



Virtual Power Plants: Overview, Key Issues, and Connections to DER Interconnection

Presentation to NARUC Interconnection Cohort
September 2026

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Virtual Power Plants Overview and Key Issues

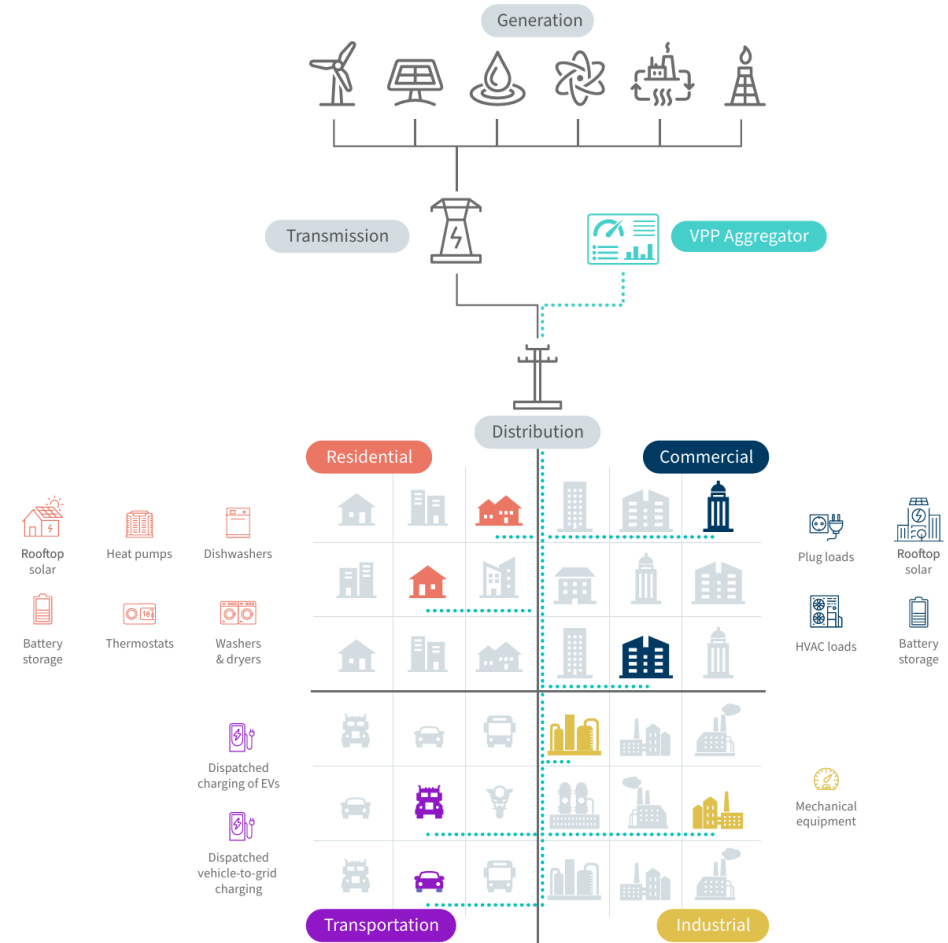
- **Virtual Power Plants Overview and Connection to Interconnection**
- **Priority Policy and Regulatory Issues for VPPs**
 - Locational Services from VPPs
 - Data Access
 - Bring Your Own Distributed Capacity for Large Loads
- **Emerging Issues; VPPs and Interconnection; and Emerging Best Practice for VPP Design**

Virtual Power Plants Overview and Connection to Interconnection

What is a Virtual Power Plant?

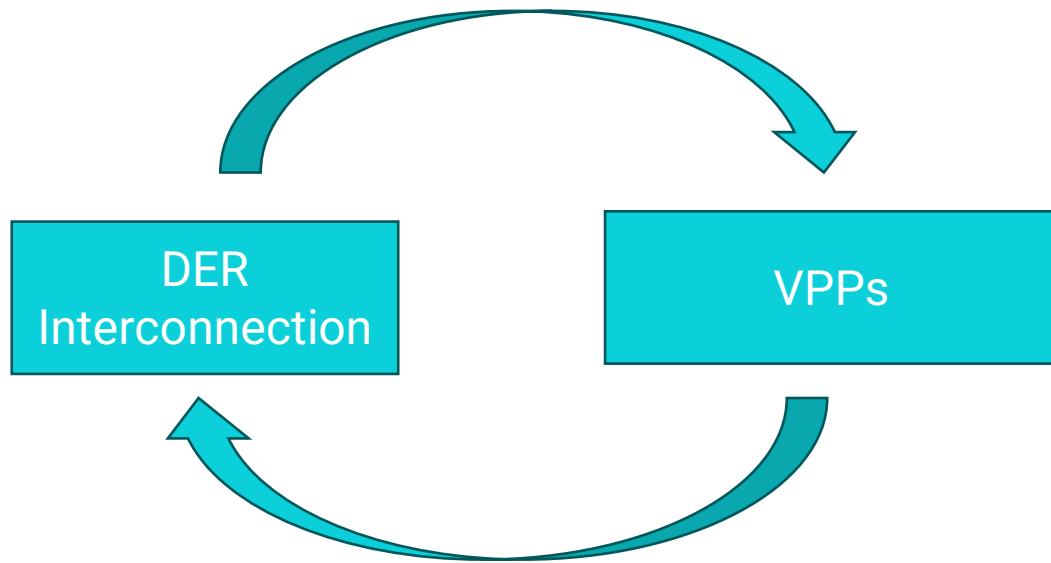
An aggregation of distributed energy resources (DERs) that can be dispatched to support the grid in exchange for compensation

- RMI Flipbook 2.0 (forthcoming, 2026)



VPPs and Interconnection

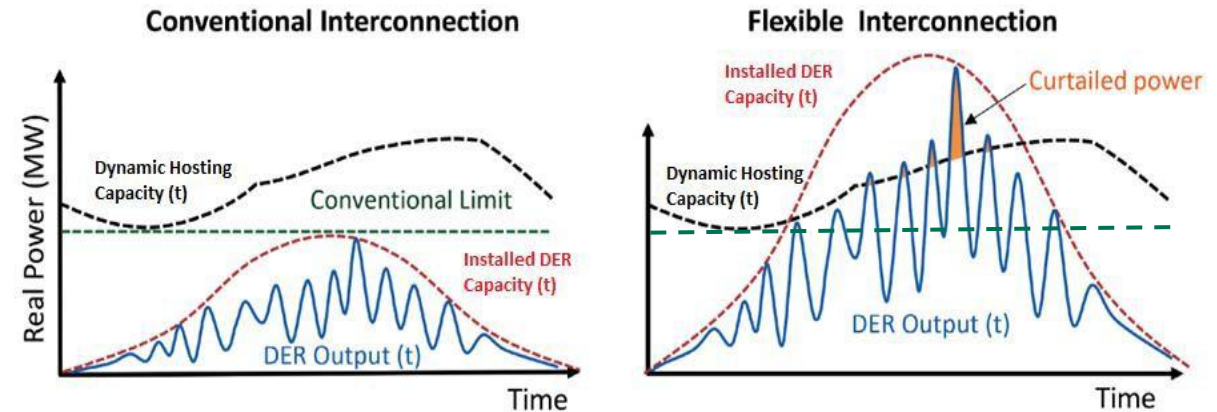
Efficient interconnection expands the pool of DERs available to participate in VPPs.



VPPs can manage DERs to avoid creating grid constraints. Flexible interconnection similarly manages DERs to enable greater use of available grid capacity.



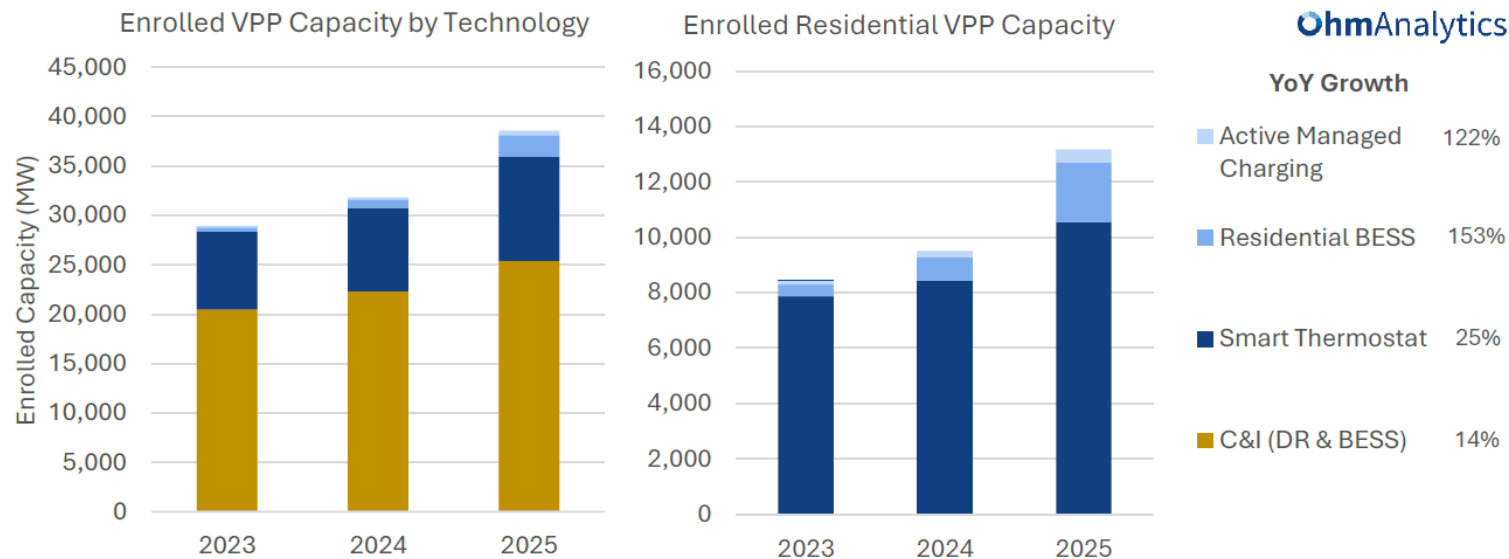
From VPP Liftoff Update (DOE, 2025)



Adopted from EPRI: Understanding Flexible Interconnection
PVWatts Calculator (nrel.gov)

What technologies are involved in VPPs?

