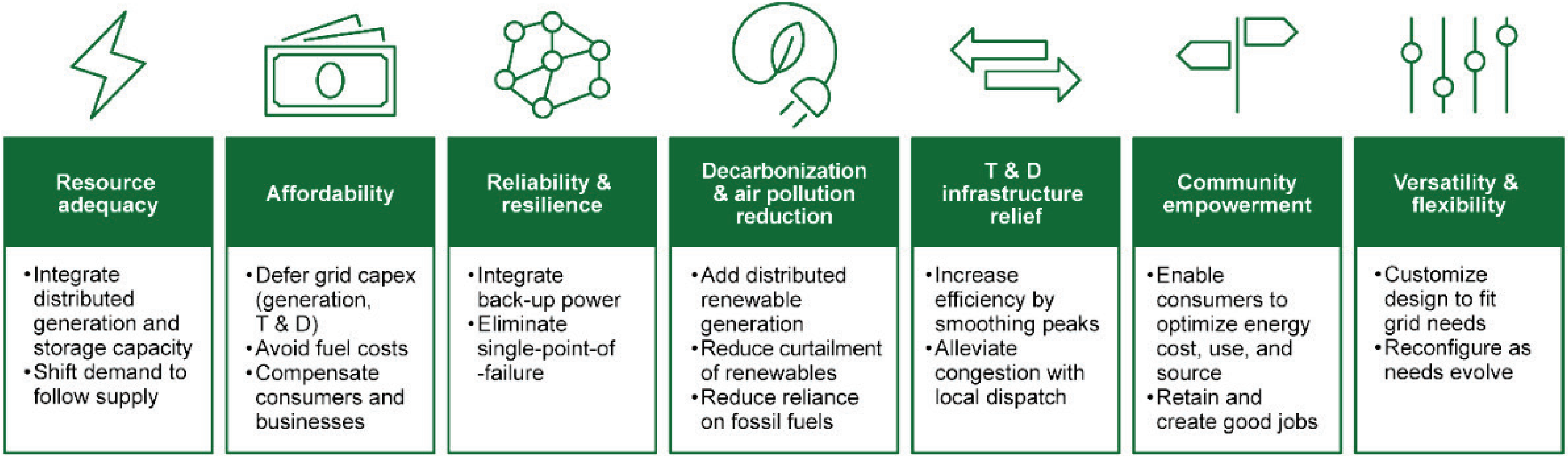
What is a virtual power plant (VPP)?



VPPs are aggregations of distributed energy resources (DERs) such as smart appliances, rooftop solar with batteries, EVs and chargers, and commercial and industrial loads that can balance electricity demand and supply and provide grid services like a traditional power plant.

