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Queued Up: 2025 Edition

Characteristics of Power Plants Seeking Transmission Interconnection As of the End of 2024

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Image source: Vecteezy.com

Interconnection.fyi
Tracking U.S. ISO & utility interconnection queues

INTERCONNECTION INNOVATION e-XCHANGE
U.S. DEPARTMENT OF ENERGY

About This Report:

The *Queued Up* report presents an annual snapshot of trends in requests for generator interconnection to the bulk-power (transmission) electric grid.

This report summarizes empirical data from transmission providers' (i.e., ISO/RTOs and utilities) publicly-available interconnection queues. In some cases, the analysis leverages additional (non-public) data provided to LBNL directly from transmission providers to fill in gaps from the public data.

The 2025 edition of the report summarizes interconnection queue data through the end of 2024. Therefore, any updates to the data and trends that occurred since January 2025 would not be represented in this report.

The report neither directly comments on nor recommends any specific policies – it simply summarizes and explains data trends.

The most up-to-date version of the report, alongside a complete data file, previous versions of the report, and other resources, can always be found at: https://emp.lbl.gov/queues

Contents

What are interconnection queues?

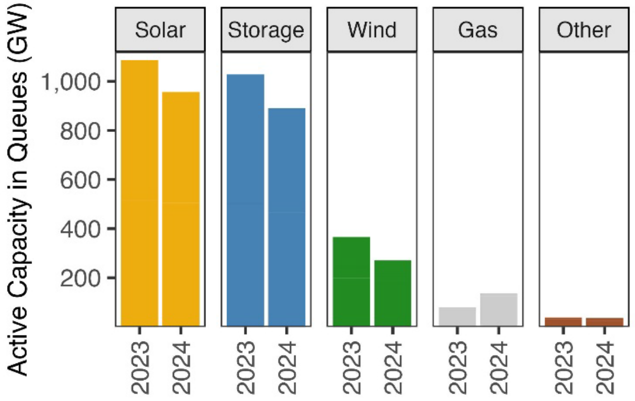
Utilities and regional grid operators (a.k.a., ISOs or RTOs) require projects seeking to connect to the grid to undergo a series of studies before they can be built. This process establishes what new grid system upgrades may be needed before a project can connect to the system and then estimates and assigns the costs of that equipment. The lists of projects that have applied to connect to the grid and initiated this study process are known as "interconnection queues".

Visit https://emp.lbl.gov/queues to access related resources including the complete dataset used for this analysis and interactive data visualization tools

High-Level Findings

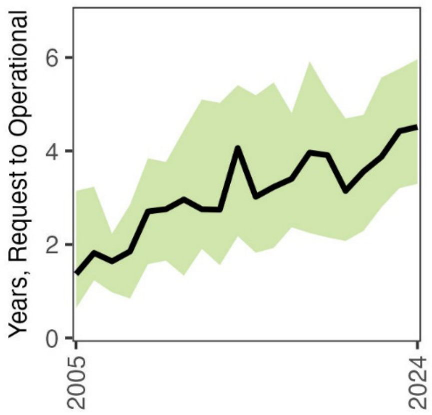
Overall queue volume decreased year-over-year, but gas increased

- Roughly 2,290 gigawatts (GW) of capacity actively seeking interconnection (1,400 GW of generation; 890 GW of storage)
- Natural gas capacity increased (+72%), while solar (-12%), storage (-13%), and wind (-26%) decreased in 2024



Completion rates are generally low; wait times are long

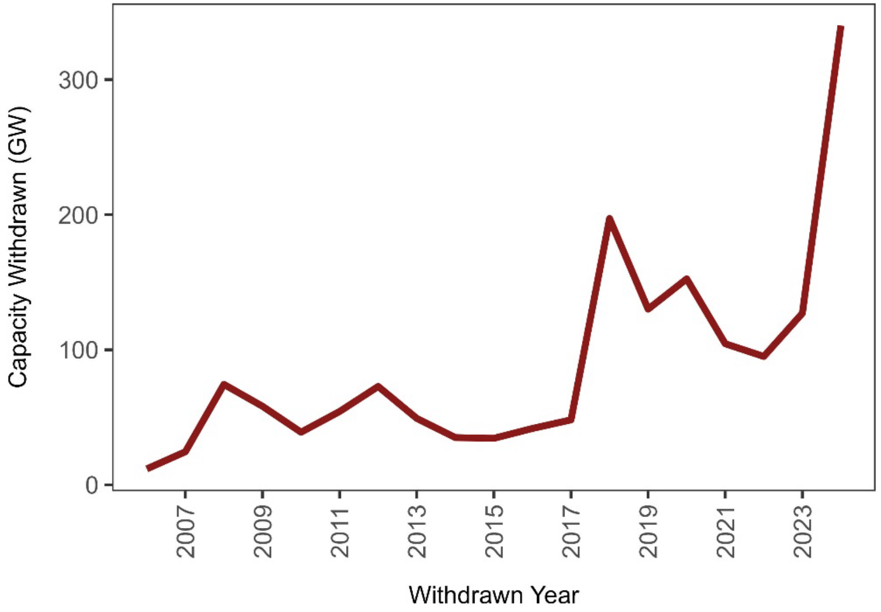
- About 19% of projects (13% of capacity) requesting interconnection from 2000-2019 reached commercial operations by the end of 2024



- The average time projects spent in queues remains high in most, but not all, regions. The typical project built in 2024 took 55 months from the interconnection request to commercial operations[1], compared to 36 months in 2015 and 22 months in 2008
- These trends raise concerns for meeting growing electricity demand and resource adequacy needs

Major process reforms have resulted in historic withdrawal rates, as well as reduced volume of new requests

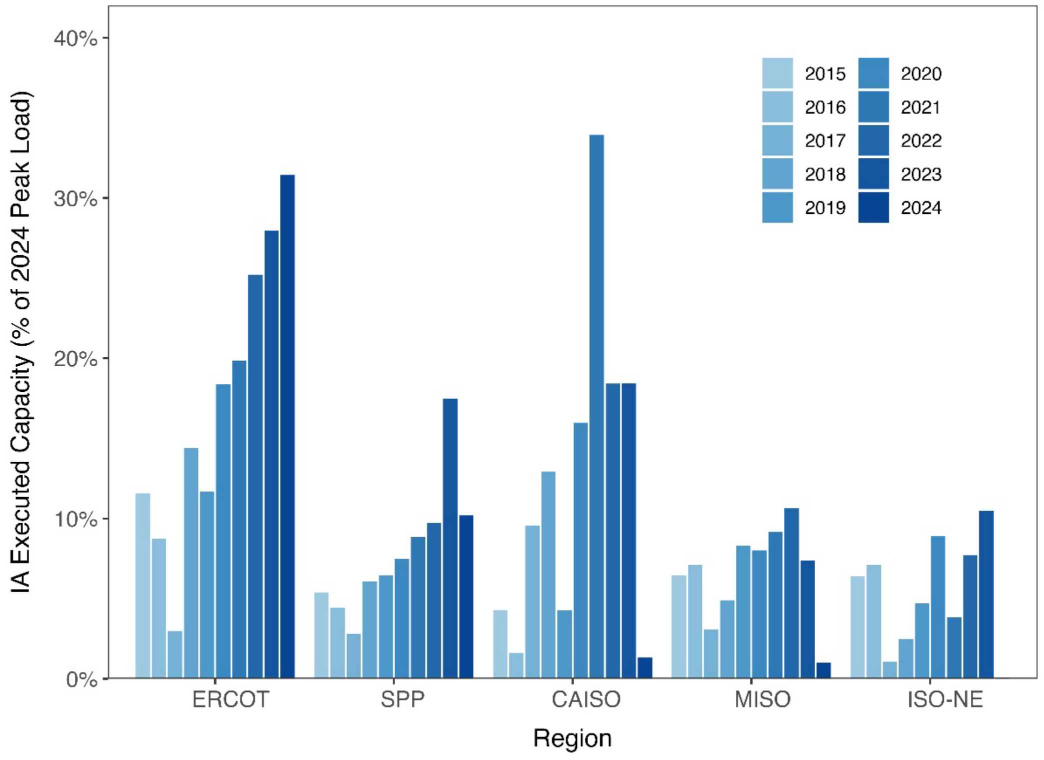
- More than 700 GW[2] of capacity withdrew in 2024, while ~500 GW submitted new requests
- Federal interconnection process reforms such as FERC Order 2023 alongside major ISO reforms (e.g., CAISO, PJM, MISO, and SPP) are driving these trends
- But, market conditions, project financing, transmission constraints, and permitting barriers may also lead to high withdrawals and reduced applications



1. In-service date was only available for 72% of all operational projects. 2. Withdrawn year was only available for 51% all withdrawn requests, so the chart illustrates less than the total withdrawn capacity in each year.

New additions for the 2025 edition of Queued Up:

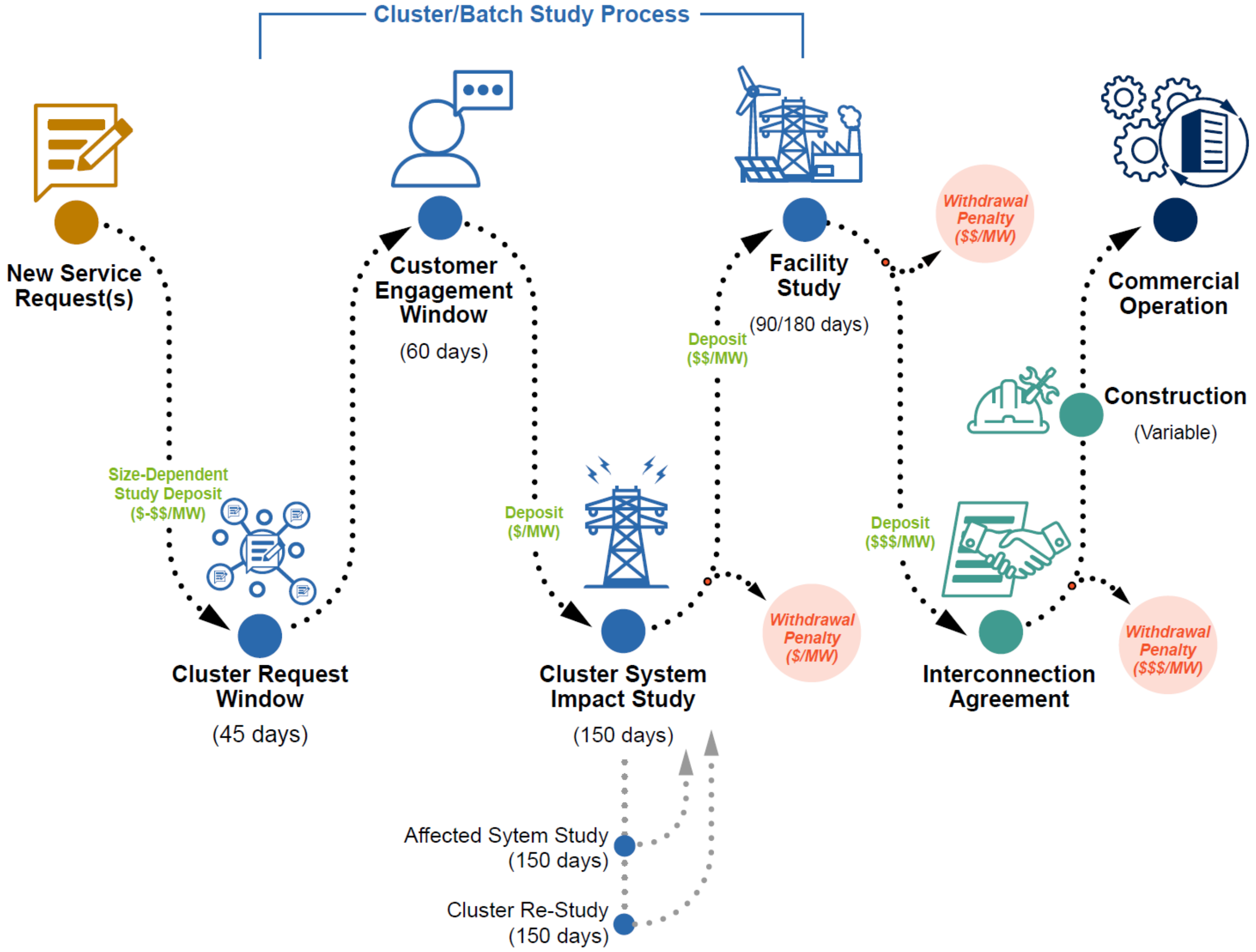
- **Additional detail on data processing methods and data gaps**
  - Detail on data cleaning and processing methods (slide 8)
  - Description and quantification of data gaps (slide 9)
- **Updates to interconnection reforms + regulatory activities**
  - Updated summary of key activities at the federal and balancing area level (slide 10)
- **Drivers of reduction in overall queue volume**
  - Description of potential drivers of reduction in queue volume (slide 14)
- **New analysis on interconnection agreements (IAs)**
  - Additional analysis on the volume of IAs executed, and fraction of requests reaching the IA stage, by region and over time (slide 25)
  - Analysis on fraction of requests that reach commercial operations after signing an IA (i.e., post-IA completion rates) (slide 34)
- **Miscellaneous items**
  - New data provider (interconnection.fyi – see slide 7)
  - Additional detail on natural gas requests (see, e.g., slide 20)
  - New data visualization style for duration time trends (slides 38-49)
  - Several additional balancing areas included (see slide 55)



Annual volume of interconnection agreements executed by region as a fraction of 2024 peak load. See slide 25 for detail.

Typical Interconnection Study Process and Timeline

- A project developer initiates a new ***interconnection request (IR)*** and thereby enters the ***queue***
- A series of ***interconnection studies*** establish what new transmission equipment or upgrades may be needed and assigns the costs of that equipment
- The studies culminate in an ***interconnection agreement (IA)***: a contract between the ISO and/or utility and the generation owner that stipulates operational terms and cost responsibilities
- Most proposed projects are ***withdrawn,*** which may occur at any point in the process
- After executing an IA, many projects are built and reach ***commercial operation***

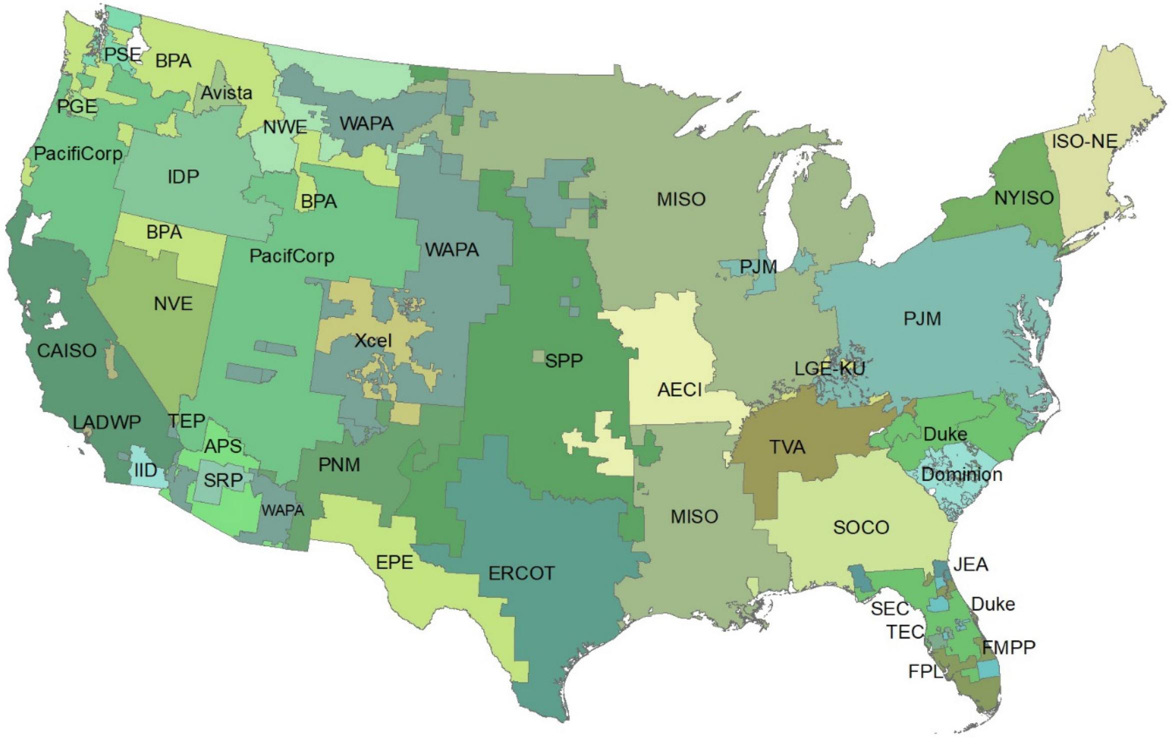


Note: These steps are in accordance with Federal Energy Regulatory Commission (FERC) pro-forma interconnection procedures as outlined in FERC Order 2023. Some ISOs already use a cluster-study approach. The data presented in this report pre-date Order No. 2023 implementation.

Data Sources

Interconnection.fyi
Tracking U.S. ISO & utility interconnection queues

- Data collection led by Interconnection.fyi
- Data collected from interconnection queues for 7 ISOs / RTOs and 49 non-ISO balancing areas (including utilities and Power Marketing Administrations), which collectively represent ~97% of currently installed U.S. electric generating capacity
  - Queue data files are downloaded from transmission provider websites and/or OASIS web pages
  - Includes projects that connect to the bulk-power system, not distribution-connected or behind-the-meter[1]
  - Includes projects in queues through the end of 2024
- The full sample[2] includes:
  - 4,432 “operational” projects (~511.8 GW)
  - 10,303 “active”[3] projects (~2,290 GW)
  - 546 “suspended”[4] projects (~113.6 GW)
  - 20,921 “withdrawn” projects (~3,924 GW)



Coverage area of entities for which data was collected
Data source: Homeland Infrastructure Foundation-Level Data (HIFLD)
Note that service areas can overlap
No data collected for Hawaii or Alaska

A full list of included balancing areas can be found in the appendix

Notes: (1) There are different processes for transmission- and distribution-system interconnection. This report only covers transmission interconnection. (2) The full ‘Queued Up’ data sample can vary somewhat year-over-year – particularly as missing records or data fields are filled in over time. (3) “Active” requests include those that are actively requesting or undergoing grid interconnection studies, as well as those that have already executed interconnection agreements but have not yet reached commercial operations. (4) The implication of “suspended” differs by balancing area but generally means the request is on hold; see slide 24 notes for detail.

Data Cleaning and Post-Processing Methods

- The initial data collection effort involves downloading >80 queue data files from 56 transmission providers (ISO/RTOs and utilities)
  - These "raw" data files are unstandardized in terms of format, layout, data fields included, and file type (Excel, CSV, PDF, HTML)
- In order to compile a clean dataset for this analysis, substantial data cleaning, standardization, and QA/QC was conducted by LBNL and Interconnection.fyi teams:
  - Standardizing all raw data fields into a specified set of columns
  - Mapping generator types into standardized categories
  - Mapping interconnection status into standardized categories
  - Generating separate capacity columns for hybrid plants (mw_1, mw_2)
  - Cleaning and standardizing other fields (e.g., dates, county, state)
  - In-filling missing data (e.g., dates) with other available data sources (e.g., non-public data shared by transmission providers) where possible
- Additional processing required for hybrid power plants
  - Some transmission providers do not explicitly identify hybrid (co-located) power plants; LBNL identifies and matches these
  - Many transmission providers do not provide separate capacity data for each component of hybrid plants. Where *storage* capacity is missing, LBNL estimates and imputes the missing values

The final cleaned, processed, and fully compiled dataset is available at: https://emp.lbl.gov/queues

Field Name	Description
q_id	queue ID number
q_status	current queue status (active, withdrawn, suspended, or operational)
q_date	interconnection request date (date project entered queue)
prop_date	proposed online date from interconnection application
on_date	date project became operational (if applicable)
wd_date	date project withdrawn from queue (if applicable)
ia_date	date of signed interconnection agreement (if applicable)
IA_status_raw	interconnection study phase / status from queue
IA_status_clean	standardized interconnection study phase / status
county	county where project is located
state	state where project is located
county_state_pairs	concatenated county and state
fips_codes	5-digit FIPS code
poi_name	point of interconnection name
region	region where project is located (ISO or non-ISO region)
project_name	project name
utility	utility name
entity	transmission provider entity name (ISO or utility)
developer	project developer name
cluster	queue cluster
service	interconnection service type (e.g., ERIS or NRIS, energy or capacity)
project_type	type of project or interconnection request (load/transmission/generation)
type1	resource type 1
type2	resource type 2
type3	resource type 3
mw1	capacity of type 1 (MW)
mw2	capacity of type 2 (MW)
mw3	capacity of type 3 (MW)
type_clean	resource type - standardized
q_year	year project entered queue
prop_year	proposed online year from interconnection application

Notable Interconnection Data Gaps

Data	Detail
Interconnection Agreement (IA) / study phase status	Unknown for ~49% of records
Commercial operations date (actual COD for operational plants)	Unknown for ~24% of operational plants (lack of interoperable IDs prevents merging dates from other sources)
Withdrawn date	Unknown for ~49% of withdrawn requests
IA date (date of executed agreement)	Unknown for ~39% of requests with draft or executed IA *including operational* (*see table*)
Hybrid capacity (breakdown for hybrid plants, i.e. MW_1, MW_2)	Missing or partially missing in most regions (complete in CAISO, ERCOT); imputed (estimated) where missing
Geospatial information	Additional spatial data on the location (lat/long) of requests (or their point of interconnection) is not available
Interconnection costs	The interconnection upgrade costs assigned to project developers are typically not accessible; (see emp.lbl.gov/interconnection_costs for LBNL's data and analysis of costs)

Completeness of "IA Date" data by region

	Count with IA (includes operational)	Count with IA Date	**Percent Populated**
CAISO	470	346	74%
ERCOT	1085	1011	93%
ISO-NE	187	144	77%
MISO	2,034	1,655	81%
NYISO	*Unknown*	109	NA
PJM	1,677	249	15%
SPP	651	561	86%
Southeast	581	164	28%
West	1,397	772	55%
All	**8,192**	**5,011**	**61%**

Berkeley Lab (with support from DOE's i2X program and Grid Deployment Office) is actively seeking to fill these data gaps through partnerships, data sharing agreements, and data transparency initiatives.

FERC Order 2023[1] overhauled the interconnection process, and many RTOs are proposing or implementing major interconnection process updates and reforms[2]

Interconnection Reforms in FERC Order 2023

- ***Cluster studies***; ***first ready, first served***; higher ***deposits & readiness*** criteria for developers
- ***Timeline, process, and reporting*** requirements for transmission providers; ***Financial penalties*** for delays
- Visual representation ***(heatmaps) of available transmission capacity***
- Improved and standardized process for ***affected system studies***
- Improved procedures and ***flexibility for storage and hybrid resources***
- Consideration of ***alternative transmission technologies (GETs)***
- Compliance filing deadline: ***May 2024***

Major ISO/RTO Reforms & Updates

CAISO
- Interconnection Process Enhancements (IPE) (*approved by FERC Oct. 2024*).
- Prioritizes requests where transmission system has available existing or planned capacity and limit requests in a study area based on planed transmission capacity.
- Delayed Cluster 16 request application window from April 2024 (new date TBD) due to queue volume and reforms (thus, no new requests in 2024).

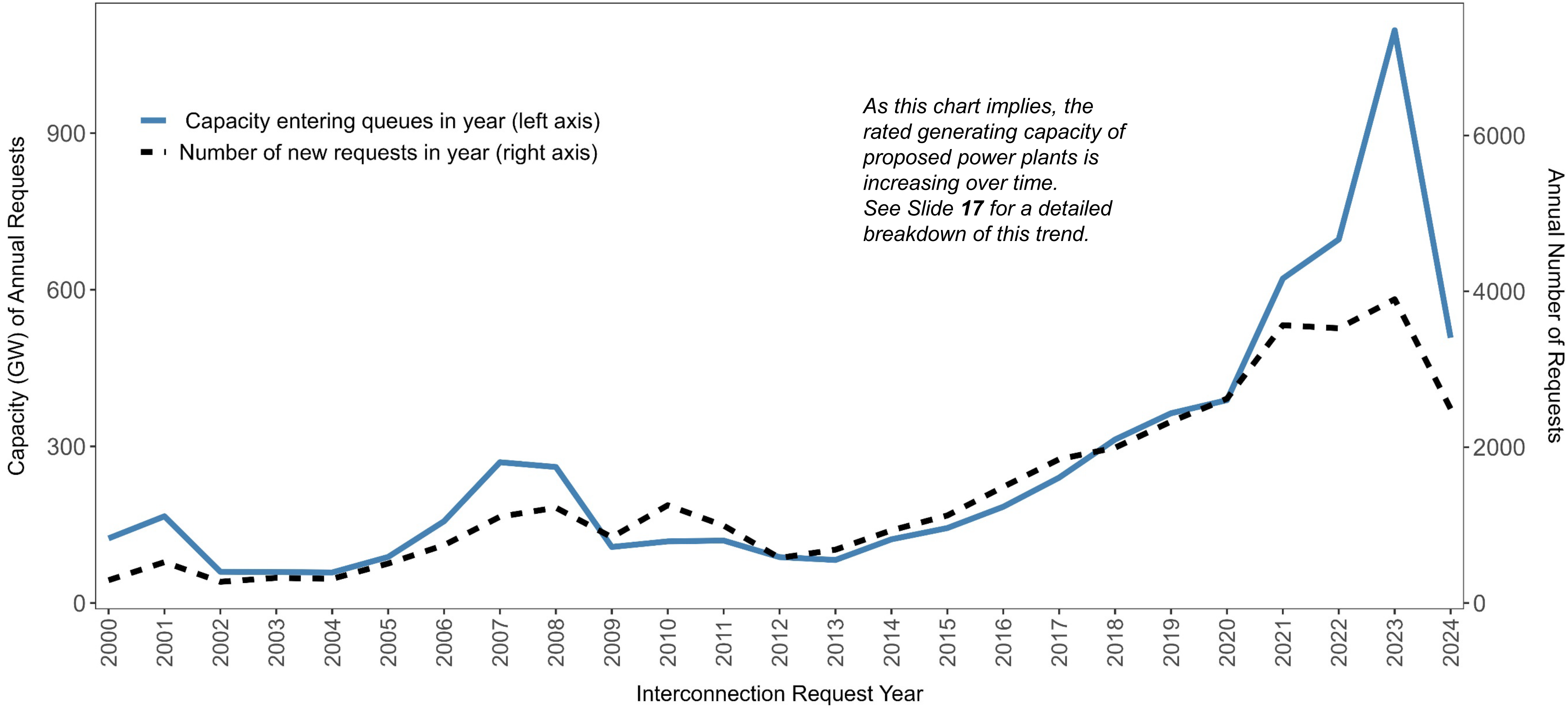
PJM
- Implemented transition from serial first-come, first-served queue process to a first-ready, first-served clustered cycle approach, grouping projects into three-phase cluster cycles for studying and allocating interconnection costs (*approved by FERC Nov. 2022*).
- New requests received in 2024 were not immediately available for study as they were still processing the backlog through the transition process.
- New one-time only fast-track process for high resource adequacy projects (*approved by FERC Feb. 2025*).

MISO
- Increased milestone payments, adopted an automatic withdrawal penalty, and expanded site control requirements for interconnection facilities (*approved by FERC Jan. 2024*).
- Proposal to cap total queue size was approved by FERC (*January 2025*).

SPP
- Filed a waiver to postpone closing of 2024 queue request window until March 2025, and defer opening the 2025 request window until April 2026 (*approved by FERC Oct. 2024*).

Notes: (1) FERC Order 2023 - RM22-14-000. https://www.ferc.gov/media/e-1-order-2023-rm22-14-000. (2) The effects of Order 2023 and other reforms will not be immediate; most data presented in this report pre-date these reforms.

Annual interconnection requests surged from 2013-2023, but slowed in 2024; Still, nearly 2,500 requests representing over 500 GW were added in 2024



Notes: (1) This total annual volume includes projects with a current queue status of "active", "suspended", "withdrawn", or "operational". (2) All values – especially for earlier years – should be considered approximate.

