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# Timelines and Costs for Distributed Energy Resources Interconnection in the United States (2000-2025)

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Presentation to NARUC/LBNL Distributed Energy Projects Cohort

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# Agenda

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- Data Sharing Practices
- Research Overview
- Key Findings
- Solutions
- Conclusions

Additional findings in forthcoming report by Kathryn Chelminski, Johnny Wong, Lisa Schwartz, Margaret Pigman, and Katherine Carlson

# Measurable Success Targets for 2030 for Timing, Access and Data

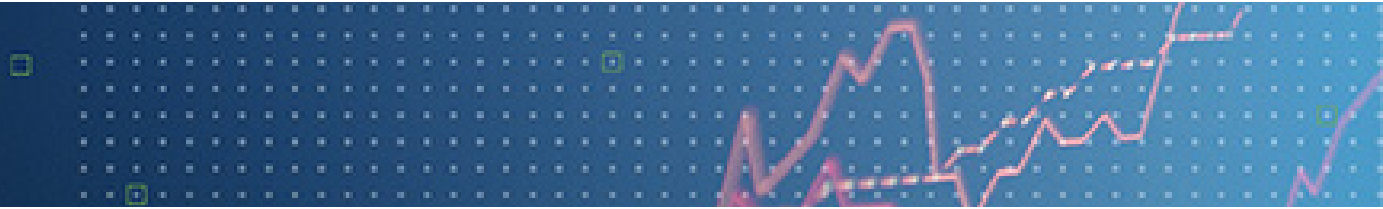
	Target	System Size*	2030 Target Value
Timing	(1) Median time from DER interconnection request to agreement <sup>§</sup>	< 50 kW	Within 1 day <sup>†</sup>
		50 kW–5 MW	< 75 days
		≥ 5 MW	< 140 days
Access	(2) Completion rate from entering the queue to execution of interconnection agreement	< 50 kW	> 99%
		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

\* System size thresholds will vary across utilities and jurisdictions.

<sup>§</sup> For systems that do not trigger system upgrades.

<sup>†</sup> Defined as 1 business day.

Source: [U.S. Department of Energy](#) (2025)



# Data Sharing Practices

# Data Sharing Practices

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- Data sharing practices vary across the United States.
  - ▣ Detailed public interconnection data are not widely available across the country ([Cadmus 2024](#)).
  - ▣ Even when utilities provide data, many data fields are missing — e.g., costs, status, capacity, and technology type.
  - ▣ The types and frequency of data sharing are not standardized, aside from common agreement on the need for adoption and compliance with IEEE 1547-2018 ([NARUC 2023](#); [Ingram et al. 2021](#)).
  - ▣ Publicly available data are often a result of state requirements for data sharing and standardization.
  
- Major barriers to data sharing and data collection 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](#)).

# Interconnection Data Are Vital to DER Deployment

- Transparent, publicly available data on interconnection projects, timelines, and costs are vital for economically efficient deployment of distributed energy resources (DERs) and to evaluate utility interconnection performance and process improvements over time.
  - Lack of quality data hinder DER siting decisions and can lead to interconnection delays and high upgrade costs
- Publicly available data are necessary for benchmarking and tracking ([Brown and Stanfield 2022](#))—for example:
  - Queue statuses
  - Timelines for various interconnection phases
  - Costs by project size and type

- Utilities require customers and third-party developers to provide data for reviewing interconnection applications and conducting any technical studies that may be needed.

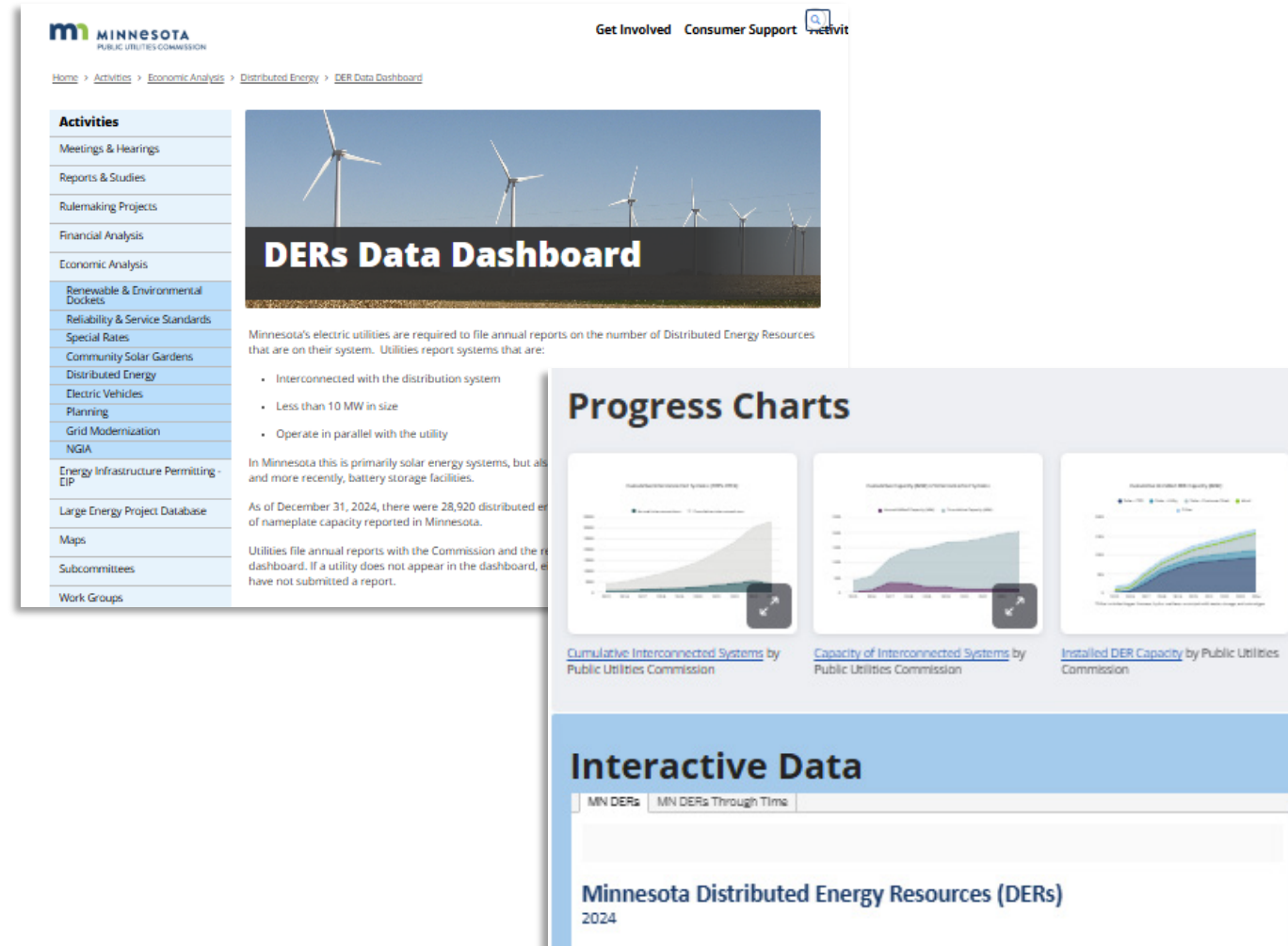
## Common data collected in applications

