Energy Storage Aggregation:
State Regulatory Policy Implications

Prepared for the

Vermont Public Utilities Commission (PUC)

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What I will be covering today.

1. Relevant terms
2. How aggregated DERs participate in electricity markets
3. Aggregation models
4. State examples
5. Building frameworks for DERs aggregation
6. Opportunities for state regulators
7. Q&A

Relevant terms.

- **Distributed Energy Resources (DERs):** "Any resource located on the distribution system, any subsystem thereof or behind a customer meter. These resources may include, but are not limited to, resources that are in front of and behind the customer meter, **electric storage resources**, intermittent generation, distributed generation, demand response, energy efficiency, thermal storage, and EVs and their supply equipment." (FERC)

Other examples:

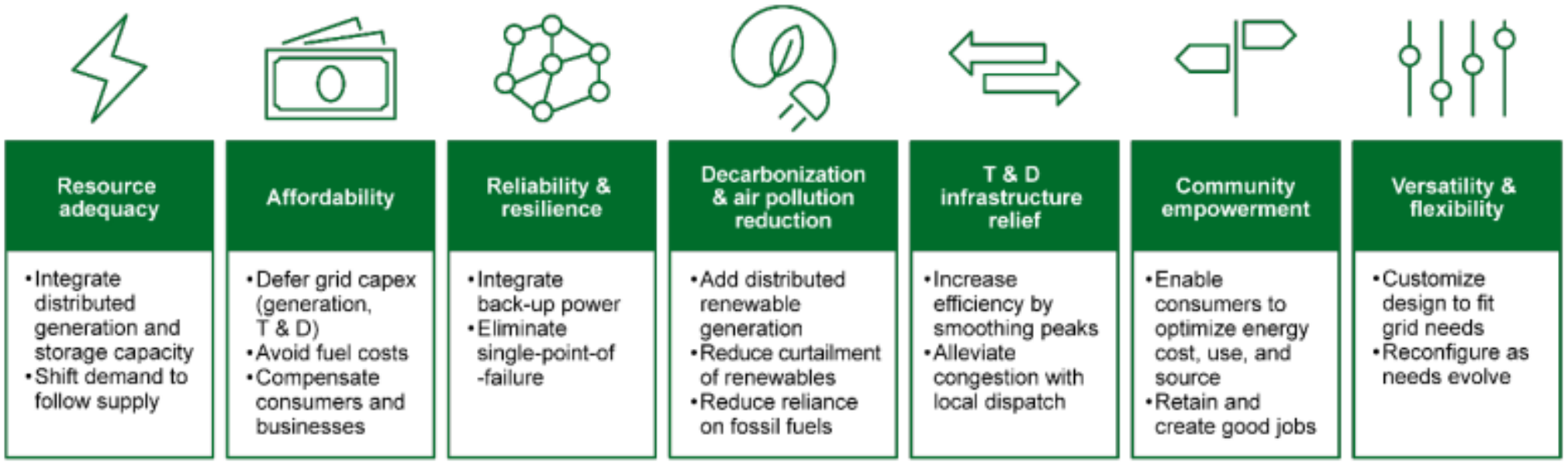
Wind farms, combined heat and power units, water heating units, pool pump controls, gas turbines, fuel cells, building energy management systems

Relevant terms.

- **DERs Aggregator:** "The entity that aggregates one or more distributed energy resources for purposes of participation in the capacity, energy and/or ancillary service markets of the regional transmission organizations and/or independent system operators." (FERC).

- **Virtual Power Plants (VPPs):** Aggregations of DERs that can contribute to grid support services like a traditional power plant. VPPs include the participation of R, C, and I customers and can include a variety of participation models. (AKA, DERs aggregations).

Value Proposition of VPPs



Source: *Pathways to Commercial Liftoff: Virtual Power Plants,* DOE, September 2023

How aggregated DERs participate in electricity markets.

➢ Variations based on market status (i.e., vertically integrated versus restructured market).

In vertically integrated markets:

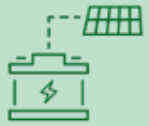
- ✓ Utilities typically own and operate generation, transmission, and distribution assets.
- ✓ Growth of DERs may be less prominent.
- ✓ Utilities play primary role in managing and using DERs.