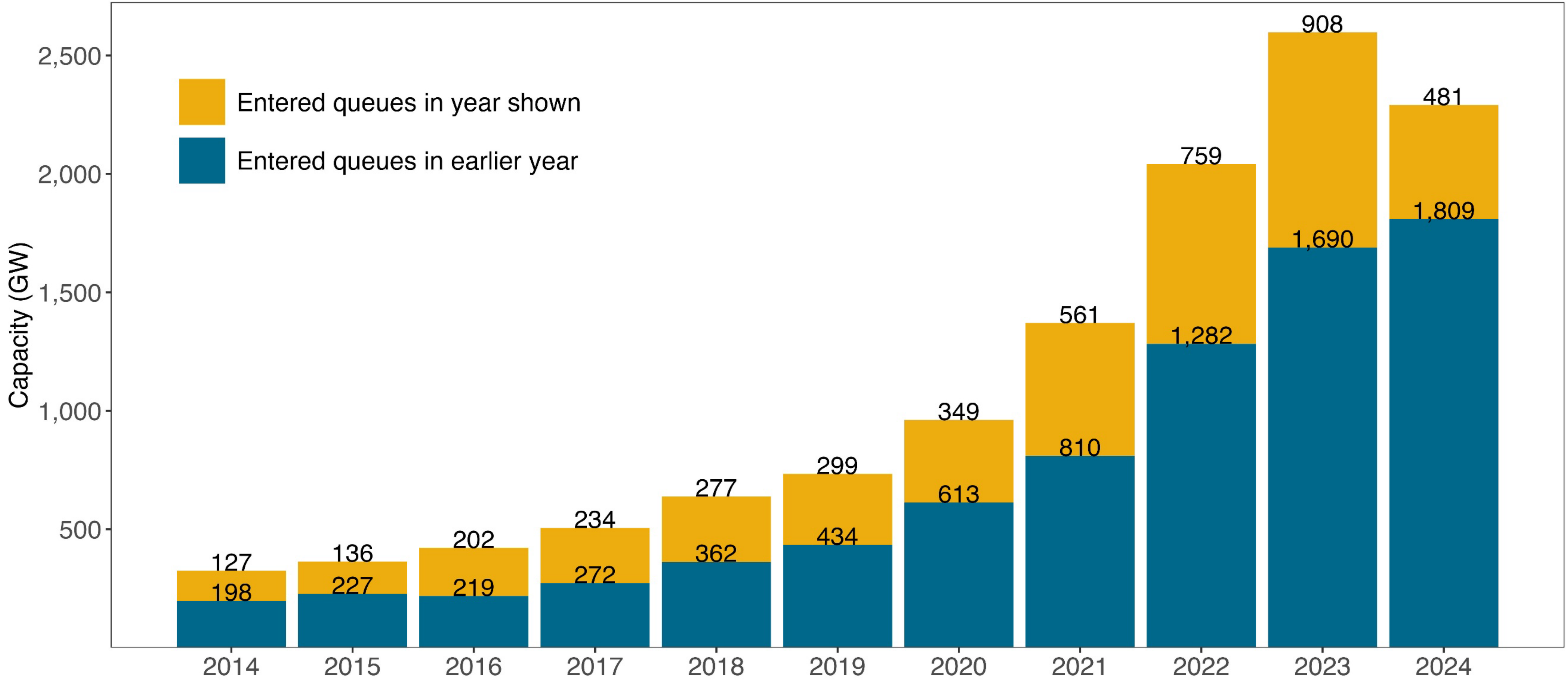
Active Projects in Interconnection Queues: Volume, Regional Trends, Study Phase, and Hybrids

Includes data from all 7 ISO/RTOs and 49 non-ISO balancing areas, totaling 10,303 requests and 2,290 GW

Region	*n* (active)	Capacity (GW)
CAISO	638	272.8
ERCOT	1,447	346.1
ISO-NE	399	45.6
MISO	2,213	447.5
NYISO	402	78.5
PJM	1,942	211.5
SPP	643	142.4
Southeast (non-ISO)	1,002	162.5
West (non-ISO)	1,617	583.5

Notes: (1) Active capacity (GW) shown includes some estimates for hybrid storage capacity in cases where it was missing. (2) Data were sought from 7 ISOs and 49 non-ISO BAs (full list available in appendix). (3) CAISO includes Cluster 15. (4) "Active" requests include those that are actively requesting or undergoing grid interconnection studies, as well as those that have already executed interconnection agreements but have not yet reached commercial operations. (5) See appendix for more detailed summary tables

Total (cumulative) active capacity in queues decreased 12% in 2024, to 2,290 GW; New (annual) requests were down by nearly half in 2024 compared to 2023



Note that some requests can be submitted and withdrawn in the same year; this chart only includes capacity remaining as of the <u>*end*</u> *of each year. Therefore, the yellow bars are lower than the total capacity of new requests in a given year (as shown on slide 11).*

Factors that may have contributed to the reduction in new requests and cumulative active queue capacity in 2024

Federal Reform: FERC Order 2023

- Many balancing areas transitioning to cluster studies
- Requires higher at-risk deposits from developers
- Requires 90% site control to submit request; 100% site control at facility study phase

ISO Reforms and Delays

- **CAISO:** Interconnection Process Enhancement
  - Cluster 15 request window closed in April, 2023
  - Cluster 16 was delayed; no new requests in 2024
- **PJM:** Transition cycle process
  - Major overhaul to PJM interconnection process
  - New requests received in 2024 were not immediately available for study as they were still processing backlog
- **SPP:** Postponed request window closing
  - Extended 2024 request window to 2025

See slide 10 for more detail on these reforms

Higher Withdrawal Rates

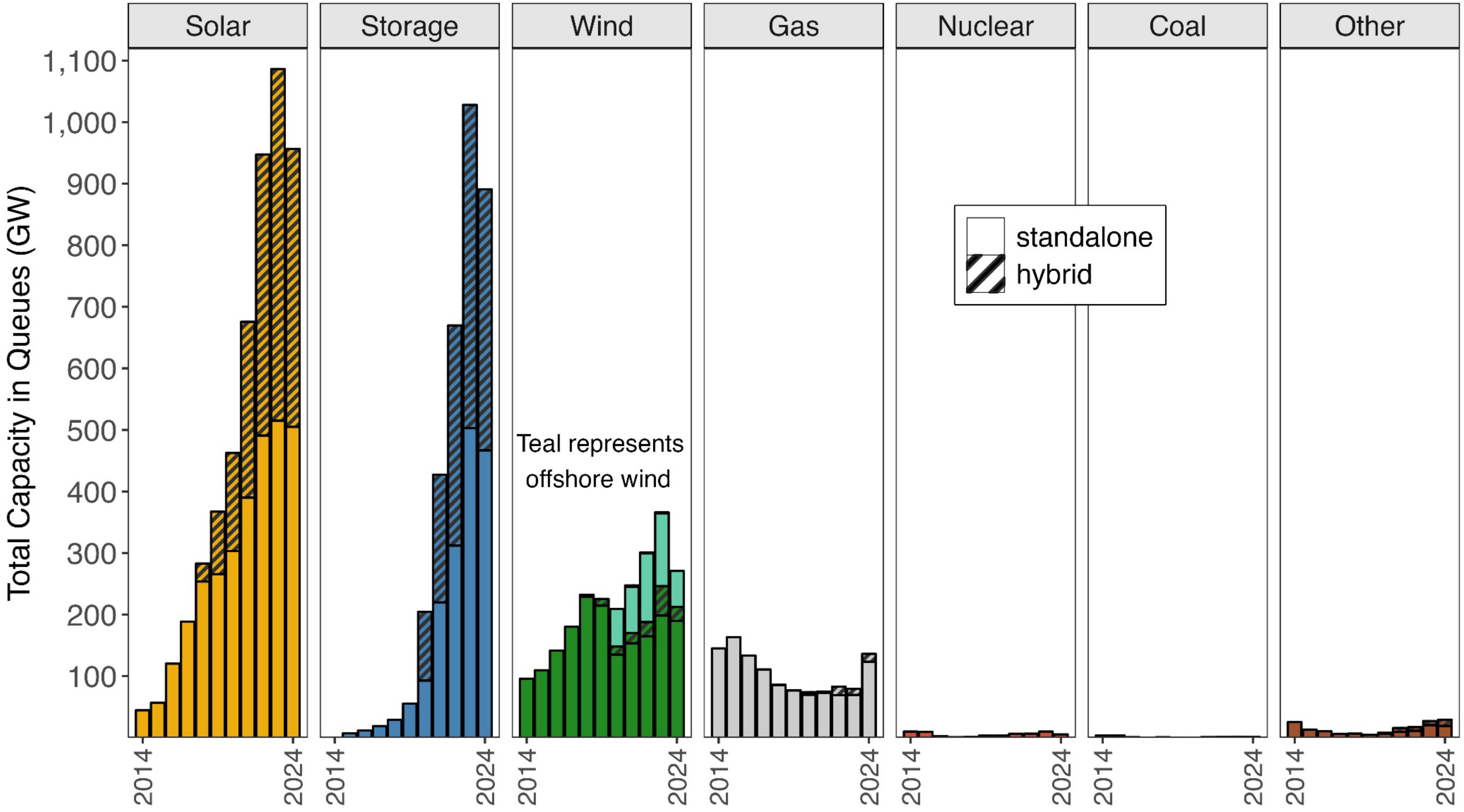
- In addition to reduced new requests, several regions experienced significant withdrawal rates in 2024, likely due to reforms (see left) as well as policy and market drivers. For example:
  - **NYISO:** Substantial offshore wind capacity withdrew in 2024
  - **CAISO:** Many withdrawals from Cluster 15 as IPE reforms go into effect
  - **PJM:** Many withdrawals as transition cluster cycles begin

High Interconnection Upgrade Costs

- Limited available transmission capacity has resulted in high network upgrade costs for new requests, which contributes to high withdrawals and may deter developers from submitting new requests
- See LBNL's related research on interconnection costs:

https://emp.lbl.gov/interconnection_costs

Gas (136 GW) capacity increased by 72% year-over-year, whereas Solar (956 GW, -12%), Storage (890 GW, -13%), and Wind (271 GW, -26%) all decreased in 2024

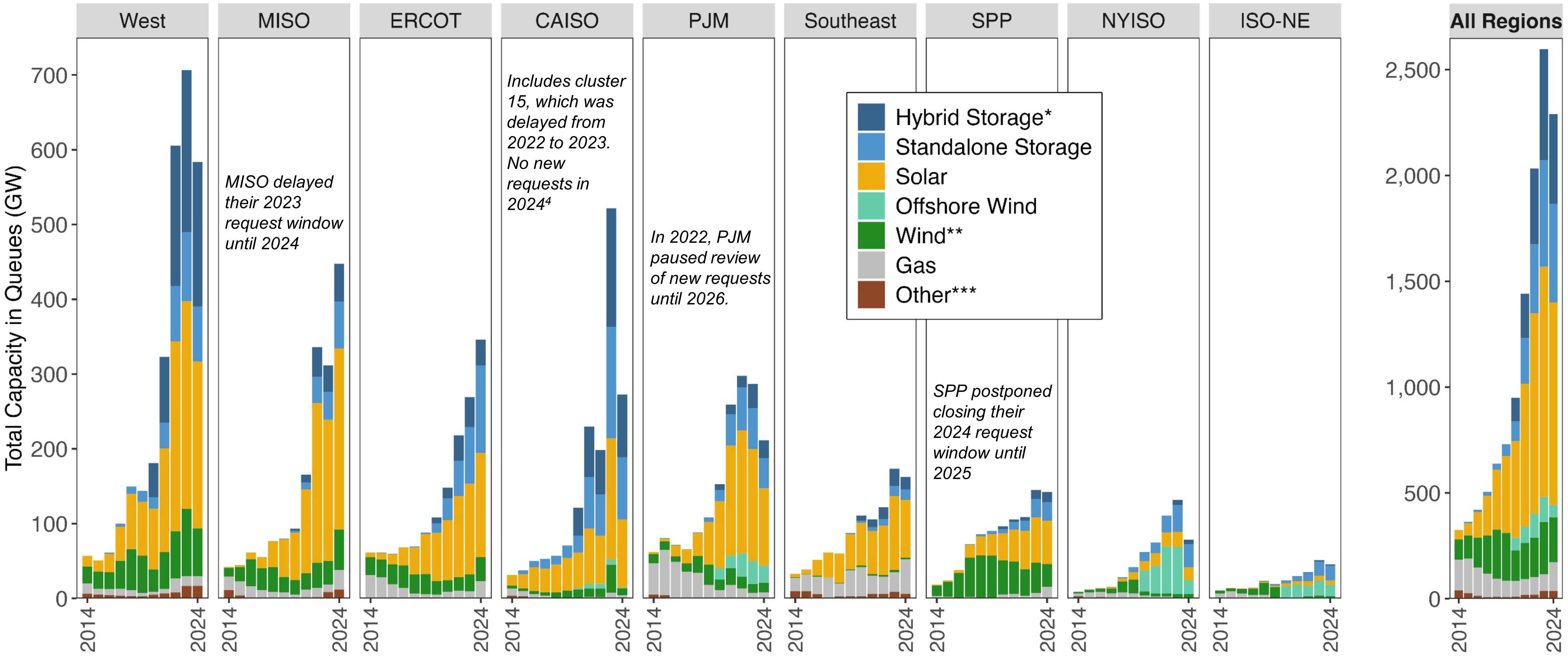


- **Wind** includes both onshore and offshore
- **Other** includes
  - Hydropower
  - Geothermal
  - Biomass/biofuel
  - Landfill gas
  - Solar thermal
  - Oil/diesel
- **Storage** is primarily (99%) battery, but also includes pumped storage hydro, compressed air, gravity rail, and hydrogen

See https://emp.lbl.gov/queues to access an interactive data visualization tool.

Notes: (1) Hybrid storage capacity is estimated for some projects using storage:generator ratios from projects that provide separate capacity data, and that value is only included starting in 2020. Storage duration is not provided in interconnection queue data. (2) Wind capacity includes onshore and offshore for all years, but offshore is only broken out starting in 2020. (3) Hybrid capacity is included separately in respective resource categories (see slide 27 for detail). (4) Not all of this capacity will be built.

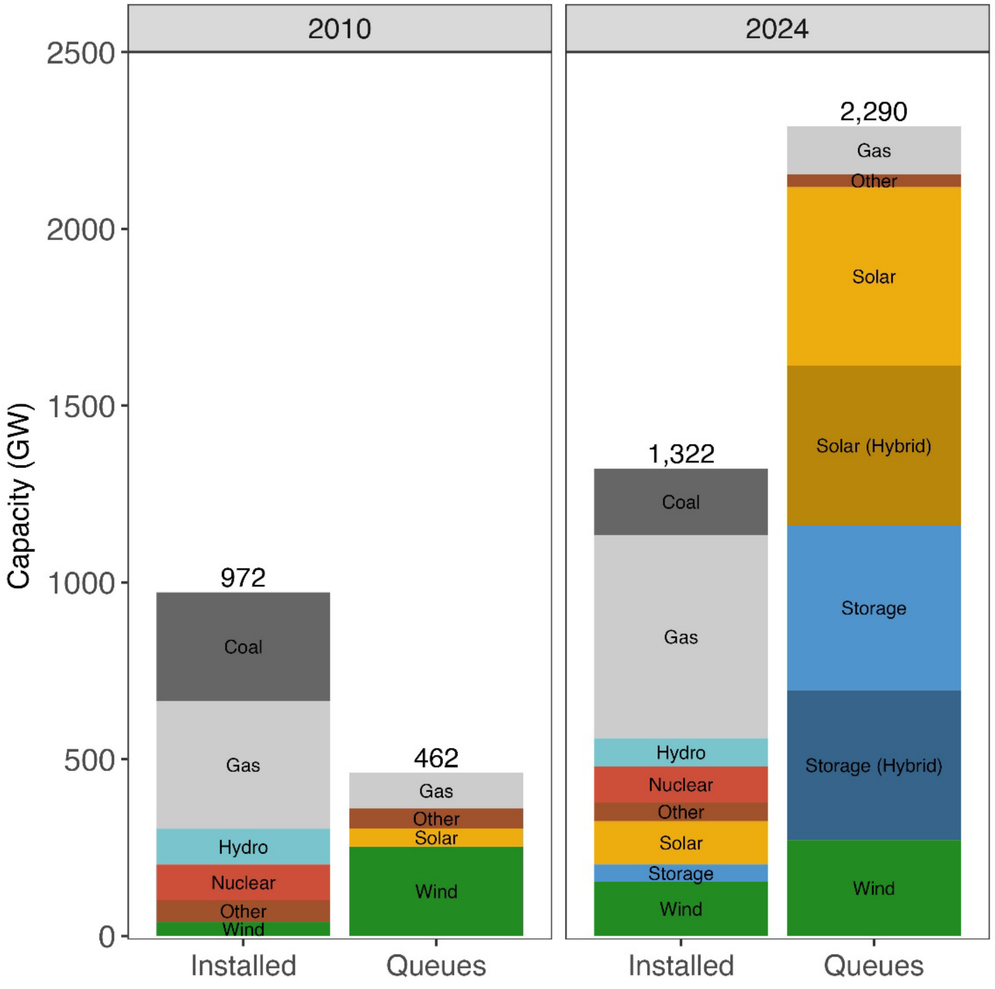
Active queue capacity is highest in the West (584 GW), followed by MISO (447 GW). Several regions have paused or delayed new requests as reforms are implemented



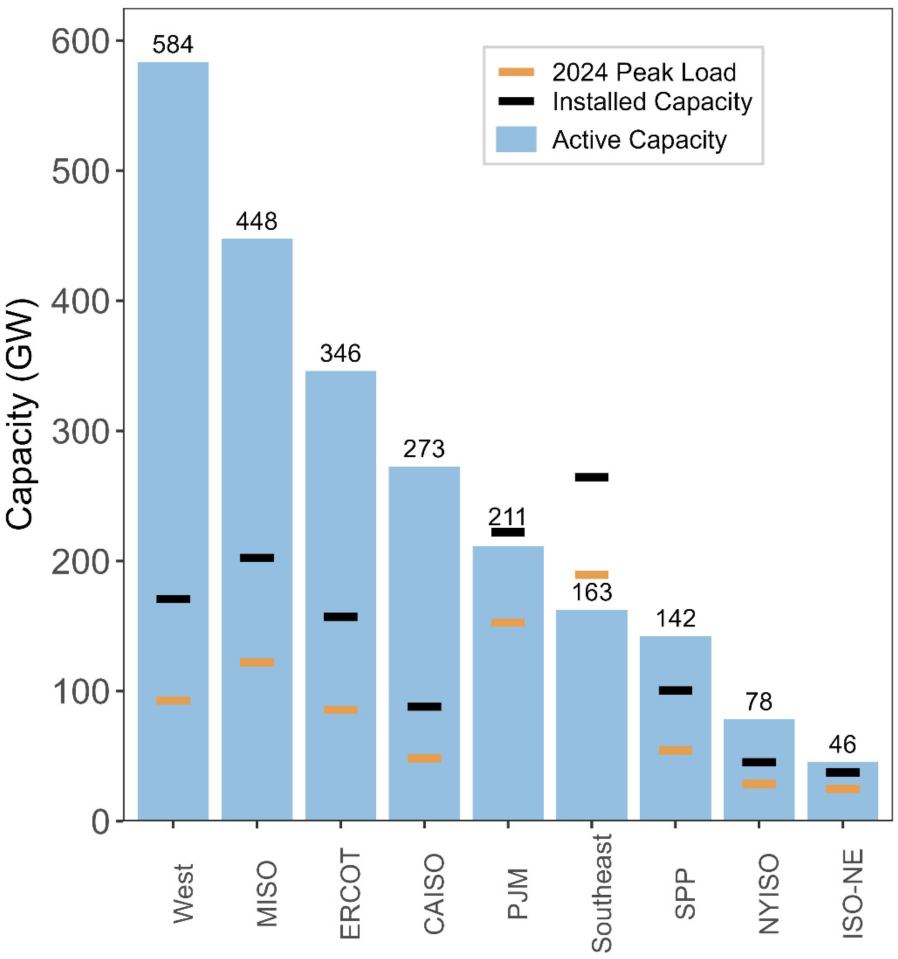
*Notes: (1) *Hybrid storage capacity is estimated for some projects using storage:generator ratios from projects that provide separate capacity data, and that value is only included starting in 2020. Storage duration is not provided in interconnection queue data. (2) **Wind capacity includes onshore and offshore for all years, but offshore is only broken out starting in 2020. (3) ***Other in this chart includes Coal, Nuclear, Hydro, Geothermal, and Other / Unknown. (4) CAISO required cluster 15 to pause due to FERC Order 2023 and resubmit in 2024, resulting in many withdrawals and some changes to requested capacity. (5) Not all of this capacity will be built.*

Active capacity in queues (~2,290 GW) is nearly twice the installed capacity of U.S. power plant fleet (~1,320 GW); greater than peak load and installed capacity in most regions

Entire U.S. Installed Capacity vs. Active Queues



Regional Installed Capacity & Peak Load vs. Active Queues

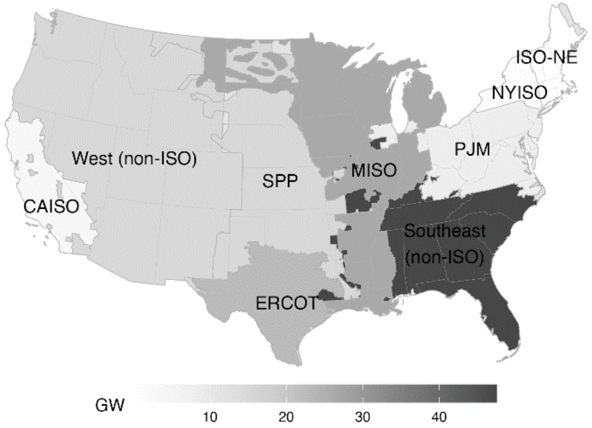


This is not an assessment of resource adequacy. Comparisons of queue capacity to installed capacity or peak load should also consider generators' contributions to resource adequacy. As variable resources, the potential contribution of solar and wind to resource adequacy and peak load requires significant analysis and it is not directly comparable to dispatchable generation resources like natural gas. ***It is highly unlikely that all of this capacity will be built (see slide 31).***

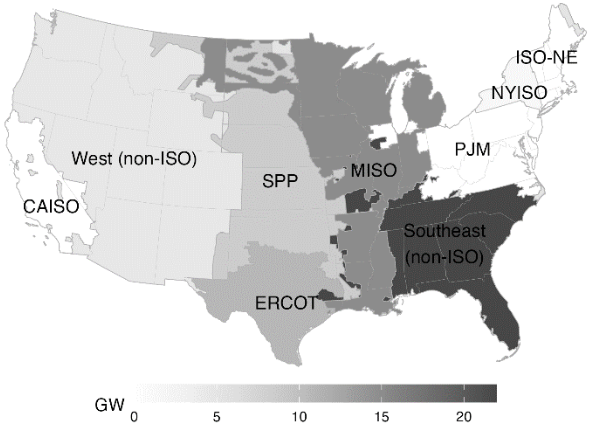
Notes: (1) Hybrid storage in queues is estimated for some projects. (2) Total and regional installed capacity from EIA-860, December 2024. (3) Peak load data from RTO websites or from NERC for non-RTO regions.

Active gas requests are primarily in the Southeast; solar is widespread, with less in SPP and Northeast; storage requests highest in the West but growing in ERCOT and MISO; most wind in the West and MISO

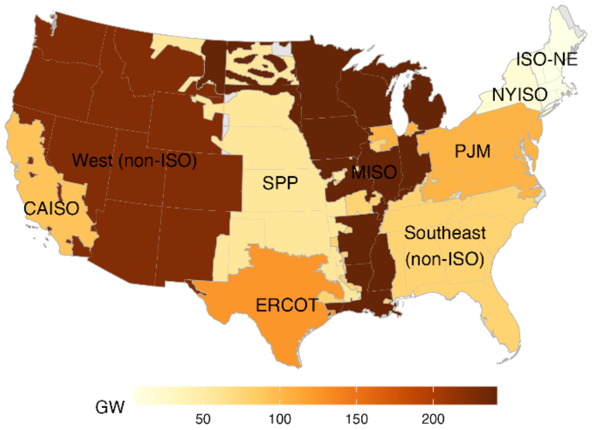
Total Gas Capacity in
Interconnection Queues at the end of 2024



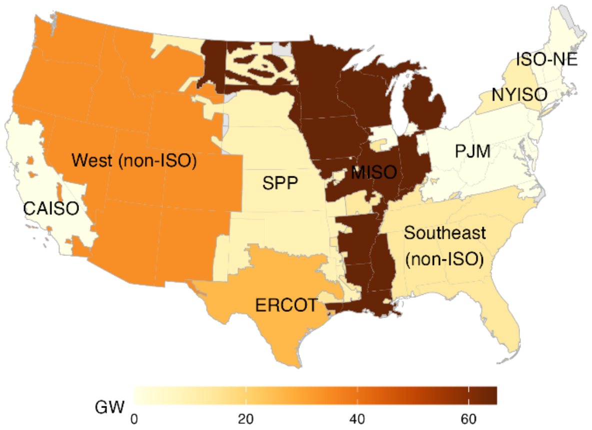
New Gas Capacity Added to
Interconnection Queues in 2024



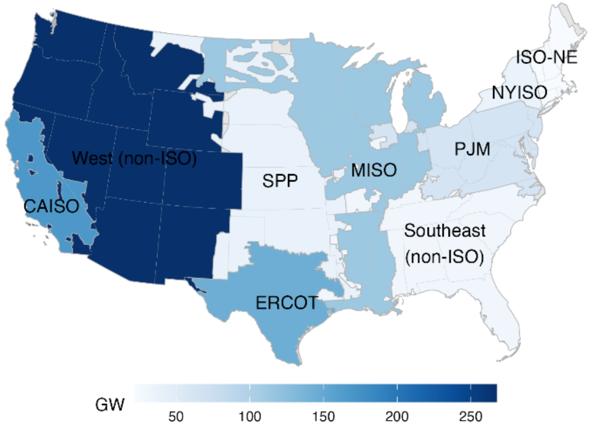
Total Solar Capacity in
Interconnection Queues at the end of 2024



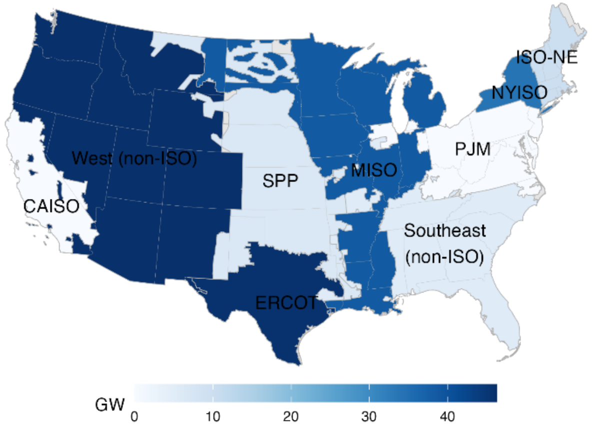
New Solar Capacity Added to
Interconnection Queues in 2024



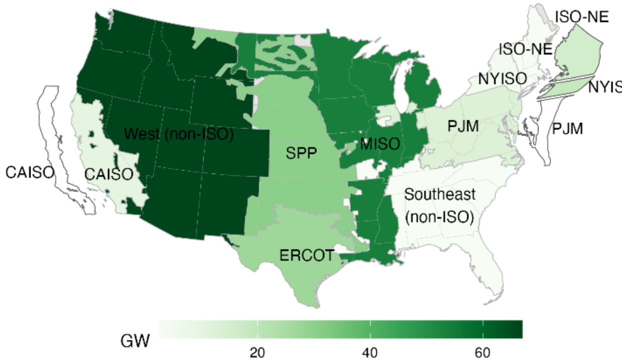
Total Storage Capacity in
Interconnection Queues at the end of 2024



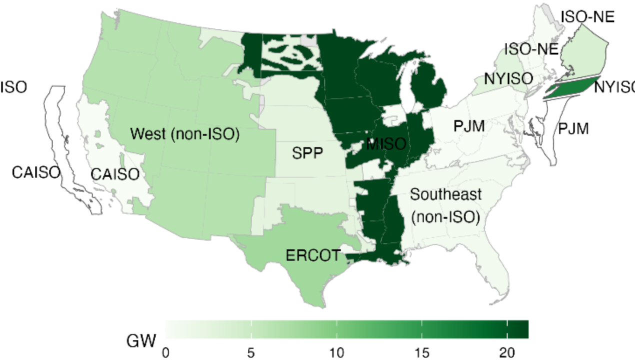
New Storage Capacity Added to
Interconnection Queues in 2024



Total Wind Capacity in
Interconnection Queues at the end of 2024



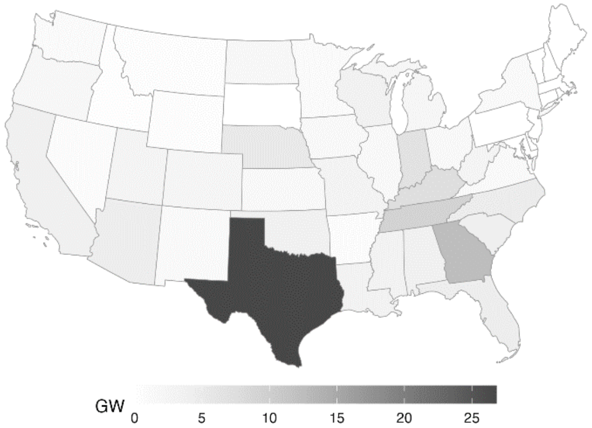
New Wind Capacity Added to
Interconnection Queues in 2024



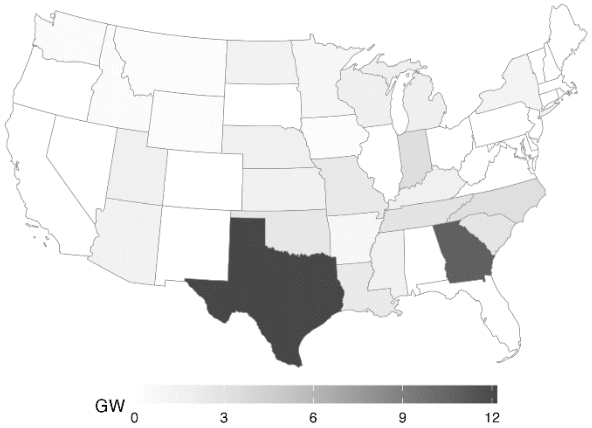
Note: Proposed and ongoing reforms in CAISO, SPP, and PJM resulted in few (or no) new requests in those regions in 2024 (see slide 10)

Texas is a very strong market across all resources. Gas requests are primarily in Texas and the Southeast. Solar requests exist in every state, but most capacity in the Southwest.