Technologies involved in VPPs



Additional DERs Included in VPPs:

- Behavioral demand response
- Appliances
- Plug loads
- Bidirectional charging
- Distributed generation
- Other DERs

Connection to Interconnection

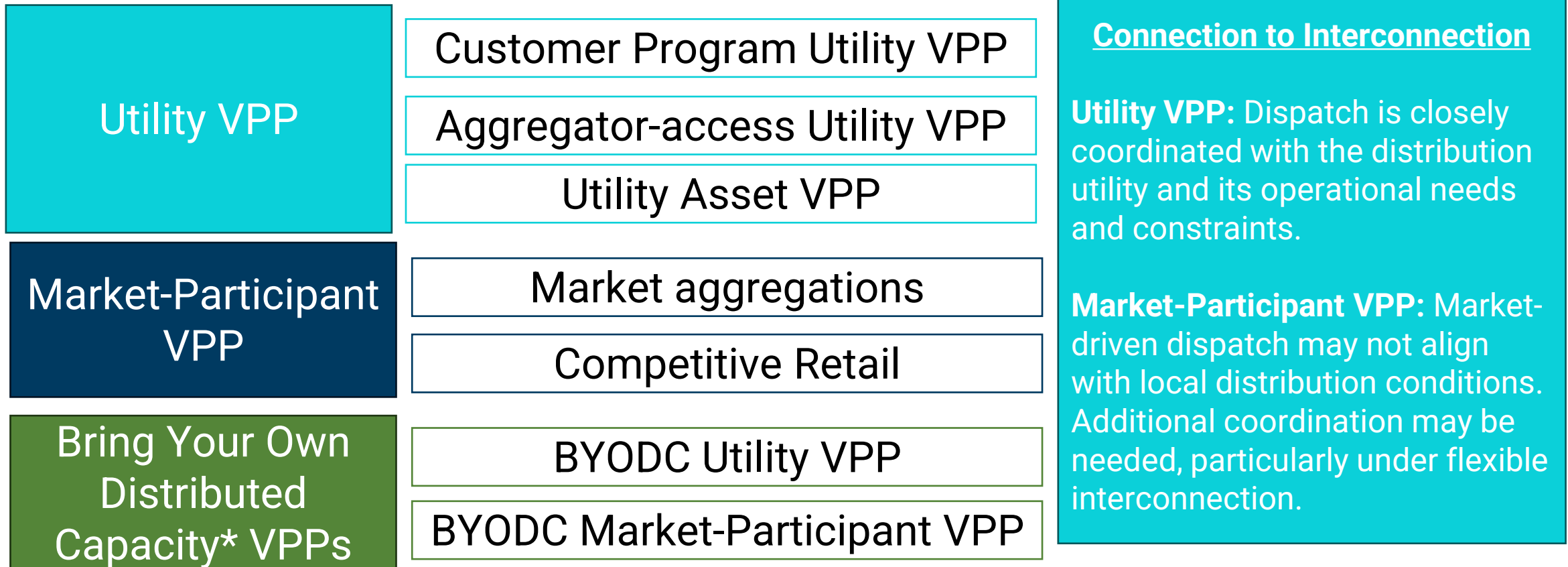
Load-Modifying DERs – generally not subject to DER interconnection

Generation/ Storage DERs – generally subject to DER interconnection

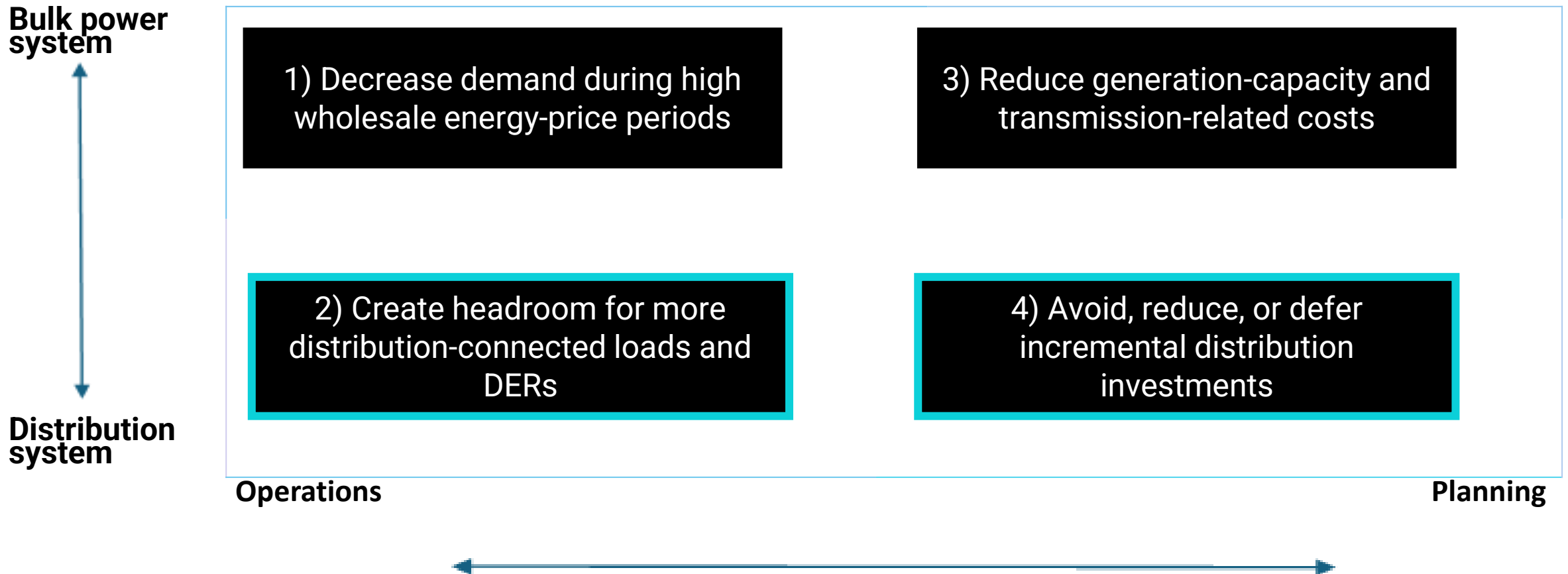
Emerging Tech Gray Area - Plug-in batteries; V2H; Plug-in/ balcony solar

What are the types of VPPs?

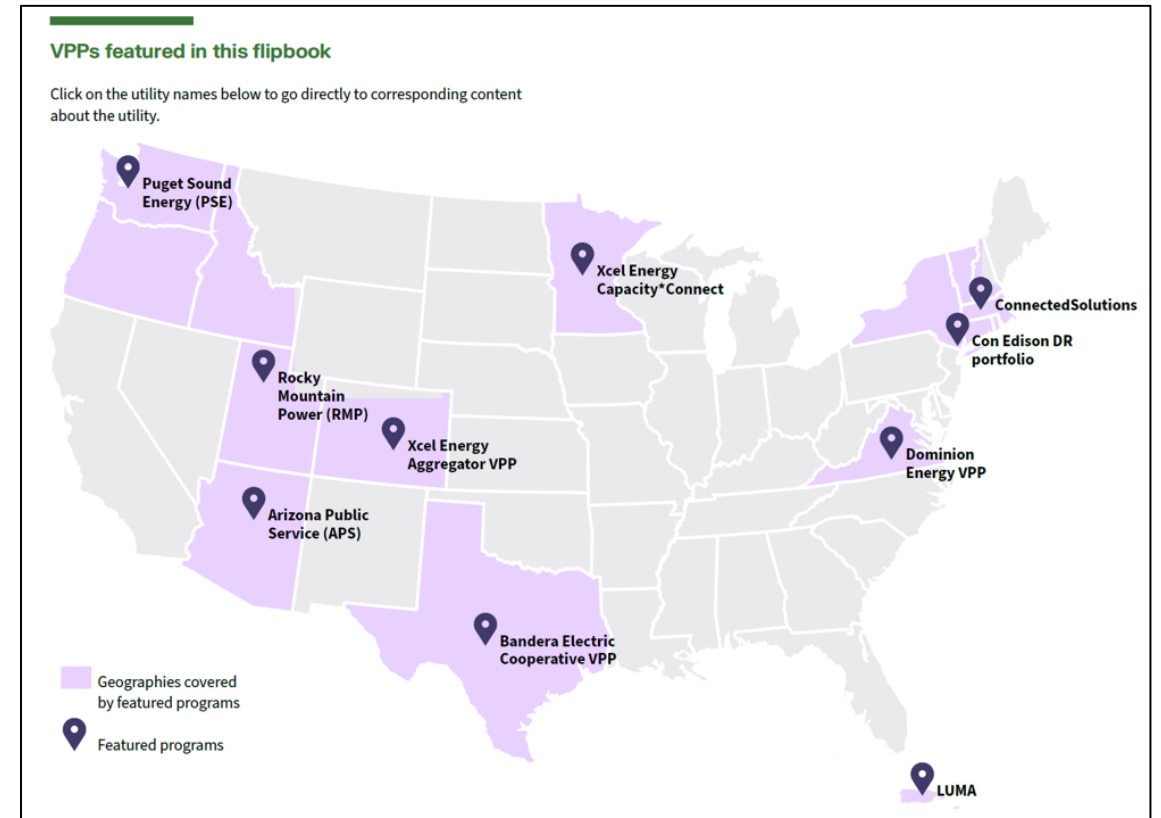
There's not broad consensus for how to talk about the types of VPPs. Here's the language we're currently using.