Vermont is the only state in New England that has chosen not to restructure its electric industry by adopting retail competition.

Restructured markets:

- ✓ VPPs can participate in wholesale markets, retail markets, or both.
- ✓ Wholesale markets:
  - ❖ Each ISO/RTO is responsible for ensuring adequate resources (e.g., generation, transmission) for their region
  - ❖ ISOs/RTOs operate their wholesale market with their own structures (e.g., energy auctions) and rules, subject to regulatory frameworks established by FERC (e.g., FERC Order 2222).
- ✓ Retail markets:
  - ❖ VPP companies can contract with utilities in bilateral arrangements, or the VPP may be operated by the utility itself.
  - ❖ Utilities use VPPs for a broad range of use-cases.

How aggregated DERs participate in electricity markets.

Example DER	Common use in VPPs
 **Smart Thermostats**	Internet-connected temperature controls can increase or decrease electricity demand from HVAC, particularly when seasonal demand is high (e.g., hot summer afternoons and cold winter mornings.) To avoid participant discomfort, buildings and homes can be pre-heated or pre-cooled during off-peak hours, and reductions in demand can be staggered over a two to four hour window.
 **Smart Water Heaters**	Heat pump or resistive water heaters can be controlled remotely, for example to pre-heat water when clean energy supply is abundant or to avoid heating during peak demand. Controls may be embedded in or external to the water heater. Changes in demand timing are typically imperceptible to the owner.
 **EV Chargers**	Managed or 'smart' EV chargers in buildings, homes, and charging stations can adjust charging power levels or delay charging sessions.[xii] Charging infrastructure may be unidirectional (charges the battery) or bidirectional (can also dispatch electricity from the battery out through the charger to a building or beyond the meter to the grid). Unidirectional chargers can time-shift demand; EV owners who leave their vehicle plugged in at home overnight, for example, will not notice changes in charge timing as long as the vehicle is sufficiently charged in the morning. Bidirectional chargers – called vehicle-to-X or V2X – may provide electricity akin to a BTM battery when an EV is plugged in.
 **BTM Batteries** *(with solar)*	Distributed battery electricity storage systems provide back-up power during grid outages. They are charged when electricity is abundant – often with clean energy from paired distributed solar generation – and dispatched when electricity from the grid is scarce. Dispatch to the building where the battery is sited reduces demand on transmission lines and intermediate infrastructure on the distribution grid, such as substations. Batteries can also provide ancillary services to balance the grid, such as frequency regulation. When energy is dispatched beyond the meter where the battery is sited (less common today), the battery can help power other assets on the local grid.

Source: *Pathways to Commercial Liftoff: Virtual Power Plants*, DOE, September 2023

Different types of DERs play different roles within a VPP.

Influencing factors: Who owns the asset, where it's located, size of asset.

Back-up power, ancillary services (e.g., frequency regulation, T&D deferral

Aggregation models.

- Three aggregation models have emerged regardless of market or region.

1. **Utility model:** Utility enrolls customer-owned DERs to provide grid services in exchange for compensation (subsidies, direct payments, enrollment incentives). Utilities may operate the VPP in-house or partner with a third-party service provider to operate the VPP. *Examples:* Green Mountain Power's battery VPP, Duke Energy's managed EV charging VPP.

2. **Retailer model:** Manufacturer or retailer of the DER who sold it to the customer takes responsibility for enrollment and management of customers, and can sell grid services for either retail or wholesale transactions for which the customer will be compensated. *Examples:* DERs companies that have launched VPP platforms include EV makers Tesla, Ford, and GM, and distributed solar and storage companies Sunrun and Sunnova.

3. **VPP platform model:** A VPP platform company enrolls DERs, which may include multiple different types and brands aggregated into a single portfolio. In some instances, the DERs aggregator contracts with a separate 'market interface' provider to facilitate participation in wholesale markets, where the rules and requirements vary by region. *Examples:* Voltus, AutoGrid, Leap.

State examples.

