Planning & Operation of Virtual Power Plants (VPPs)

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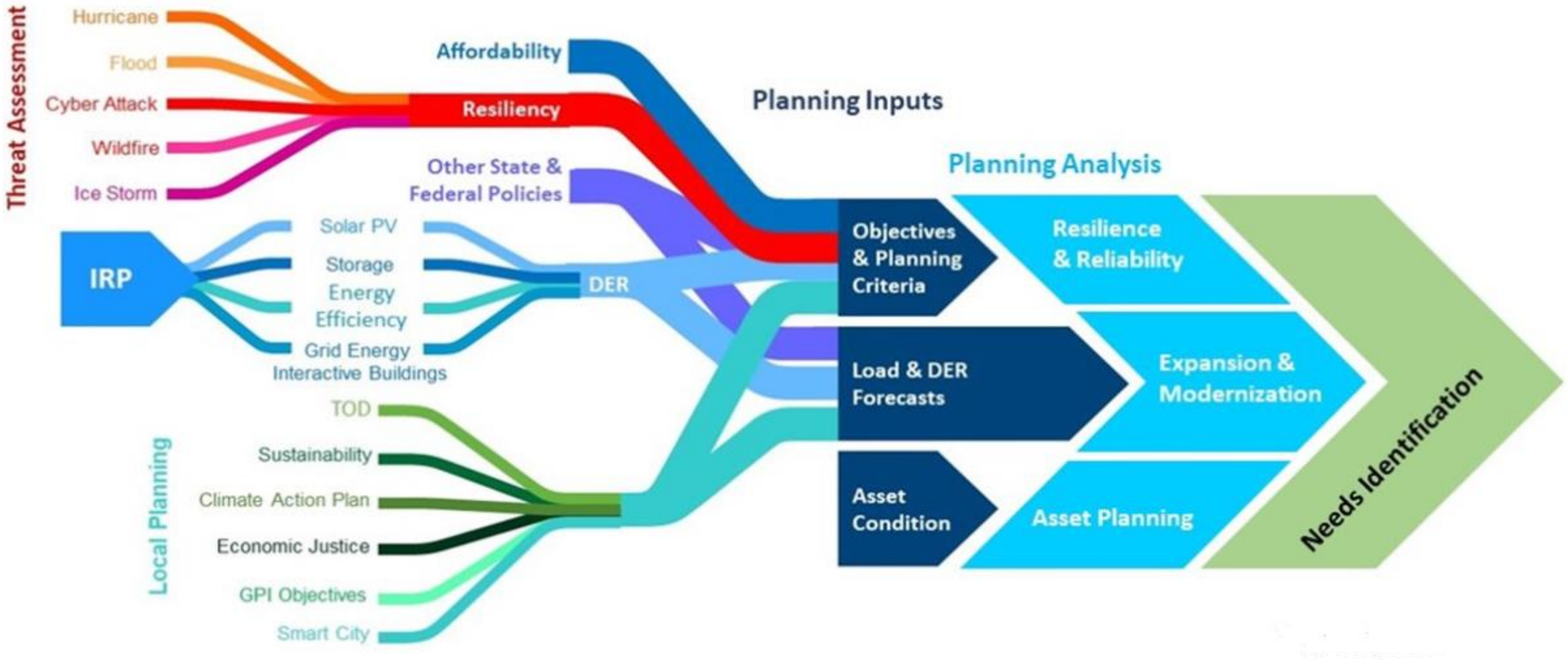
Modernize the Grid with Distributed Energy Resources (DERs)

- **VPPs modernize and transform the grid** by enabling DER integration at large scales.
- VPPs **aggregate and control** multiple DERs to provide grid services that utilities and regional grid operators need
- VPPs allow grid operators **visibility to manage and dispatch DERs to respond to grid needs in real time** (or closer to real time).
- **VPPs unlock DER value** including aggregation, grid stability, reliability, resiliency, resource adequacy, affordability, decarbonization, air pollution, electrification, community empowerment, and health and equity.