How are VPPs supporting affordability?



VPP Design: Select takeaways from *VPP Flipbook: 2026 Update*



Trends and emerging themes from VPPs featured in the flipbook

New programmatic approaches to dispatch and compensation for locational distribution grid services

*Xcel CO AVPP
Connected Solutions+*

Increased use of performance-based compensation

*Xcel CO AVPP
Dominion VPP*

Utility ownership of DER assets

*Xcel Capacity*Connect
(MN)*

Portfolio approach for DSM and VPP programs

*Dominion VPP
Coned DR Portfolio
Puget Sound Energy*

Connection to Interconnection

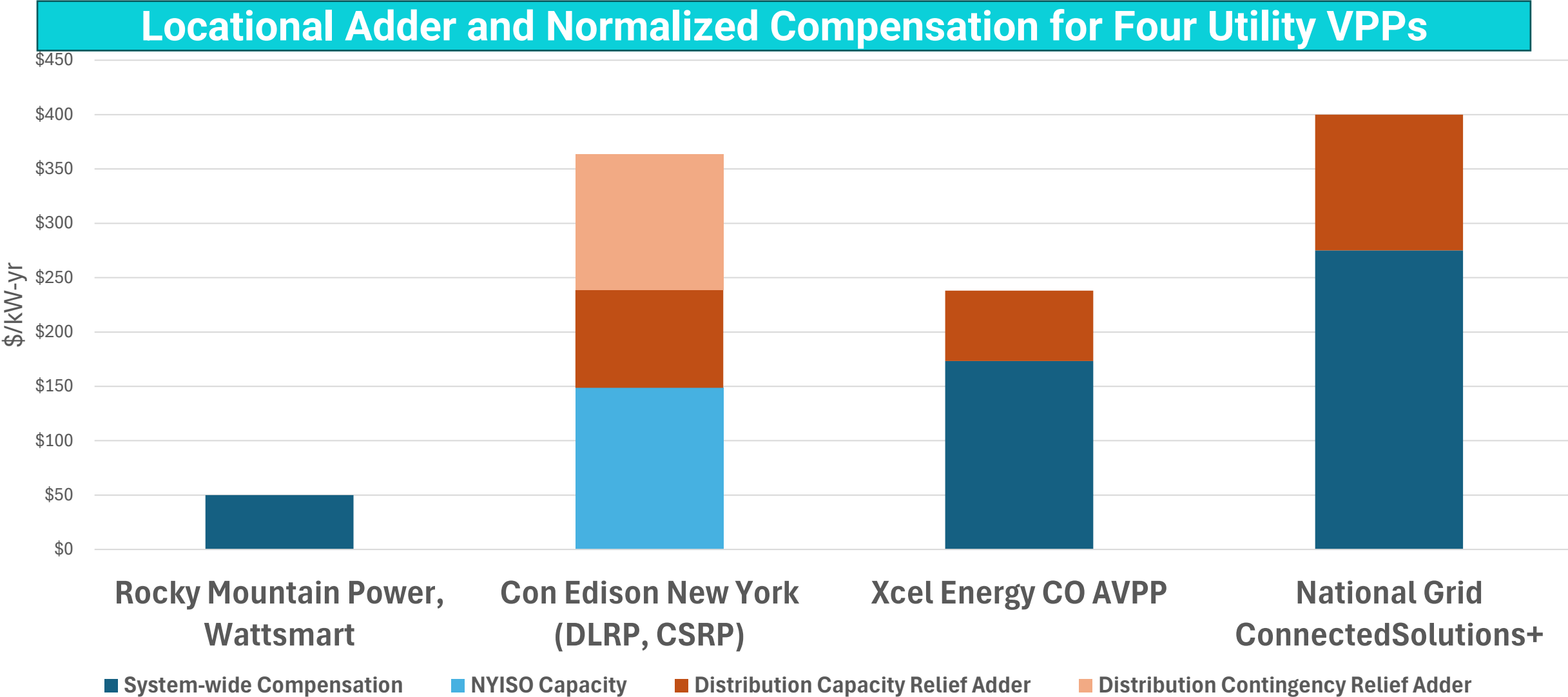
Priority Policy and Regulatory Issues for VPPs

Locational Services from VPPs

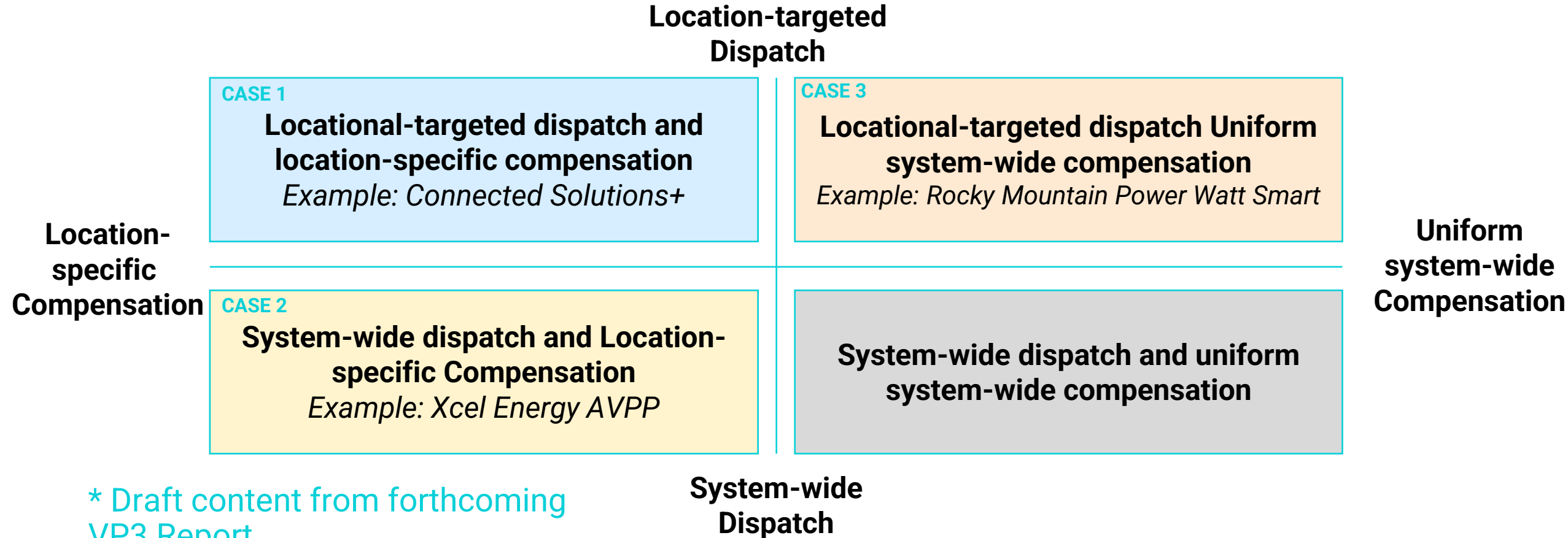
Data Access

Bring Your Own Distributed Capacity for Large Loads

Payment for Locational Distribution Grid Services from VPPs



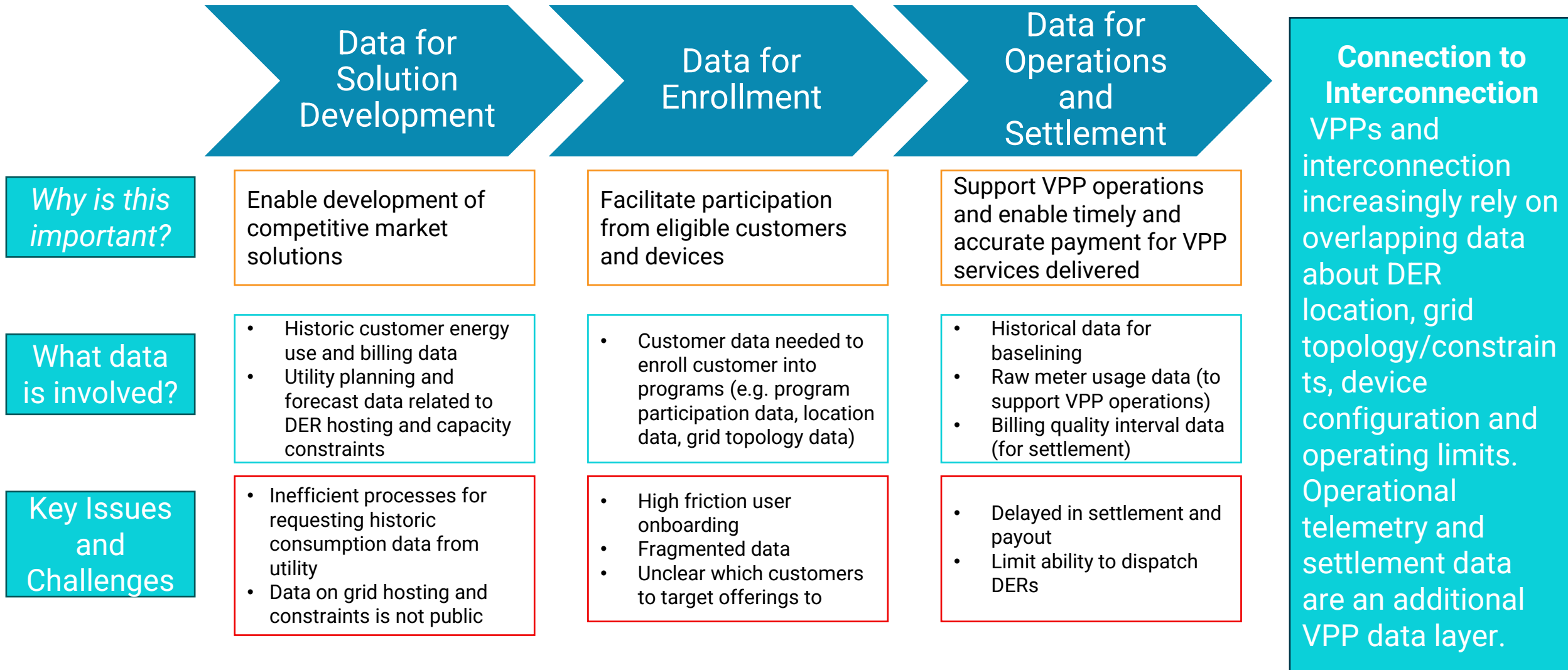
Approaches for VPPs to Provide Locational Services



* Draft content from forthcoming VP3 Report

Connection to Interconnection: Both interconnection and locational VPP design depend on understanding location-specific distribution constraints. VPP dispatch can help manage some of those constraints and reduce the need for distribution upgrades.