- Rated power (kW)
- Stored energy (kWh)
- Technology/system type
- Location: substation/feeder
- IEEE 1547 Reactive Power Category, referred to as “voltage and reactive power capability”
- IEEE 1547 Disturbance Category, referred to as “voltage and frequency ride-through capability”

Sources: [DOE 2025](#), [BATRIES 2022](#)

# Examples of Interconnection Data

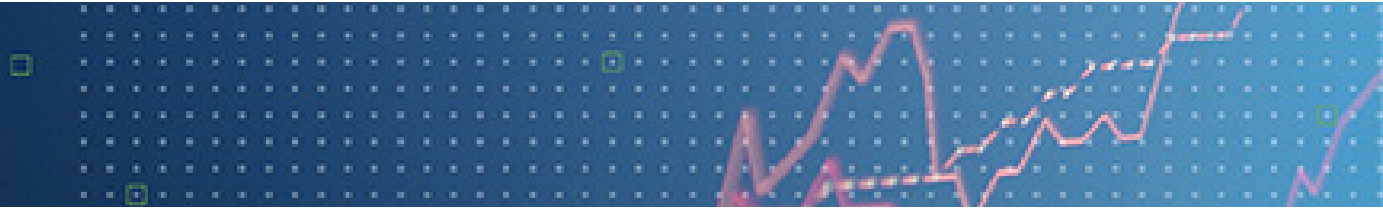
- ❑ Queue position and identification number
- ❑ Cumulative queue volume
- ❑ Application date and interconnection agreement date
- ❑ Estimates of initial and final upgrade costs
- ❑ Timelines – Dates of system impact study start and completion, and construction completion date
- ❑ Group study results, if applicable
- ❑ Technical screen failures and results, if applicable
- ❑ Application status (next slide)



Source: [MN PUC DERs Data Dashboard](#)

# Application Status

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



# Research Overview

# Methodology

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- LBNL explored DER interconnection projects, timelines, and costs across the country—specifically:
  - How do interconnection metrics vary across states, project sizes, technology types, and over time?
- LBNL collected data for 188 utilities in 24 states during the period 2000–2025\* and conducted quantitative analysis of trends over time.
- The dataset includes the following DER technologies:
  - Biomass/biofuels, coal, geothermal, hydropower, natural gas/oil, nuclear,\*\* solar, storage, wind, hybrid^, and other
    - “Other” includes steam turbines, fuel cells, hydrogen, combined heat and power, and bidirectional electric vehicle chargers.
- The analysis includes distribution-connected projects up to 50 MW.†
- The dataset includes all metering configurations (offsite/virtual, behind the meter, paired, islanding-capable).
- To provide context for the findings, LBNL interviewed utilities, regulators, and industry stakeholders, as well as incorporated insights from LBNL’s i2X webinar series on DER interconnection.

\*The dataset does not represent comprehensive data for 2025. LBNL acquired some datasets prior to the end of 2025.

\*\*The dataset includes one nuclear project.

^“Hybrid” represents microgrids and any other project that includes more than one type of technology.

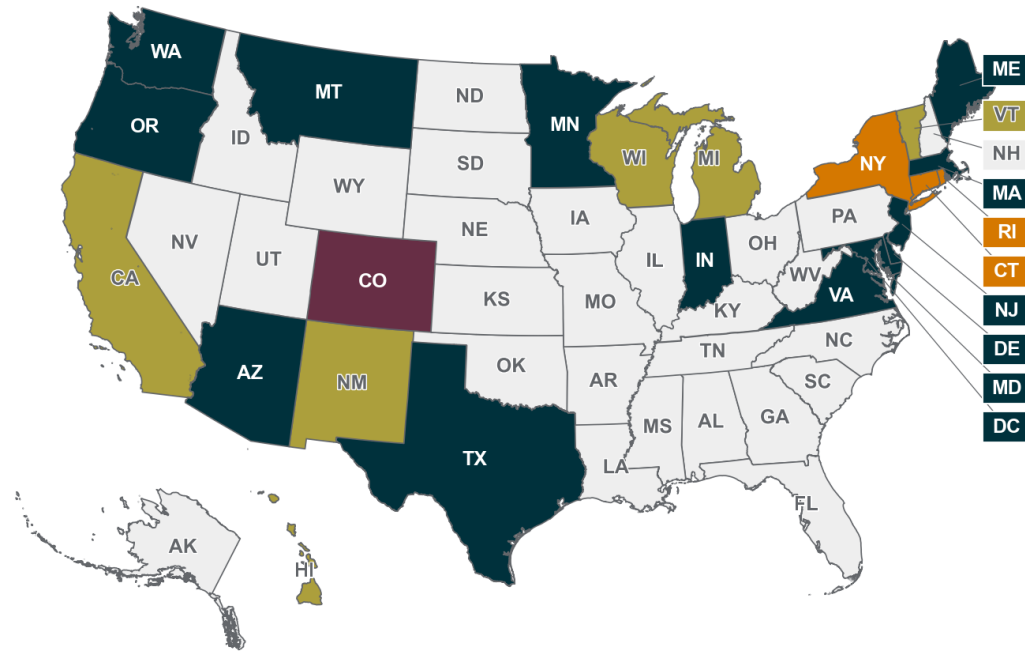
† The dataset includes only distribution and sub-transmission level projects between 1 kW and 50 MW.

## Data Collection

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- The project focuses on quantitative analysis, using data primarily from two sources:
  - *Public websites* hosted by utilities, public utility commissions, and state energy offices – LBNL collected this data in summer 2025.
  - *Data from Interconnection.fyi*, through a non-disclosure agreement (NDA) – LBNL used this data, as of February 2026, when it was more detailed than information from public websites.
  
- LBNL also collected data directly from state agencies and utilities, including some data under NDAs with utilities (November 2025–January 2026).
  
- Public data are not available for all states, and even states with public data do not provide data for all utilities.

# DER Interconnection Dataset Overview



## Data Availability

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

## Data Availability and Count of Projects by Metric

	General Information on DER 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

\*States with timeline data (application to ISA): CT, DC, MA, ME, MN, NJ, RI, VA

\*\*States with timeline data (application to 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 Limitations