California / CAISO[lxi]

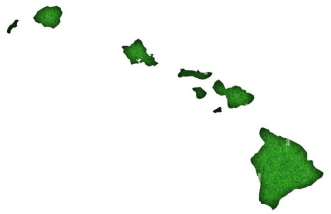
- **Demand Response Auction Mechanism**: A marketplace for VPPs to sell demand response to utilities.
- **Emergency Load Reduction Program**: Customer program that pays electricity consumers for reducing consumption during periods of electrical grid emergencies.
- **Self-Generation Incentive Program**: Rebates for installing energy storage systems.
- **Distribution investment deferral framework:** Mechanism to identify, review and select opportunities for existing or new BTM systems to alleviate future grid stress.
- **California Independent System Operator (CAISO)** allows full participation by VPPs in wholesale markets.

Source: *Pathways to Commercial Liftoff: Virtual Power Plants*, DOE, September 2023

State examples.

Source: *Pathways to Commercial Liftoff: Virtual Power Plants*, DOE, September 2023

Hawaii



- A VPP comprising BTM BESS and other DERs is planned to help provide frequency support to the grid, including fast frequency response.
- Utility pilot program.

New York / NYISO[lxiii]

- **Utility (retail-level) demand response programs allow dual participation** with NYISO (wholesale-level) demand response programs; e.g.,
  - Commercial System Relief Program
  - Distribution Load Relief Program
- New York ISO has multiple load reduction programs that incorporate qualified behind-the-meter DER aggregations; e.g.,
  - Special Case Resources program
  - Demand-Side Ancillary Services Program
- **Value of Distributed Energy Resources** is a retail electricity pricing scheme (called a tariff) that pays for electricity injection from DERs and accounts for multiple sources of value, including environmental benefits and avoided distribution system costs.
- **Non-wires alternatives** requirements mandate utilities must solicit bids from eligible DER solutions for all load growth-driven grid upgrades.[29]

Texas / ERCOT[lxii]

- ERCOT's **Emergency Response Service** program procures capacity from distributed resources and loads.
- **Aggregated Load Resource** provisions of ERCOT's protocols are expanding to include a new asset class of **Aggregated Distributed Energy Resources** (i.e., VPPs).
- **Commercial Load Management** programs, run by Texas utilities, compensate aggregations or individual loads for providing demand response.
- ERCOT **settles energy costs at the meter**, which means retail utilities pay ERCOT for consumed power as measured by smart meters, the price of which varies every 15 minutes based on supply and demand. This creates a financial incentive for retail energy providers to reduce peak-time consumption of their customers.

Building frameworks for DERs aggregation.

Priority potential solutions for VPP liftoff

Imperatives for liftoff	Potential solutions
1 Expand DER adoption with equitable benefits	a. Financial assistance for DER adoption b. Workforce development for DER installation & maintenance
2 Simplify VPP enrollment	c. Consumer education d. Automatic enrollment with opt-out e. VPP-enablement in DER manufacturing
3 Increase standardization in VPP operations	f. Common modeling tools and datasets for performance forecasting, management, and measurement g. Standardized service agreement contracts h. Industry- and regulator-aligned distribution system reliability standards and grid codes i. Narrowed set of DER interconnection and data standards j. Nationally-recognized cybersecurity measures
4 Integrate into utility planning and incentives	k. Comprehensive valuation of VPP benefits l. Integrated distribution system planning requirements for utilities m. Aligned incentives in utility compensation and rate design n. Proactive VPP planning and deployment among utilities
5 Integrate into wholesale markets	o. Support for ISOs/RTOs to overcome region-specific barriers to FERC Order 2222 implementation

Source: *Pathways to Commercial Liftoff: Virtual Power Plants*, DOE, September 2023

Opportunities for state regulators.

- Increase the presence of BTM storage on the grid, particularly among certain customer classes or in certain regions.
- Set mandatory energy storage targets for systems connected to the transmission system and distribution system.
- Develop financial incentives, such as low-interest loans, grants, or tax credits, to drive targeted adoption
- Provide financial assistance to disadvantaged customers to increase access to DERs
- Define compensation mechanisms for DERs
- Require consideration of DERs within utility IRPs.
- Require DERs participation in demand response, or peak reduction programs.

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The energy storage policy landscape continues to evolve.

Sandia National Labs monitors and analyzes activity at the federal and state levels and publishes information in the Global Energy Storage Database, available at this link:

https://www.sandia.gov/ess-ssl/global-energy-storage-database/

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