Data Access: VPP Data Needs to Support VPP Scaling*



Data Access: Solutions and Possible Approaches

1) Identify and prioritize data types needed

Priority Data Needs:

- Historic customer consumption and billing data
- Customer data necessary for enrollment into VPP/ market demand response program
- Billing quality interval data for VPP settlement

2) Create efficient processes to enable third party access to data

- Green Button Connect My Data AND low-friction processes for aggregators and customers

3) Consider development of state-wide data sharing platforms

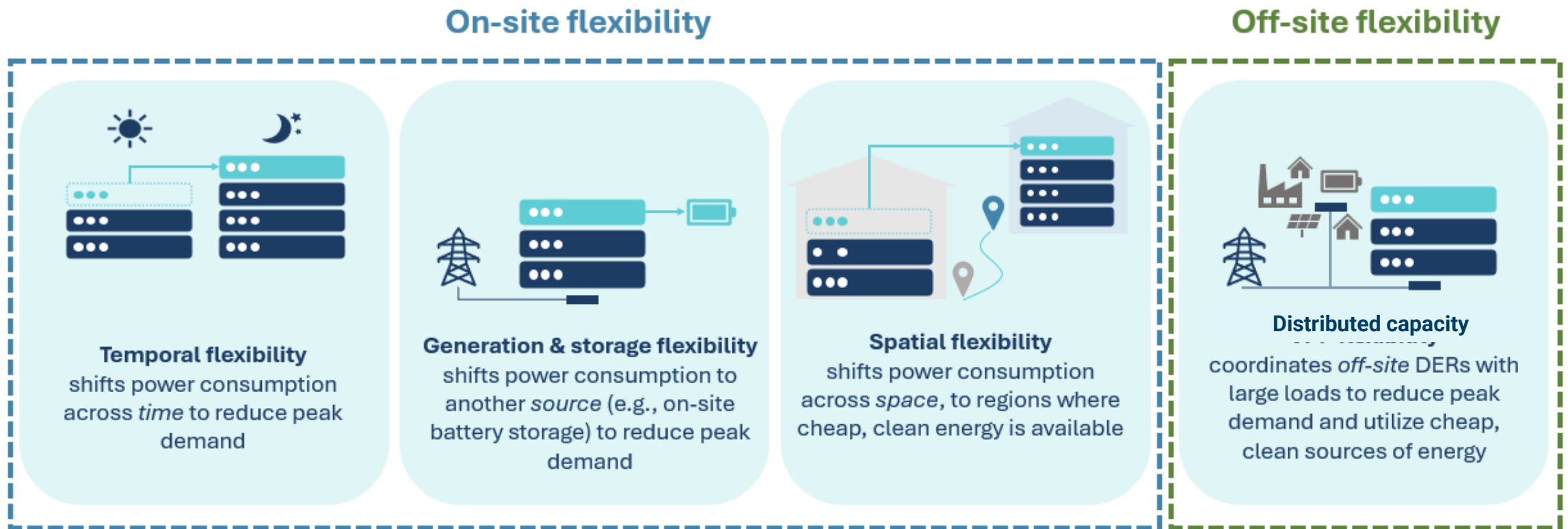
- State Examples (established or developing): New York, Texas, California, Maryland, Massachusetts

4) Monitor utility progress and support continued data provision

- Regulator audits may be needed

Large Loads and Distributed Flexibility

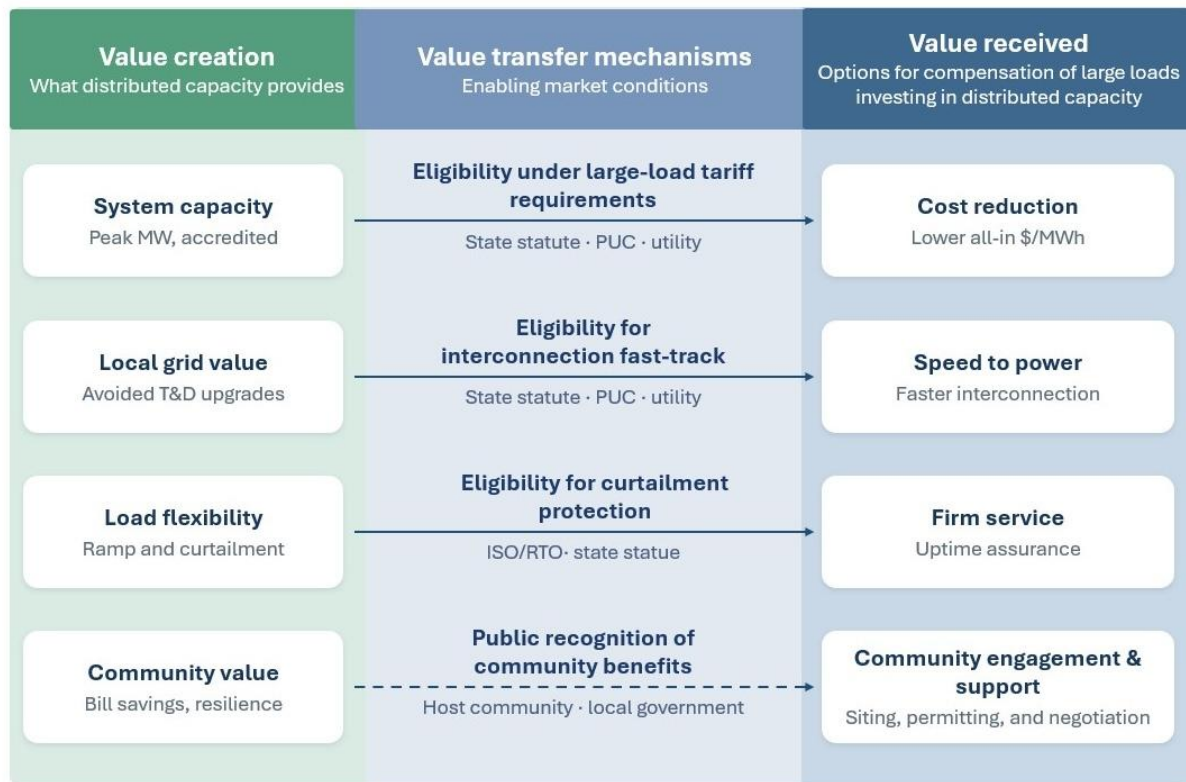
Data centers are showing interest in procuring offsite 'distributed capacity' to meet demand



Connection to Interconnection: BYODC models seek to rapidly deploy new DERs at scale – not just leveraging latent DER capacity.

Large Loads and Distributed Flexibility

Several Contractual Models are Being Explored



Resources and Reports:

- RMI, States Are Opening the Door to Data Center Investment in Virtual Power Plants
- How Virtual Power Plants Can Help the United States Win the AI Race (RMI)
- Bridging the Load Gap (Alliance to Save Energy and Ad Hoc Group)
- Google and Voltus Deal (Utility Dive write-up)

Emerging Issues to Monitor

Emerging Issues for 2027: Conversations at VP3's Annual Convening

Major Focus Areas/ Tracks

- VPPs and Data Center Load Growth
- Utility Business Model Reform to Scale VPPs
- Integrating New Distributed Battery Types into VPPs and the Grid
 - Appliance-integrated batteries
 - V2G
 - Plug-in Batteries
 - Front of the meter batteries

Additional Conversations and Themes

- VPPs and State Policy in the PJM Region
- Net Metering and VPP Participation
- Integrating VPPs into Planning
- Competitive Retail 2.0

Connection to Interconnection: Emerging battery solutions are blurring traditional boundaries between non-exporting and export-capable devices.

Questions for Consideration

1. **VPPs and Flexible/ Streamlined Interconnection:** Could DER management through a VPP help enable more flexible or streamlined interconnection? Are any states already exploring this?
2. **Technical Requirements:** Which DER-side capabilities established through interconnection requirements can also support VPP enrollment and operation? How can regulators leverage those capabilities without creating duplicative or overly prescriptive requirements?
3. **Regulatory Coordination:** How can commissions connect DER-related topics such as interconnection, VPPs, EVs, data, and distribution-planning work without creating duplicative processes or slowing action?
4. **Emerging technologies:** How should interconnection rules treat V2H, plug-in batteries, and plug-in solar when they can supply power but may not be intended to export?



Thank You!