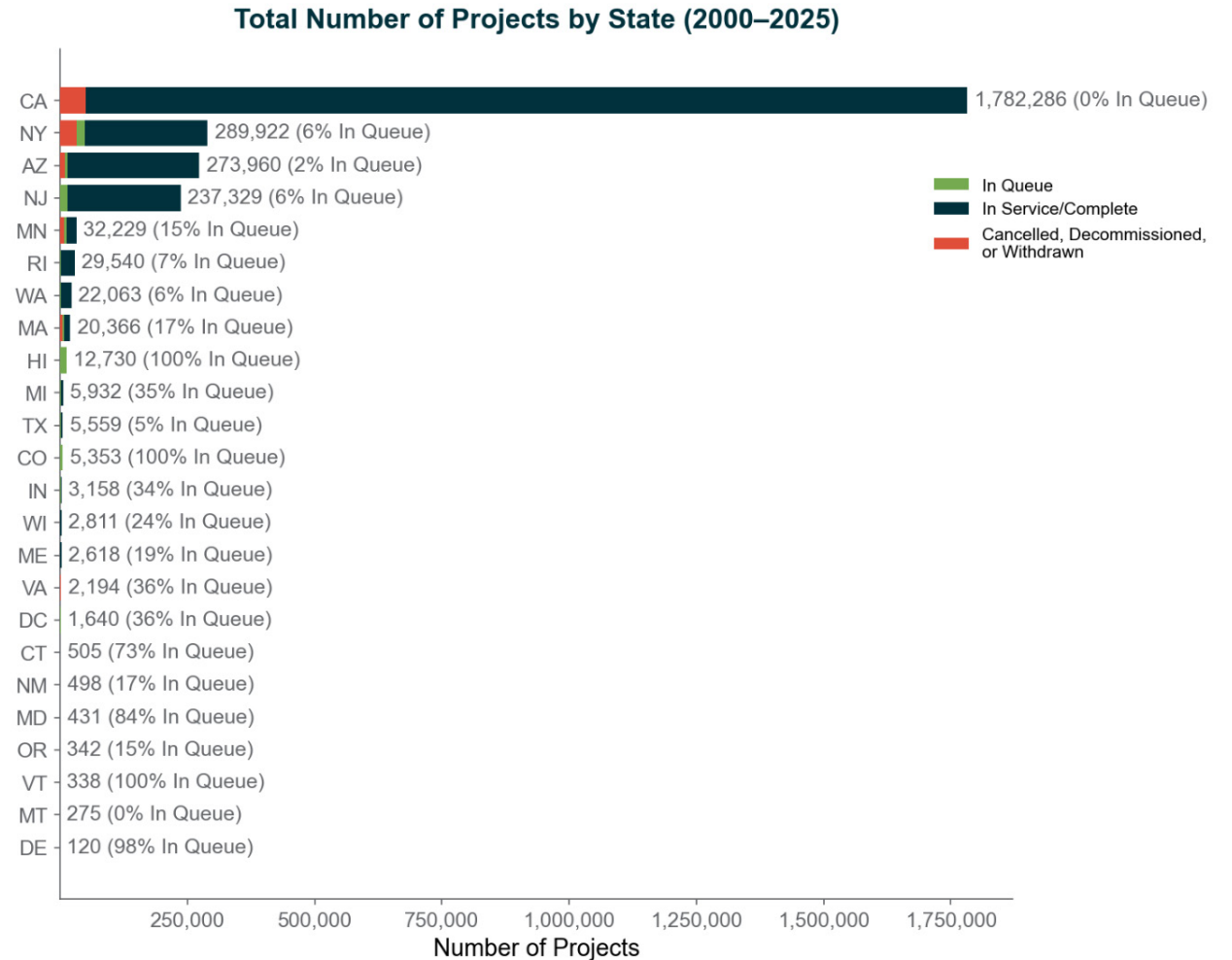
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- Each state/utility has different standards for sharing data publicly, including the type of data shared and cadence.
  
- Data reporting methods vary by jurisdiction, which can make comparisons difficult.
  - The datasets LBNL collected required extensive standardization across technology types, interconnection statuses, dates, and types of costs, among other data fields.
  
- The data fields in interconnection reports filed by regulated utilities are not standardized—for example:
  - Most utility datasets did not include information on the cost of required distribution system upgrades.
  - Not all datasets include the same timeline metrics, which makes it challenging to analyze timelines.

# Key Findings

# Summary of Interconnection Project Data (1)

- The interconnection queue data are heavily represented by California, which makes up 65% of the data, followed by New York (11%), Arizona (10%), and New Jersey (9%).
- The interconnection status of the majority of projects in the queue in a given year is *permission to operate (PTO)*—when a project is allowed to connect to the grid or is in service.

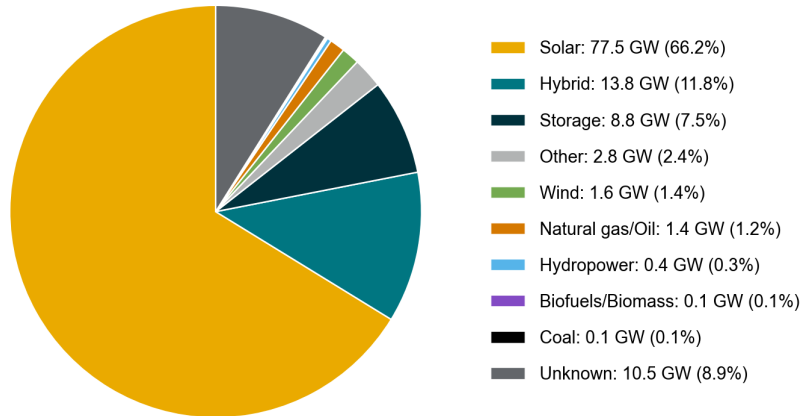


# Summary of Interconnection Project Data (2)

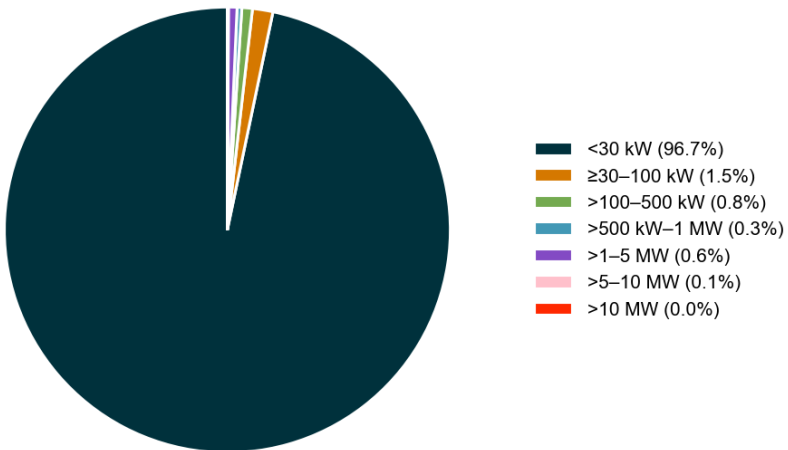
□ The majority of DER interconnection projects in the dataset are solar (66%), representing nearly 78 GW of capacity, followed by hybrid systems (12%, 14 GW), “other” technologies (2%, 3 GW), and storage systems (7.5%, 9 GW).

□ Small systems (<30 kW), typically residential, make up the majority of projects in the dataset (~97%).