Why VPPs Matter

A VPP provides capacity, **energy and flexibility** for an entire group of interconnected DERs.

Unlike traditional power plants, VPPs do not own the resources. Instead, **they own the data transferred** between each VPP resource on the grid.

Any decentralized entity producing, storing or consuming **electricity can become a part of a VPP**.

VPPs focus on optimizing the way each resource is connected to the grid, and thanks to the flexibility of a decentralized grid, they **can effectively balance the grid**.

VPPs are able to maintain this balance by combining different resources in their portfolio and **providing new value such as resiliency and clean energy**.

Maturity Model

Grid Wise Alliance, Grid Investments to Support FERC Order 2222

Accommodate

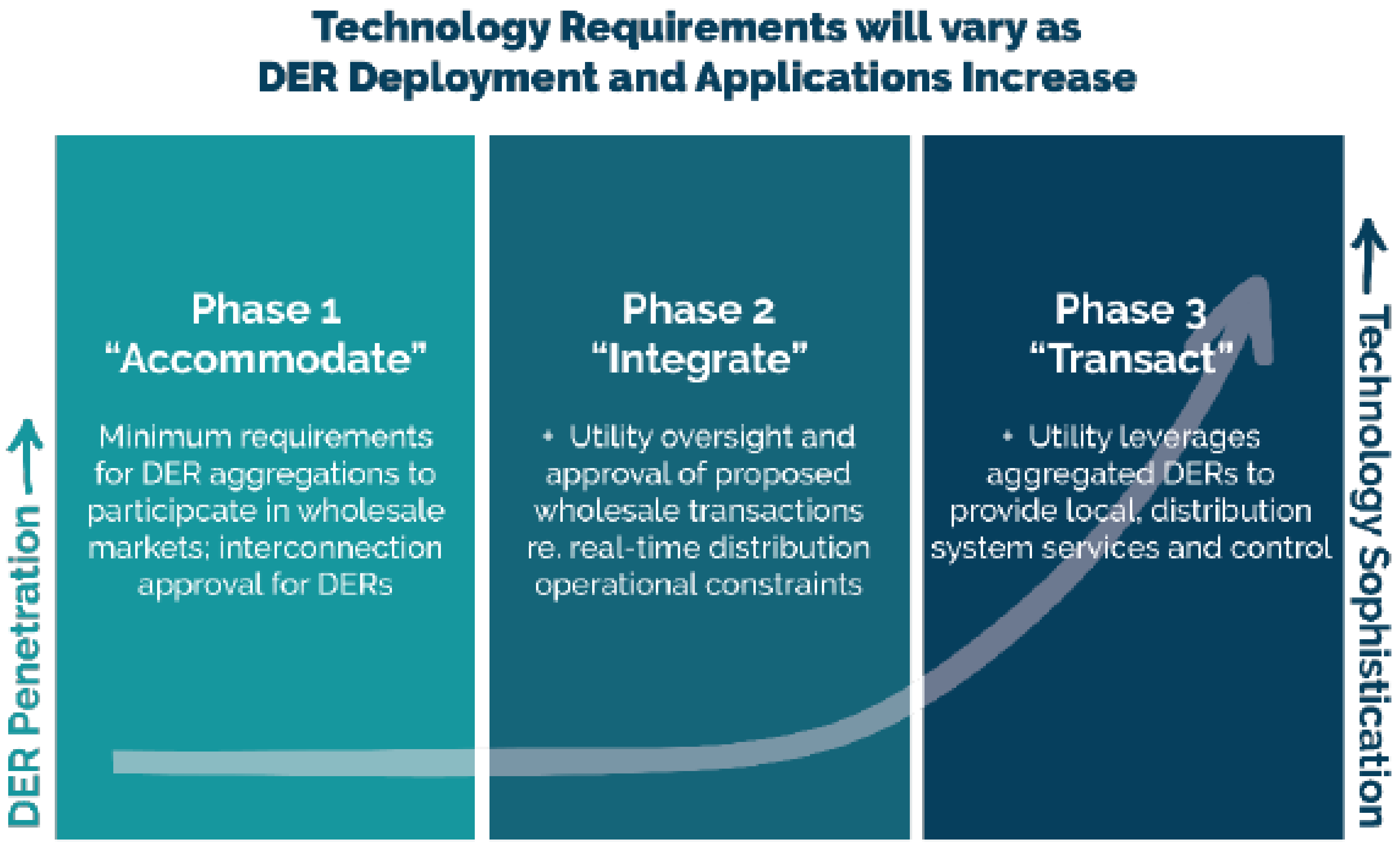
- Utilities **invest in and deploy** technologies that allow for a variety of load and supply conditions.
- Under this phase, advanced communication between DERs and various support technologies are used to **coordinate visibility and control**.