Source: DOE

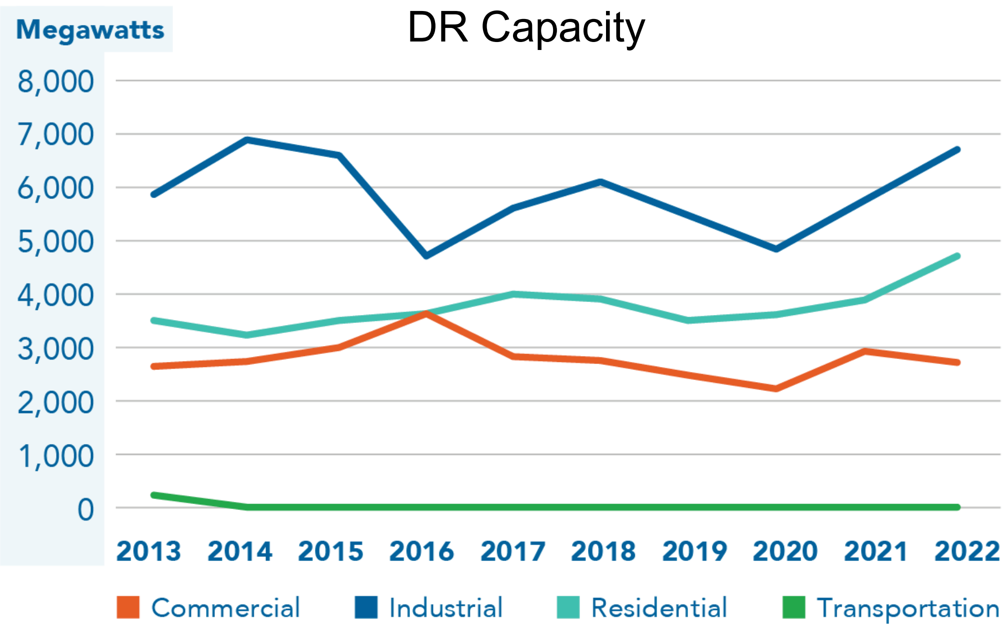
VPP value proposition

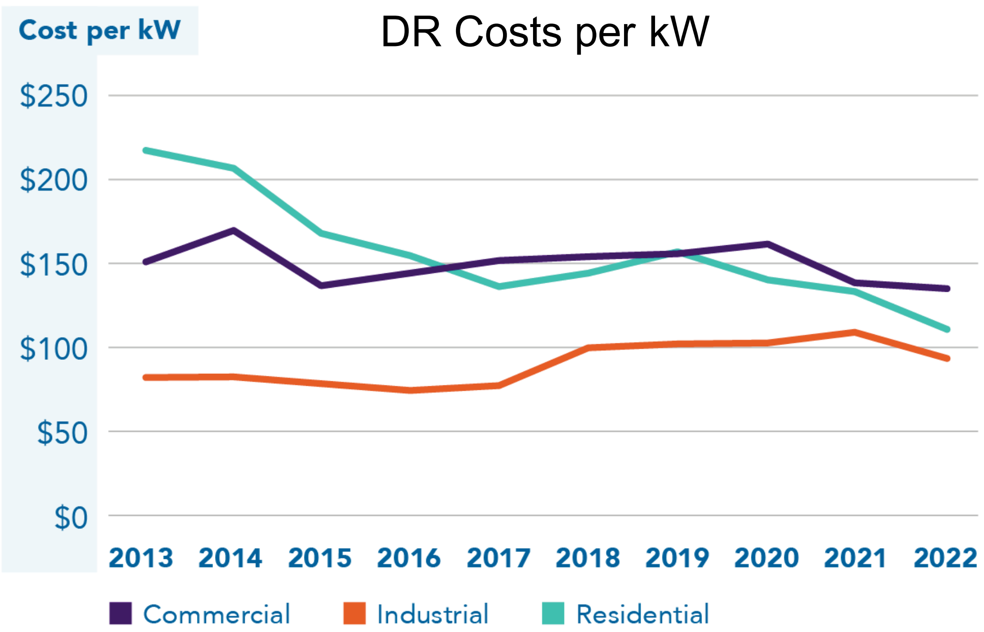


Source: DOE

Today, most VPPs provide peak demand reductions

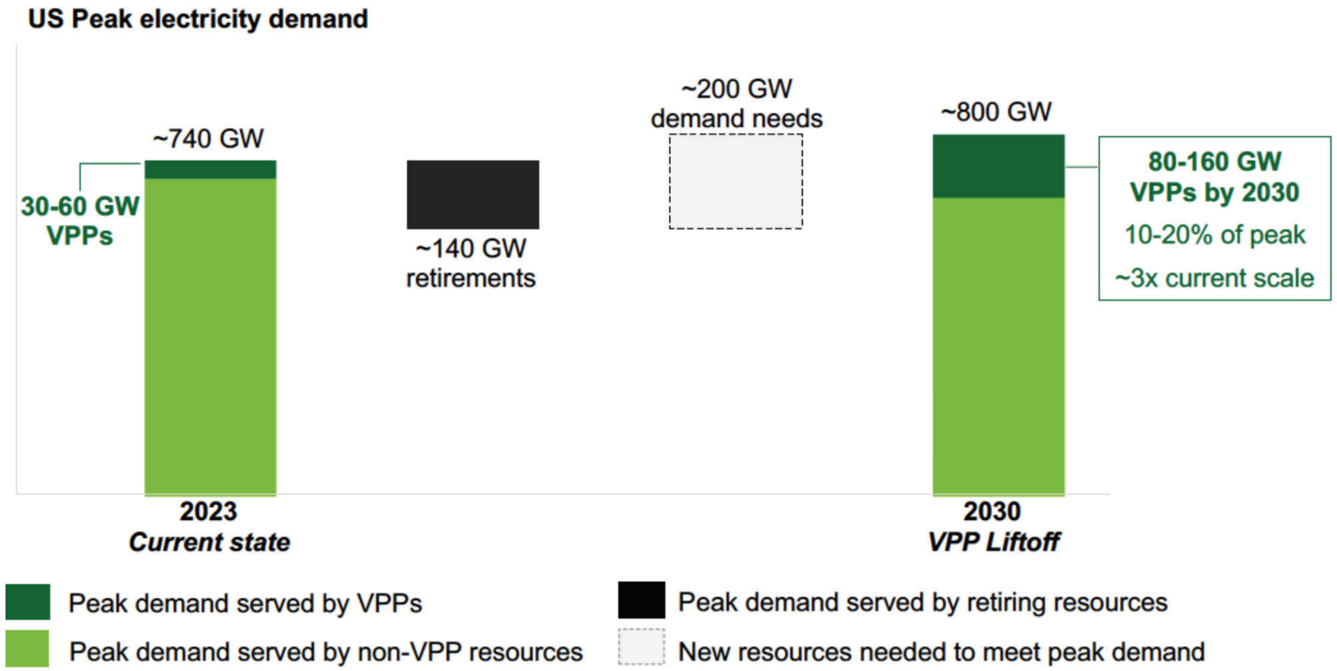
- Composed of DER aggregations that provide limited grid services due to