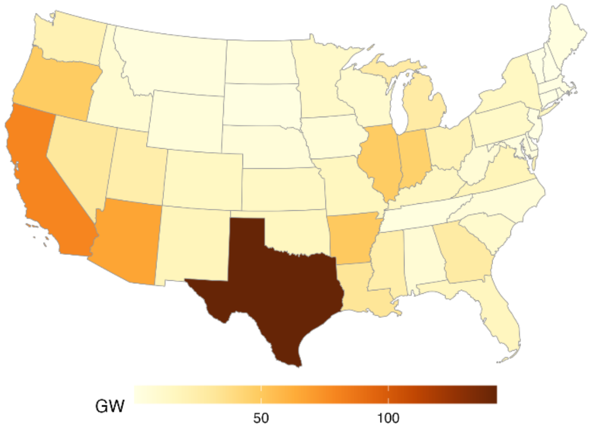
Total Gas Capacity in Interconnection Queues at the end of 2024



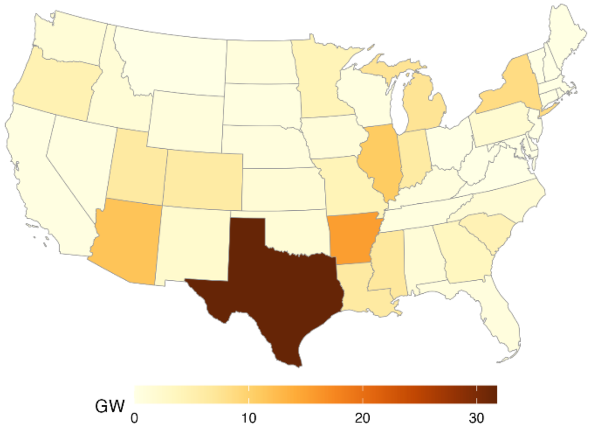
New Gas Capacity Added to Interconnection Queues in 2024



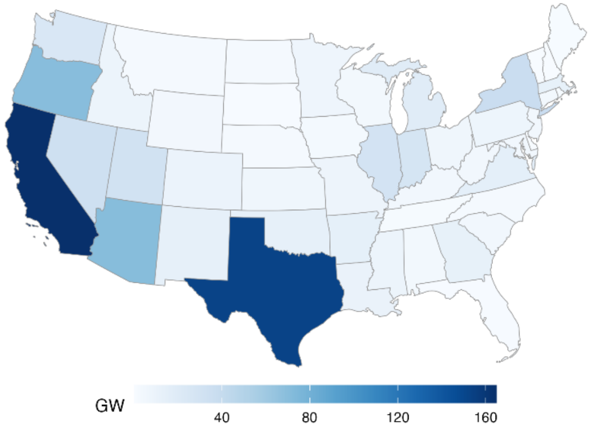
Total Solar Capacity in Interconnection Queues at the end of 2024



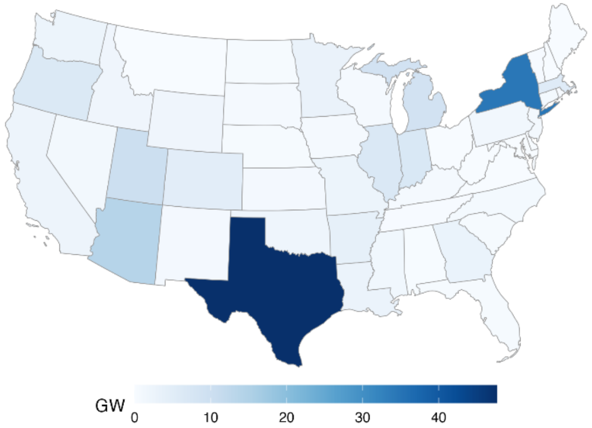
New Solar Capacity Added to Interconnection Queues in 2024



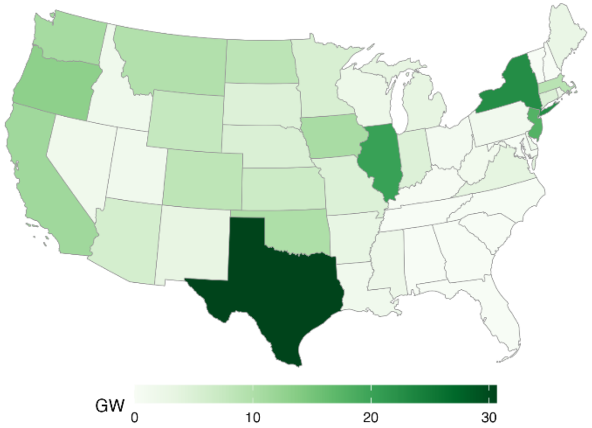
Total Storage Capacity in Interconnection Queues at the end of 2024



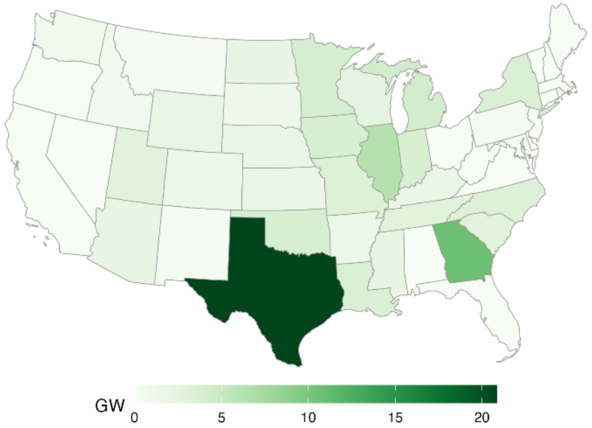
New Storage Capacity Added to Interconnection Queues in 2024



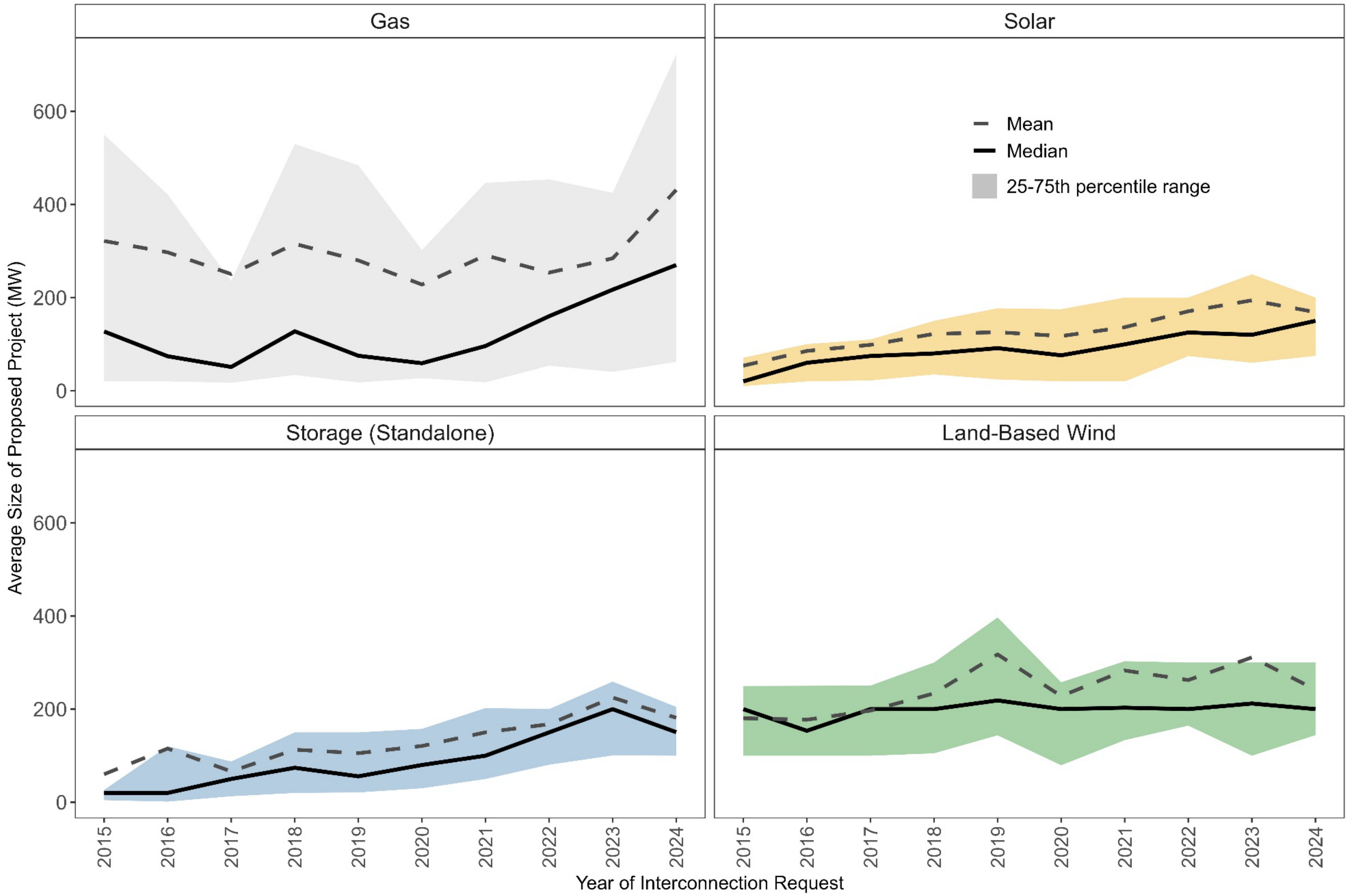
Total Wind Capacity in Interconnection Queues at the end of 2024



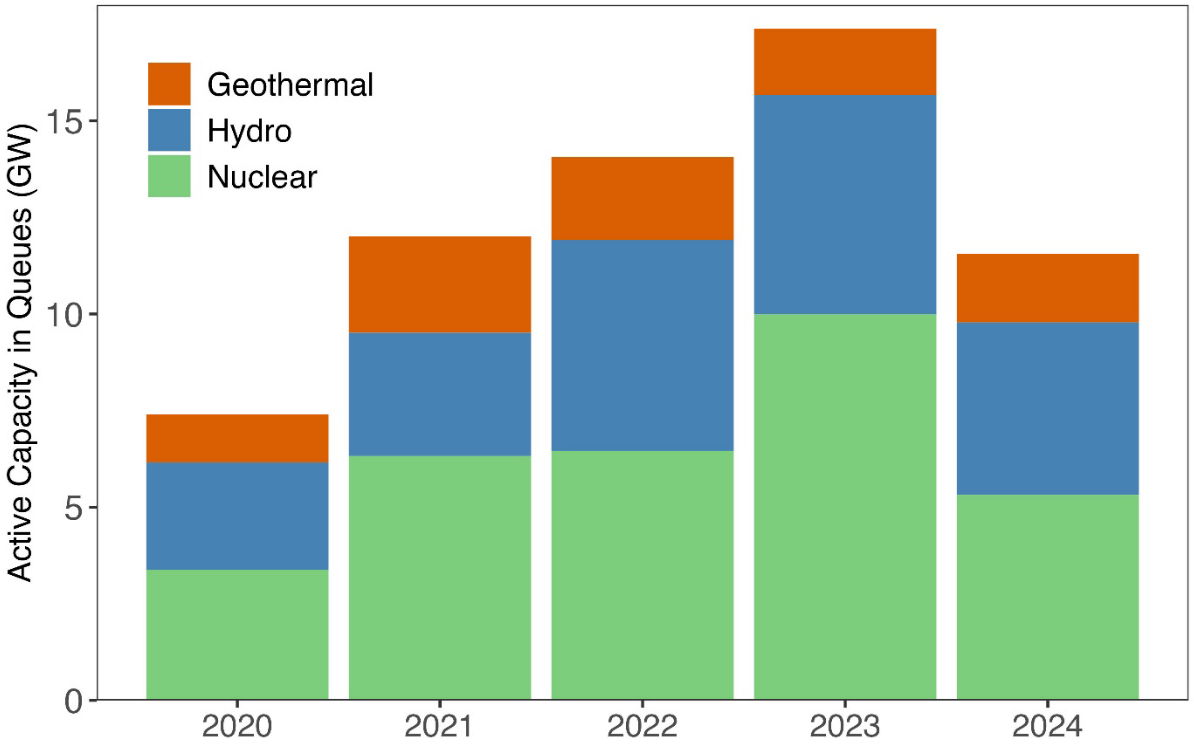
New Wind Capacity Added to Interconnection Queues in 2024



The average (plant-level) interconnection request size has grown over time: Mean gas (+34%), solar (+214%), storage (+202%), and wind (+34%) plants have all grown substantially since 2015



Active Nuclear capacity declined in 2024, while Hydro and Geothermal held relatively steady. These resources represent ~12 GW of capacity, indicating significant development interest



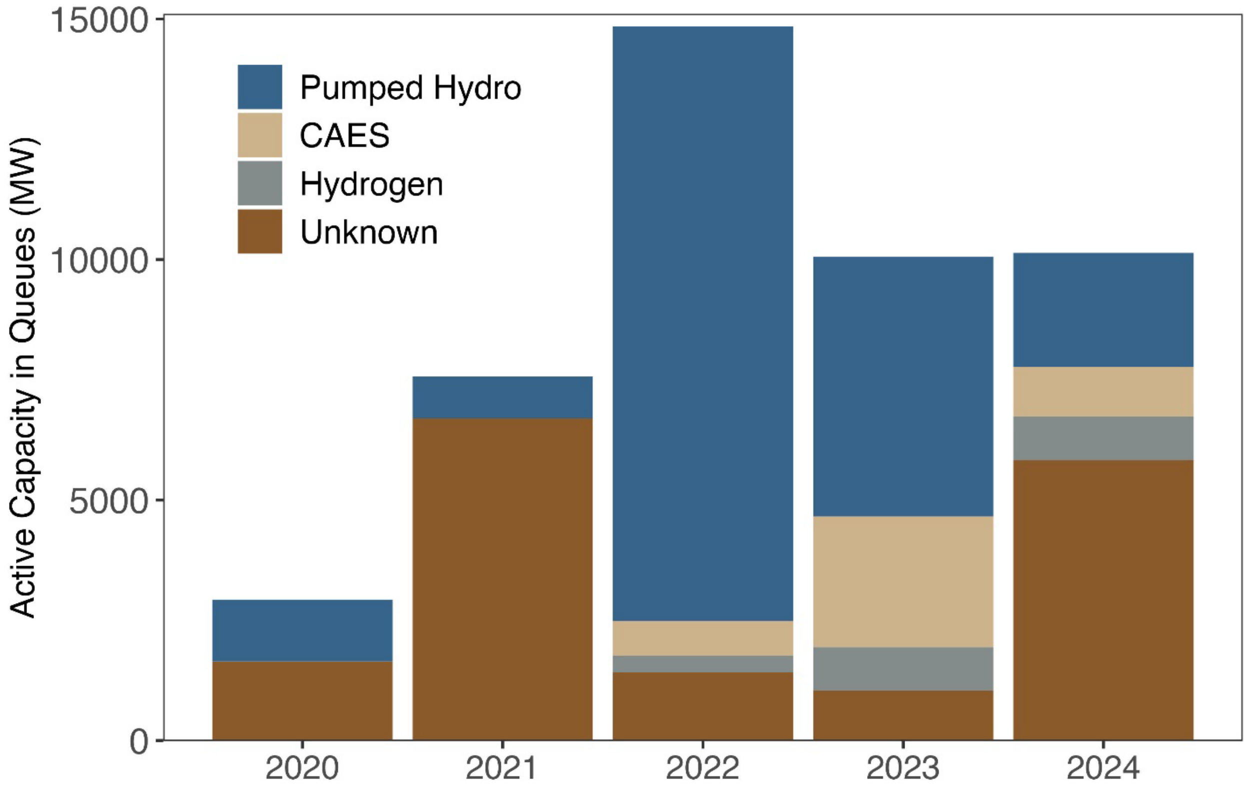
	Active Capacity in Queues (MW)		
Region	Hydro	Nuclear	Geothermal
CAISO	5		53
ISO-NE	28		
MISO	201	153	
PJM	88	44	
Southeast (non-ISO)	620	3,274	
West (non-ISO)	3,525	1,890	1,718

Active Nuclear capacity seeking grid connection decreased[1] to 5.3 GW in 2024 (down from ~10 GW in 2023), while Hydropower (4.5 GW) and Geothermal (1.8 GW) capacity held roughly steady.

Hydropower plants are proposed in several regions, but the majority of capacity is in the non-ISO West. Proposed Nuclear is primarily in the non-ISO Southeast and West, and Geothermal is only found in the West and CAISO.

Note: (1) Decrease in active Nuclear capacity is primarily due to the Vogtle nuclear plant in Georgia coming online in 2024 (and therefore moving from “active” to “operational”).

Batteries make up ~99% of storage capacity in the queues, but there are 10 GW of active requests for Pumped Hydro, Hydrogen, Compressed Air (CAES), and Unknown storage

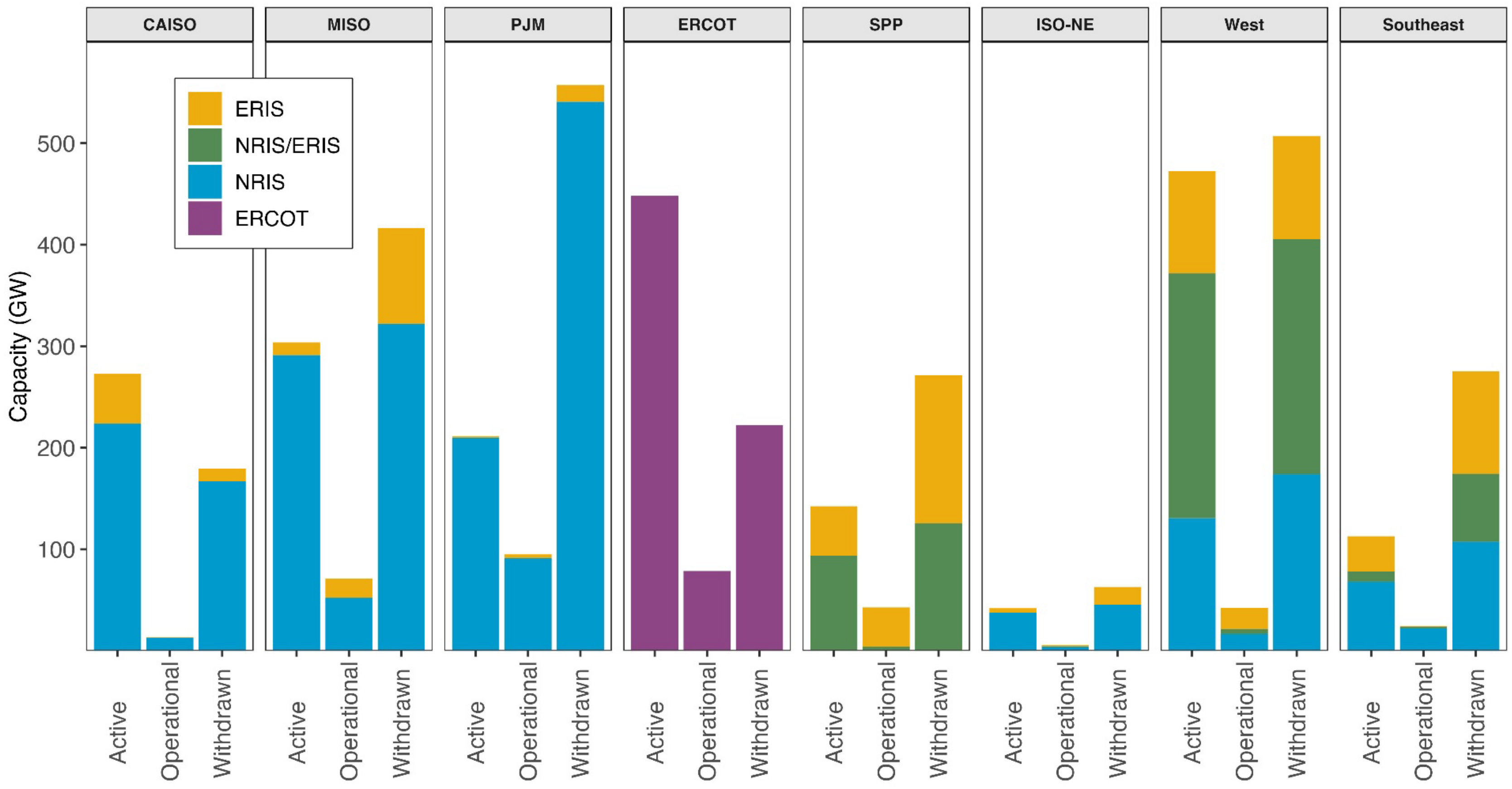


	Active Capacity in Queues (MW)			
Region	Pumped Storage	CAES	Unknown	Hydrogen
CAISO	569	1,035	44	
ERCOT			1,232	
Southeast (non-ISO)			216	
West (non-ISO)	1,800		4,340	902

Note: (1) It is not always possible to determine the type of storage being proposed from available data (hence the "Unknown" category). Some portion of the unknown storage may, in fact, be battery storage requests.

The majority of all active capacity requested to be studied for Network Resource Interconnection Service (NRIS). ERCOT's approach is similar to Energy Resource Interconnection Service (ERIS)

Outside of ERCOT, **84%*** of active capacity requested to be studied for NRIS.



Network Resource Interconnection Service (NRIS) allows the Interconnection Customer to connect its Generating Facility to the Transmission Provider's Transmission System and be deliverable during congested grid conditions, such that the generator can be designated as a capacity resource and contribute to resource adequacy requirements.

Energy Resource Interconnection Service (ERIS) allows the Interconnection Customer to connect its Generating Facility to the Transmission Provider's Transmission System to be eligible to deliver the Generating Facility's electric output using the existing firm or non-firm capacity of the Transmission Provider's Transmission System on an "as available" basis.

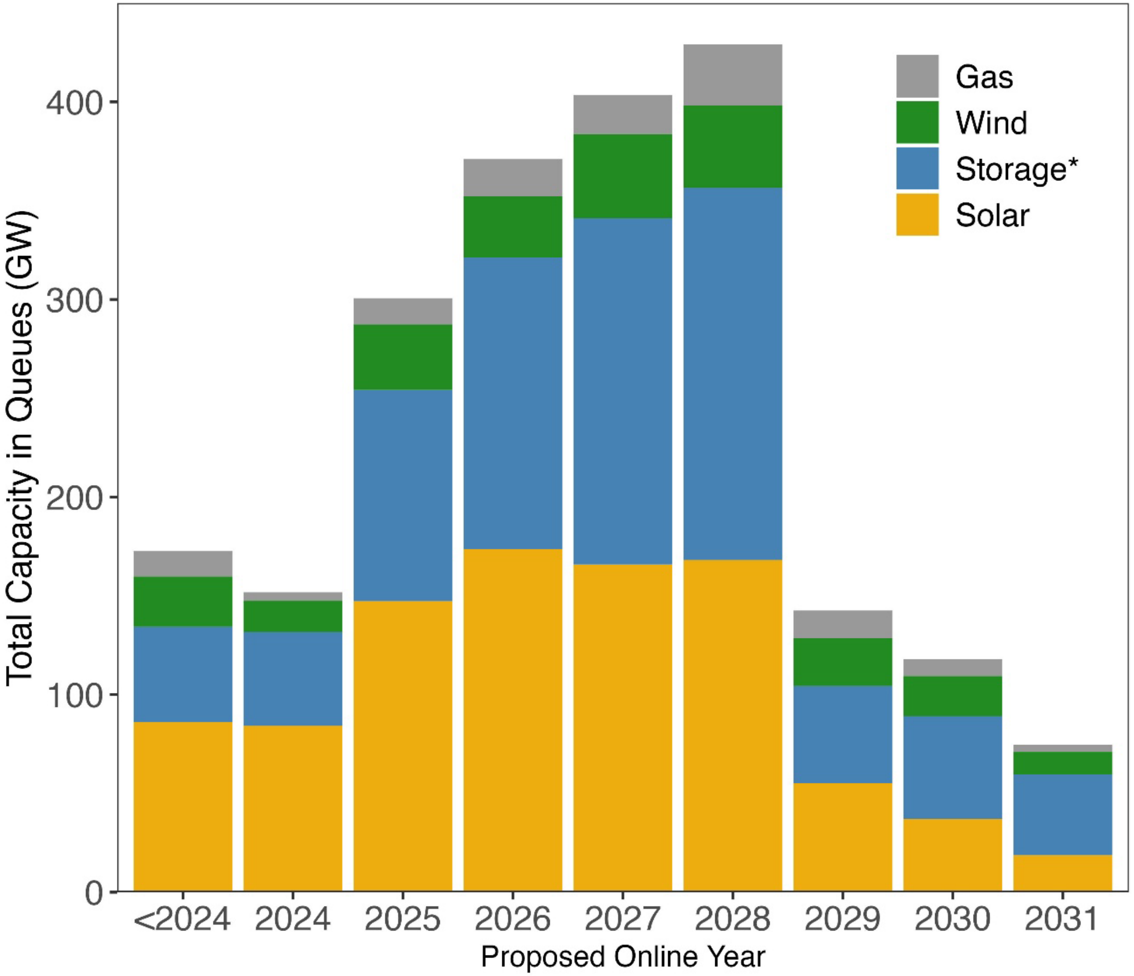
	% of Active Capacity	
region	**ERIS**	**NRIS***
CAISO	18%	82%
MISO	4%	96%
PJM	1%	99%
SPP	34%	66%
ISO-NE	11%	89%
West	21%	79%
Southeast	31%	69%

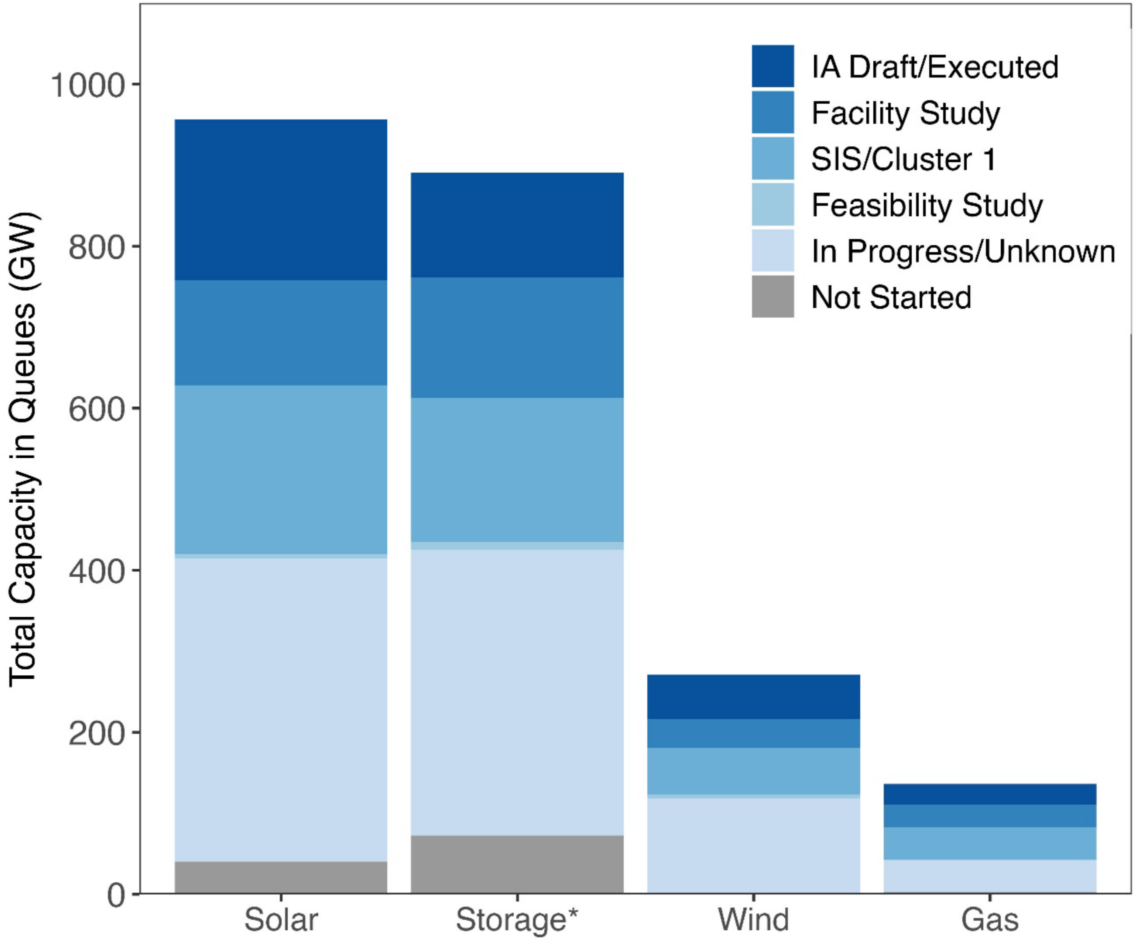
**These calculated percentages include projects choosing the NRIS/ERIS study option at time of request, which is allowed in a few regions as indicated in the graph*

Notes: (1) NRIS and ERIS were developed under FERC Order 2003, and apply to FERC-jurisdictional transmission providers. (2) ERCOT is not FERC jurisdictional, but uses a "connect and manage" interconnection service that is more similar to ERIS. (3) Data available for 29,744 requests from 6 ISOs and 32 non-ISO balancing areas.