DER Interconnection Project Data by Technology (2000-2025)



Share of Project Counts by Project Capacity Size (2000-2025)

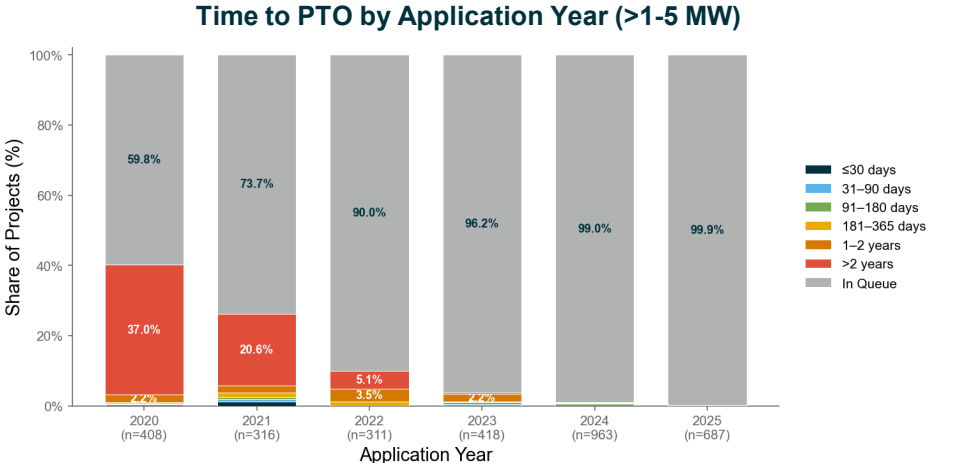
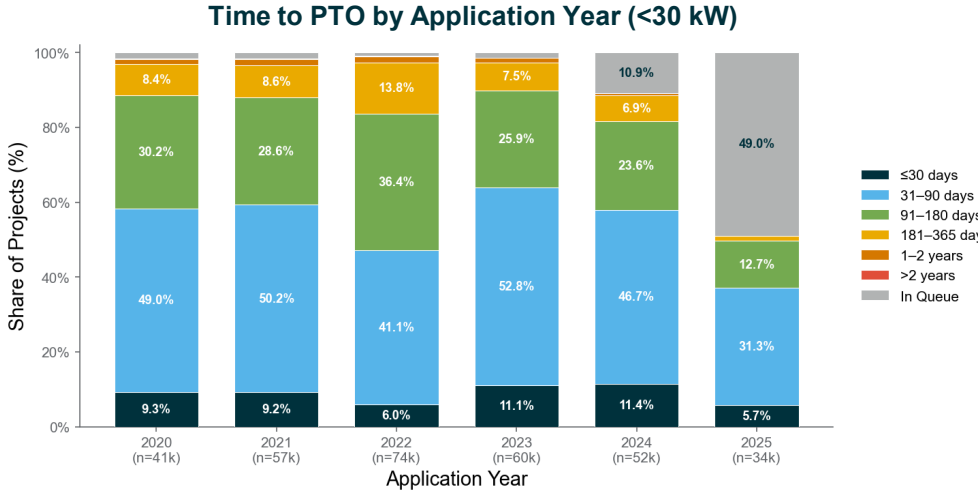


Project Type	Share in Database	Capacity (GW)
Solar	66%	77.5 GW
Hybrid	12%	13.8 GW
Storage	7.5%	8.8 GW
Other	2.4%	2.8 GW
Wind	1.4%	1.6 GW
Natural gas/Oil	1.2%	1.4 GW

Unknown technologies are for projects that did not specify the technology type. Hybrid systems are any project with more than one technology, including microgrids and combinations of biomass, coal, diesel, fuel cells, fuel oil, geothermal, hydropower, hydrogen, natural gas, wind, solar, and storage. “Other” includes steam turbines, fuel cells, hydrogen, combined heat and power, and bidirectional electric vehicle chargers.

# Interconnection Timelines (1)

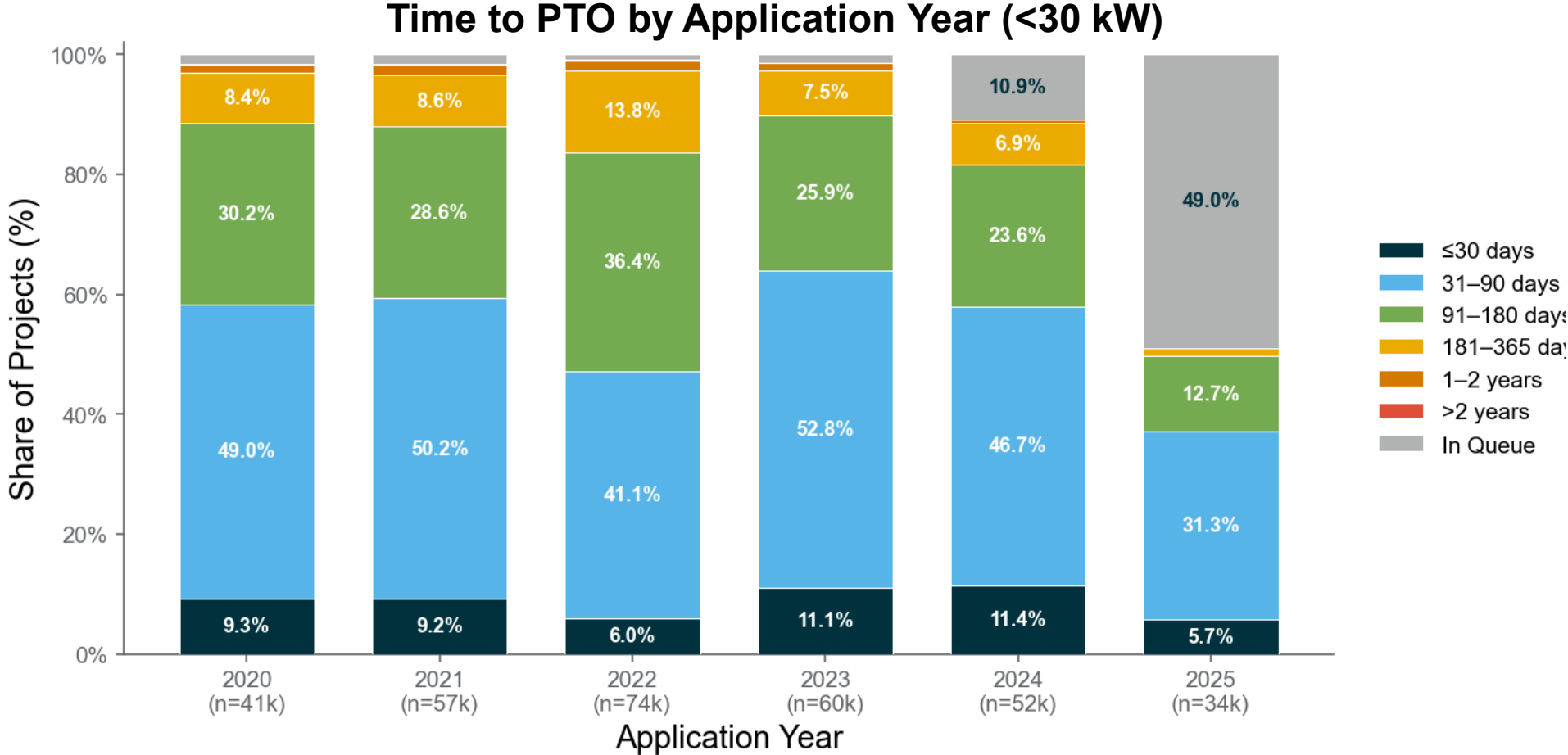
- The figures depict an analysis of the timeline duration of a project moving through interconnection processes by application year and by project size.
- The share of projects in the queue generally increases as project size increases.
  - For example, 46% of projects <30 kW were PTO in 31-90 days between 2020-2025, but <1% of projects >100 kW–10 MW were PTO in 31-90 days during the same period.
  - The majority (86%) of larger projects (>1-5 MW) remained in interconnection processes without achieving PTO during the period 2020-2025.