lack of communications, visibility, and control.
- Predominently owned and operated by utilities.
- Typically demand response programs for peak load reduction.
  - Smart thermostat programs
  - Battery programs





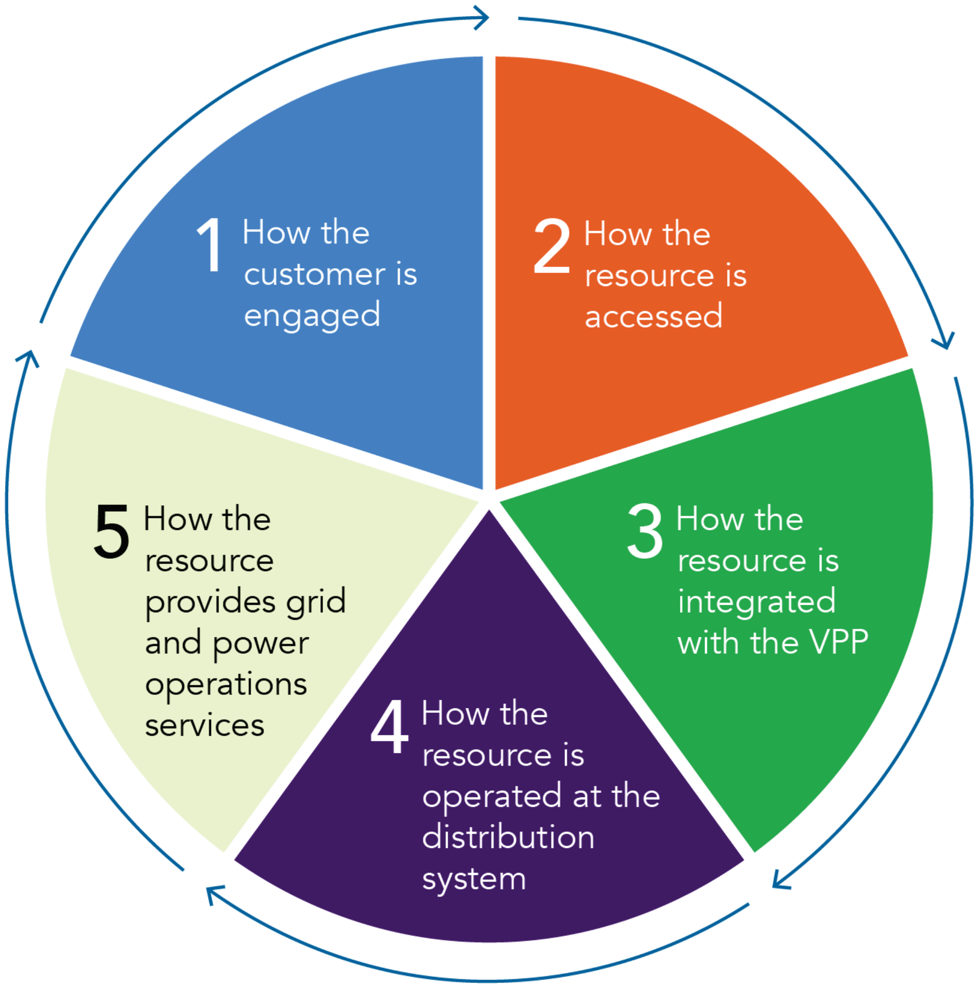
Opportunities to accelerate scaling VPPs