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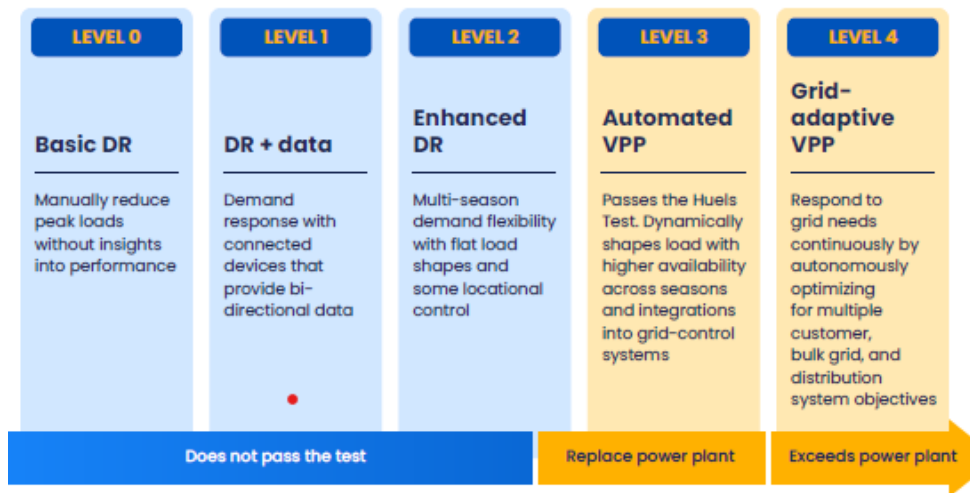


Appendix Slides

DER Visibility and VPPs Capabilities: Key Figures from EnergyHub's VPP Maturity Model

Full VPP maturity level criteria

Figure 1: VPPs outperform a peaker plant as capabilities mature



Energy Hub, Building Trustworthy Virtual Power Plants: The VPP Maturity Model, 2026

		LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
		Basic DR	DR + Data	Enhanced DR	Automated VPP	Grid-adaptive VPP
OPERATIONAL MATURITY	Passes the Huels test?	No	No	Almost	Yes	Yes
	Availability	~10 short events, one season	~20 short events, one season	~40 4-hr events, multi-season	100+ 6-hr events, year-round	24/7/365 operations
	Schedule tracking	Requested start/stop times	Defined start/stop times	Events with flat load shed	Follow daily, hourly schedules	Follow real-time grid signals
	Dispatch latency	Hours	Hour+	<15 minutes	<5 minutes	<1 minute
	Telemetry	None	hourly with delay	15 minutely	5 minutely	~2-6 seconds
	Data accuracy	None	Uncertain	<10% error	<5% error	<2% error
	Forecast accuracy	None	Uncertain	<15% error	<10% error	<5% error
AUTONOMY	Control room integrations	None	Minimal	Basic dispatch	EMS/SCADA for forecasts, dispatch, and telemetry	Level 3 + Grid DERMS/ADMS
	Peak management	Manual events	Manual events	Trigger from system load feed or system alert	Peak forecasting + optimal event times	Co-optimization for peak loads with other feeds
	Market prices	Manual events	Manual events	Trigger from price feed	Optimize for day-ahead prices	Co-optimization for real-time prices with other feeds
	Customer data	None	None	Adjust dispatch based on typical retail rate	Optimization for retail rates or customer comfort	Co-optimization for retail prices, customer comfort, and other feeds
	Multiple grid services	None	None	User manually chooses grid service	System recommends settings to user	System can optimally select among grid services
GRID IMPACT	Grouping	None	None	Limited number of static groups, manually updated	Hierarchical groups periodically synced with grid models	Any group with any topology, with real-time updates
	Locational forecasts	None	None	Approximate	Available	High quality
	Grid optimization	None	None	Trigger locational events	Optimize for static grid limits	Optimize for dynamic grid limits

VPP policy and design takeaways from *VPP Flipbook* research

VPP Policy and Design Considerations

1) Increase access to VPP options

- 1a) Remove barriers to market-participant VPPs (e.g. 3rd party AMI data access)
- 1b) Establish utility VPPs
- 1c) Advance BYODC solutions

2) Maximize VPP value by stacking services

- 2a) Design VPPs to provide local & bulk system services
- 2b) Enable dual enrollment in wholesale market & utility VPPs

3) Ensure VPPs are leveraged to avoid system costs

- 3a) Integrate VPPs into planning
- 3b) Integrate VPPs into operations

4) Adopt a pragmatic and learning mindset

- 4a) Learn from leading practice
- 4b) Start with a workable policy/program & improve it over time

Summary of Data Fields for the Distributed Energy Project Interconnection Data Template and Guide for Electric Utilities

Presentation to NARUC Cohort – 23 September 2026
Kathryn Chelminski, LBNL



Energy Technologies Area
BERKELEY LAB

Outline

- Introduction
- Guide and Template
- Discussion



Poll Question (1)

- Has your Commission made any interconnection process changes recently? Are you planning to make interconnection process changes?
 - Yes, recent changes made to interconnection processes
 - No changes planned
 - Not yet, but planning an interconnection process change

Poll Question (2)

- How do you currently (or plan to) track interconnection success?
 - Tracking timeline improvements
 - Tracking application to permission to operate completion rates
 - Tracking upgrade costs
 - Other [Write in response]

Definitions

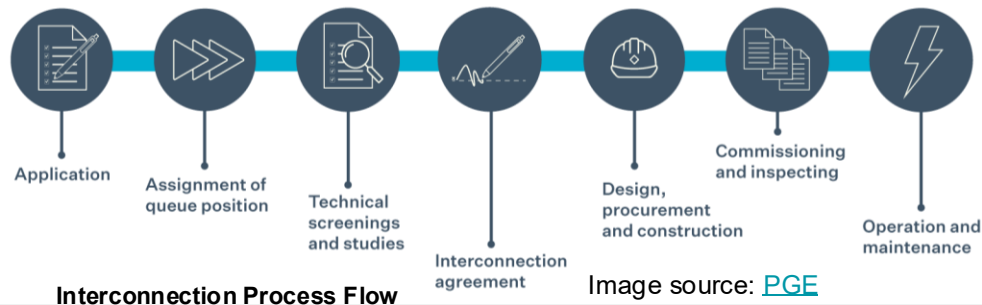
What are distributed energy projects?

Generation and storage technologies sited close to customers can provide all or some of their immediate power needs. These technologies can be used to provide supply or reduce demand to satisfy the energy, capacity, or ancillary service needs of the electricity system as well. Distributed energy projects can support electricity customer reliability, affordability, and choice.

Adapted from [NARUC 2016](#)

What is interconnection?

- ❑ Interconnection is the process of adding a distributed energy project to a utility's distribution system.
 - ❑ The term may refer to the technical, procedural, and legal requirements of the interconnection process.
- ❑ Interconnection allows utility customers and third-party service providers to connect generation and storage projects at customer premises and operate them in parallel with the utility system.



Introduction (1)

- Transparent, publicly available data on interconnection projects, timelines, and costs are vital for economically efficient deployment of distributed energy projects and to evaluate utility interconnection performance and process improvements over time.
 - Lack of quality data hinder project siting decisions and can lead to interconnection delays and high upgrade costs.
- Standardized data reporting, with regular updates, is integral to benchmarking and tracking interconnection performance both within and across states and utilities ([Brown and Stanfield 2022](#))—for example:
 - Interconnection statuses
 - Timelines for various interconnection phases
 - Upgrade costs by project size and type

Introduction (2)

- Utilities require customers and third-party developers to provide data for reviewing interconnection applications and conducting any technical studies that may be needed.
 - However, data sharing practices on interconnection applications, timelines, and costs vary significantly across the United States.
 - Types of data and frequency of data sharing are not standardized across the country ([NARUC 2023](#); [Ingram et al. 2021](#)).
 - Publicly available data are typically the result of state requirements for data sharing.
- Research by LBNL in the 2026 Distributed Interconnection Report found that detailed public interconnection data are not widely available across the country ([Chelminski et al 2026](#); also see [Cadmus 2024](#) on variability of data availability).

Introduction (3)

The Department of Energy (DOE) Interconnection Information e-Xchange (i2X) set measurable distributed interconnection success targets for 2030.

Measurable success targets for 2030

	Target	System Size*	2030 Target Value
Timing	(1) Median time from DER interconnection request to agreement [§]	< 50 kW	Within 1 day [†]
		50 kW–5 MW	< 75 days
		≥ 5 MW	< 140 days
Access	(2) Completion rate from entering the queue to execution of interconnection agreement	< 50 kW	> 99%
		50 kW–5 MW	> 90%
		≥ 5 MW	> 85%
Data	(3) Availability of public state-level interconnection queue data	All	50 states, Washington, D.C., and territories have public, detailed, and current queue data
Reliability	(4) No BPS disturbance events exacerbated by inaccurate DER modeling	All	0
Resilience	(5) Lower Customer Average Interruption Duration Index (CAIDI) [‡]	All	25% improvement (e.g., from 4 to 3 hours per occurrence)

* System size thresholds will vary across utilities and jurisdictions.

[§] For systems that do not trigger system upgrades.

[†] Defined as 1 business day.

[‡] CAIDI with loss of load removed but major event days included.

Introduction (4)

- Challenges for data sharing include:
 - Labor and resources needed to collect, aggregate, clean and standardize the data,
 - Computing requirements for data collection and sharing, and
 - Privacy and security of the data ([Ingram et al. 2021](#)).
- This presentation discusses the template for standardizing data fields for utility interconnection reporting and companion guide.