States represented in the sample include AZ, CT, DC, DE, MA, MD, ME, MN, MT, NY, OR, RI, TX with majority of the data representing NY (55%) and MD (11%) and MA (11%).

The data for <30 kW figure heavily represent Arizona (42%) and New York (39%). The data for >1-5 MW figure heavily represent New York (55%). The totals for each bar are impacted by the sample for each year.

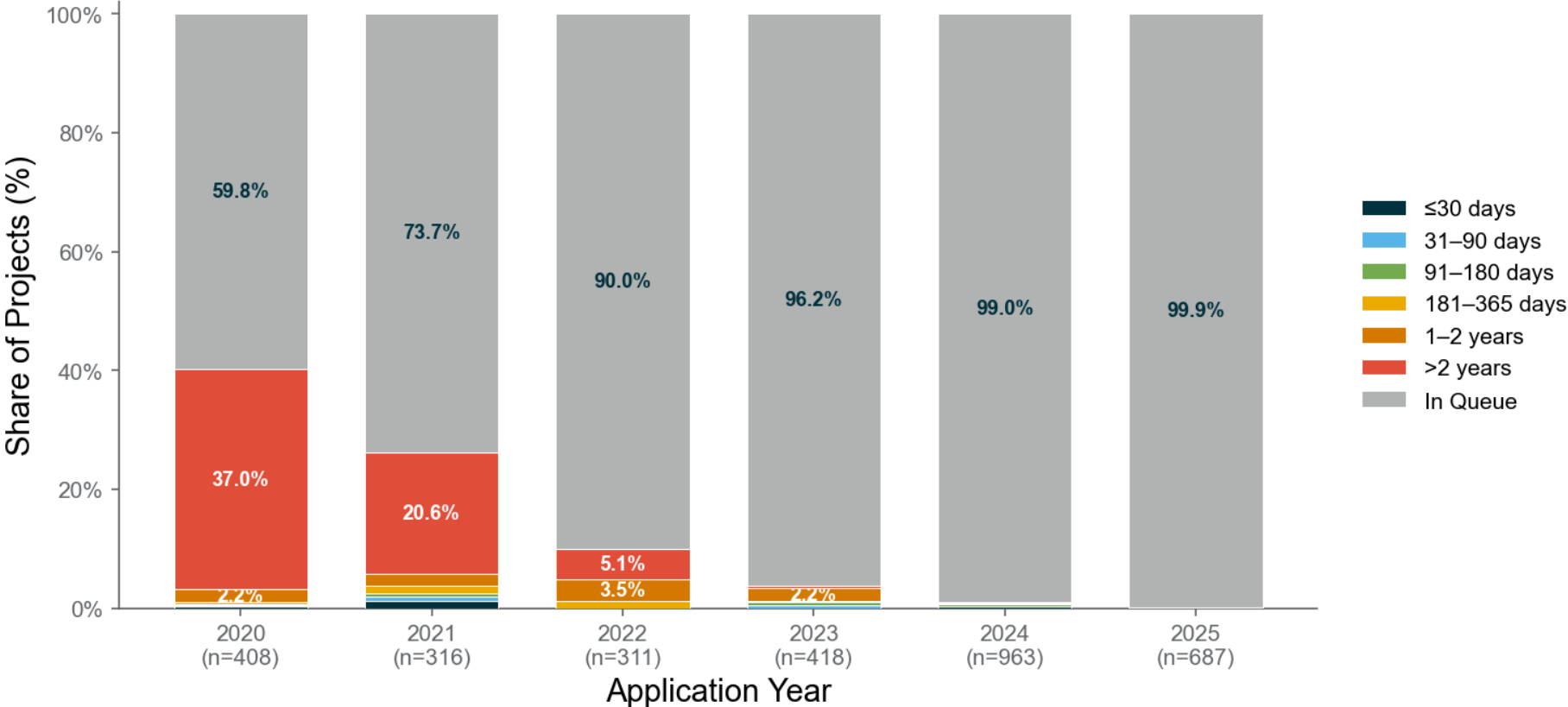
# Interconnection Timelines (2)



The data heavily represent Arizona (42%) and New York (39%). The totals for each bar are impacted by the sample for each year.

# Interconnection Timelines (3)

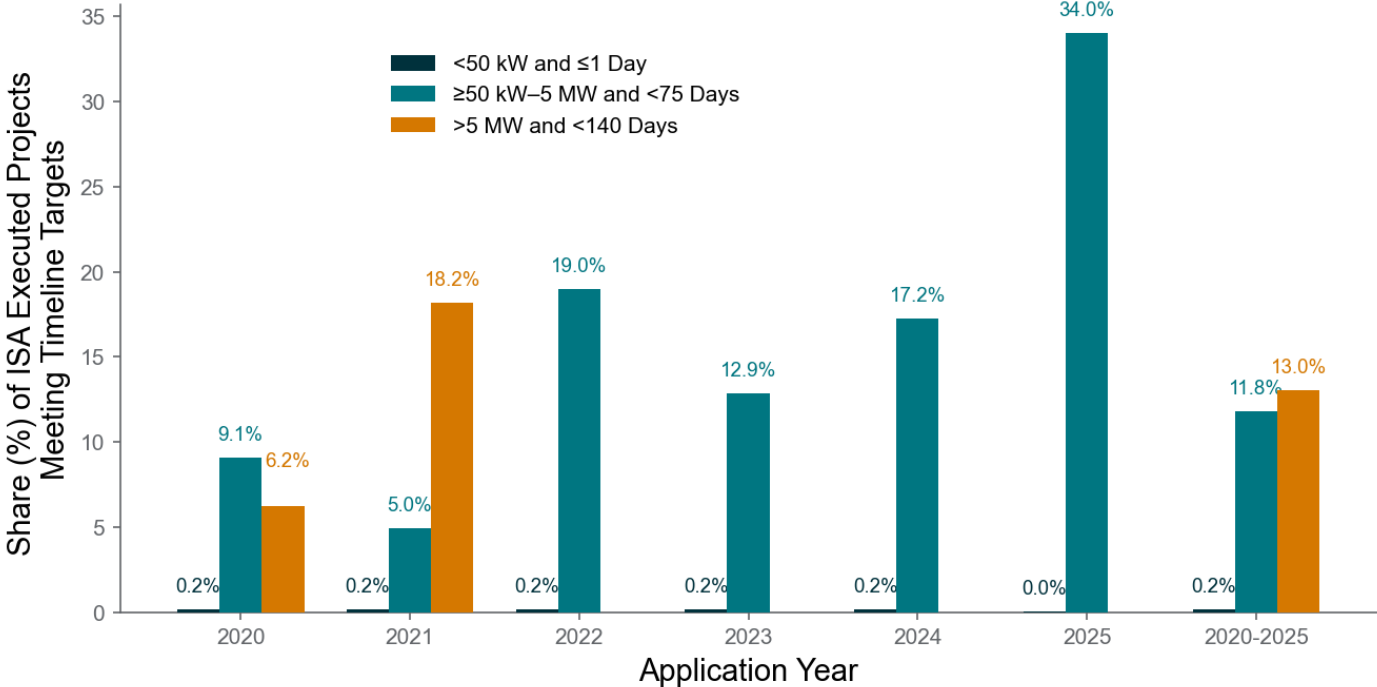
## Time to PTO by Application Year (>1-5 MW)



States represented in the sample include AZ, CT, DC, DE, MA, MD, ME, MN, MT, NY, OR, RI, TX with majority of the data representing NY (55%) and MD (11%) and MA (11%).