- Establish clear goals and objectives
- Identify and implement how DERs can be integrated into different organizational silos
- Design programs for customers
- Ensure grid operators see VPPs as a credible, reliable resource
- Leverage existing DERs to more quickly create VPPs
- Understand what grid investments are needed, based on the sophistication of the VPP



Source: DOE

Scaling VPPs: Clear goals and objectives

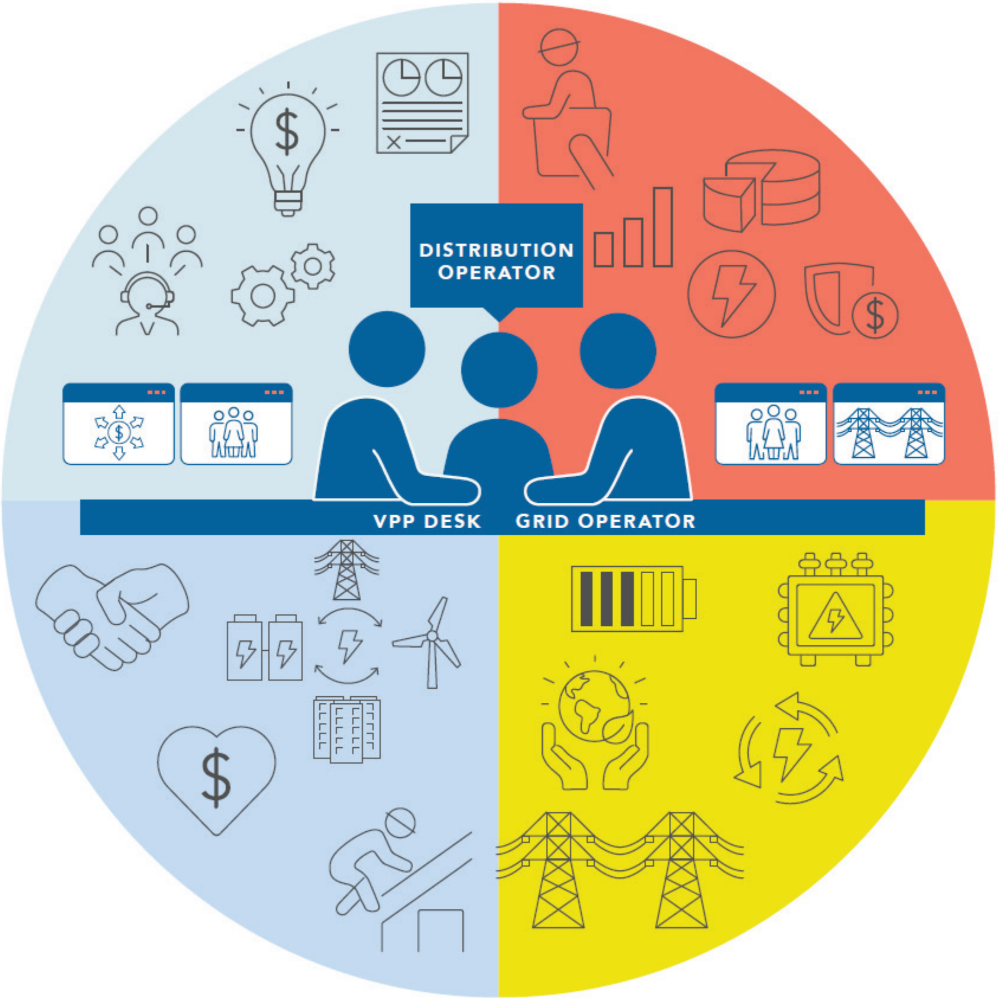


There are many definitions of VPPs, which can create confusion when communicating between regulators, utilities, aggregators and other parties. To avoid this, successful VPPs establish specific goals and objectives, including:

- Desired grid services
- Eligible DERs
- Standards and protocols for DER participation
- Target customer type/class
- How often the VPP will be used
- Policy goals the VPP will contribute to achieving
- How cost-effectiveness (or if a VPP is a least-cost resource) is determined