61% (1,400 GW) of active capacity in queues has proposed online date before 2028; 18% (408 GW) has a draft or executed interconnection agreement (IA)

69% of solar capacity (657 GW) originally proposed to come online before 2028, compared to 59% of storage (525 GW), 55% of wind (148 GW), and 51% of gas (69 GW). 21% of solar and wind capacity has a draft or signed IA, 19% of gas, and 15% of storage[1].

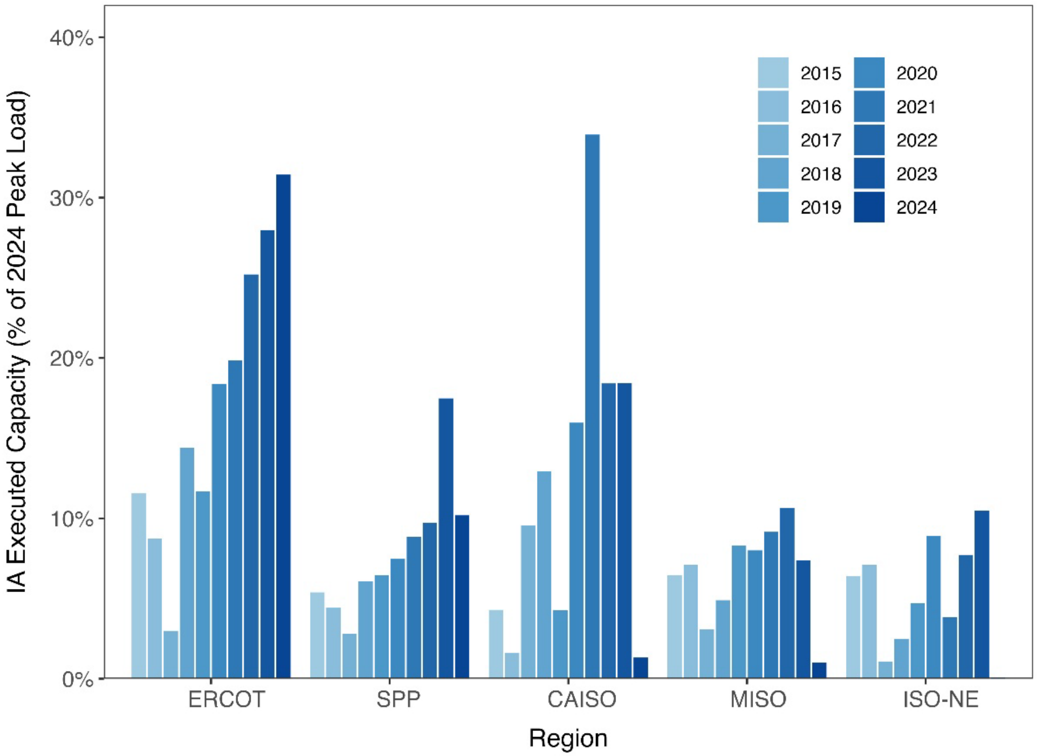




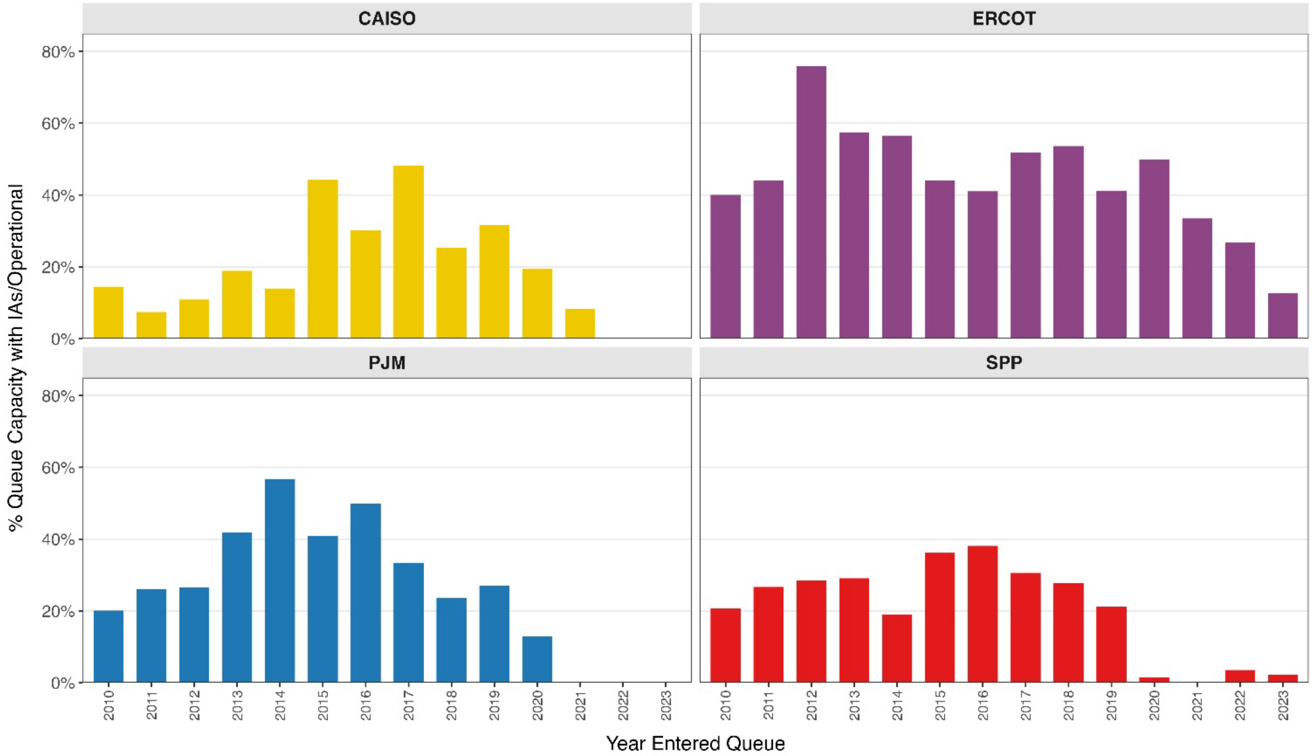
*Notes: (1) See appendix for breakdown of capacity with IA by resource type. (2) *Hybrid storage capacity is estimated for some projects. (3) Proposed online dates are included in the developer's original interconnection request, and may differ from actual online date. (4) Not all of this capacity will be built. (5) Study status categories are simplified and correspond to the process pre- FERC Order No. 2023 reforms.*

ERCOT executed IAs amounting to >30% of their peak load in 2024; ERCOT also tends to have a relatively high share of total requests reach IA stage

Annual volume of interconnection agreements executed by region as a percentage of 2024 peak load



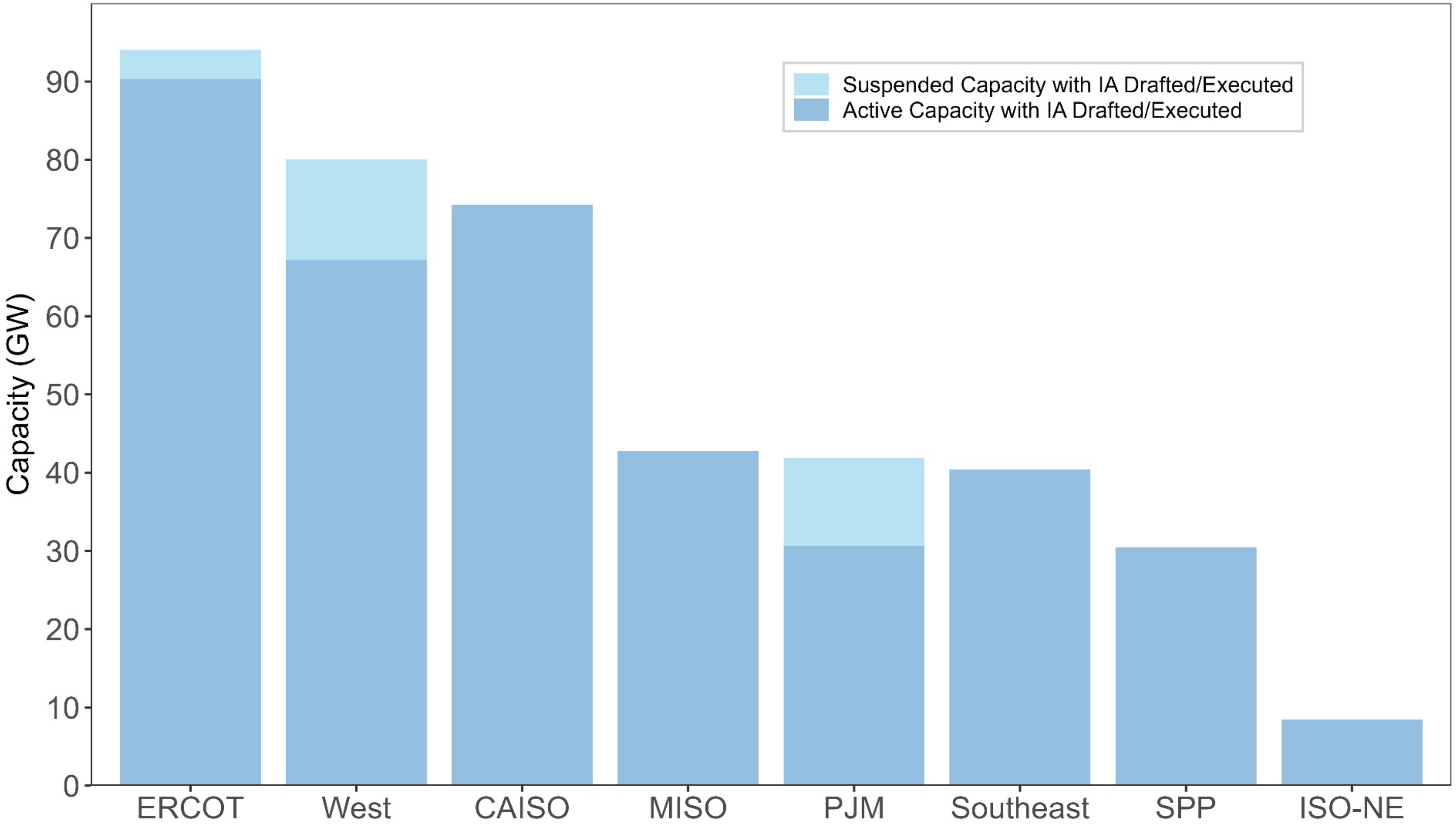
Fraction of annual interconnection request volume that have executed interconnection agreements by the end of 2024



ERCOT's "connect and manage" approach to generator interconnection does not require network upgrades for interconnections, instead managing grid congestion through redispatch and curtailment. This approach differs from other balancing areas, and is likely one reason for the higher IA rates seen in ERCOT.

Notes: (1) Left chart limited to regions where "IA date" is at least 70% populated (see table on slide 9). See appendix for absolute (GW) volume rather than fraction. Available data for 2024 IAs may be lagging in some regions. (2) Right chart (fraction) limited to regions with complete information on interconnection phase / agreement status, as well as complete data on total annual requests. (3) Not all requests executing IAs will ultimately come online – see slide 34 for detail on post-IA completion rates.

ERCOT has the most capacity with draft or executed IAs (90 GW active; 4 GW suspended), followed by CAISO (74 GW active) and the West (67 GW active; 13 GW suspended)



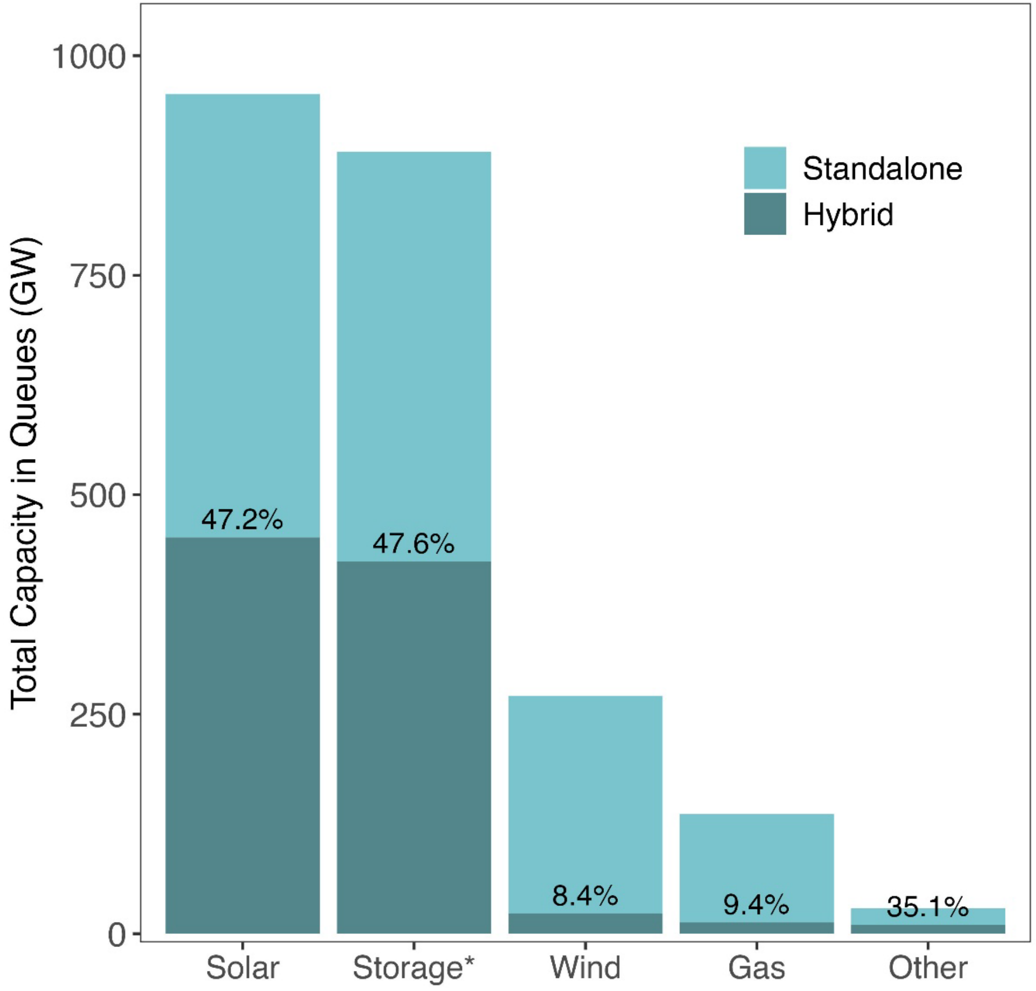
Note: Not all of these plants will be built.

Signed interconnection agreements can provide a useful signal about the nearer-term pipeline of proposed power plants, but many other factors influence whether a proposed power plant is ultimately built or not. Many requests with signed IAs have historically withdrawn (*see slide 34*).

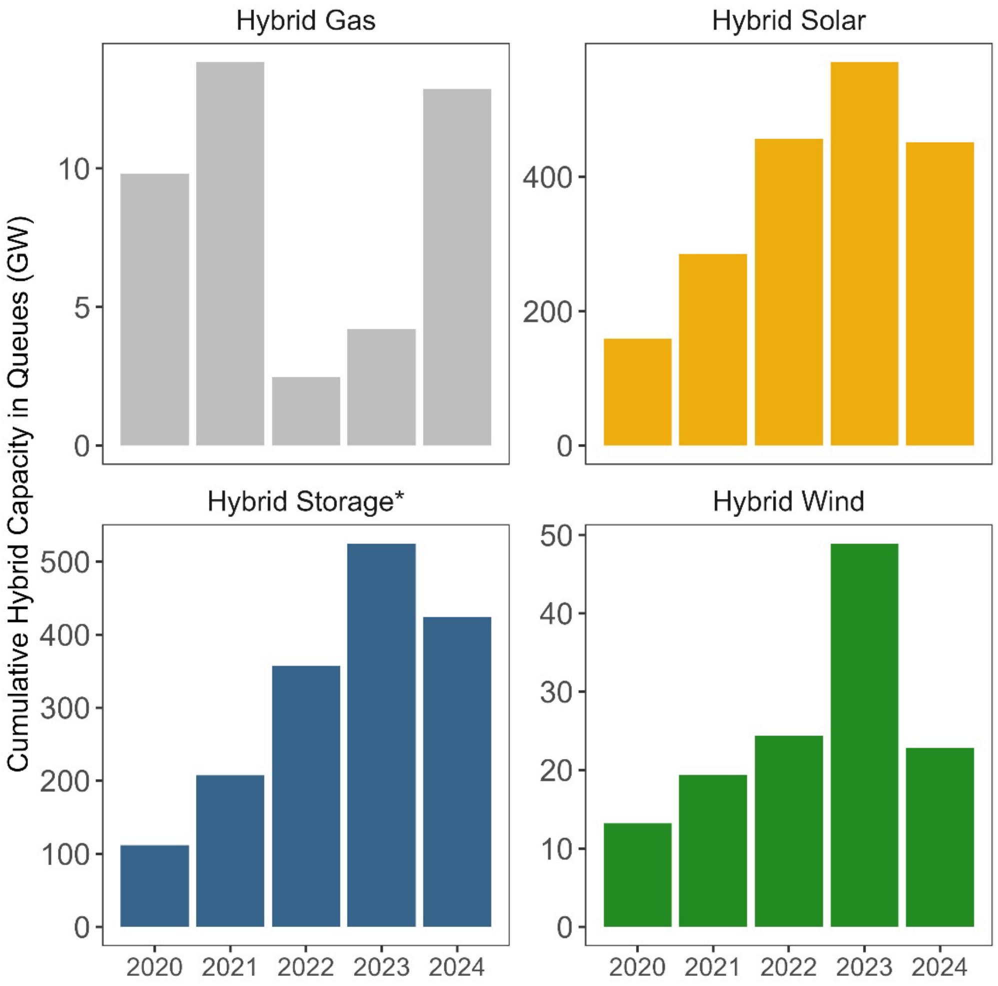
Capacity shown is the *nameplate* capacity for these interconnection requests, which is not necessarily deliverable at all times and may be lower during peak or critical load hours.

Notes: (1) IA capacity bars include capacity in the queues that has either a draft or fully executed interconnection agreement but has not yet reached commercial operations. The darker blue portion of the bar includes only active capacity; light blue portion includes suspended queue requests with an executed/drafted IA. The implication of "Suspended" queue status differs by ISO. e.g., in PJM it is voluntary and elected by the developer; in MISO it requires a force majeure event to suspend a project.

Requests for hybrid plants are common: Hybrids comprise 47% of active solar (451 GW), 48% of storage (424 GW), and <10% of wind (23 GW) and gas (13 GW)



Hybrid storage capacity is estimated when missing in source data using storage:generator ratios from requests that provide separate capacity data



Notes: (1) Some hybrids shown may represent storage capacity added to existing generation; only the net increase in capacity is shown; (2) Capacity for hybrid plants (e.g., Wind+Solar+Storage) is included separately in each resource category (i.e., the solar component shows up in hybrid solar, storage in hybrid storage), presuming the capacity is known for each type. "Hybrid Storage" therefore represents only the storage portion of generator+storage hybrid plants.

Hybrids comprise a sizable fraction of all proposed solar plants in multiple regions; gas and wind hybrids are less common overall but still a large proportion in CAISO

% of Active Capacity in Hybrid Configurations				
Region	**Solar**	**Wind**	**Gas**	**Storage***
CAISO	93%	60%	81%	50%
ERCOT	47%	4%	3%	23%
ISO-NE	29%	0%	69%	7%
MISO	22%	7%	17%	45%
NYISO	32%	2%	0%	15%
PJM	23%	0%	0%	37%
SPP	22%	2%	4%	36%
Southeast	25%	0%	2%	55%
West	83%	16%	26%	72%
TOTAL	**47%**	**8%**	**9%**	**48%**

**Hybrid storage capacity is estimated when missing in source data using storage:generator ratios from requests that provide separate capacity data*

- Hybrid configurations are especially common in CAISO, and somewhat common in the non-ISO West
- Solar hybridization has been steady around 45-50% overall in recent years, with CAISO consistently having >90% of solar capacity in hybrids
- Gas hybridization decreased from 12% last year, with new gas requests predominantly standalone
- Wind hybridization also decreased from 13% last year, with fewer hybrid wind requests in the West in particular

Operational & Withdrawn Projects: Volume and Completion Rates

Operational project data were available from all 7 ISO/RTOs and 35 non-ISO balancing areas, totaling 4,432 projects.

Region	*n* (Operational)	Capacity (GW)
CAISO	228	36.4
ERCOT	489	78.6
ISO-NE	219	15.8
MISO	492	71.9
NYISO	112	12.5
PJM	1,195	97.0
SPP	287	43.8
Southeast (non-ISO)	444	90.9
West (non-ISO)	966	64.9

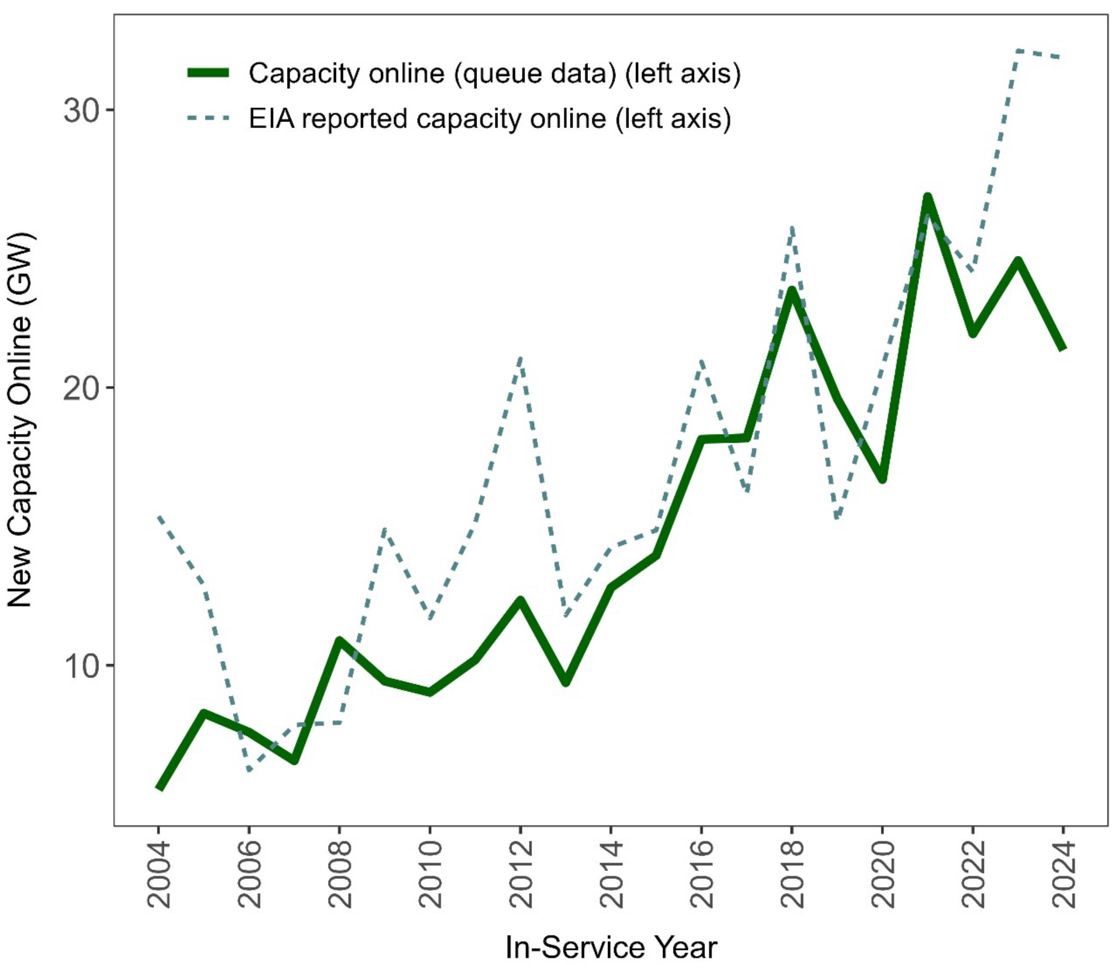
Withdrawn request data were available from all 7 ISO/RTOs and 43 non-ISO balancing areas, totaling 20,921 requests.