The data heavily represent New York (55%). The totals for each bar are impacted by the sample for each year.

# Interconnection Timelines (4)



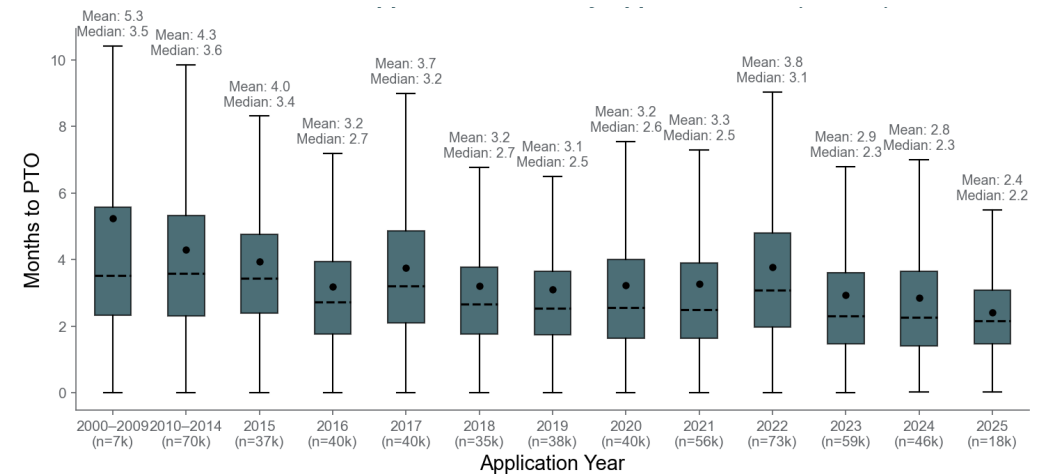
- Using metrics [established by DOE](#) to improve DER interconnection timelines by 2030, LBNL analyzed timeline data to determine the share of projects that applied for interconnection between 2020-2025 and achieved ISA execution.
  - Virtually no projects <50 kW met the target for executing an ISA within 1 day.
  - 12% of projects ≥50 kW-5 MW met the target of executing an ISA in <75 days.
  - 13% of projects >5 MW met the target of executing an ISA in <140 days.

Bars with no or insufficient data (<10 projects) are excluded.  
 92% of the data for this analysis is for NJ projects.

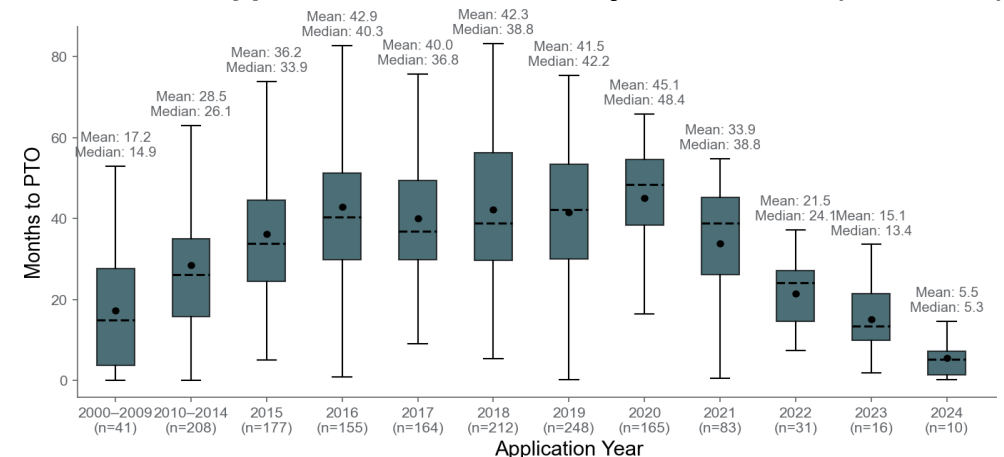
# Interconnection Timelines (5)

- ❑ The median timeline from application to PTO, for all project sizes and technologies, was less than four months from 2000-2025.
- ❑ These results match the median and mean timelines for small projects (<30 kW), which make up 97% of the dataset.
- ❑ Median timelines from application to PTO for projects >1–5 MW more than doubled between 2000 and 2018, but have significantly improved since then.

Months From Application to PTO for Projects <30 kW (2000-2025)<sup>1</sup>



Months From Application to PTO for Projects >1-5 MW (2000-2024)<sup>2</sup>



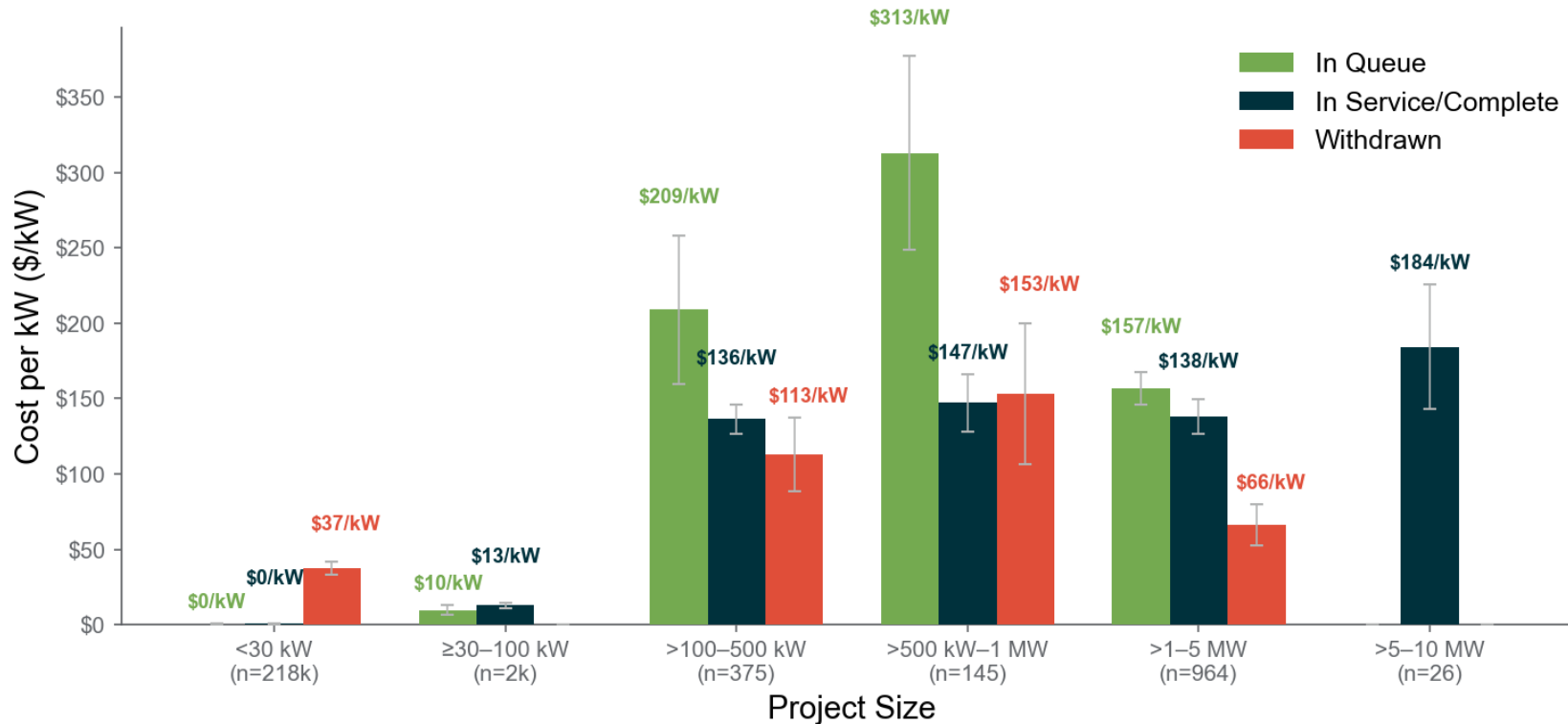
<sup>1</sup>States represented include: AZ, DC, IN, MA, ME, MN, NY, RI, TX, WA, but the majority of data is represented by AZ data (46%) and NY data (42%).