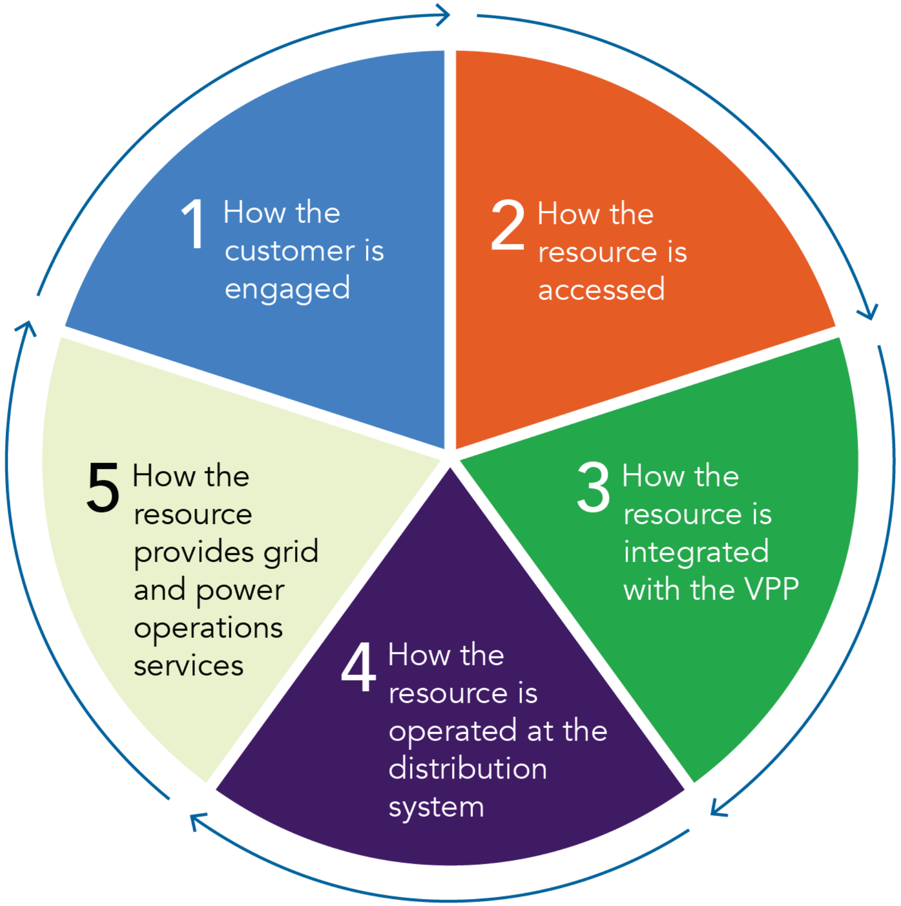
Scaling VPPs: Organizational change

- This transition from traditional grid operations to more complex VPP requires active participation from all levels of the organization, from operators to leadership.
- Implementing advanced VPPs will likely require a shift from conventional grid practices.
- Engaging all levels of the organization is an integral part of the process, from integrating DERs into grid operations to customer programs.



Scaling VPPs: Design programs for customers

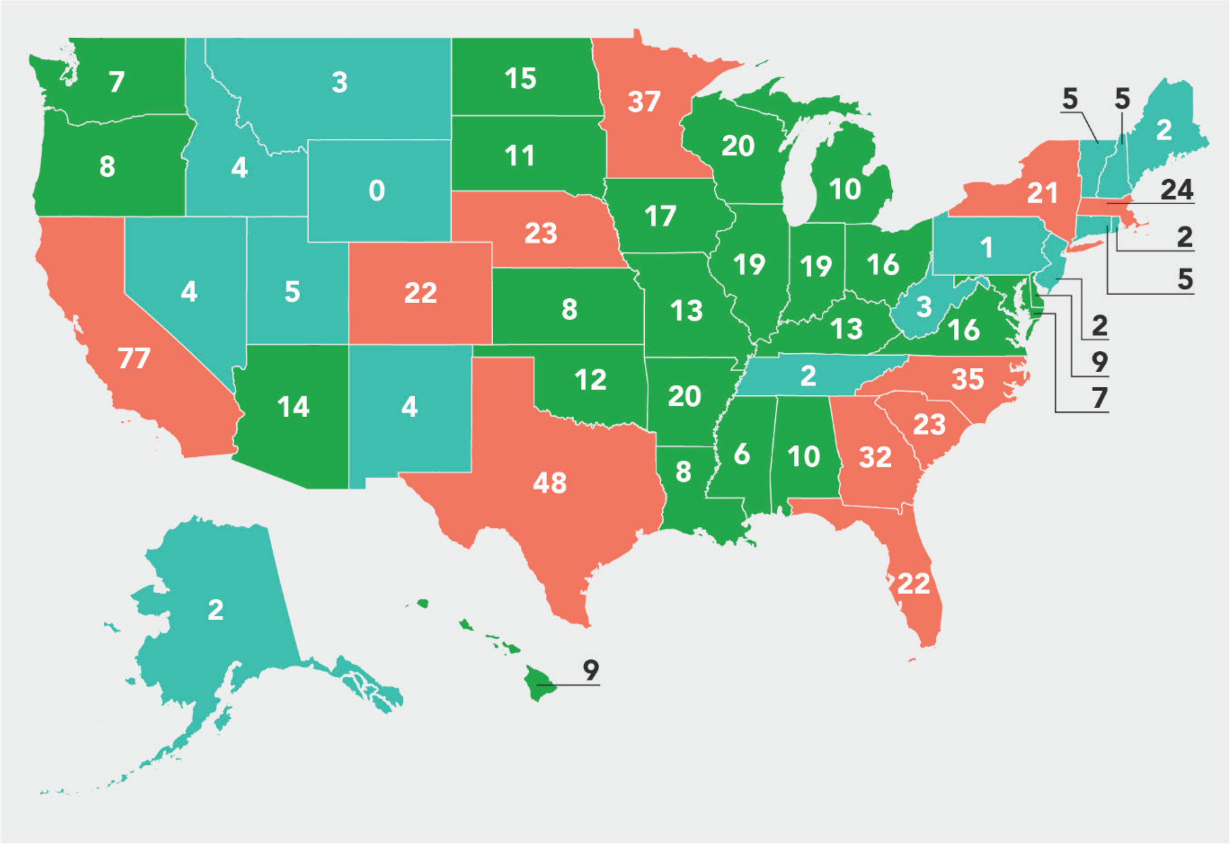
- Focusing on customer needs in program design can improve VPP success and vaue
  - SMUD My Energy Optimizer Partner+ - Bring Your Own DER programs can provide additional value streams for customers for assets they already own
- Identify customer priorities (e.g., resilience, affordability) and focus program incentives to meet those needs
  - Portland General Electric offers higher incentives for energy efficiency and renewable energy in specific geographic locations, including a 1.4 MW Flex Load resource project targted at a historically underserved community.
- Designing cost-effective programs for low to moderate income (LMI) customers can help keep the grid affordable for all customers.
  - Identified 37 equity-focused VPPs, representing 9 GW of capacity
  - National Grid and Generac are offering 2000 free batteries, leveraging federal resilience grants.