Region	*n* (Withdrawn)	Capacity (GW)
CAISO[4]	1,971	596.2
ERCOT	955	222.1
ISO-NE	663	90.7
MISO	2,272	432.1
NYISO	1,303	278.4
PJM	4,885	580.2
SPP	1,531	308.9
Southeast (non-ISO)	2,470	558.8
West (non-ISO)	4,871	856.9

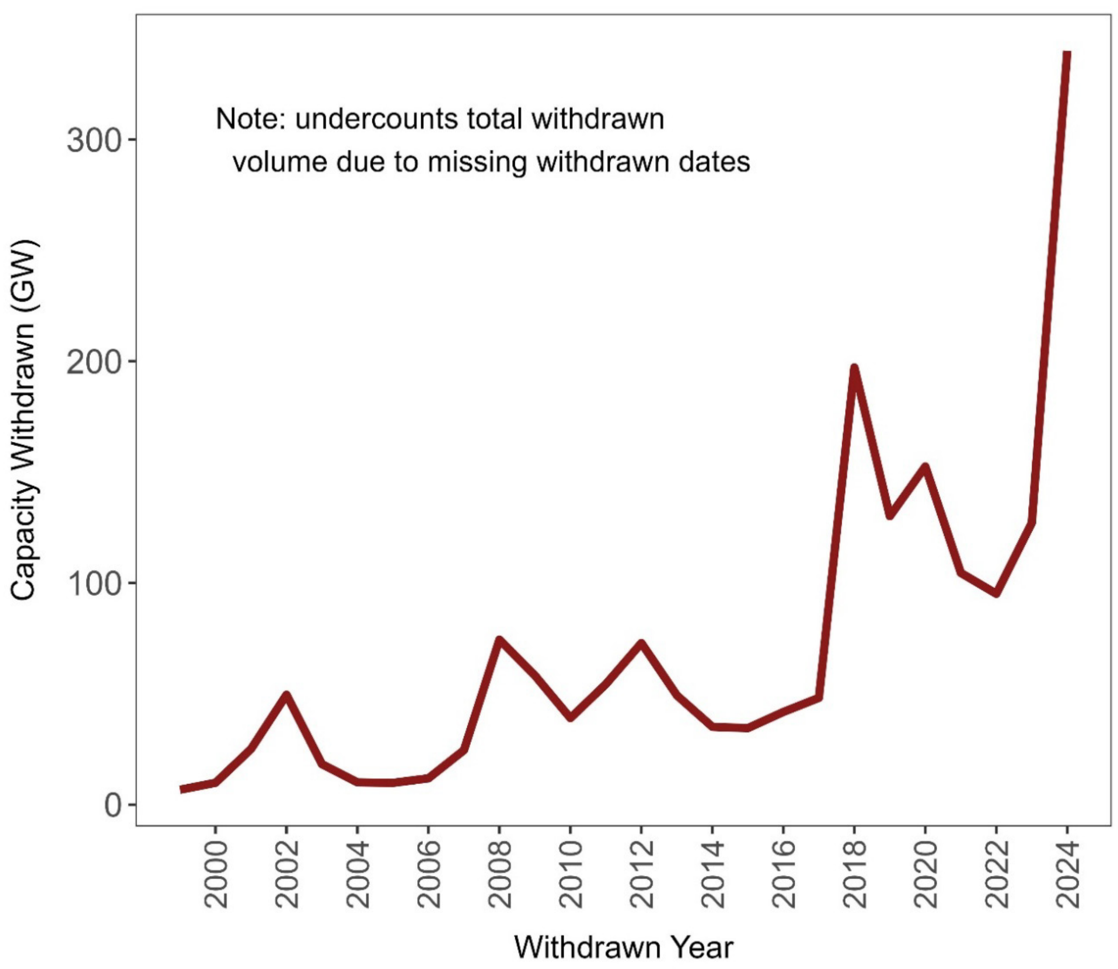
Notes: (1) The number of operational and withdrawn projects with available data may be fewer than the total number of operational or withdrawn projects for each entity. (2) Data were sought from 7 ISOs and 49 non-ISO BAs; operational and withdrawn project data may be delayed or unavailable. (3) Capacity (GW) shown in these tables does ***not*** *include estimates for missing hybrid storage capacity. (4) Withdrawn includes CAISO cluster 15 requests that were not resubmitted in 2024 (as required by CAISO to continue).*

Volume (capacity) of operational and withdrawn projects is trending upward; more than 700 GW[1] of capacity was withdrawn in 2024

Operational Projects[2]

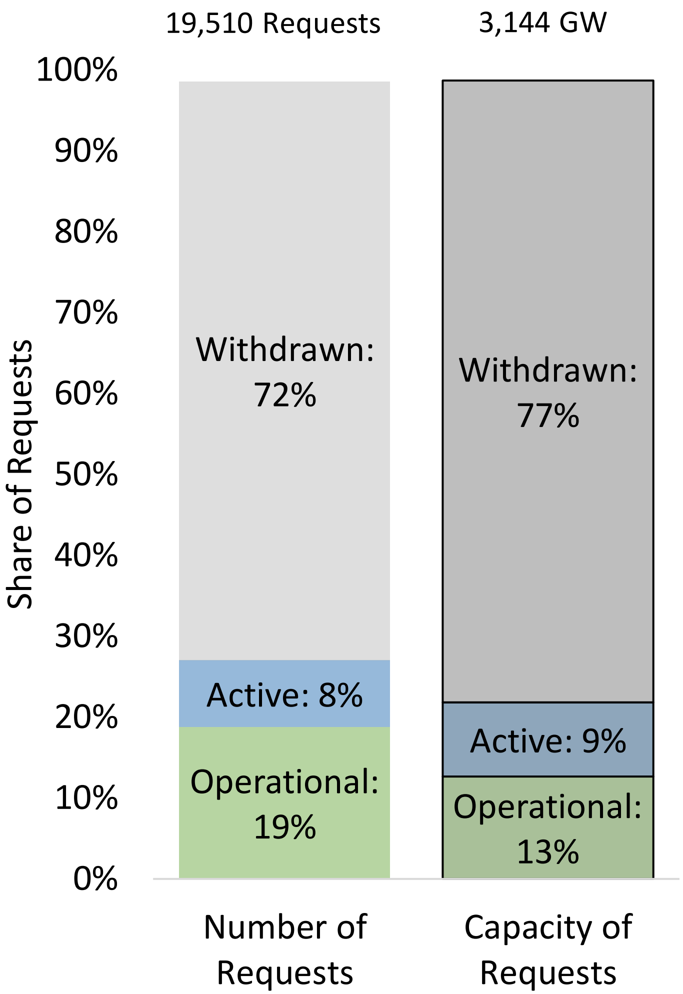


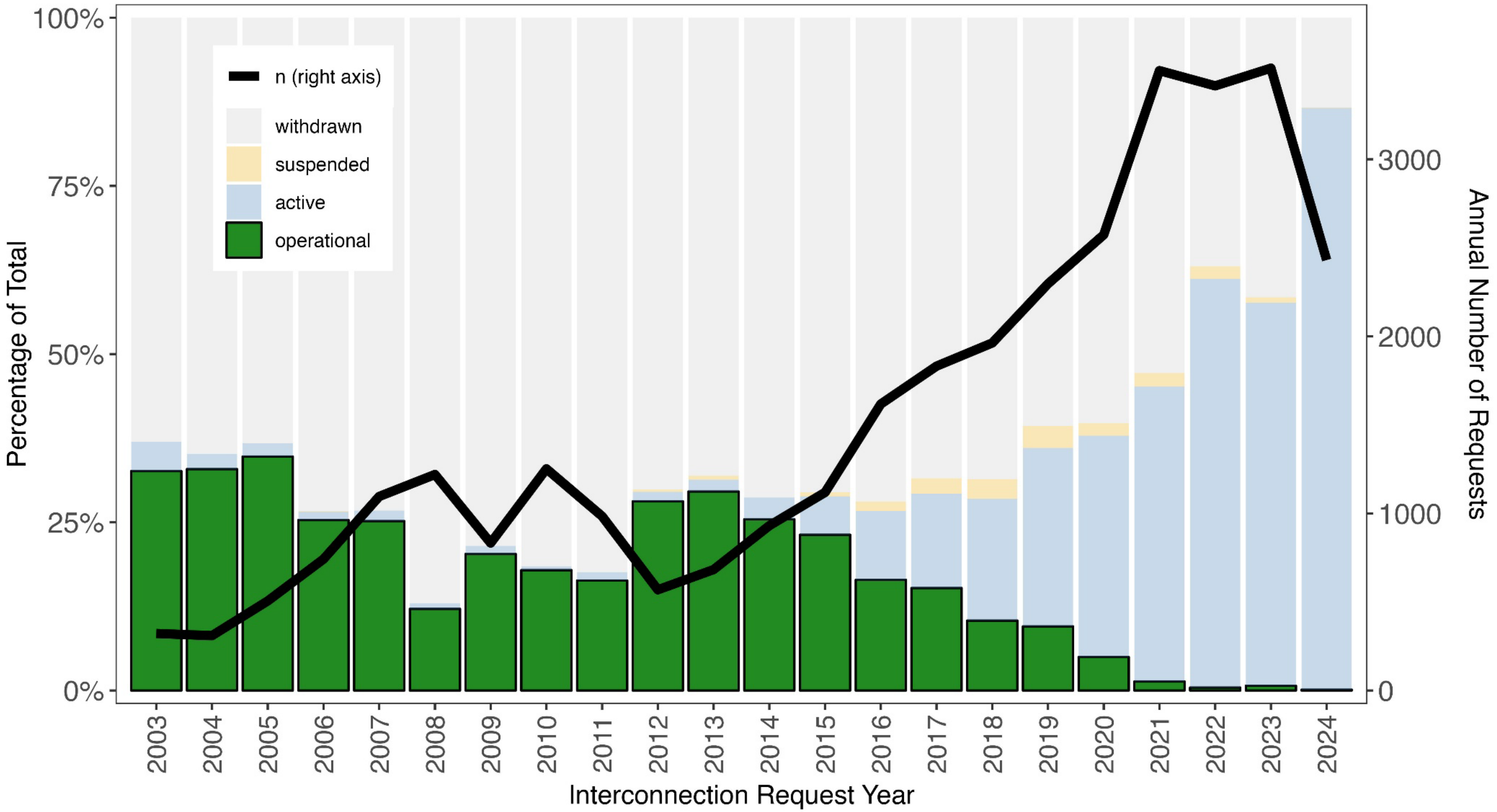
Withdrawn Requests[3]



Note: (1) In-service year only available for 64% of the "operational" project sample; withdrawn year only available for 51% of the "withdrawn" project sample. These figures therefore only include a subset of total data. (2) The discrepancy between queue capacity and EIA capacity is primarily due to missing in-service dates and lags or gaps in reporting in the queue data. EIA data are filtered to only include balancing areas for which LBNL collects queue data, and only include transmission-interconnected plants. (3) Includes CAISO cluster 15 requests that were not resubmitted in 2024 (as required by CAISO to continue).

The majority (>70%) of interconnection requests are withdrawn. Just 13% of capacity submitted into queues from 2000-2019 had come online as of the end of 2024

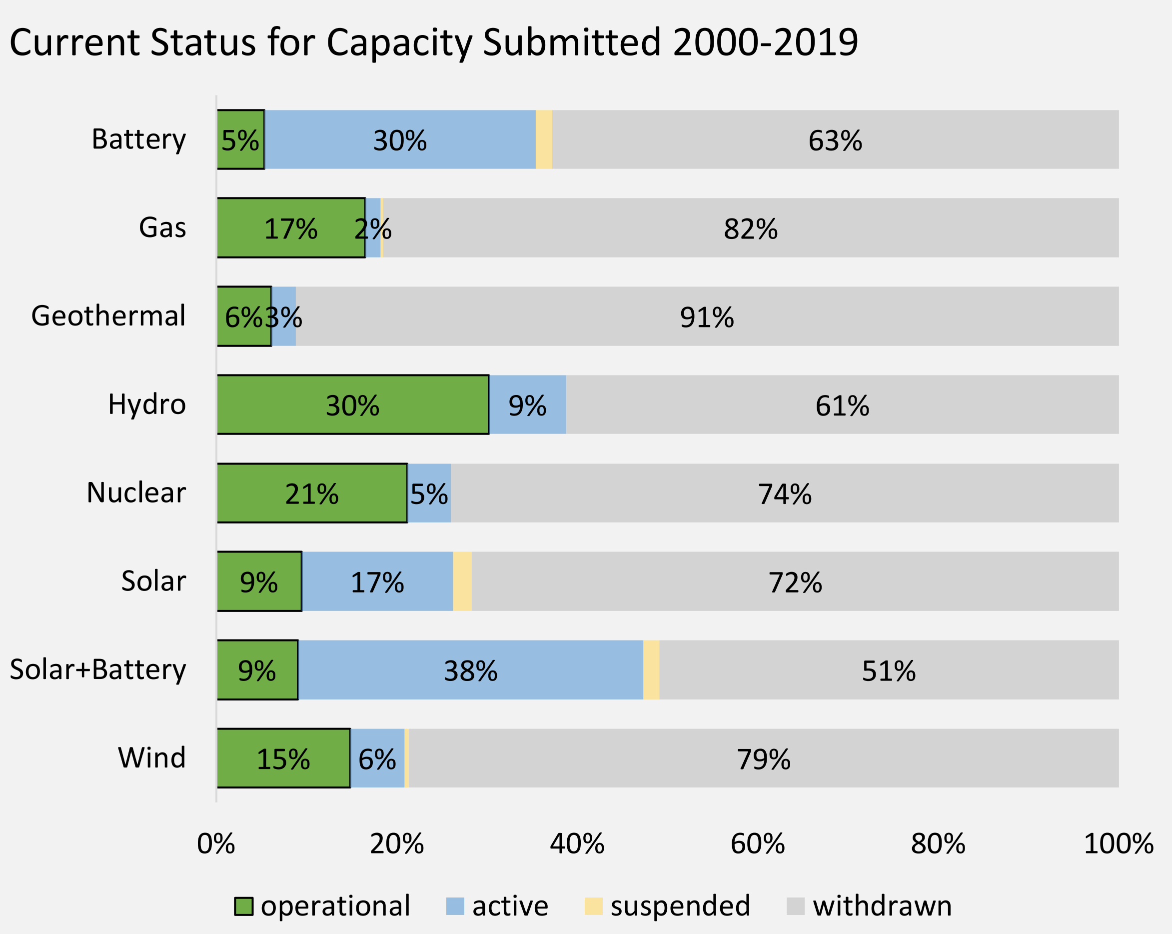




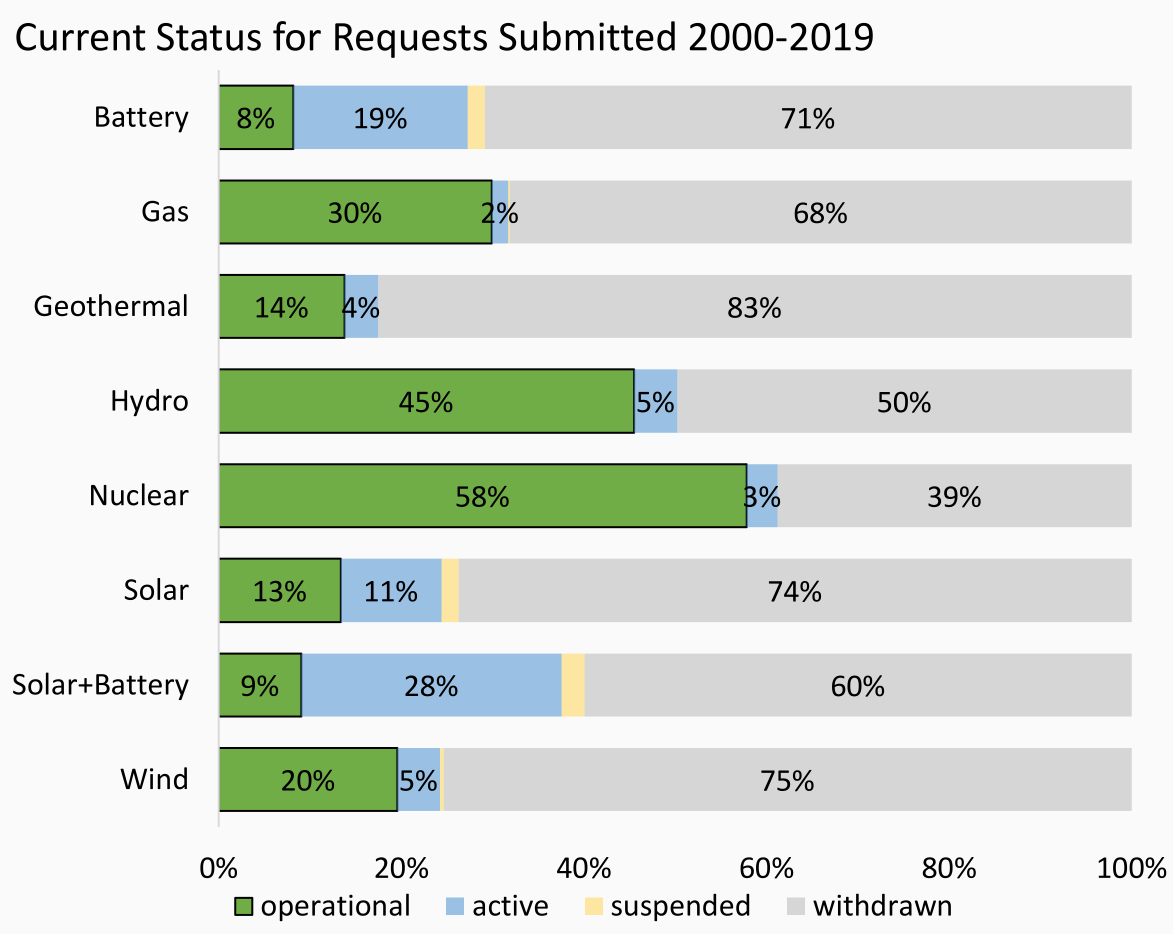
Notes: (1) Final outcome for projects entering the queues in recent years may not yet be determined; some take 5 or more years from request to COD. (2) Status shown represents a snapshot of all available data as of the end of 2024. (3) Completion rate shown in chart on right is calculated by number of projects, not capacity. (4) Limited to data from 7 ISO/RTOs and 32 non-ISO balancing areas which provide comprehensive status information (but, since online date is not required for this analysis, data are roughly complete for these regions).

There is considerable variation in completion rates across generator types; In terms of capacity, Hydro (30%), Nuclear (21%), and Gas (17%) have highest average completion rates

By Capacity of Requests

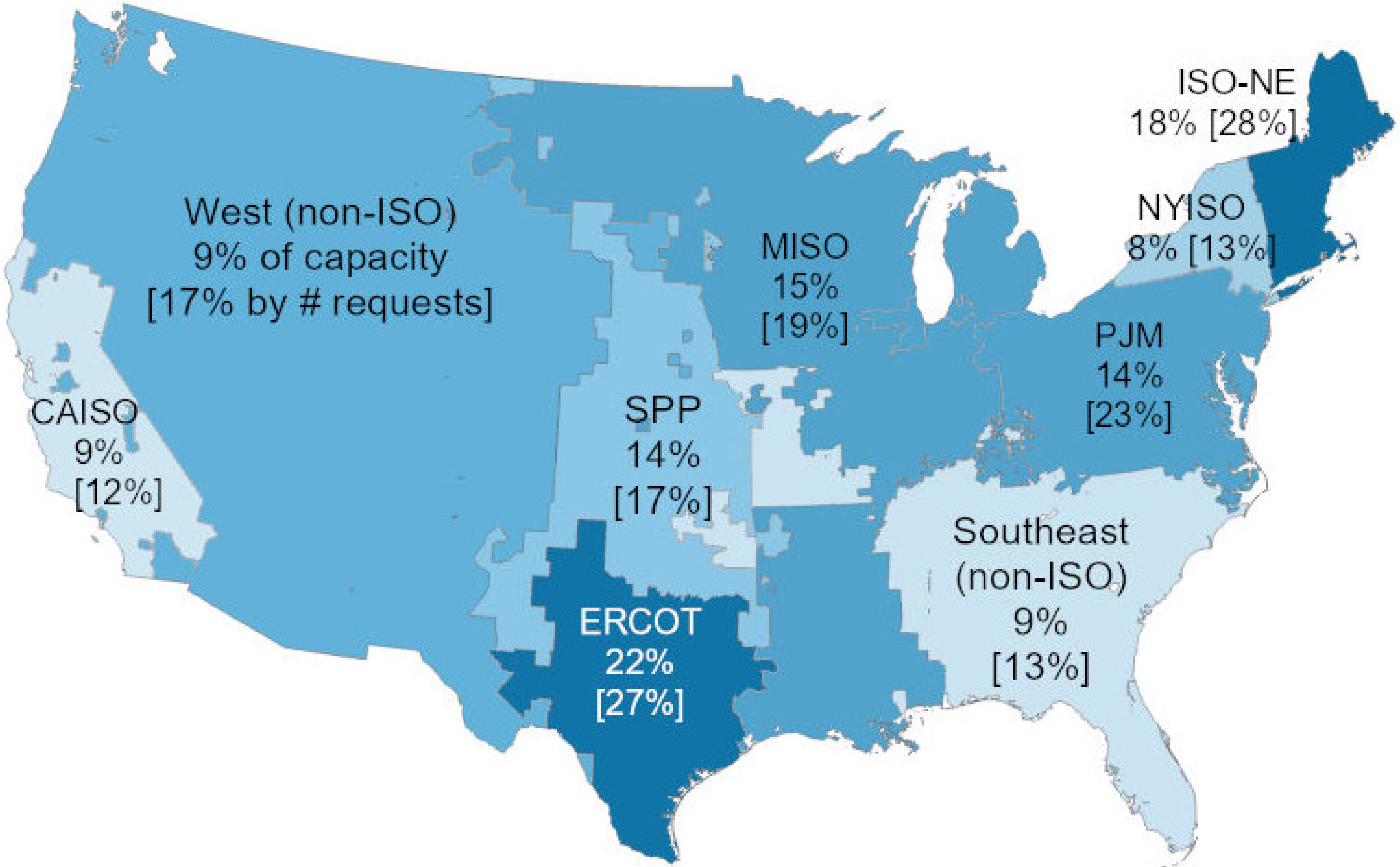


By Number of Requests



Notes: (1) Calculated as number of projects operational as of EOY 2024 divided by the total number of requests from 2000-2019. (2) Includes data from 7 ISOs and 32 non-ISO BAs which provide comprehensive status information.

The share of projects requesting interconnection from 2000-2019 that have reached COD is relatively low across regions: Only ERCOT exceeds 20% completion (by capacity)



- Completion rates by number of requests are slightly higher overall (in brackets [%])
  - Still, only ERCOT and ISO-NE exceed 25% completion by number of requests
- For interconnection requests from 2000-2019, ERCOT (22%) and ISO-NE (18%) had the highest project completion percentages, with NYISO (8%), CAISO (9%), the West (9%), and the Southeast (9%) lower on average
- These rates are variable over time, and trends may be shifting as queue volumes and reforms evolve
- Completion rates are a factor of the amount of developer interest in a given market alongside various factors that enable or disable project completion
  - Although not assessed here, comparing annual built capacity to forecasted need in each region could be a useful metric

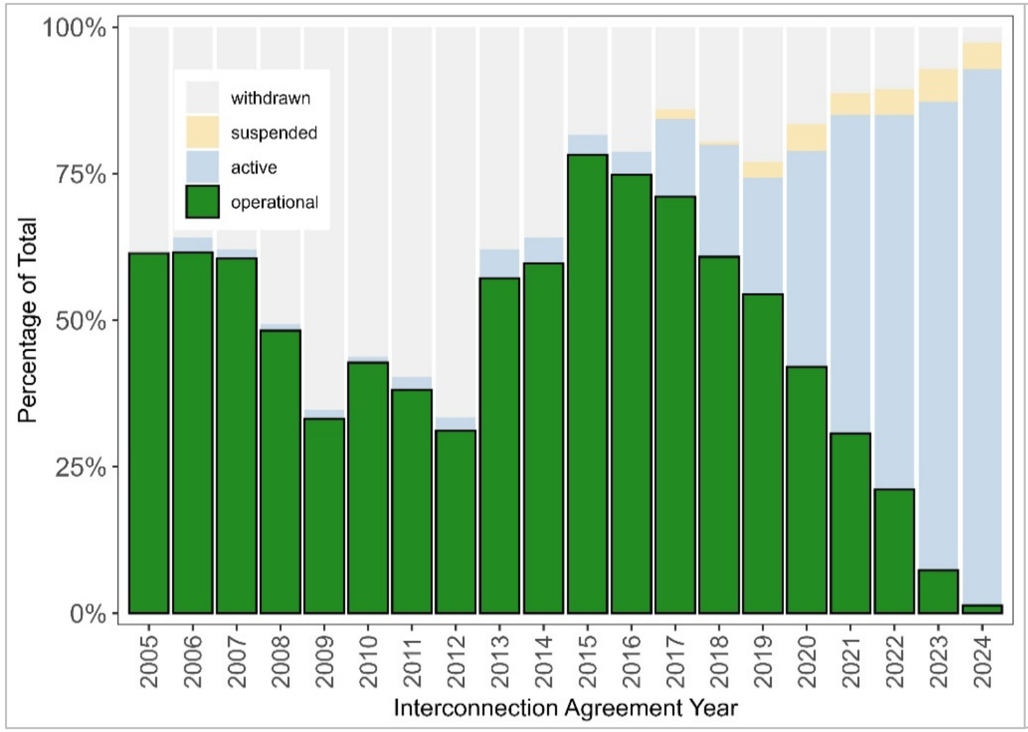
Notes: (1) Capacity-weighted completion rates are shown first, completion by number of requests shown in brackets [ ]. (2) Percentages only include projects requesting interconnection from 2000-2019. (3) Includes data from 7 ISOs and 32 non-ISO balancing areas which provide comprehensive status information.

Even after signing an interconnection agreement (IA), many requests withdraw. 36% of IAs (43% of capacity) signed 2000-2021 had withdrawn by the end of 2024

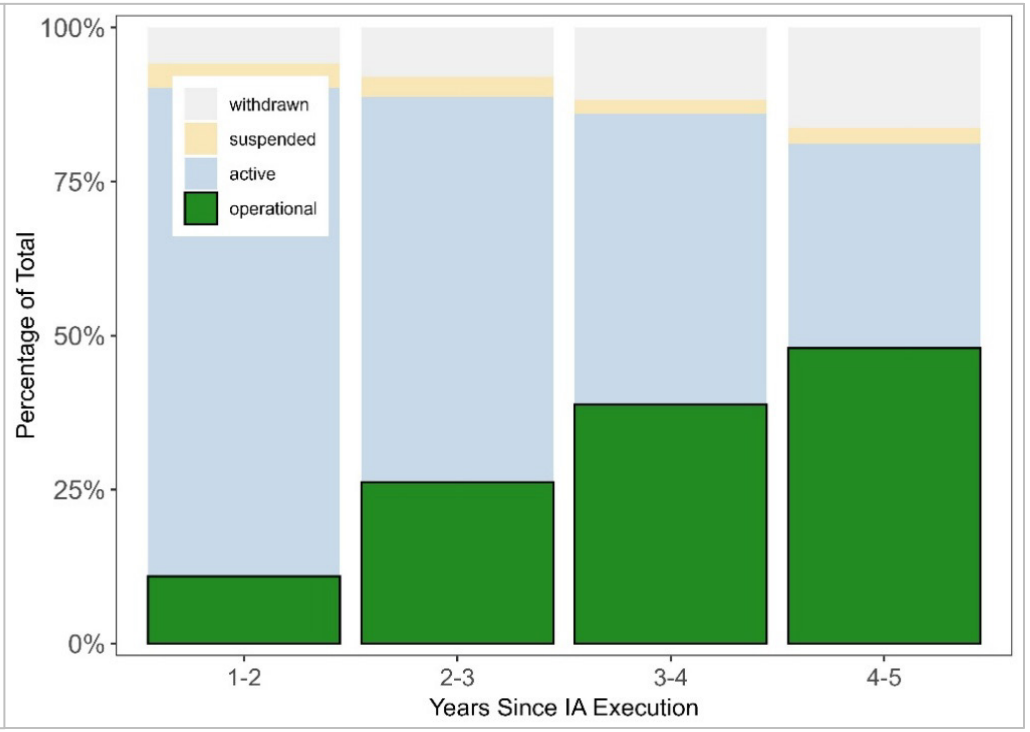
Count of IAs signed 2000-2021…		
Status *(as of end of 2024)*	Count	Percentage
operational	1878	49%
active	509	13%
suspended	39	1%
withdrawn	1379	36%

Capacity (GW) of IAs signed 2000-2021…		
Status *(as of end of 2024)*	Cap. (GW)	Percentage
operational	271	42%
active	92	14%
suspended	6	1%
withdrawn	281	43%

Current (2024) status for requests with executed interconnection agreements (IA), by IA year

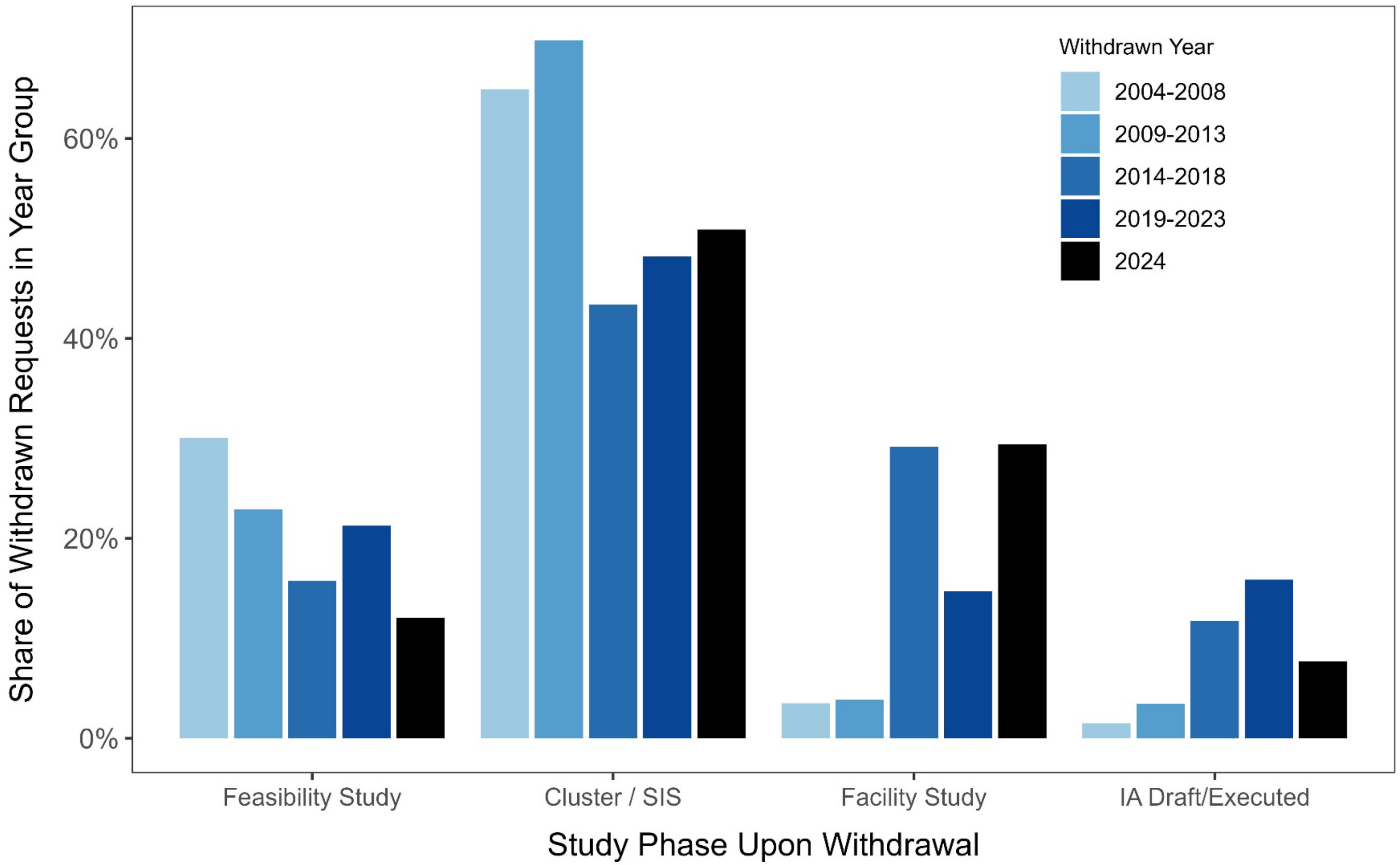


Status by number of years after IA execution



Notes: (1) Table and charts only include requests with executed interconnection agreements and for which the IA date was available. (2) Includes data from 7 ISOs and 5 non-ISO BAs that provide IA dates. (3) Overall this data sample is dominated by requests in MISO (34%) and ERCOT (20%), but MISO requests particularly dominate the earlier years (55% of requests from 2005-2012). (4) Right-hand chart compiles data from LBNL's historical annual interconnection queue datasets - not just the most recent data year.