<sup>2</sup>States represented include: AZ, CT, DC, DE, MA, MD, ME, MN, MT, NY, OR, RI, but the majority of data is represented by NY data (59%) and MA data (27%).

Cut-off date for sample collection biases timelines in 2024 and 2025. We excluded 2025 from the >1-5 MW figure because there is only one project.

# Total Upgrade Costs (1)

Average Upgrade Costs per kW by Project Size and Status (2015–2025)

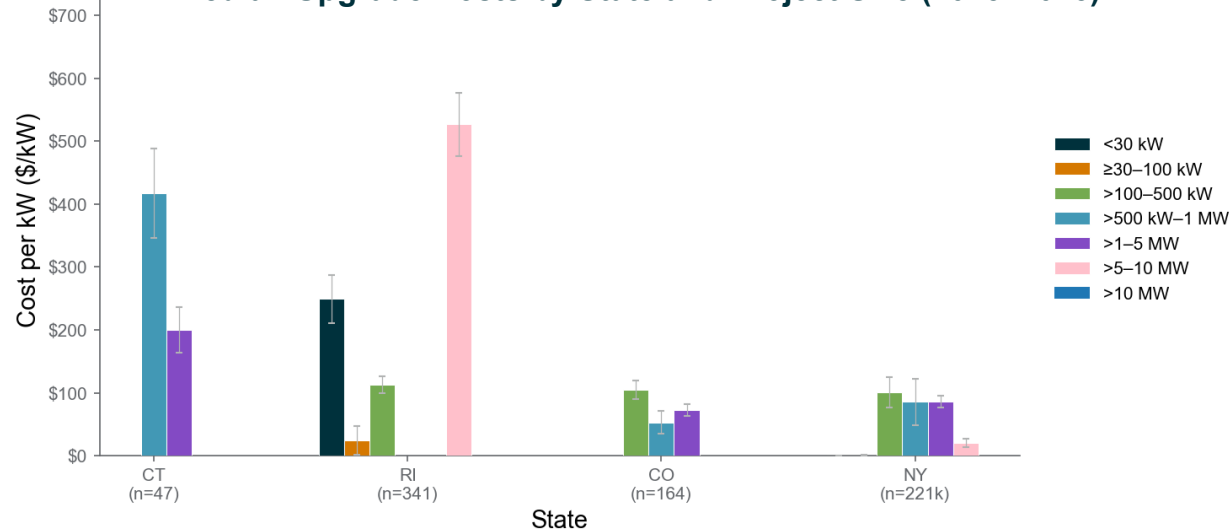


States represented in the cost data sample: CO, CT, NY, RI. NY represents >99% of the cost data. The figure excludes bars where the sample size is less than 10 projects.

- The cost data represent distribution system upgrade costs *paid by DER interconnection customers*.
- High upgrade costs (per kW) for projects <30 kW are associated with withdrawal of projects from the queue.
- Average upgrade cost per kW of withdrawn projects was lower for projects >1–5 MW than projects >100 kW–1 MW.

# Total Upgrade Costs (2)

Median Upgrade Costs by State and Project Size (2015–2025)



- ❑ Median upgrade costs were lowest overall in New York,\* followed by Colorado.
  - ❑ Lower costs may be indicative of cost sharing mechanisms, particularly in New York.
  - ❑ However, costs vary by project size.

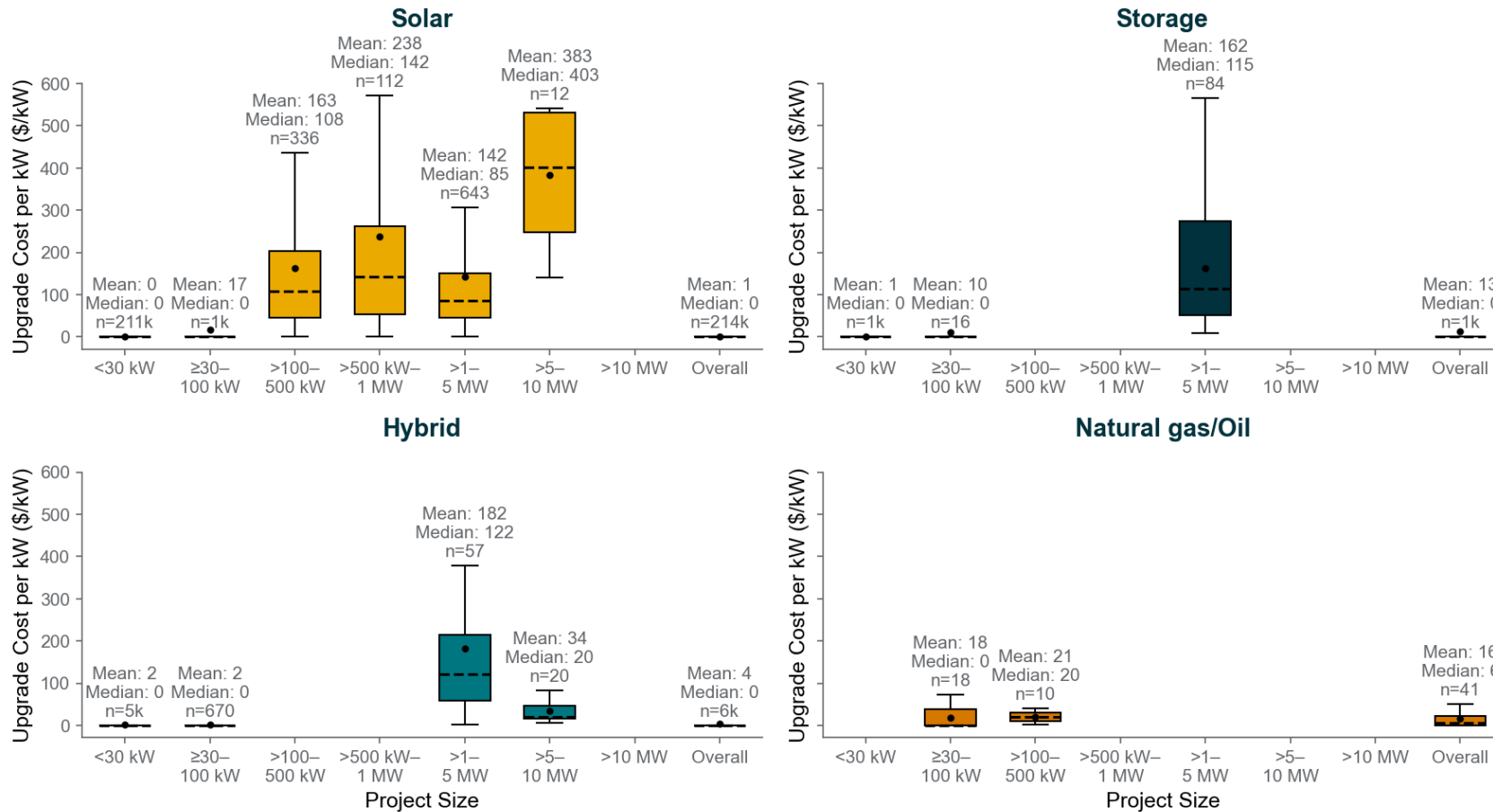
Median Cost per kW (2015-2025)								
State	<30 kW	≥30–100 kW	>100–500 kW	>500 kW–1 MW	>1–5 MW	>5–10 MW	>10 MW	Overall
CT				\$417	\$200	\$155		\$281
RI	\$249	\$25	\$113			\$527		\$173
CO			\$105	\$53	\$72			\$87
NY	\$0	\$0	\$101	\$85	\$86	\$20		\$0
Overall	\$0	\$0	\$108	\$130	\$86	\$46		\$0