Integrate

- Under this phase, **advanced communication between DERs** and various support technologies are used to coordinate visibility and control.

Transact

- During the transact phase, **utilities and third-party aggregators fully participate in the wholesale power market**.
- This phase is marked by **full recognition that DERs can provide significant value** to the grid both within the local distribution network as well as on the bulk power system.



Technology Requirements will vary as DER Deployment and Applications Increase

Phase 1 "Accommodate"

Minimum requirements for DER aggregations to participcate in wholesale markets; interconnection approval for DERs

Phase 2 "Integrate"

- Utility oversight and approval of proposed wholesale transactions re. real-time distribution operational constraints

Phase 3 "Transact"

- Utility leverages aggregated DERs to provide local, distribution system services and control

Figure 1: GridWise Alliance Maturity Phase model for adopting FERC 2222 supportive technology.

Capability Needs for VPPs

Grid Wise Alliance, Grid Investments to Support FERC Order 2222

Technology-Enabled Processes

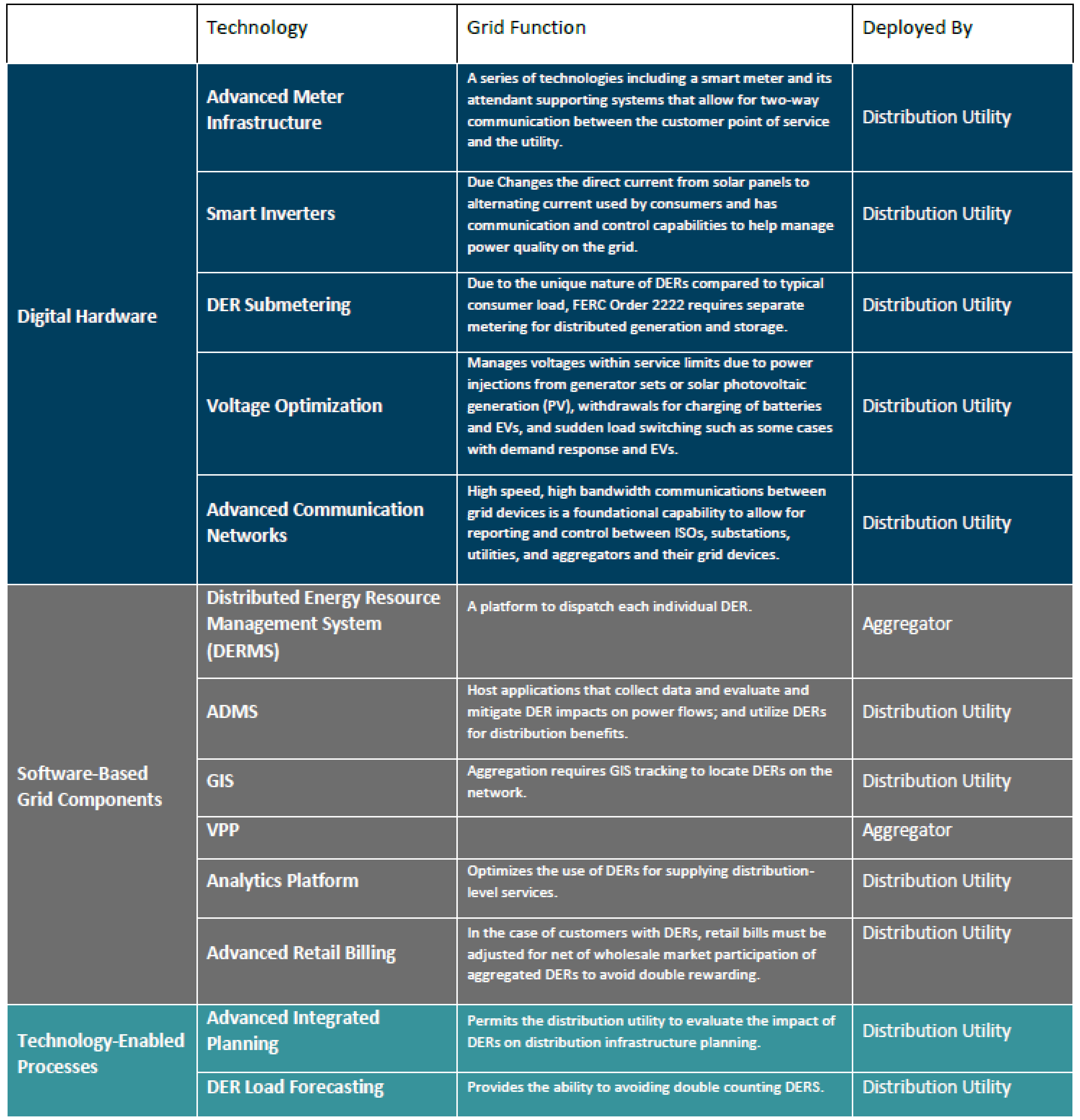
- DER Load Forecasting, Advanced Integrated Planning