Most withdrawals occur in earlier study phases, but more than 1/3 of 2024 withdrawals occurred at the facility or IA phases



Later-stage withdrawals can be more costly for developers (sunk costs, deposits) and can trigger re-studies for other projects in the queue, increasing delays and costs.

Note: Only includes data for entities that provide study phase for withdrawn projects (33% of withdrawn projects).

Duration Trends: How Long Do Projects Spend In the Queues?

Withdrawn Requests:

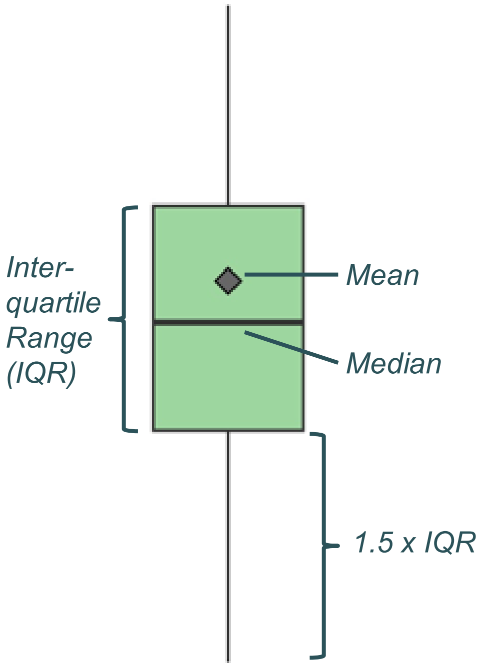
- Duration from Interconnection Request (IR) to Withdrawn Date
  - By region and generator type

Requests with Signed Interconnection Agreements (IA):

- Duration from IR to IA
  - By region, generator type, size, and service type

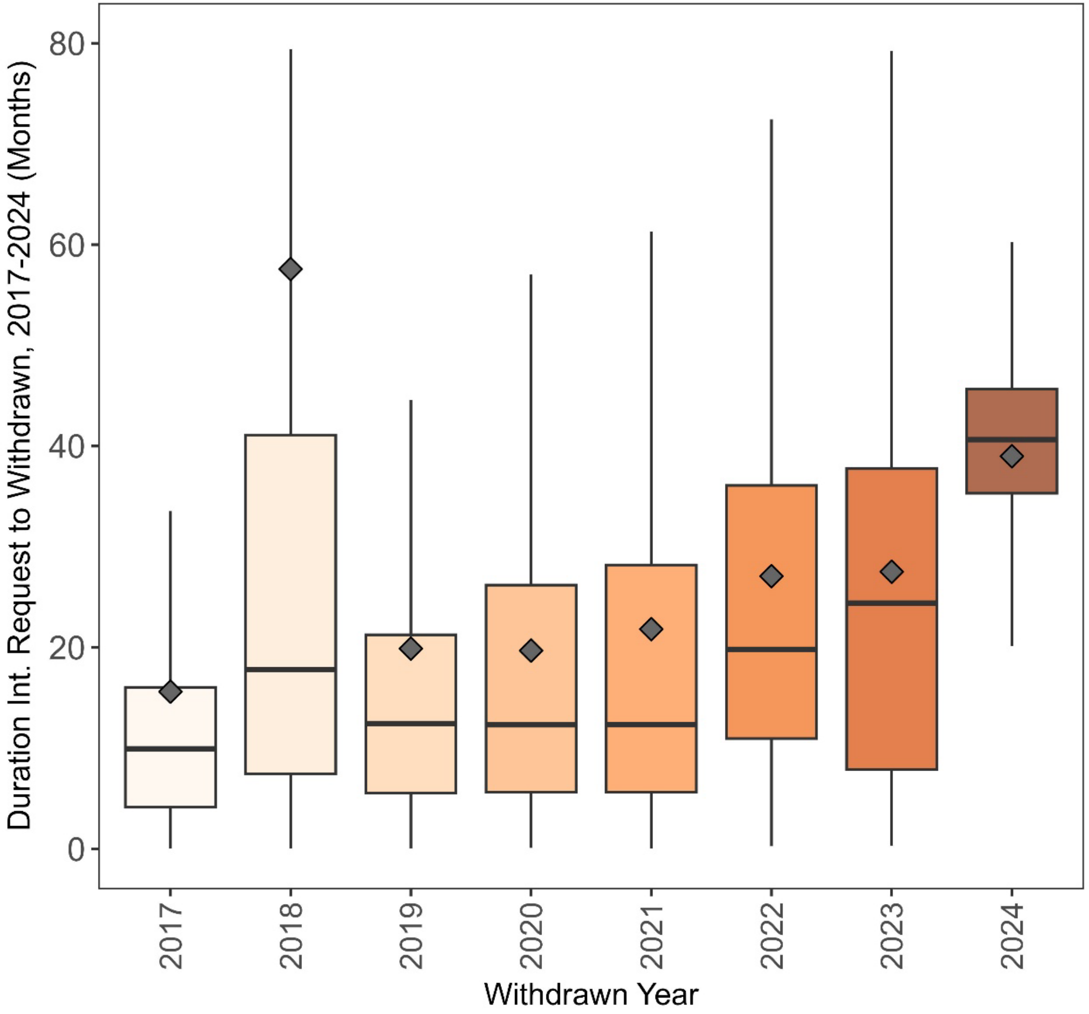
Operational Projects:

- Duration from IA to Commercial Operations Date (COD)
  - By region and generator type
- Duration from IR to COD
  - By region, generator type, and size



***Note on Boxplots**: Many of the following slides utilize box and whisker plots. The boxes represent the interquartile range (IQR – the middle 50% of data), with the central horizontal line being the median. Gray diamonds are the mean. Whiskers (vertical lines) are 1.5 times the IQR (up to min / max). Outliers are not shown.*

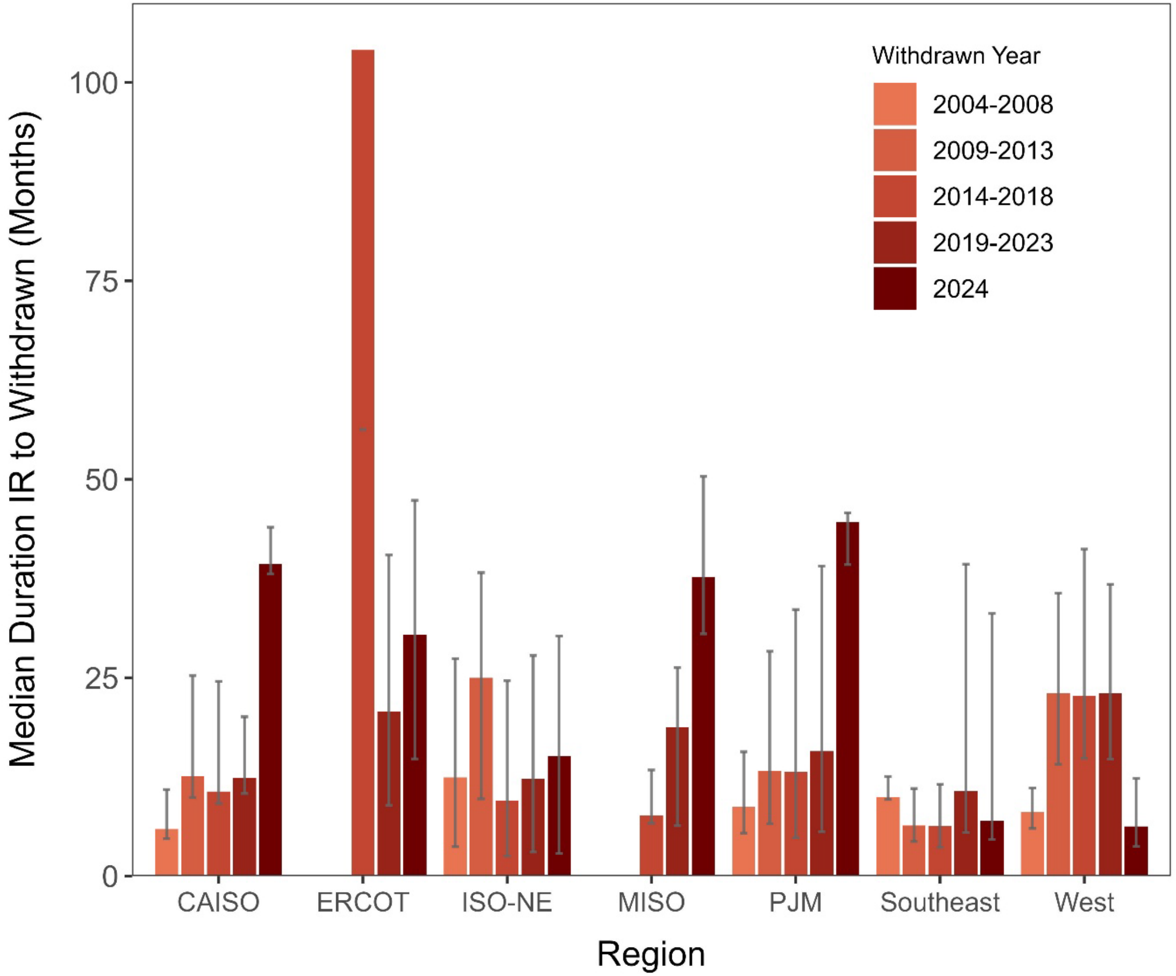
The average duration from interconnection request to withdrawal date has increased considerably in recent years – especially for 2024 withdrawals

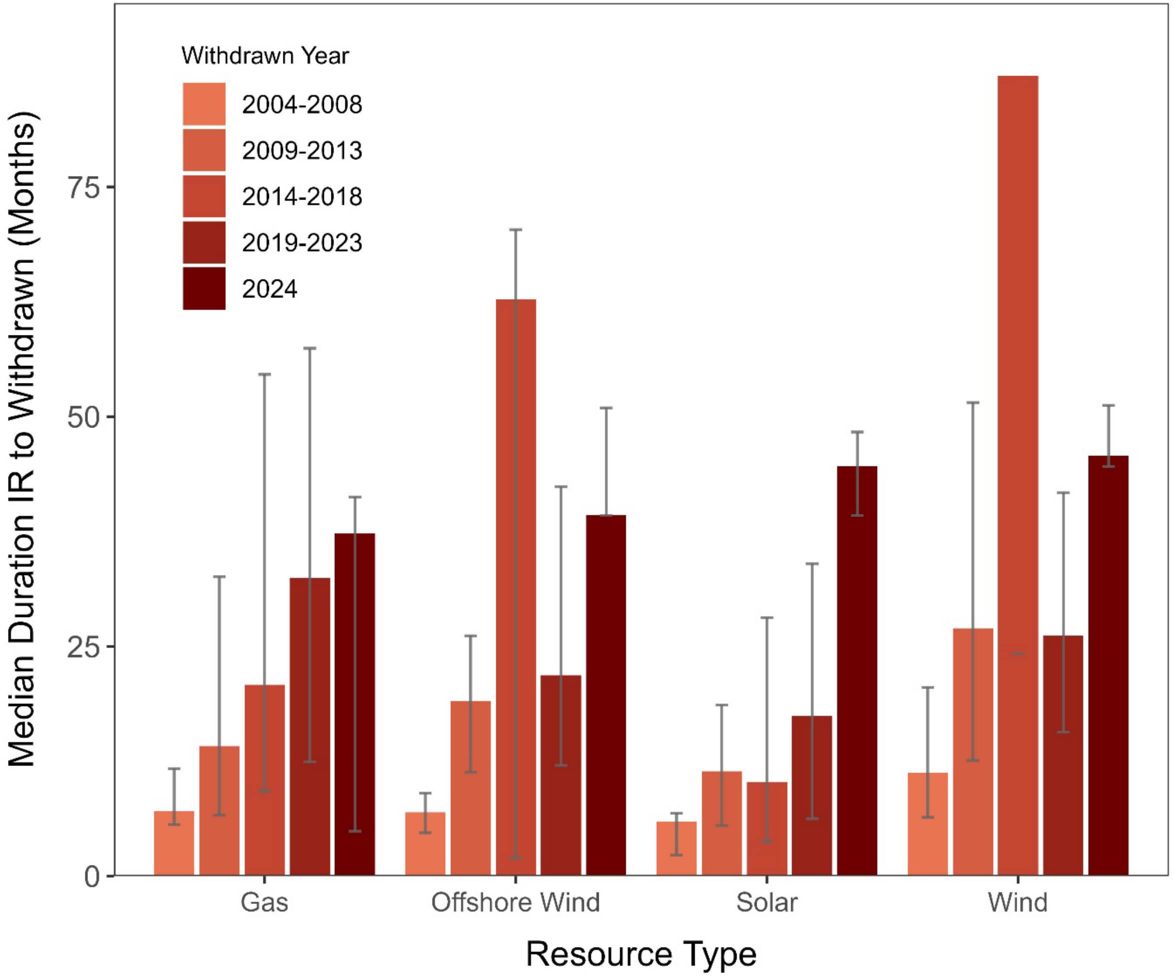


- This trend implies that some recently-withdrawn projects have waited longer in the queues before making the determination to withdraw
- FERC Order 2023 and other reforms may have motivated some older, less viable requests to withdraw in 2024
- Later stage withdrawals can be costly for developers and can disrupt assumptions built into other projects' interconnection studies, necessitating re-studies in some cases and lengthening study durations
  - Withdrawals from cluster studies can also raise costs to requests remaining in the cluster

Notes: (1) Withdrawn date was available for 9,978 requests from 7 ISOs and 8 non-ISO balancing areas. (2) Duration is calculated as the number of months from the queue entry date to the date the project was withdrawn from queues.

Time from request to withdrawal is trending upward in several regions, and across resource types

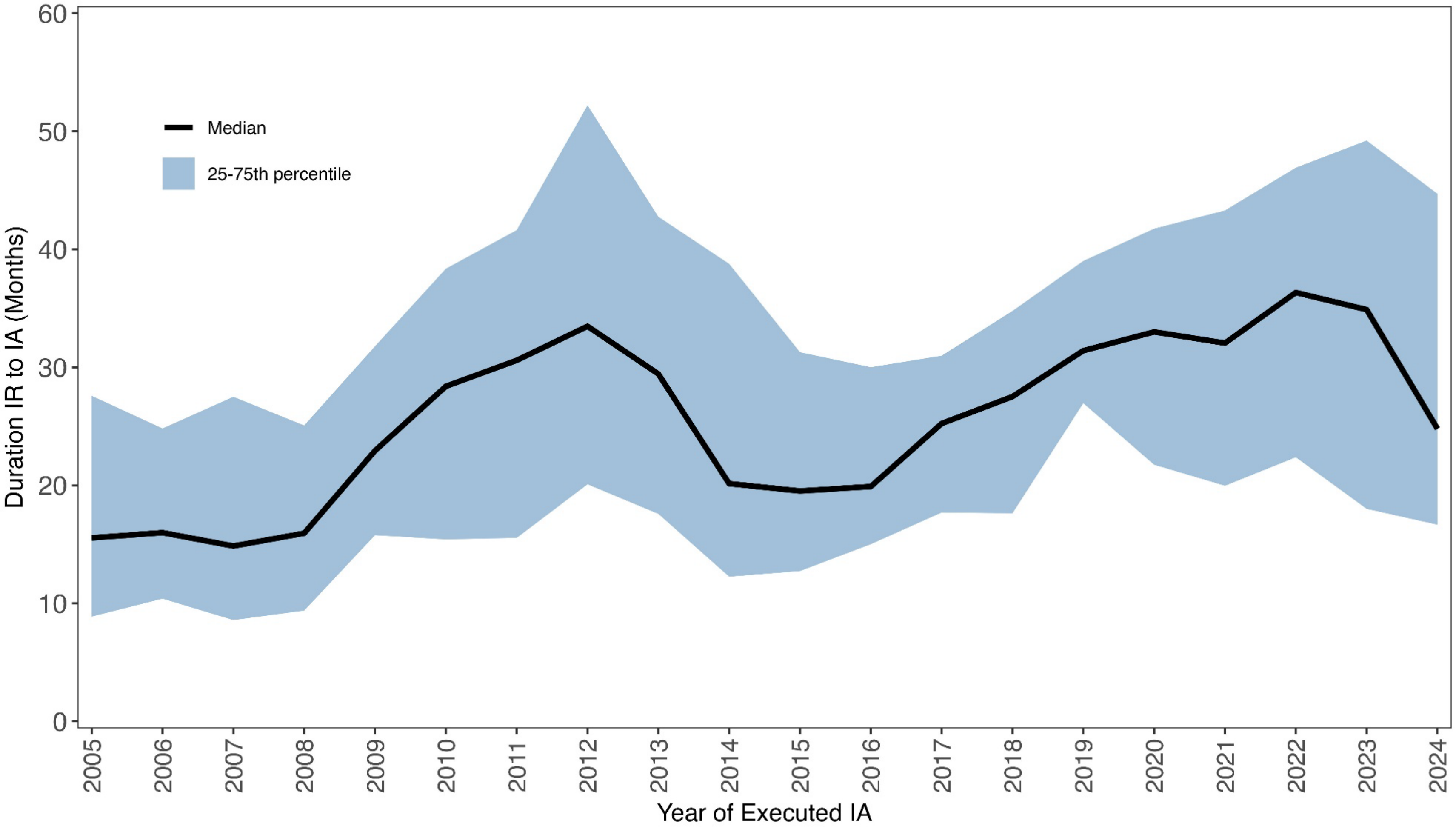




Notes: (1) Withdrawn date was available for 9,978 requests from 7 ISOs and 8 non-ISO balancing areas. (2) Duration is calculated as the number of months from the queue entry date to the date the project was withdrawn from queues. (3) Withdrawn dates were not available for CAISO Cluster 15, though a large number from that cluster withdrew in 2024; those requests would shorten the 2024 durations for CAISO and Solar, but are not included in these charts.

Duration from interconnection request to interconnection agreement had increased recently, but moderated slightly in 2024 (note: 2024 data sample is dominated by ERCOT)

Duration Analyzed:	Interconnection Request (IR)	→	Interconnection Agreement (IA)	→	Commercial Operations (COD)

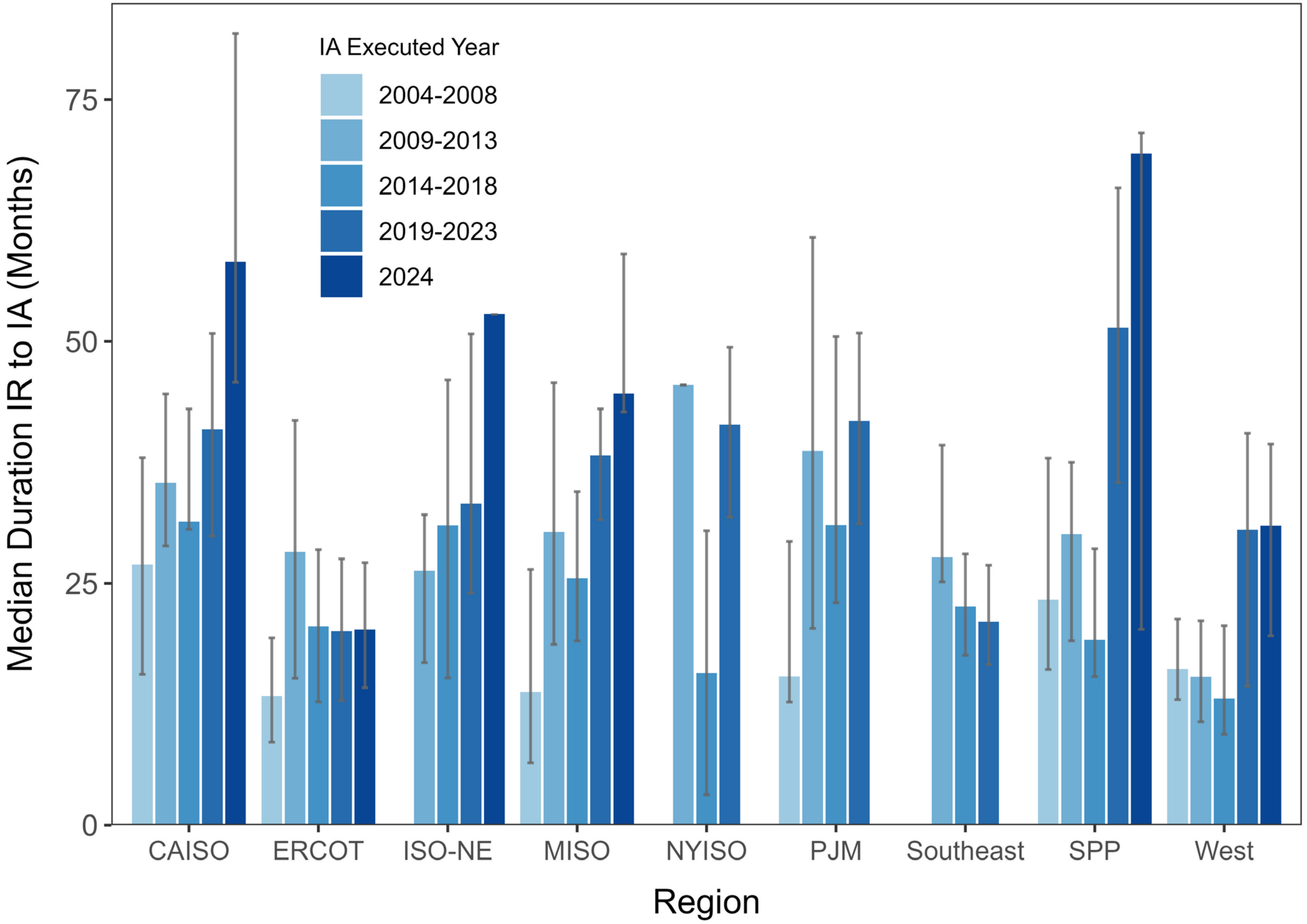


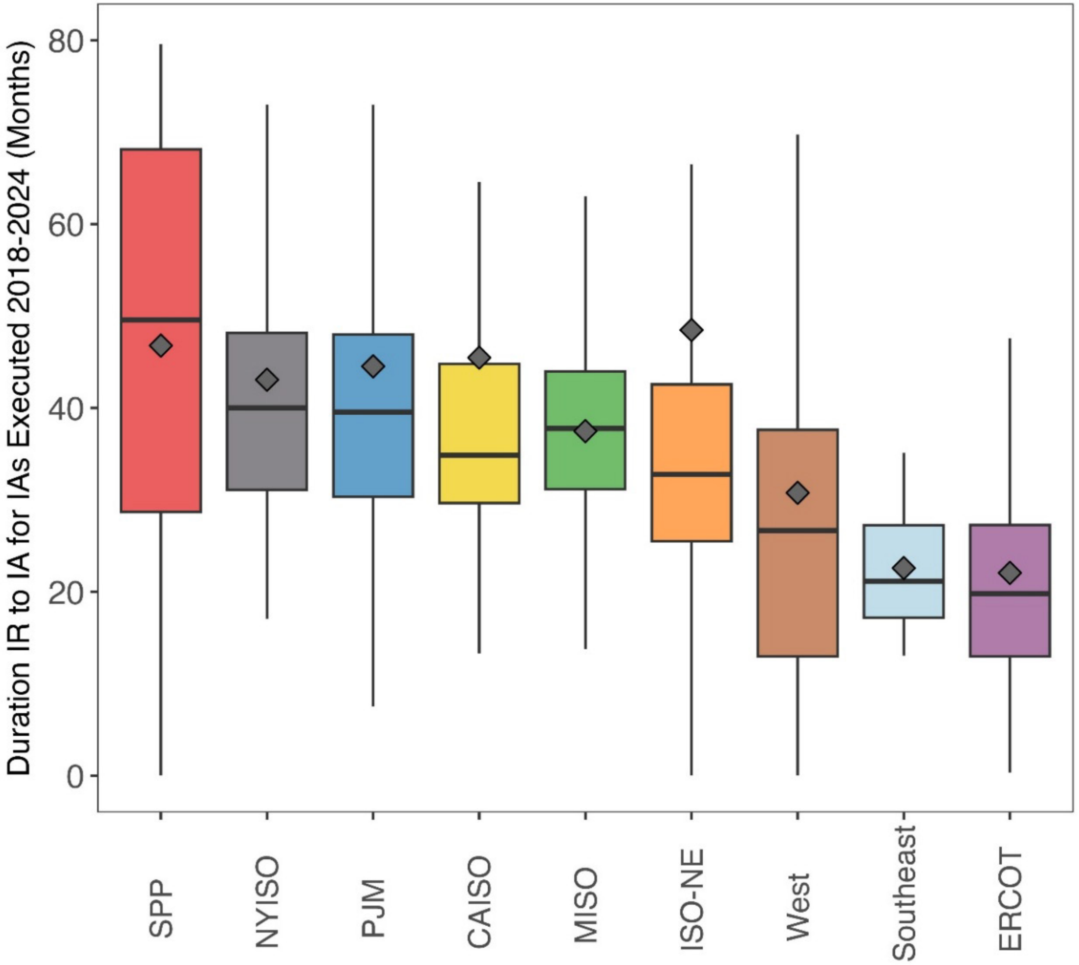
Sample Size (# IA dates) by Region and Year

Region	2018	2019	2020	2021	2022	2023	2024
CAISO	22	14	25	32	20	25	4
ERCOT	56	49	83	85	105	135	123
ISO-NE	12	5	17	16	9	19	1
MISO	22	65	54	76	82	102	24
NYISO	4	14	24	35	8	23	0
PJM	17	30	25	35	10	0	0
Southeast	21	25	6	6	0	0	0
SPP	26	30	38	33	46	76	48
West	43	51	44	34	25	61	14

Notes: (1) The majority of the 2024 data sample for this analysis came from ERCOT (57%), which typically has relatively shorter durations (see next slide); date of IA execution for projects with IA agreement completed in 2023-2024 was not accessible in database format from PJM. (2) Sample includes 4,393 projects from 7 ISO/RTOs and 5 non-ISO balancing areas with executed interconnection agreements since 2005. (3) Not all data used in this analysis are publicly available.