\*In LBNL’s sample, 99% of projects in process or in service in New York paid no upgrade costs.

The sample includes only projects in process or operating; it excludes withdrawn or cancelled projects. Cells in the Median Cost table are grayed out where data were not available or too few (<10) projects were included in a dataset.

# Total Upgrade Cost (3)

Upgrade Cost per kW by Technology & Size (2015–2025)



- Natural gas/oil technologies had the highest average upgrade costs overall at \$16/kW for all project sizes.
- Solar technologies had the lowest average upgrade costs overall at \$1/kW for all project sizes.
- Costs vary significantly by project size.
  - For example, solar projects >5-10 MW had the highest average upgrade costs (\$383/kW); solar and natural gas/oil projects <30 kW had the lowest average upgrade cost of \$0/kW.

The sample includes only in process or operating projects; it excludes withdrawn or cancelled projects. Majority of states represented in the sample — Solar: NY (>99%); Storage: NY (99%); Hybrid: NY (>99%); Natural gas/Oil: NY (98%). The figure excludes box plots where the sample size is less than 10 projects.



# Data Sharing Solutions

# Solutions for Sharing Interconnection Data

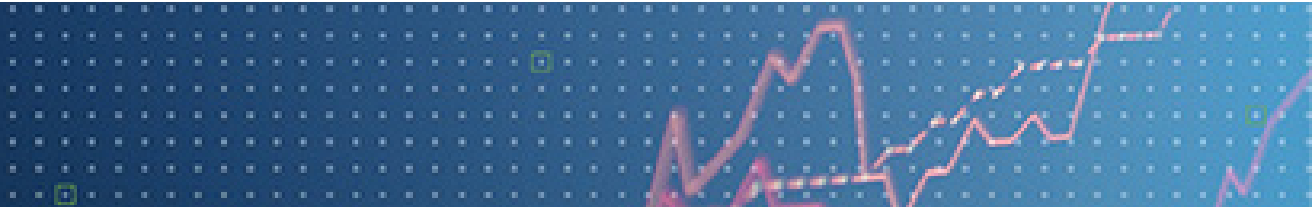
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- Establish guidelines for collecting and sharing data
  - ▣ Consider trade-offs between value created, effort required, and data security and accessibility concerns
- Expand and standardize reporting of interconnection data
  - ▣ Including project attributes and interconnection cost estimates

## Solutions for Timelines

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- Provide pre-application educational materials and self-service options for smaller DER projects
- Establish and require that large DER interconnection applicants meet clear criteria for commercial readiness and queue dwell-time
- Implement and enforce appropriate DER interconnection study timelines and consider penalties for delays in completing studies
- Continue automating parts of DER interconnection application processing
- Implement automation, where possible, to streamline completion of interconnection studies
- Enable flexible interconnection so DERs can be used to defer grid upgrades and avoid delays in exchange for curtailing generation
- Use a group study process to address existing queue backlogs or avoid anticipated queue backlogs
- Develop and standardize an interconnection process for DERs connected to new building construction projects

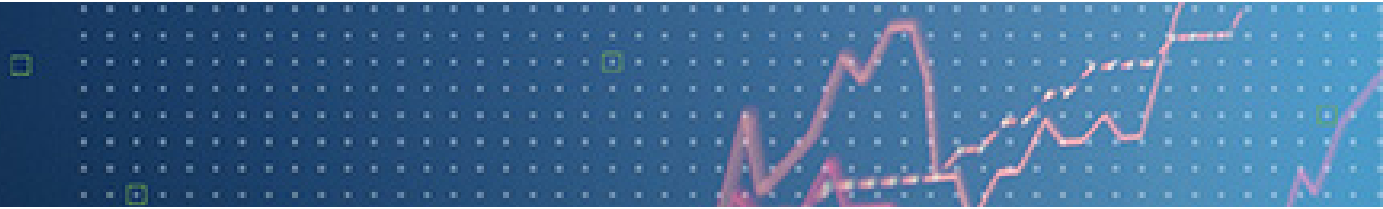


# Conclusions

# Conclusions

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- DER interconnection timelines and costs vary dramatically depending on the state, utility, project size, and technology.
  
- Publicly available DER interconnection data are limited across the U.S.
  - Data are not available for all states, and information on upgrade costs is available only for a few states.
  - Even in states with public data, information is not available for all utilities.
  
- Standardized data reporting, with regular updates, is integral to benchmarking and tracking DER interconnection performance both within and across states and utilities.
  
- The forthcoming LBNL DER Interconnection Dashboard will provide direct access to aggregated data and visualizations from this analysis.



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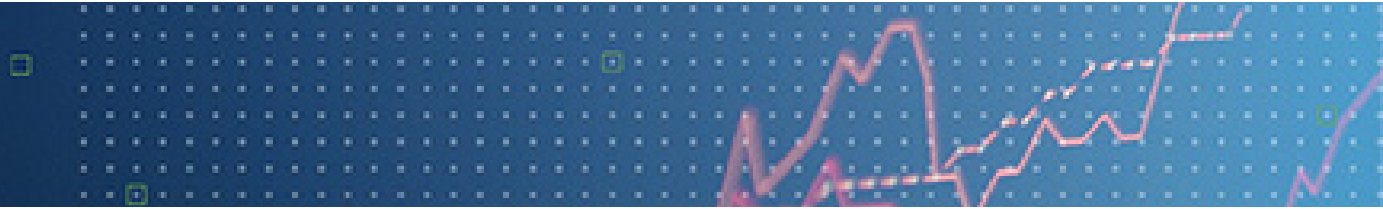
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