Distributed Interconnection Reporting Template

Core Data in Template

Data Category	Data field	Description	Unit
Project information	Address	Address 1, Address 2, City, State, Zip Code	
	Feeder substation #	Circuit ID or Substation (name)	
	Interconnection id	Application/ Job #	
	Project/queue id	Queue id #	
Technology information	Nameplate capacity (AC)		kW AC
	Nameplate capacity (DC)		kW DC
		Differentiating between nameplate capacity and export capacity for battery energy storage systems (BESS)	
	Storage export (%) capacity	Hybrid systems	kW DC
	Storage capacity		kWh
	Generation type (canonical)	Listing technology type(s)	
Interconnection status	Status	Interconnection phase of the project at the time of the report/export	
Timeline information	Interconnection application date	Date the interconnection application was received by	MM/DD/YYYY
	Application approved date	Date interconnection application approved by utility	MM/DD/YYYY
		Date interconnection service agreement has been executed or is under review	MM/DD/YYYY
	ISA executed (date)	Date that a technical review or study completed	MM/DD/YYYY
	Study completed (date)	Date construction completed	MM/DD/YYYY
	Construction completed (date)	Date of the witness test	MM/DD/YYYY
	Witness test (date)	Date that a project is placed in service or receives permission to operate (PTO)	MM/DD/YYYY
Cost information	PTOI in service (date)		
	Cost of upgrade	Total distribution system upgrade costs paid by DER/interconnection customer	Dollars (\$)
	Normalized cost of upgrade	Cost of upgrade/Capacity of project	\$/kW
	Total system cost	Total system installation costs	Dollars (\$)

Additional Data Fields

Overview of LBNL i2X Distributed Energy Projects Interconnection Dashboard



Distributed Energy Projects Interconnection Dashboard

Explore and analyze distribution-level interconnection data across the United States

Launch Data Query Tool

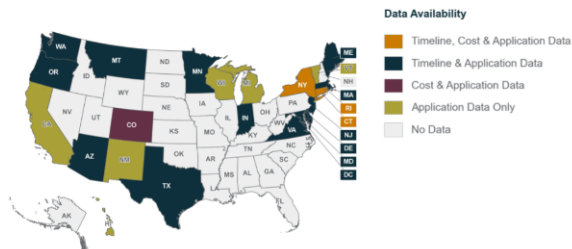
Build a custom query from scratch and jump directly into visual analysis.

[Launch Data Query Tool](#)

Featured Starter Queries

Start with curated examples from the shared query library to quickly explore common analyses.

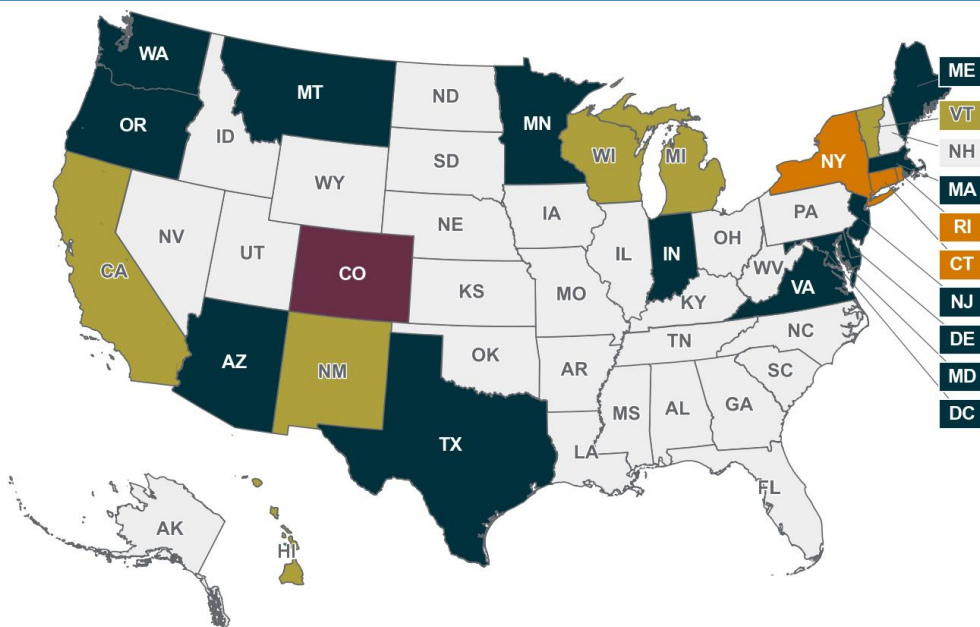
[Featured Starter Queries](#)



- LBNL's [Distributed Energy Projects Interconnection Dashboard](#) harnesses data from across the country on applications, timelines and costs for all types of distributed generation and storage connected to utility distribution systems.
- Data sources include public websites hosted by utilities, public utility commissions, and state energy offices; Data from Interconnection.fyi, through a non-disclosure agreement (NDA); Data collected directly from state agencies and utilities, including some data under NDAs with utilities.



Interconnection Data Availability Based on LBNL Report



Data Availability

- Timeline, Cost & Queue Data
- Timeline & Queue Data
- Cost & Queue Data
- Queue Data Only
- No Data

- States with timeline data for Interconnection Service Agreement (ISA): CT, DC, MA, ME, MN, NJ, RI, VA
- States with timeline data for permission to operate (PTO): AZ, CT, DC, DE, IN, MA, MD, ME, MN, MT, NY, OR, RI, TX, WA
- States with upgrade cost data: CO, CT, NY, RI

Data Availability and Count of Projects by Metric

	General Information on Distributed Interconnection Dataset	Timeline (Days to ISA)	Timeline (Months to PTO)	Upgrade Costs
States	24	8*	15**	4
Utilities	188	36	28	10
Total Projects	2.73 million	237K	574K	226K

Outline for Distributed Interconnection Reporting Template



Outline Interconnection Data Fields

Project information

Technology
information

Interconnection
status

Timeline information

Cost information

Programmatic
information



Project Information



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Project Information

- Location information for the applicant project (Optional level of detail*)
 - City
 - State
 - ZIP code
- Feeder/substation number
 - The feeder or substation identification number can help locate a project on the grid with respect to other projects.
- Interconnection/Project/Queue identification number
 - Identification number assigned to project at the time of application that acts as a tracking number.



Source: [Zhang et al](#)

*Some states and utilities report full addresses, while others consider this information to be confidential due to personally identifiable information (PII)



Project Information: Additional Data Fields

- Customer sector type (e.g. Residential, Commercial, Industrial, Educational)
- Other locational information*:
 - Property legal description (e.g. Lot #)
- Installer information:
 - Organization Name
 - City, State, ZIP
- Third party ownership information (where relevant):
 - Third party ownership type (e.g. PPA)
 - Third party name
- Prior interconnection identification number (where relevant)
- Group study number (where relevant)

*Some states and utilities report Latitude, longitude, combined location (e.g. 37.8758° N, -122.2486° W), while others consider this information to be confidential due to PII

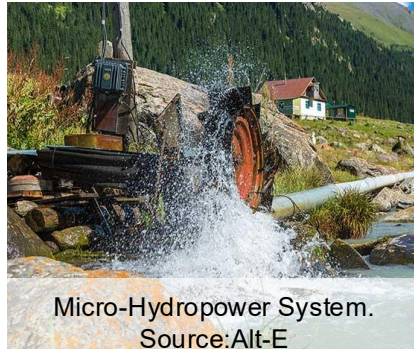
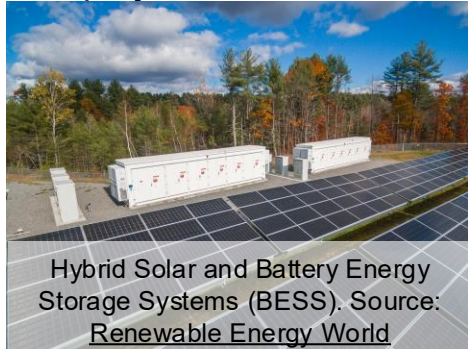
Technology Information



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Technology Information

- Project technology type: Standardized list of technologies including multiple technologies for hybrid projects



Capacity

- Capacity is defined as the total nameplate capacity of the applicant project.
 - Total capacity can be listed in kW, MW or GW
 - Capacity should be differentiated between alternative current (AC) or direct current (DC), and ideally both should be reported.
- Nameplate generating capacity
- Export capacity for the projects that incorporate energy storage
- Distinguishing between the two differentiates between generator operating conditions and how the inverter may set different capacity that is exported to the grid.
 - Avoids overestimating grid impacts and related upgrade costs

Source: [IREC](#) 2022

Distributed Energy Resource Information *

Phase configuration of Distributed Energy Resource(s): ☐ Single-Phase ☐ Three-Phase

DER Type (Check all that apply and list aggregate capacity of each type):

☐ Solar Photovoltaics Size (kW AC): ☐ Wind Size (kW AC):

☐ Storage Size (kW AC): ☐ Other Size (kW AC):

Please specify other:

Export Capacity Limitation *

Is the Maximum Physical Export Capacity request the same as the nameplate capacity: ☐ Yes ☐ No

If Yes, please continue to the next section.

If No, what is the Maximum Physical Export Capacity Requested (kW_{ac}):

Is the Export Capacity Limited (e.g. though the use of a control system, power relay(s), or other similar devices setting of adjustment?): ☐ Yes ☐ No

If Yes, please attach detailed information describing the method of limiting export capacity.

Inverter Interconnected System Information – non ESS (if applicable) *

Aggregate Inverter Rating (kW AC): Number of Total Inverters:

Phase configuration of inverter(s): ☐ Single-Phase ☐ Three-Phase

Voltage of Inverter(s):

Inverter Manufacturer:

1. Model No.

Certification

☐ UL 1741 ☐ UL 1741-SA ☐ UL 1741-SB

Inverter Rating (kW AC):

Number of Units of this Model:

2. Model No.

Certification

☐ UL 1741 ☐ UL 1741-SA ☐ UL 1741-SB

Inverter Rating (kW AC):

Number of Units of this Model:

Minnesota Distributed Energy Resources Interconnection Process
(MNDIP) [Source: MN DIP](#)

Examples of Differentiating by Non-Export

- Energy storage systems can introduce greater levels of control over the amount and timing of when a distributed system imports and exports power (IREC 2022).
- In several states, interconnection procedures treat non-exporting system with differentiated, and sometimes expedited review processes. See list of states below and examples.