IR to IA duration is typically longer in FERC-jurisdictional ISOs. ERCOT and the non-ISO regions (Southeast and West) have faster processing times

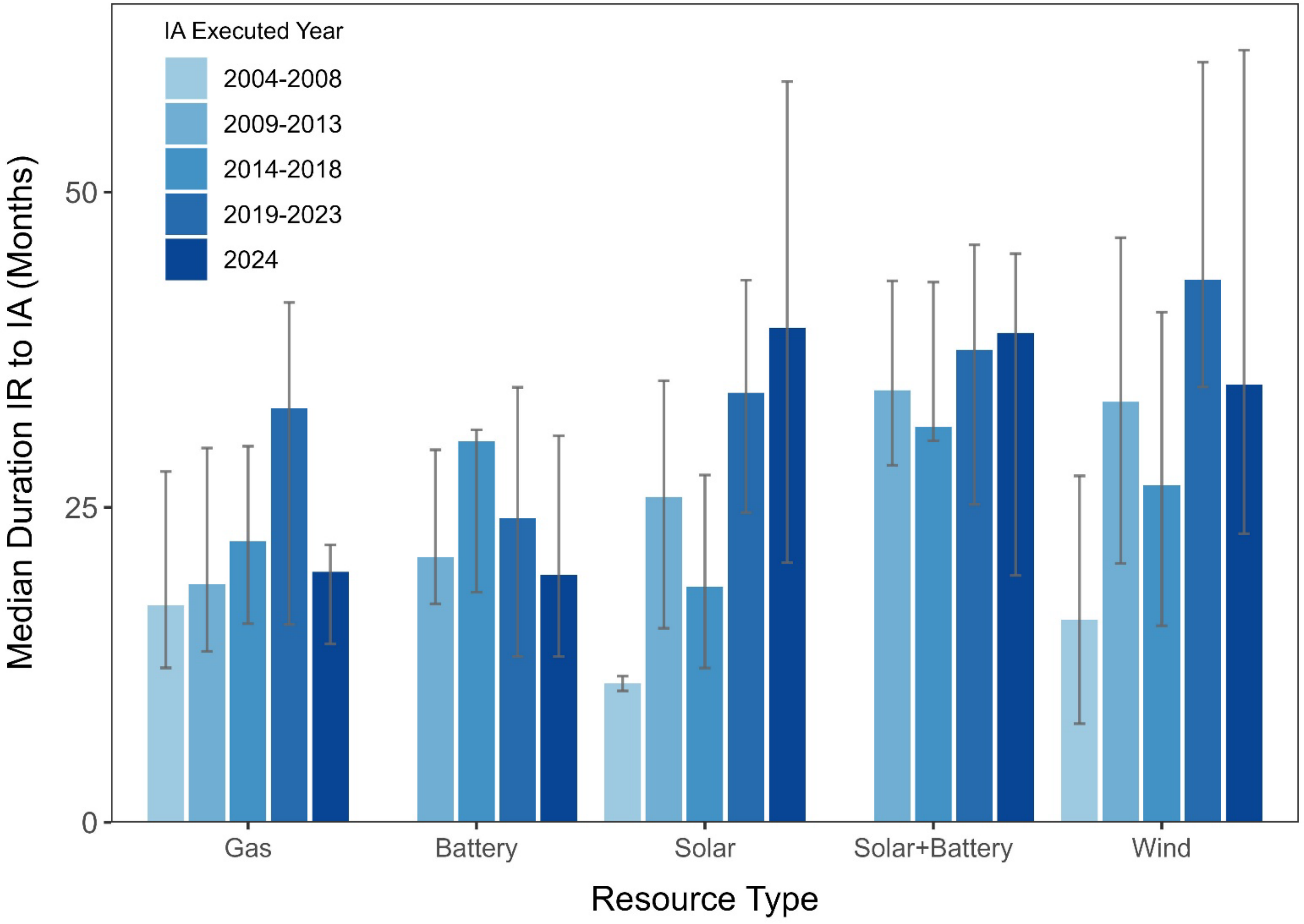


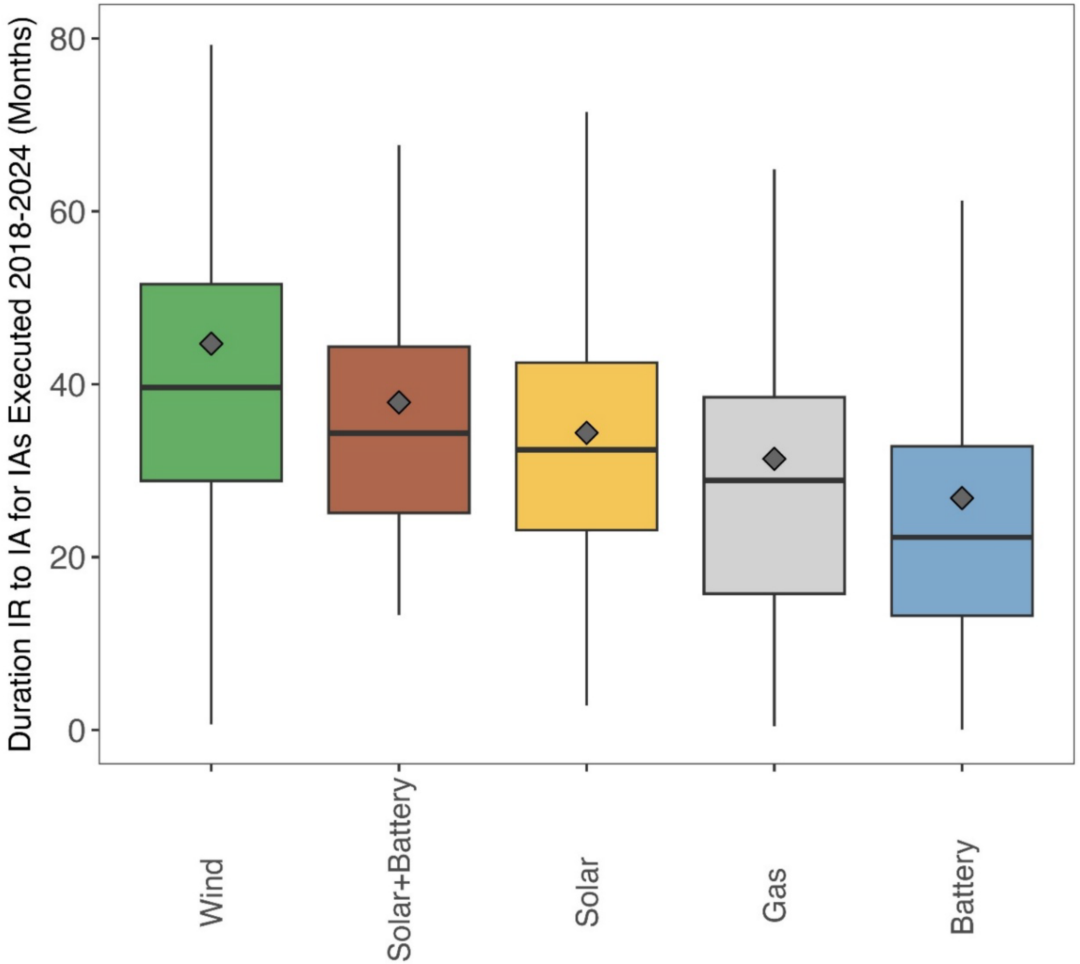


Notes: (1) Sample includes 4,393 projects from 7 ISO/RTOs and 5 non-ISO balancing areas with executed interconnection agreements since 2005. (2) The majority of the 2024 data this analysis are from ERCOT (57%). (3) Not all data used in this analysis are publicly available. (4) Date of IA execution for projects with IA agreement completed in 2023-2024 was not accessible in database format from PJM.

Wind projects typically face longer interconnection study timelines, but recent solar requests are trending up. Recent battery and gas projects have been processed more quickly

Duration Analyzed: | *Interconnection Request (IR)* → *Interconnection Agreement (IA)* → *Commercial Operations (COD)*

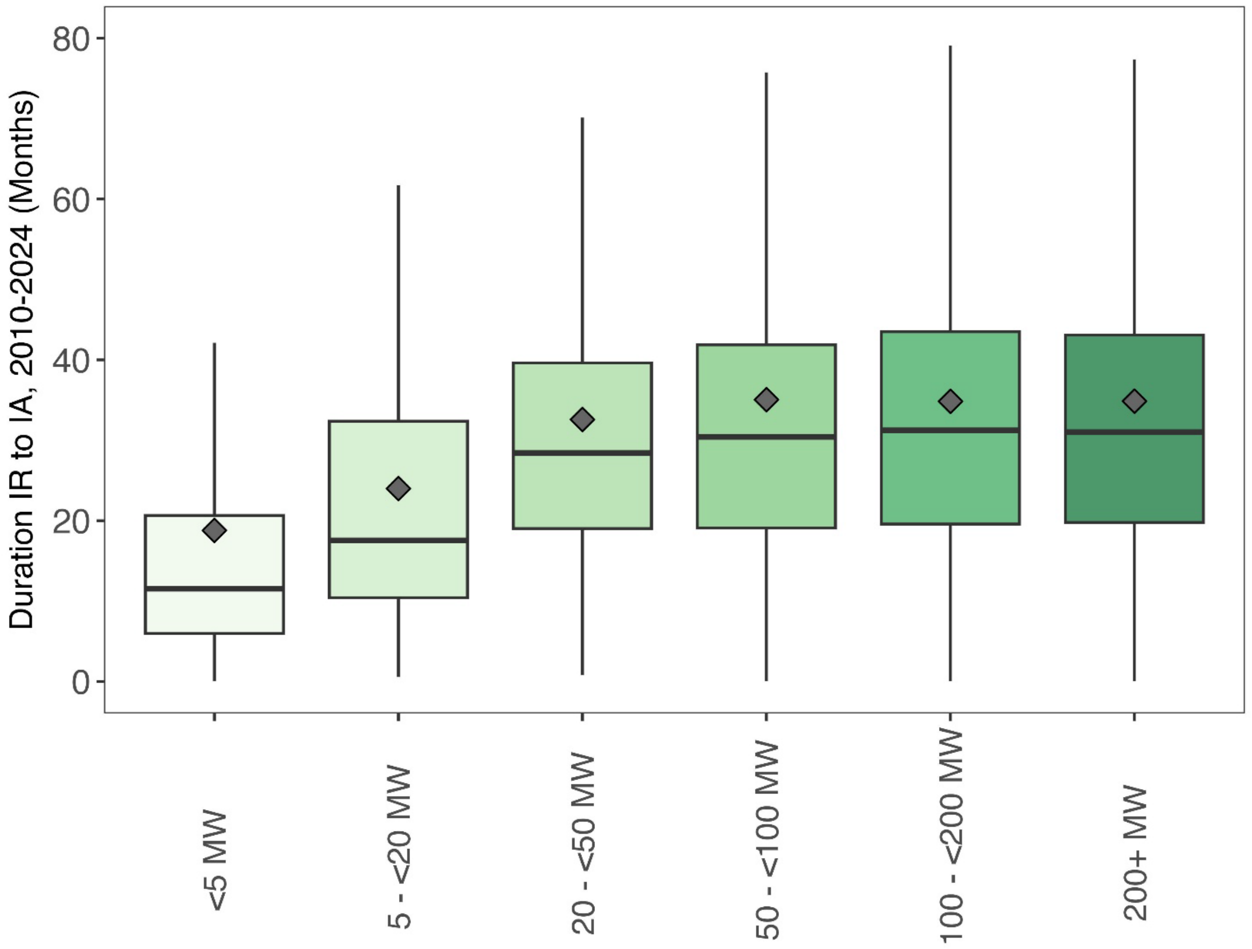




Notes: (1) Sample includes 4,393 projects from 7 ISO/RTOs and 5 non-ISO balancing areas with executed interconnection agreements since 2005. (2) The majority of the 2024 data this analysis are from ERCOT (57%). (3) Not all data used in this analysis are publicly available.

There is a clear step change in IR to IA duration between “small” (<20 MW) and “large” (>20 MW) generator interconnection procedures

Duration Analyzed:	Interconnection Request (IR)	→	Interconnection Agreement (IA)	→	Commercial Operations (COD)

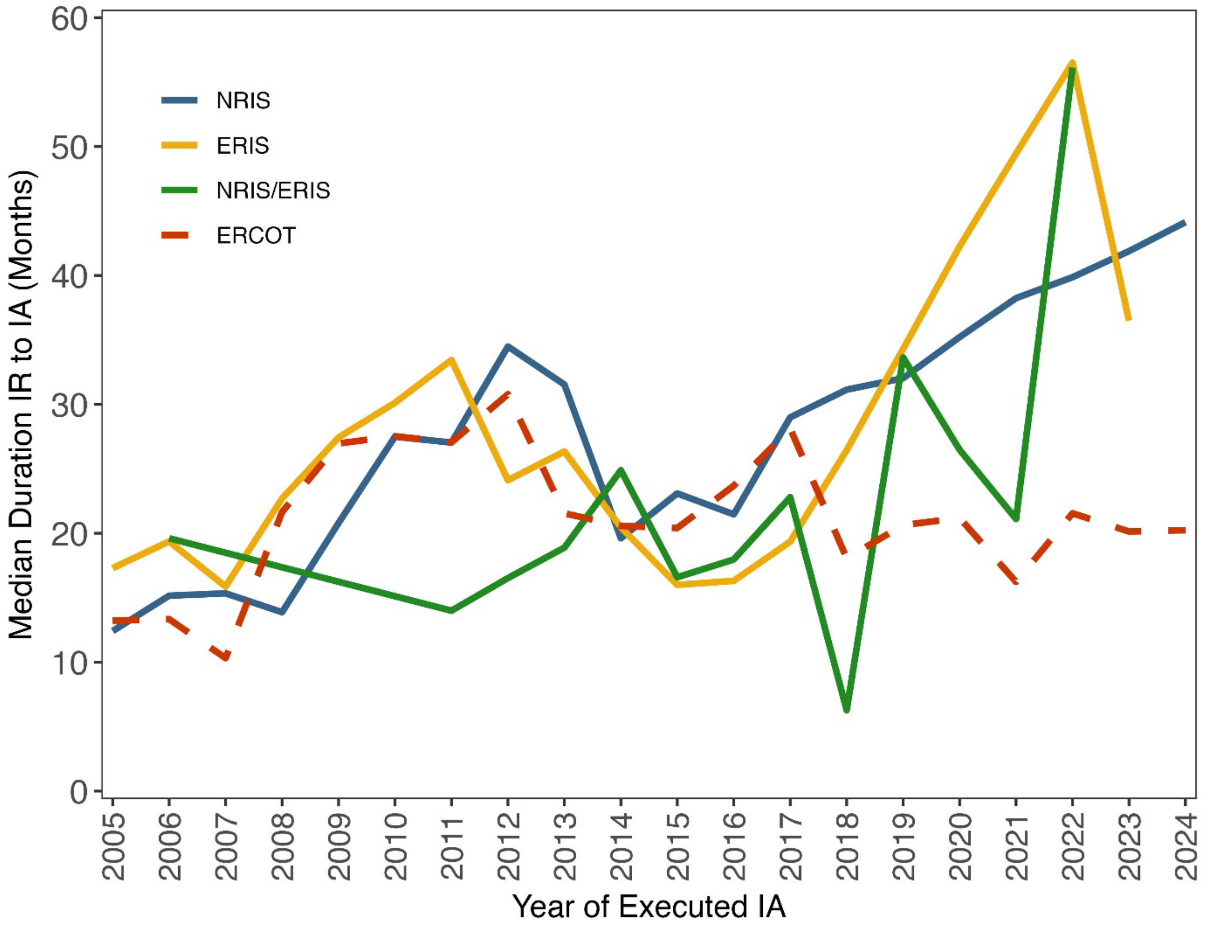


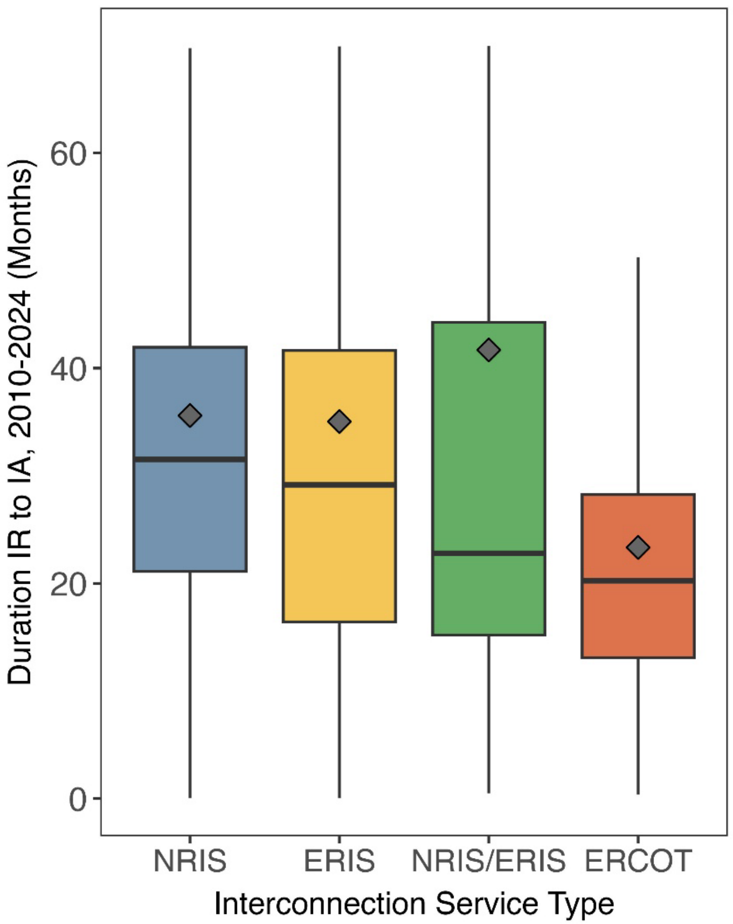
- Projects with rated capacity <20 MW typically complete studies and execute interconnection agreements much faster than larger projects
  - Median is 12 months for projects <5 MW
  - 18 months for projects 5 - <20 MW
- The median duration for projects 20 MW or larger hovers around 30 months across the four larger project groups analyzed
- 20 MW is the threshold between the FERC “large” and “small” generator interconnection procedures (LGIP / SGIP)
  - The median LGIP duration is twice the median SGIP duration for projects in our sample

Notes: (1) Sample includes 4,393 projects from 7 ISO/RTOs and 5 non-ISO balancing areas with executed interconnection agreements since 2005. (2) The majority of the 2024 data this analysis are from ERCOT (57%). (3) Not all data used in this analysis are publicly available.

Energy Resource Interconnection Service (ERIS) requests are not significantly faster to process than Network Resource Interconnection Service (NRIS), though ERCOT requests are faster

Duration Analyzed:	*Interconnection Request (IR)*	→	*Interconnection Agreement (IA)*	→	*Commercial Operations (COD)*



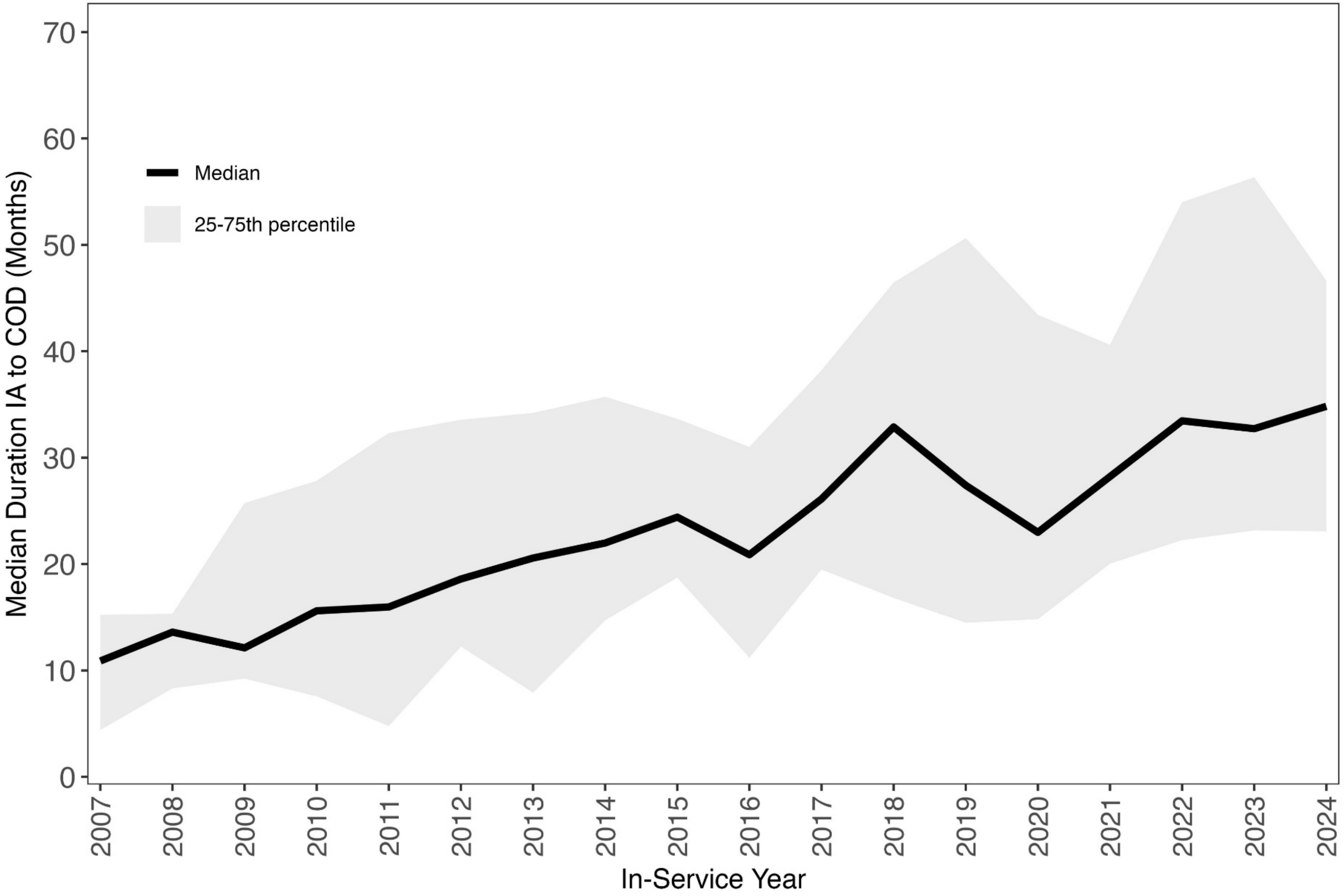


Based on t-tests of mean durations, the average IR-IA duration for ERIS requests submitted since 2010 (35 months) is not significantly ($p = 0.3$)[1] shorter than that for NRIS requests (~36 months).

ERCOT – which is not FERC jurisdictional – utilizes a 'connect and manage' approach, which is similar to ERIS. But ERCOT requests are processed significantly ($p < 0.001$) faster on average (~23.3 months) than ERIS requests in other regions since 2010.

Notes: (1) T-tests were used to determine whether there is a statistically significant difference between the mean duration of groups. We consider a p-value less than 0.05 to be statistically significant. (2) Sample includes 4,164 projects from 6 ISO/RTOs and 4 non-ISO balancing areas with executed interconnection agreements since 2005 that also provided service type information (3,493 since 2010). (3) Not all data used in this analysis are publicly available.

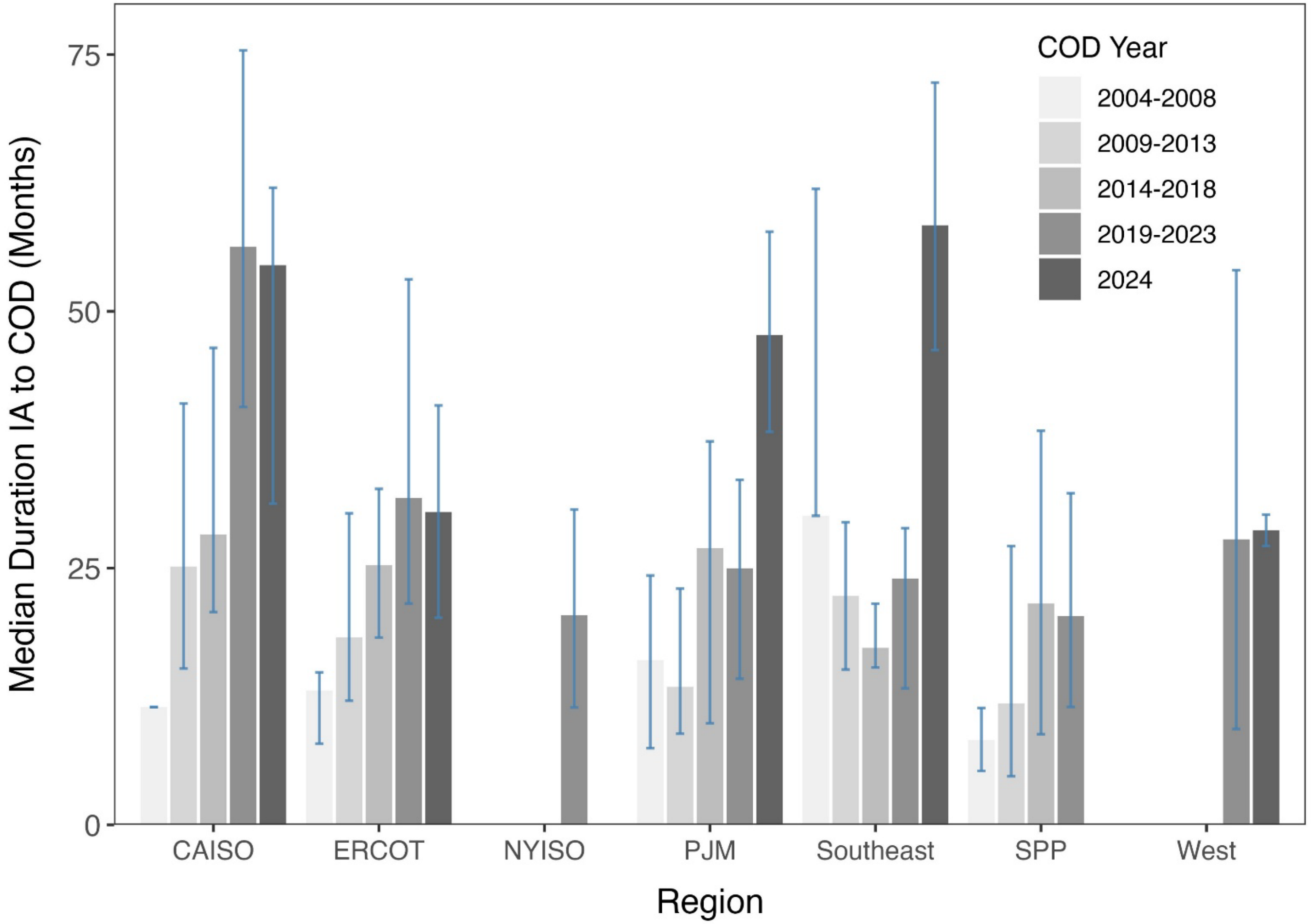
Projects can face substantial delays *after* securing an interconnection agreement (IA). The median duration from IA to commercial operations date (COD) has increased over time

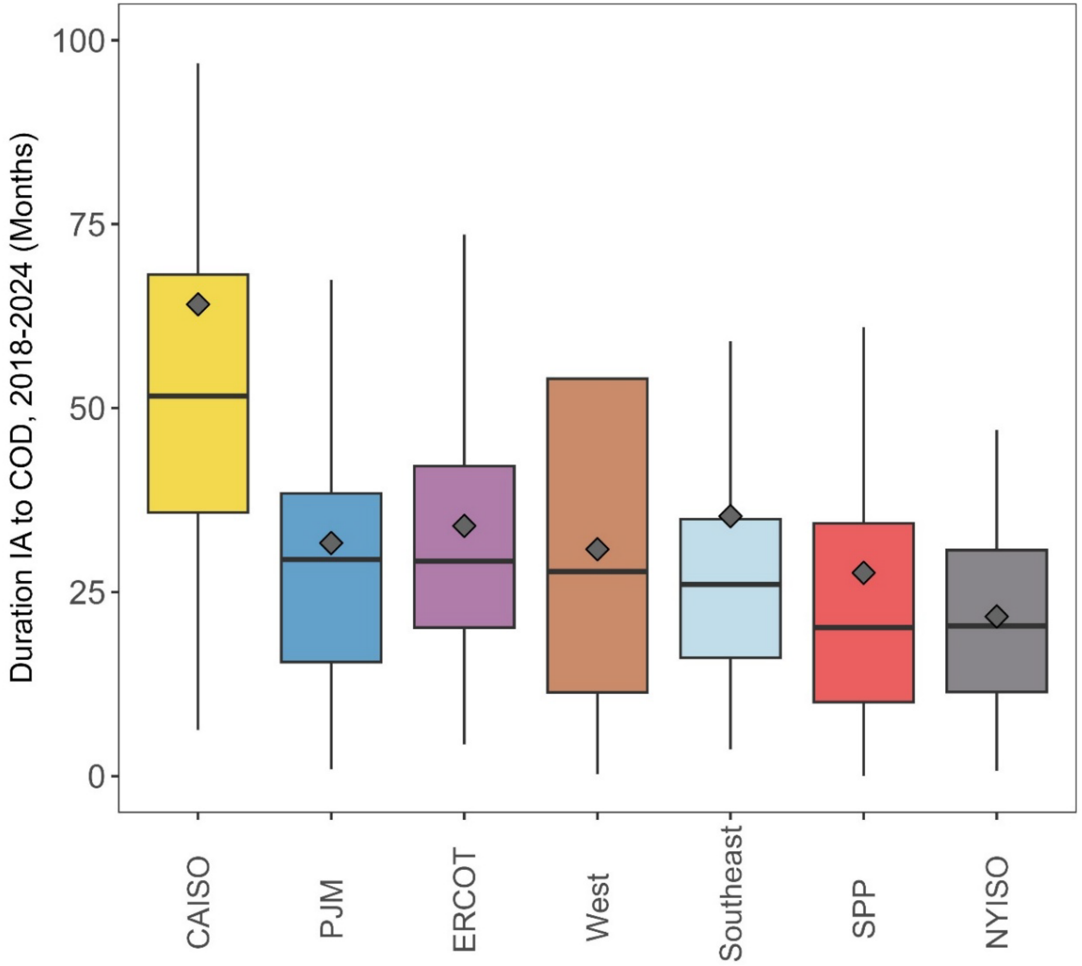


- Limited data were available to analyze typical durations from interconnection agreement to commercial operations
- Considering 1,161 projects across 7 entities, the median IA to COD duration has increased notably
  - From 11 months for projects built in 2007, 19 months in 2015, and **35 months for those built in 2024**
- But, that duration has been especially high in CAISO recently (see next slide)
  - The typical solar project built in CAISO since 2018 took over 4 years to reach commercial operations *after securing an interconnection agreement*; those built in 2022 averaged over 5 years
  - This is largely due to factors outside of the interconnection process, such as procurement / offtake, permitting, and transmission completion

Notes: (1) Data were only available for 1,161 projects across 5 ISO/RTOs and two utilities, out of 4,432 total "operational" projects in the full dataset. (2) Not all data used in this analysis are publicly available.