Software-Based

- VPP, Advanced Billing, Distributed Energy Management Systems (DERMS), Geographic Information System (GIS), Advanced distribution management system (ADMS)

Hardware

- Advanced Metering Infrastructure (AMI), DER Sub-metering, Smart Inverters, Voltage Optimization, Advanced Communication Networks



	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

Factors Driving Successful VPP Deployment (1)

Forthcoming Berkeley Lab report for U.S. Department of Energy

- Utilizing an interview and a case study approach to examine factors leading to successful VPPs.
- Draw upon lessons learned, best practices, and insights from real life examples to inform states, utilities, regional grid operators, and DER aggregators of successful policies, programs, and projects.
- Identify key characteristics, methods and strategies needed to successfully deploy a VPP.

Questions are organized around 5 themes:

- VPP Design & Deployment
- Grid Planning & Operations
- Policy & Regulatory Environment
- VPP Business Model
- Driving Success in Future Deployments

Factors Driving Successful VPP Deployment (2)

Forthcoming Berkeley Lab report for U.S. Department of Energy

Design

- Deployment
- Programmatic (e.g., VPP characteristics, including technology types, and recruitment strategies)
- VPP business models
- Cost-benefit analysis

Planning & Operations

- Integration of VPPs
- VPPs operation as a utility resource
- Types of grid services VPPs provide

Barriers and Opportunities

- Opportunities for technology scaling and regulatory processes
- Overcoming barriers and challenges
- Current and emerging VPP policies
- Learnings from case studies

Factors Driving Successful VPP Deployment (3)

Puget Sound Energy

- VPP platform to enable 86 MW of demand response programs by the end of 2025

Rocky Mountain Power

- Cool Keeper Program: ~200 MW
- Soleil Lofts Residential Apartment: 12.6 MW
- Wattsmart Battery Program (NEW): Potential of 74 MW by 2042
- EV Battery Program (NEW): Potential of 85 MW by 2042

Portland General Electric

- VPP Platform: 2,000 MW by 2030 through VPP enabled programs (e.g., Peak Time Rebates, Time of Day rate, Smart Thermostat, TestBed)

Thank You

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