States that differentiate non-exporting systems: [AZ Administrative Code § R14-2-2623\(B\)](#); CA Pub. Util. Comm., Southern California Edison, [Rule 21, § G.1.i](#) (Screen I); [HI Pub. Util. Comm., Rule 22](#); [IL Admin. Code tit. 83, § 466.80\(c\)](#); [Iowa Admin. Code r. 199.45.7\(3\)](#); MD COMAR [Code MD Regs. 20.50.09.11\(C\)-\(D\)](#); NV Pub. Util. Comm., Docket 17-06014, [NV Power Co. Rule 15 § I](#).

R14-2-2623 Expedited Interconnection Process – A Customer interconnecting a Non-Exporting inverter-based Energy Storage Generating Facility or an Inadvertent Export GF with a Maximum Capacity of 20 kW or less may apply for Interconnection under the Expedited Interconnection Process. In order to qualify for the Expedited Interconnection Process, the Customer's GF must meet the applicable conditions specified in subsection (B) and (C) of R14-2-2623.

Excerpt of text from Arizona Interconnection Rules ([APS](#))

ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS

Sheet 278

N. EXPEDITED INTERCONNECTION PROCESS FOR NON-EXPORT ENERGY STORAGE GENERATING FACILITIES

Applicants with Interconnection Requests for Non-Export Energy Storage Generating Facilities who meet the requirements outlined below are eligible for expedited interconnection in accordance with the Fast Track Process technical review requirements of Section F.2. Applicants with Non-Export AC/DC Converters that meet the requirements outlined in O. below are also eligible.

Excerpt of text from California Rule 21 ([PG&E](#))

Technology Information: Additional Data Fields (2)

- An inverter is an electronic device that converts DC electricity into AC electricity.
 - Some states collect and report data on inverter size in interconnection reports.
- Additional fields include:
 - Component manufacturers:
 - Generator manufacturer model #
 - Generator quantity
 - Inverter manufacturer model #
 - Inverter quantity
- System output monitoring:
 - Some states require reporting on distributed system output (production, stored, and consumed). The standards set the metering accuracy needed for compliance.
 - [New York State Energy Research and Development Authority](#) (NYSERDA)'s System Output Monitoring Requirements and Guidance provides an example ([NYSERDA 2020](#)).

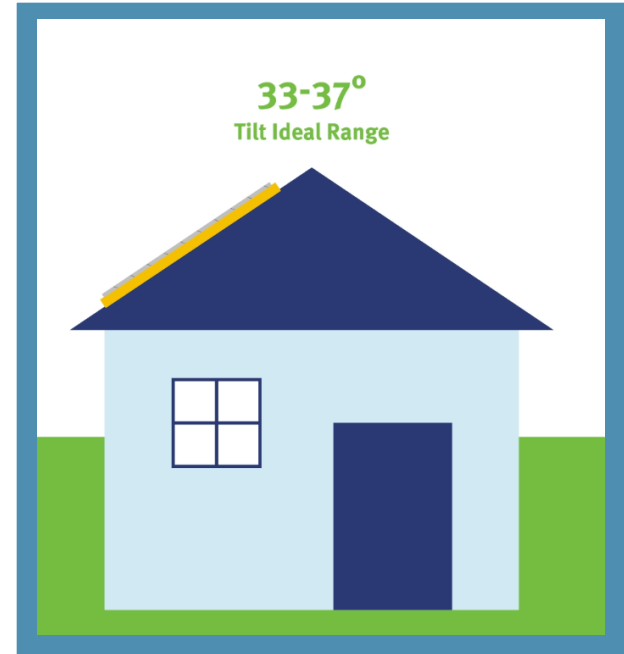
MONITORING AND DATA COLLECTION STANDARD FOR DISTRIBUTED ENERGY RESOURCE (DER) SYSTEMS

January 2020

New York's System Output Monitoring Requirements and Guidance. Source: [NYSERDA](#)

Technology Information: Additional Data Fields (1)

- System Design:
 - **Tilt:** Angle of solar panels relative to the ground (flat or parallel to the ground).
 - **Azimuth:** Direction that solar panels measured in degrees ([Illinois Shines](#)).
- Mounting Method: e.g. Ground, Mixed, Rooftop
- Tracking:
 - **Fixed:** A solar project that remains stationary with panels mounted at a fixed angle
 - **Single-Axis:** Solar mounting system that rotates panels along one axis
 - **Dual-Axis:** Solar mounting system that has two rotational axes
 - Source: [Shielden](#)



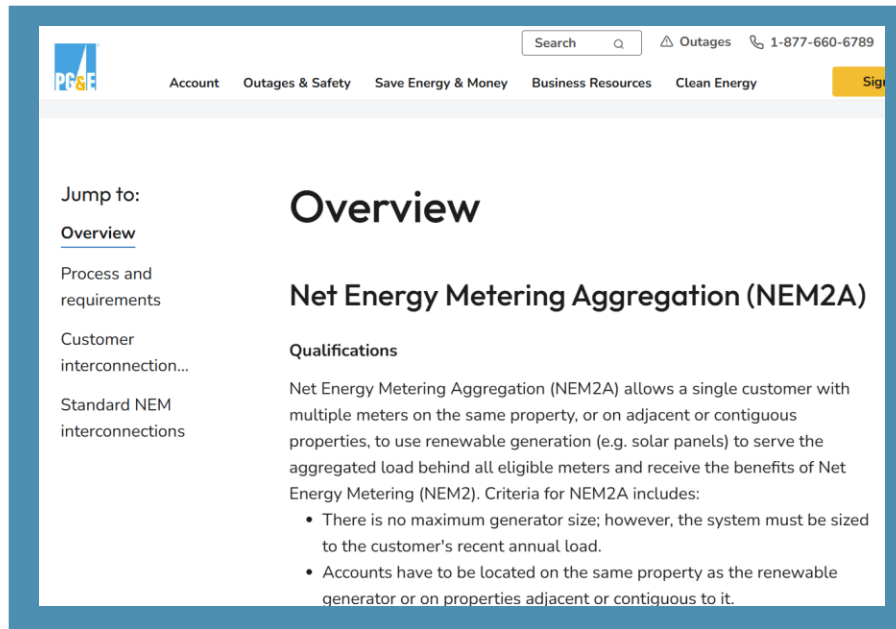
Tilt range for the Illinois Shines program Source: [Illinois Shines](#)

Programmatic Information



Programmatic Information: Additional Data Information

- Interconnection applications can include data fields for the type of interconnection program or net metering program a project is subscribed to or participating in.
- Examples include:
 - Interconnection program (e.g. “CA EXPNEM”, “Non-Export”)
 - Net energy metering tariff type (e.g.1, 2)
 - Net energy metering type (e.g. virtual net metering, behind the meter, net metering aggregation)
 - Net energy metering aggregation



The screenshot displays the PG&E website interface. At the top, there is a navigation bar with the PG&E logo, a search bar, and links for Outages, a phone number (1-877-660-6789), and a Sign In button. Below the navigation bar, a secondary menu includes links for Account, Outages & Safety, Save Energy & Money, Business Resources, and Clean Energy. The main content area is titled "Overview" and focuses on "Net Energy Metering Aggregation (NEM2A)". On the left side of this section, there is a "Jump to:" menu with links for Overview, Process and requirements, Customer interconnection..., and Standard NEM interconnections. The "Qualifications" section explains that NEM2A allows a single customer with multiple meters on the same property or on adjacent or contiguous properties to use renewable generation (e.g. solar panels) to serve the aggregated load behind all eligible meters and receive the benefits of Net Energy Metering (NEM2). It lists two criteria for NEM2A: 1) There is no maximum generator size; however, the system must be sized to the customer's recent annual load. 2) Accounts have to be located on the same property as the renewable generator or on properties adjacent or contiguous to it.

Overview of net metering types for CA
PG&E interconnection applications

Source: [PG&E](#)

Interconnection Status



Interconnection Status

The interconnection application status captures the current phase of a project in the interconnection process.

Application Status	Description
Application	Interconnection application has been received by utility
Interconnection Service Agreement (ISA)	Interconnection service agreement has been executed or is under review
Under Study/Review	Project is undergoing a technical review or study
Design and Construction	Project interconnection design or construction is underway
Finalization	Project is undergoing witness test, commissioning, or other final steps directly prior to being placed in service
Permission to Operate (PTO)	Utility provided permission to operate, or the project is in service
On Hold	Project is on hold in the interconnection process
Cancelled/Decommissioned/Withdrawn	Project is either cancelled, withdrawn, or decommissioned

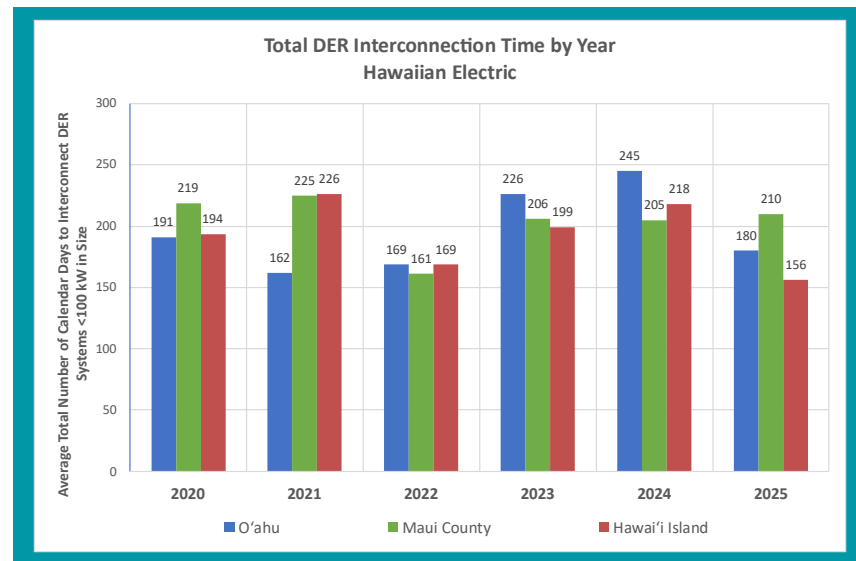


Timeline Information



Timeline Information

- The availability of timeline data varies across utilities, in terms of the first year that interconnection applications are reported, the particular interconnection statuses covered, and interconnection process dates reported.
- Two important timeline measures are the number of days/months/years between:
 - (1) interconnection application submittal and execution of the ISA with the utility, and
 - (2) application submittal and PTO or the in-service date.