Scaling VPPs: Grid planners and operators must see VPPs are credible, reliable resources

- Conducting pilots allows for testing of resources and builds trust (reference earlier PAC study verbally)
- Utility ownership of assets allows for low-cost equipment for customers, and testing for utility
- Setting standards for aggregator/OEM participation in VPP streamlines the process and provides better coordination between utility and aggregator/OEM
- Involve distribution system operator from planning to implementation ensures resources help the system and grid edge

Existing DERs can be aggregated to quickly scale a VPP



Count of VPPs per U.S. state

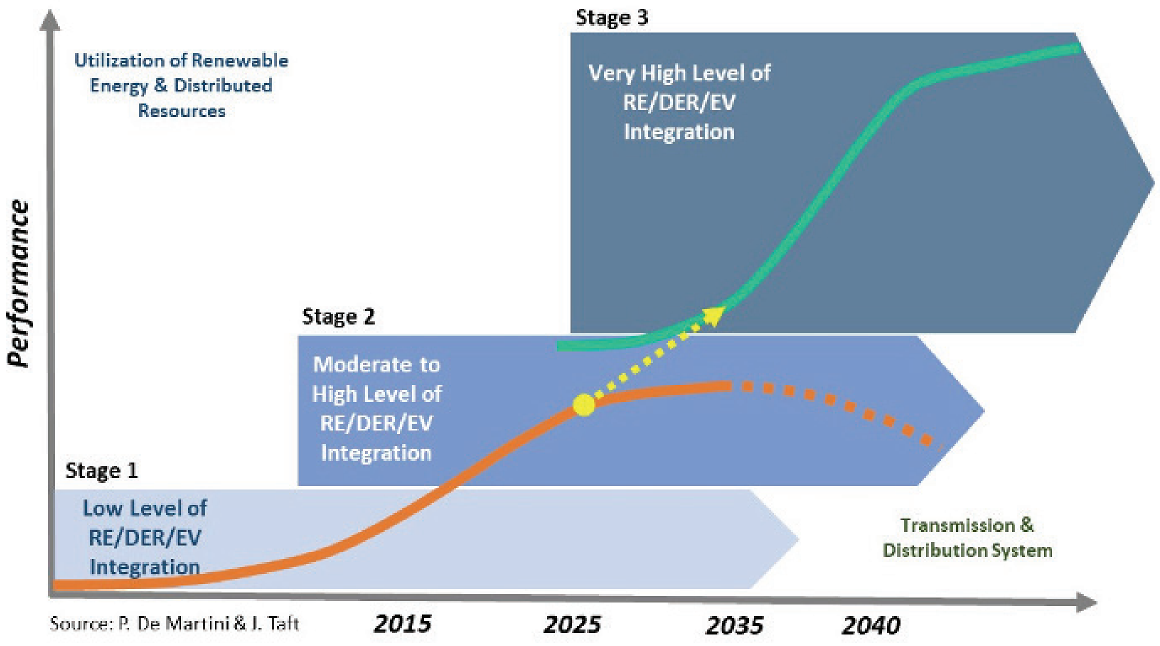
5 or less | 6 – 20 | More than 20

Programs can scale quickly. For example, Arizona Public Service's residential demand response smart thermostat (Cool Rewards) program has increased capacity each year:

- 48 MW 2020
- 112 MW in 2021
- 122 MW in 2022
- 145 MW in 2023

Source: Rockcress Consulting, *Virtual Power Plant Basecamp* (forthcoming)

Scaling VPPs: Grid investment may be needed



	Technology	Grid Function	Deployed By
Digital Hardware	Advanced Meter Infrastructure	A series of technologies including a smart meter and its attendant supporting systems that allow for two-way communication between the customer point of service and the utility.	Distribution Utility
	Smart Inverters	Due Changes the direct current from solar panels to alternating current used by consumers and has communication and control capabilities to help manage power quality on the grid.	Distribution Utility
	DER Submetering	Due to the unique nature of DERs compared to typical consumer load, FERC Order 2222 requires separate metering for distributed generation and storage.	Distribution Utility
	Voltage Optimization	Manages voltages within service limits due to power injections from generator sets or solar photovoltaic generation (PV), withdrawals for charging of batteries and EVs, and sudden load switching such as some cases with demand response and EVs.	Distribution Utility
	Advanced Communication Networks	High speed, high bandwidth communications between grid devices is a foundational capability to allow for reporting and control between ISOs, substations, utilities, and aggregators and their grid devices.	Distribution Utility
Software-Based Grid Components	Distributed Energy Resource Management System (DERMS)	A platform to dispatch each individual DER.	Aggregator
	ADMS	Host applications that collect data and evaluate and mitigate DER impacts on power flows; and utilize DERs for distribution benefits.	Distribution Utility
	GIS	Aggregation requires GIS tracking to locate DERs on the network.	Distribution Utility
	VPP		Aggregator
	Analytics Platform	Optimizes the use of DERs for supplying distribution-level services.	Distribution Utility
	Advanced Retail Billing	In the case of customers with DERs, retail bills must be adjusted for net of wholesale market participation of aggregated DERs to avoid double rewarding.	Distribution Utility
Technology-Enabled Processes	Advanced Integrated Planning	Permits the distribution utility to evaluate the impact of DERs on distribution infrastructure planning.	Distribution Utility
	DER Load Forecasting	Provides the ability to avoiding double counting DERS.	Distribution Utility

Source: Grid Investments to Support FERC Order 2222

Actions states can take to advance VPPs

- Encourage transparent distribution system planning and grid modernization (see LBNL's Integrated Distribution System Planning resources)
- Remove barriers to aggregating DERs (e.g., Missouri, Michigan)
- Require VPP pilots or programs (e.g., Colorado)
- Implement building codes and standards that ensure DERs support VPPs (e.g., California)
- Consider updating DER interconnection rules, metering, cost allocation, and billing (e.g, Pennsylvania)
- Consider innovative DER compensation and tariff design (e.g., Hawaii)

Select resources

- The Pathway to: VPP Commercial Liftoff, U.S. DOE
- Aggregated DER in 2024: The Fundamentals, National Association of Regulatory Utility Commissioners
- Grid Investments to Support FERC 2222: Technologies that Enable Aggregated DER Participation in Wholesale Power Markets, GridWise
- Research and Emerging Issues: Virtual Power Plants, Colorado Public Utilities Commission
- VPP Flipbook, Rocky Mountain Insitute
- VPP and Energy Justice, National Renewable Energy Laboratory
- Locational Value of Distributed Energy Resources, Lawrence Berkeley National Laboratory
- Integrated Distribution System Planning, Lawrence Berkeley National Laboratory

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