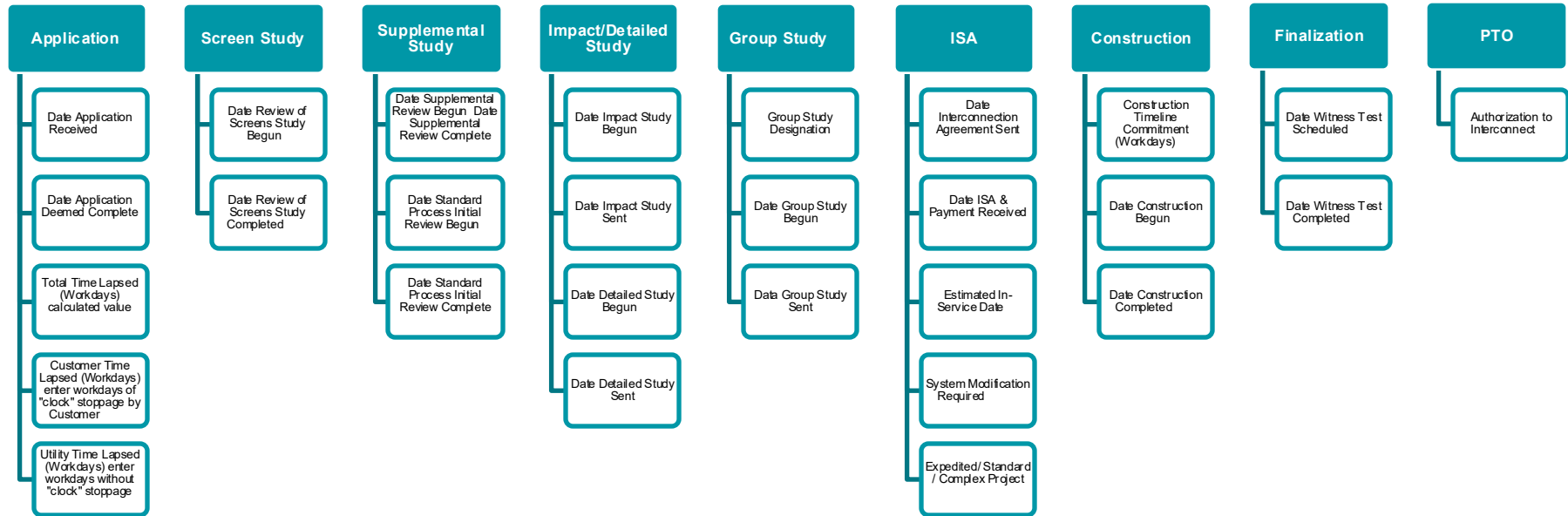


Hawaii Electric Performance Scorecards and Metrics
Total number of days to PTO for <100 kW systems

Source: [Hawaii Electric](#)

Timeline Information: Additional Data Fields

- Timeline data for the following phase of interconnection can also be specified in report. The inclusion of dates for each phase of interconnection also enables tracking and reporting against specific timeline requirements.



Poll Question (3)

What kind of timeline data does your state report on?

- Interconnection Service Agreement
- Permission to Operate
- Every interconnection process milestone date
- Other [Fill in blank]

Cost Information



Cost Information

- The interconnection cost information reports distribution system upgrade costs paid by interconnection customers.
- Additional data fields can include total system installation costs. However, interconnection upgrade cost is a necessary field as a standalone data field.
 - Consider specifying that the total installation cost should exclude the amount of incentives and or grants received.
- Cost data is underreported across utilities. Some utilities report barriers to sharing cost data.



Discussion



Poll Question (4)

What are the biggest challenges to reporting data?

- Confidentiality and PII
- Cybersecurity concerns
- Resources/lack of automation

Which fields pose the most challenges?

- Project information
- Timeline information
- Cost information

Discussion Question

What type of interconnection data are a priority for utilities in your state to collect data on and report?

Project information:

- Address
- Interconnection id #

Technology information

- Capacity
- Technology

Timeline information:

- ISA
- PTO

Cost information:

- Upgrade costs
- Total system costs



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- New York State Energy Research and Development Authority (NYSERDA) (2020) Monitoring and Data Collection Standard for Distributed Energy Resource (DER) Systems. NYSERDA: Albany, NY.



Additional Resources

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- [LBNL Distributed Energy Projects Interconnection Dashboard](#)
- DOE (2025) [Distributed Energy Resource Interconnection Roadmap](#).
- LBNL resources on the i2X Interconnection Innovation e-Xchange, [Interconnection Resources](#)
- Interstate Renewable Energy Council (IREC), [IREC Model Interconnection Procedures 2023](#)
- Building a Technically Reliable Interconnection Evolution for Storage (BATRIES), [Solutions to Improve Energy Storage Interconnection](#)
- IREC (2024) [IEEE 1547-2016 Adoption Tracker](#)



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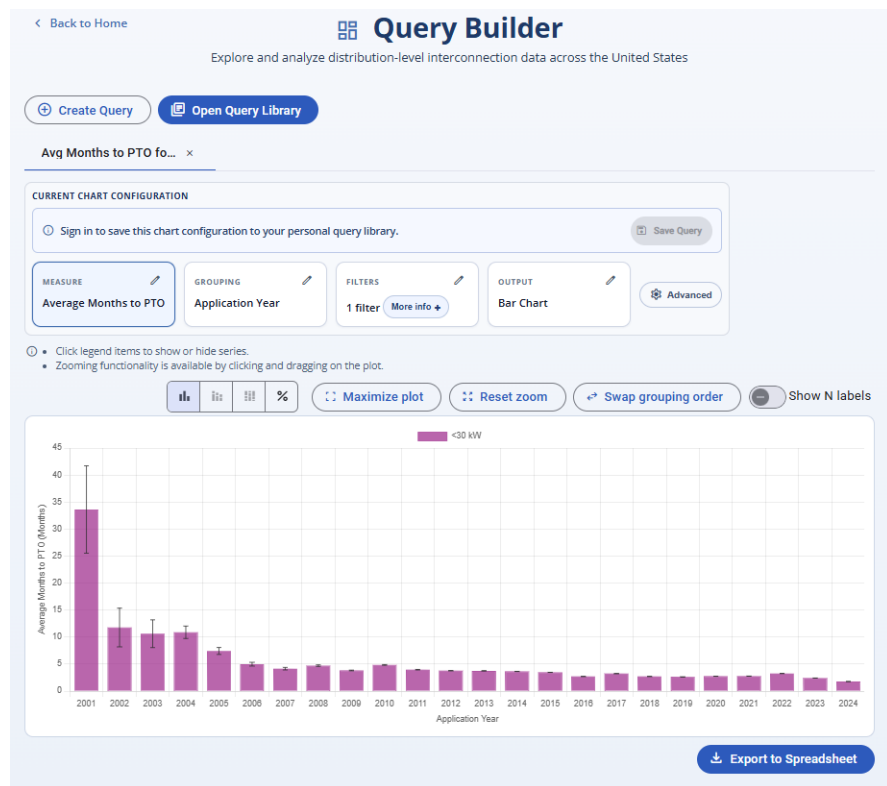
Appendix



Methodology

- To inform the template and companion guide, LBNL identified 24 states with utilities filing interconnection reports.
 - LBNL collected data as part of the [LBNL Interconnection Timelines and Costs for Distributed Energy Projects in the United States \(2000-2025\)](#) report and [Distributed Energy Projects Interconnection Dashboard](#).
 - Data sources included: public websites hosted by utilities, public utility commissions, and state energy offices; data from [Interconnection.fyi](#), through a non-disclosure agreement (NDA), which also contributed to data standardization; Data collected directly from state agencies and utilities, including some data under NDAs with utilities.
 - LBNL used the most recent report published or available (2023-2025). The metrics identified in this report were also prioritized are from the DOE i2X Roadmap.
- The metrics and data fields prioritized are pulled from the distributed interconnection report and dashboard as the data fields needed to analyze applications, timelines, and upgrade costs. These are common fields that are reported in distributed interconnection reports.
 - The actual fields reported vary by state, but are often specified in public utility commission proceedings and compliance tariffs.
 - The additional fields are highlighted as other data points included in some interconnection reports that could be considered.

Interconnection Dashboard Query Builder



- The interactive tool allows users to build custom queries on interconnection applications, timelines, and costs.
- Users can apply filters, aggregate metrics, and visualize results in multiple formats.
- Dashboard also enables users to download visualizations and associated aggregated data.