The timeline from IA to COD is increasing across regions; this period is typically longest in CAISO, though PJM and the Southeast also had long durations for projects built in 2024

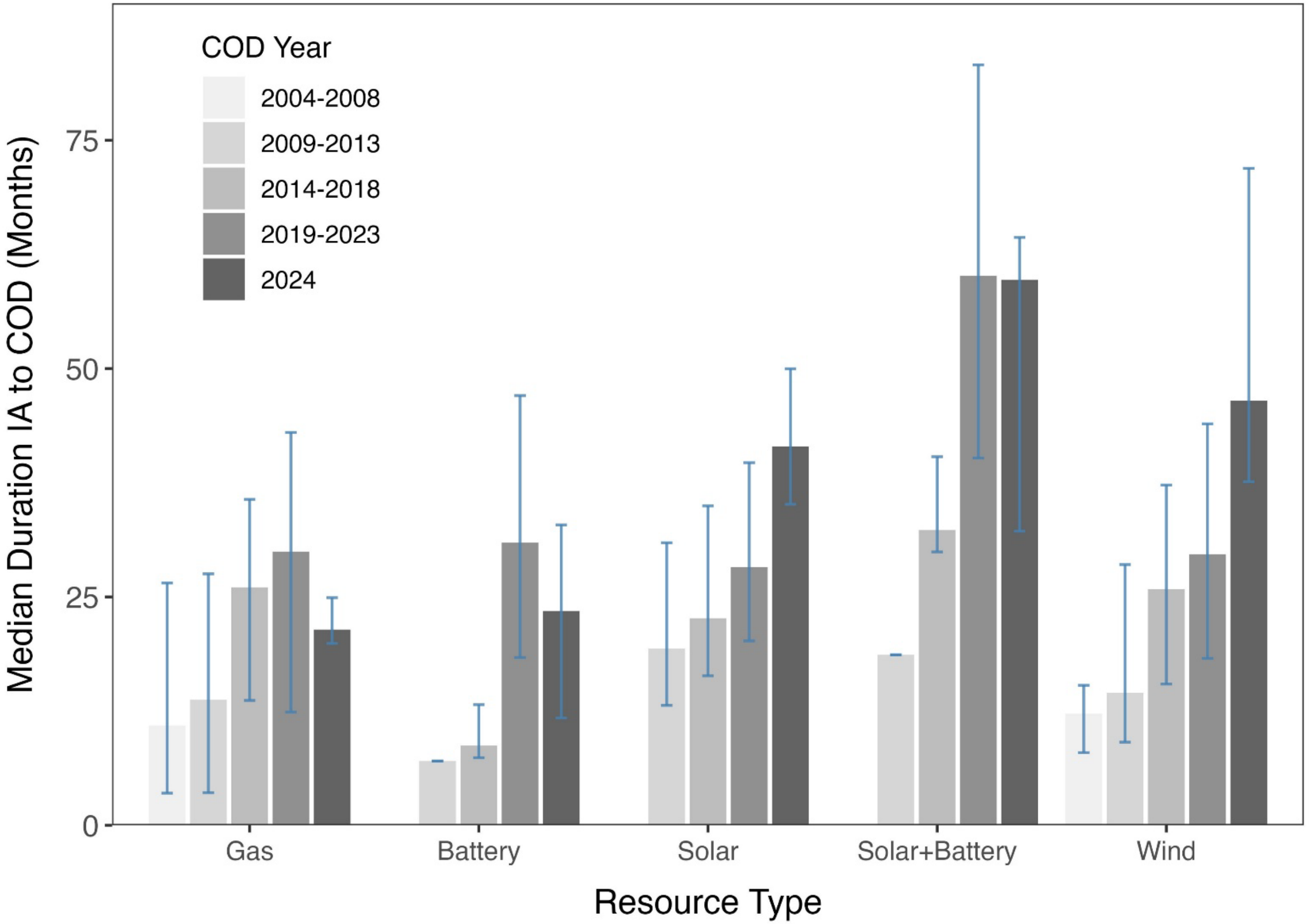


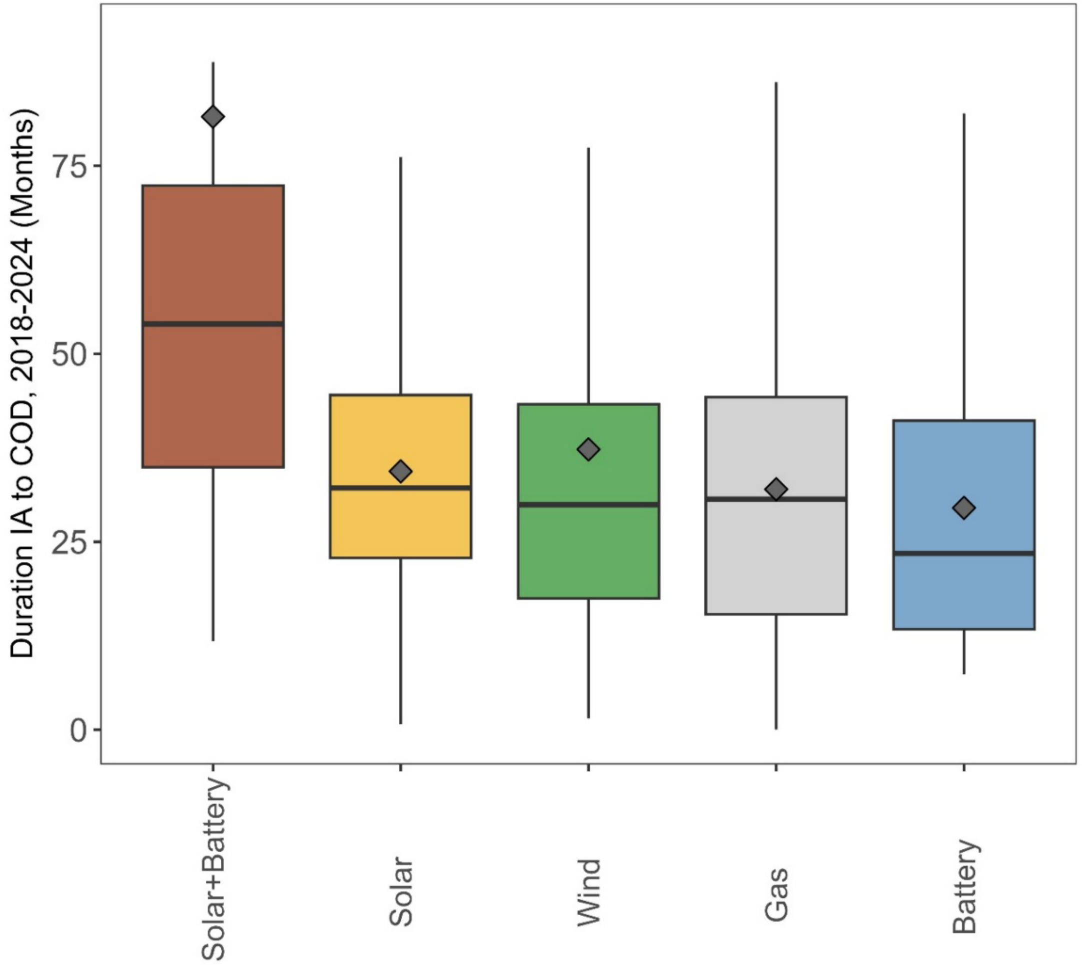


Notes: (1) Data were only available for 1,161 projects across 5 ISO/RTOs and two utilities, out of 4,432 total “operational” projects in the full dataset. (2) Not all data used in this analysis are publicly available.

IA to COD duration is increasing across resource types, too. Solar+battery projects typically take longest[1], whereas standalone battery plants tend to move fastest

Duration Analyzed: Interconnection Request (IR) → Interconnection Agreement (IA) → Commercial Operations (COD)

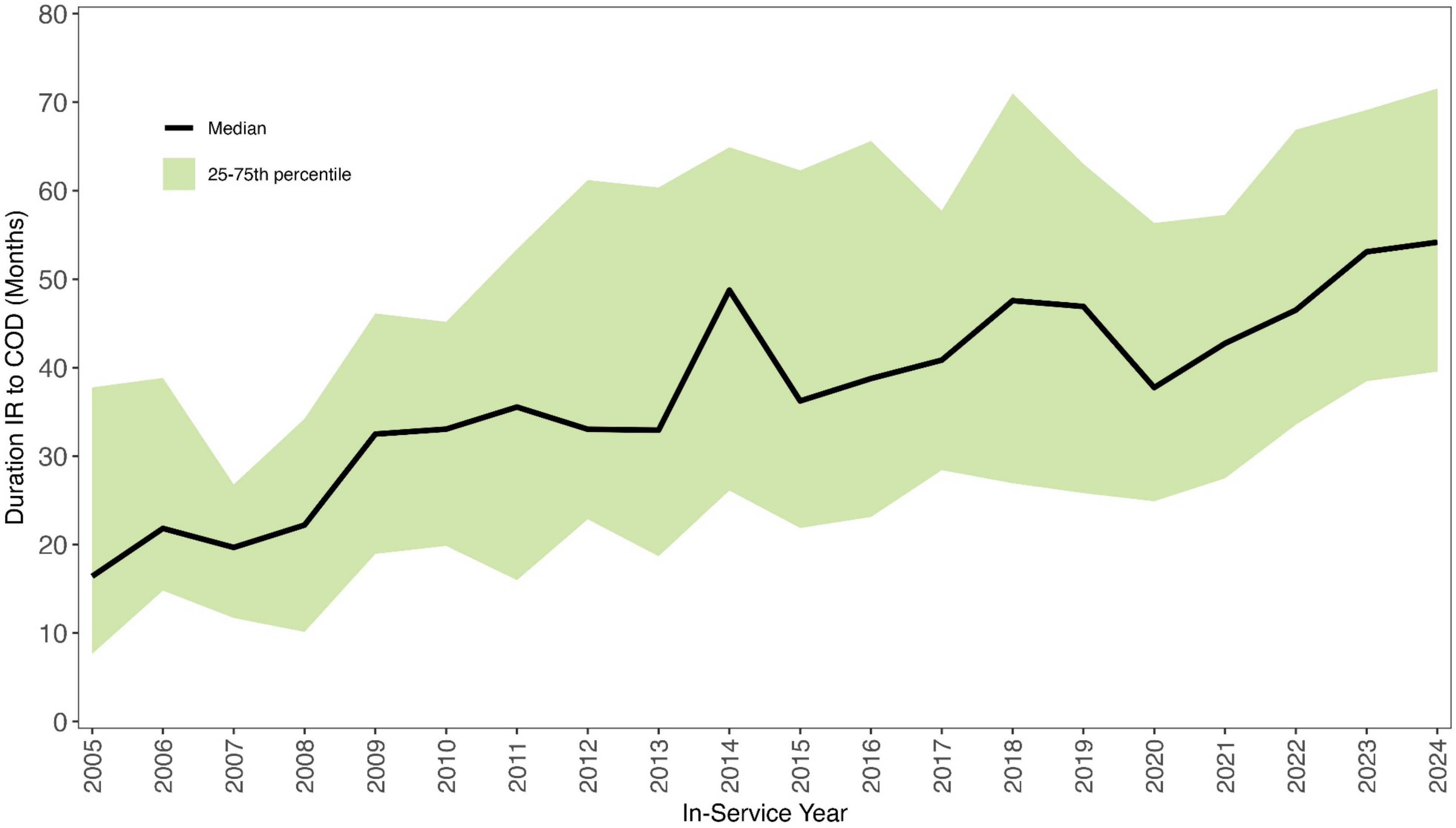




Notes: (1) The sample of Solar+Battery plants in this analysis are predominantly from CAISO, where there were recent procurement / offtake delays (see previous slides). (2) Data were only available for 1,161 projects across 5 ISO/RTOs and two utilities, out of 4,432 total "operational" projects in the full dataset. (3) Not all data used in this analysis are publicly available.

The median duration from interconnection request (IR) to commercial operations date (COD) continues to rise: 55 mo. for projects completed in 2024 (2024 sample dominated by ERCOT)

Duration Analyzed:	*Interconnection Request (IR)*	→	*Interconnection Agreement (IA)*	→	*Commercial Operations (COD)*



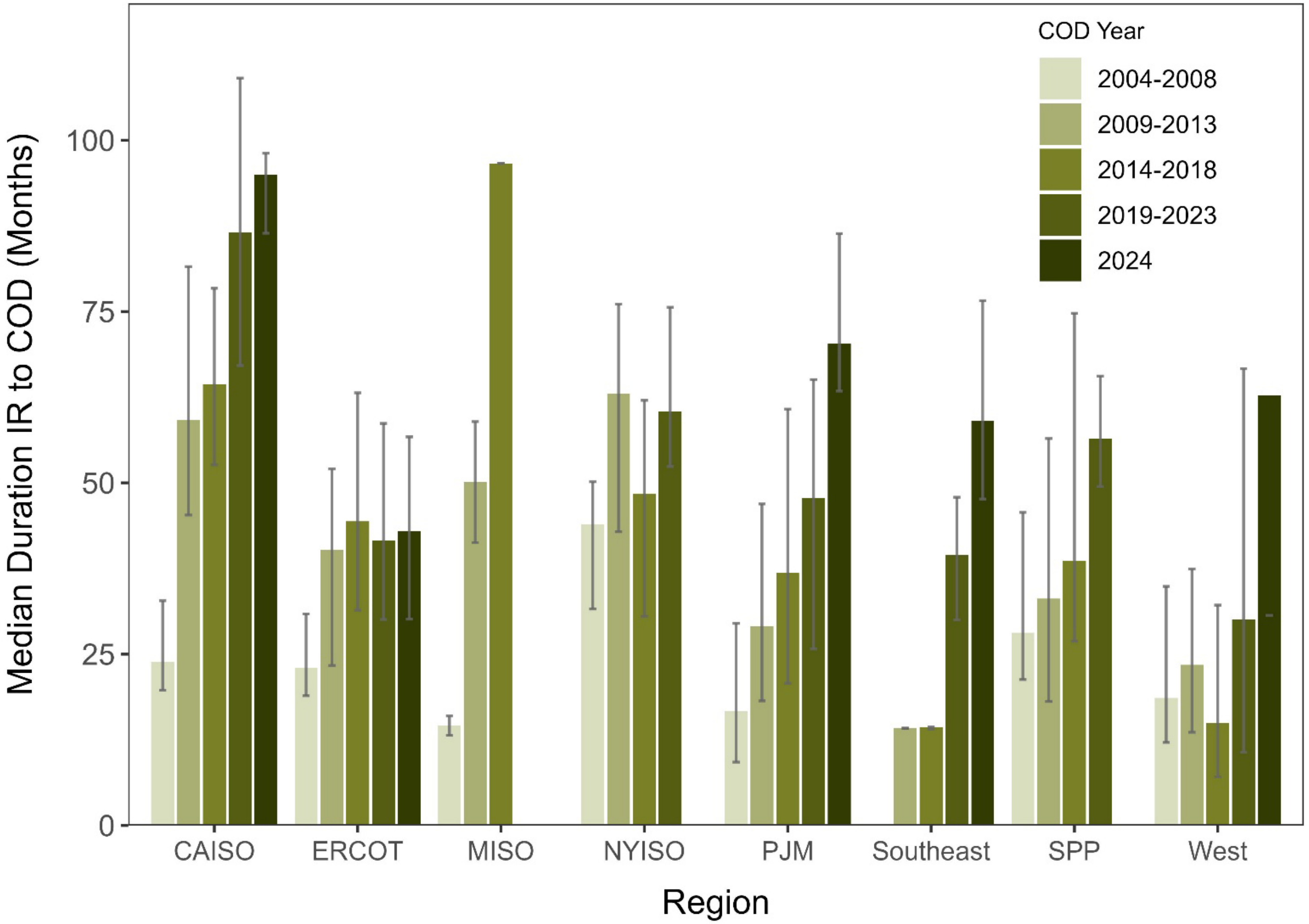
Sample Size (# requests) by Region and Year

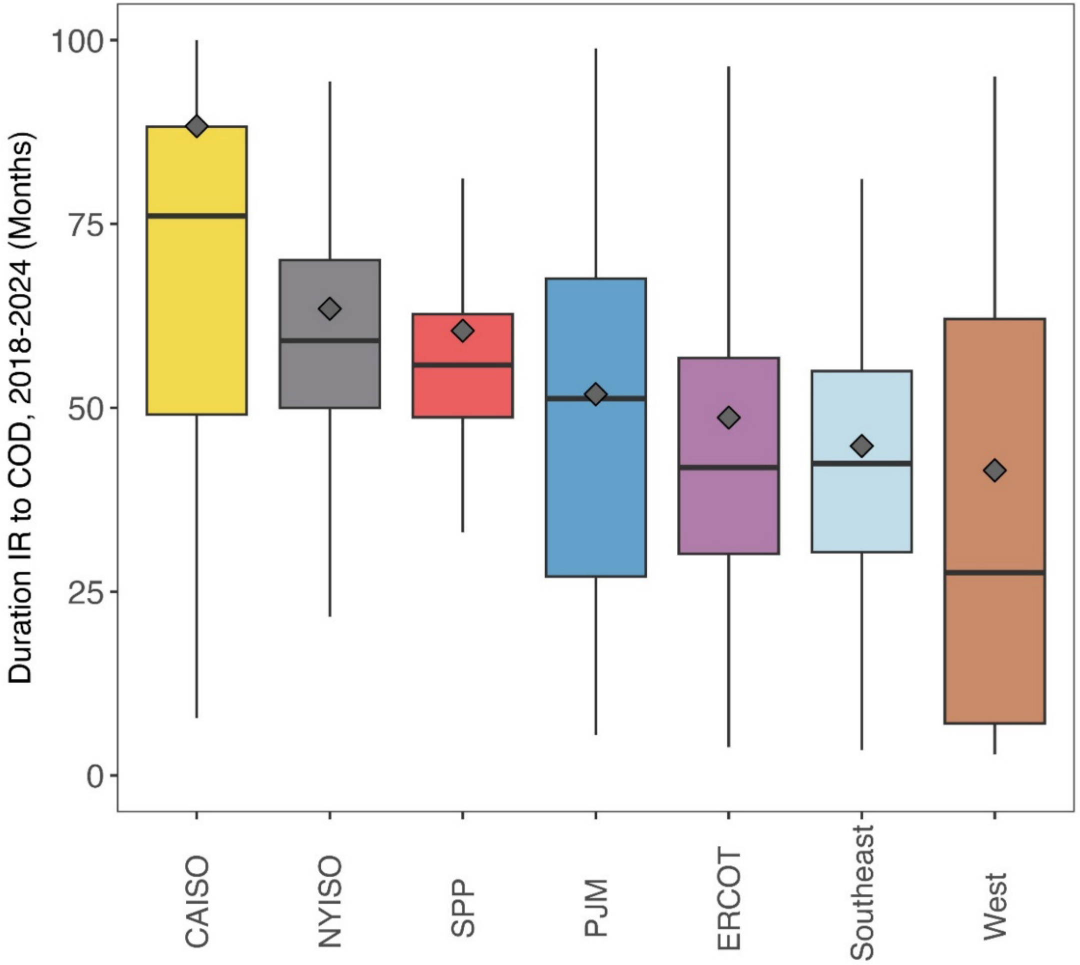
Region	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
CAISO	8	11	8	18	13	12	7
ERCOT	62	76	79	139	91	95	144
NYISO	3	10	1	4	9	4	0
PJM	67	55	92	50	35	63	60
Southeast	4	4	29	36	31	43	46
SPP	15	9	27	15	7	4	0
West	6	2	2	9	10	7	7

Notes: (1) The majority of the 2024 data sample for this analysis came from ERCOT (55%), which typically has relatively shorter durations (see next slide); (2) Includes data from 5 ISOs and 17 non-ISO BAs representing 72% of all operational projects in our sample. (3) Duration is calculated as the number of months from the queue entry date to the commercial operations date.

The request to operational timeline has increased in many regions; duration tends to be longer in FERC-jurisdictional ISOs

Duration Analyzed:	*Interconnection Request (IR)*	→	*Interconnection Agreement (IA)*	→	*Commercial Operations (COD)*

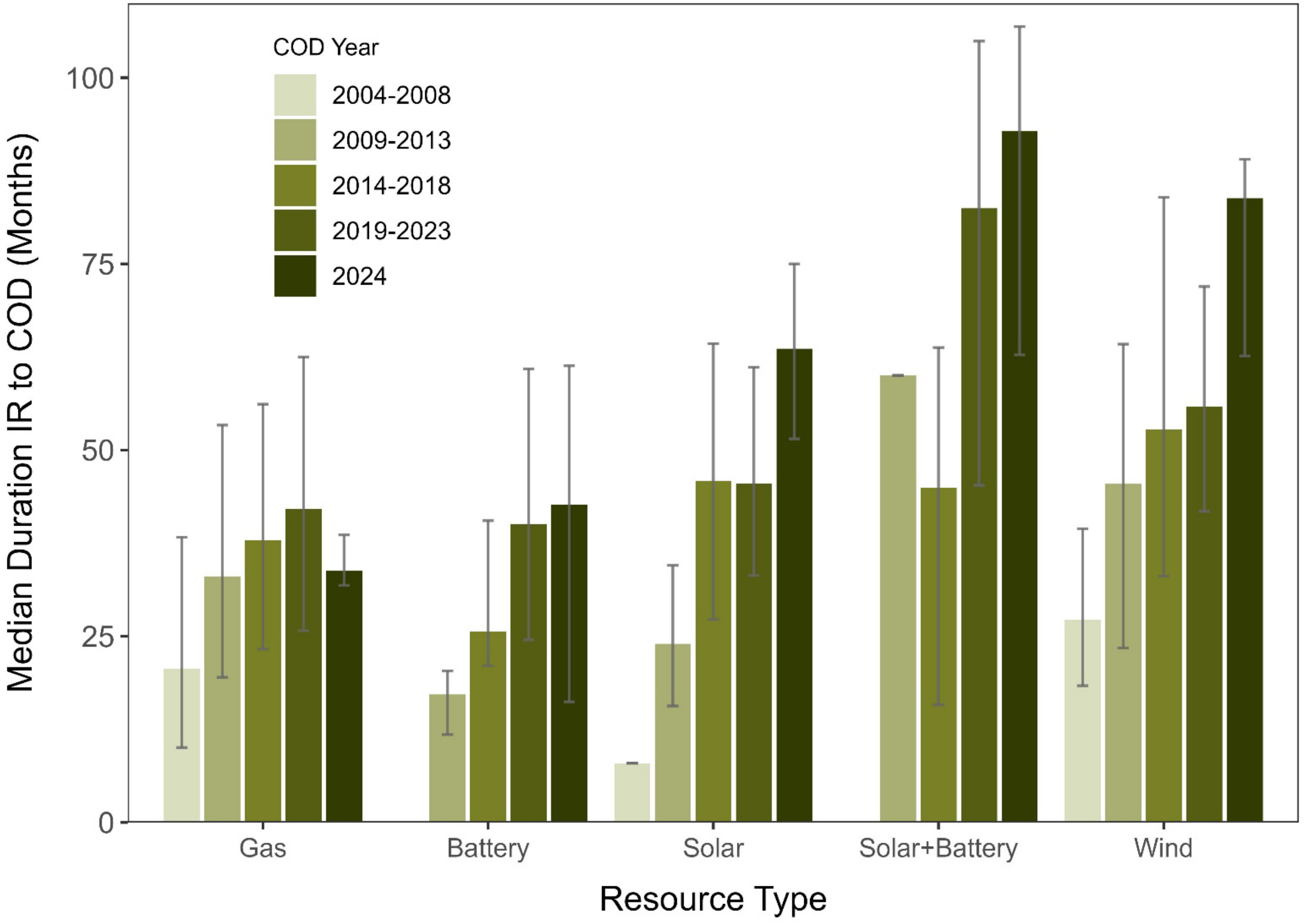


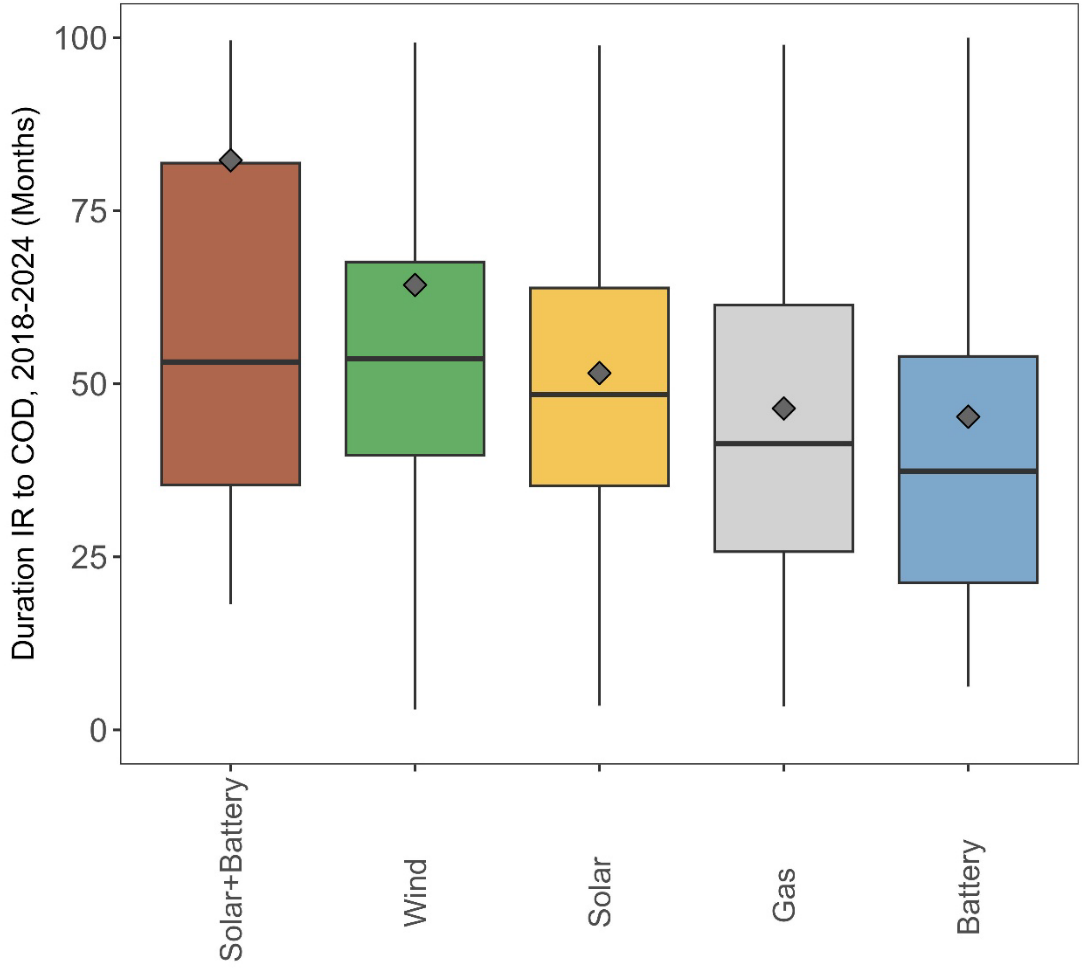


Notes: (1) Includes data from 5 ISOs and 17 non-ISO BAs representing 72% of all operational projects in our sample. (2) Duration is calculated as the number of months from the queue entry date to the commercial operations date.

Duration from request to COD is also increasing across resource types. Solar+battery and wind projects typically take longest

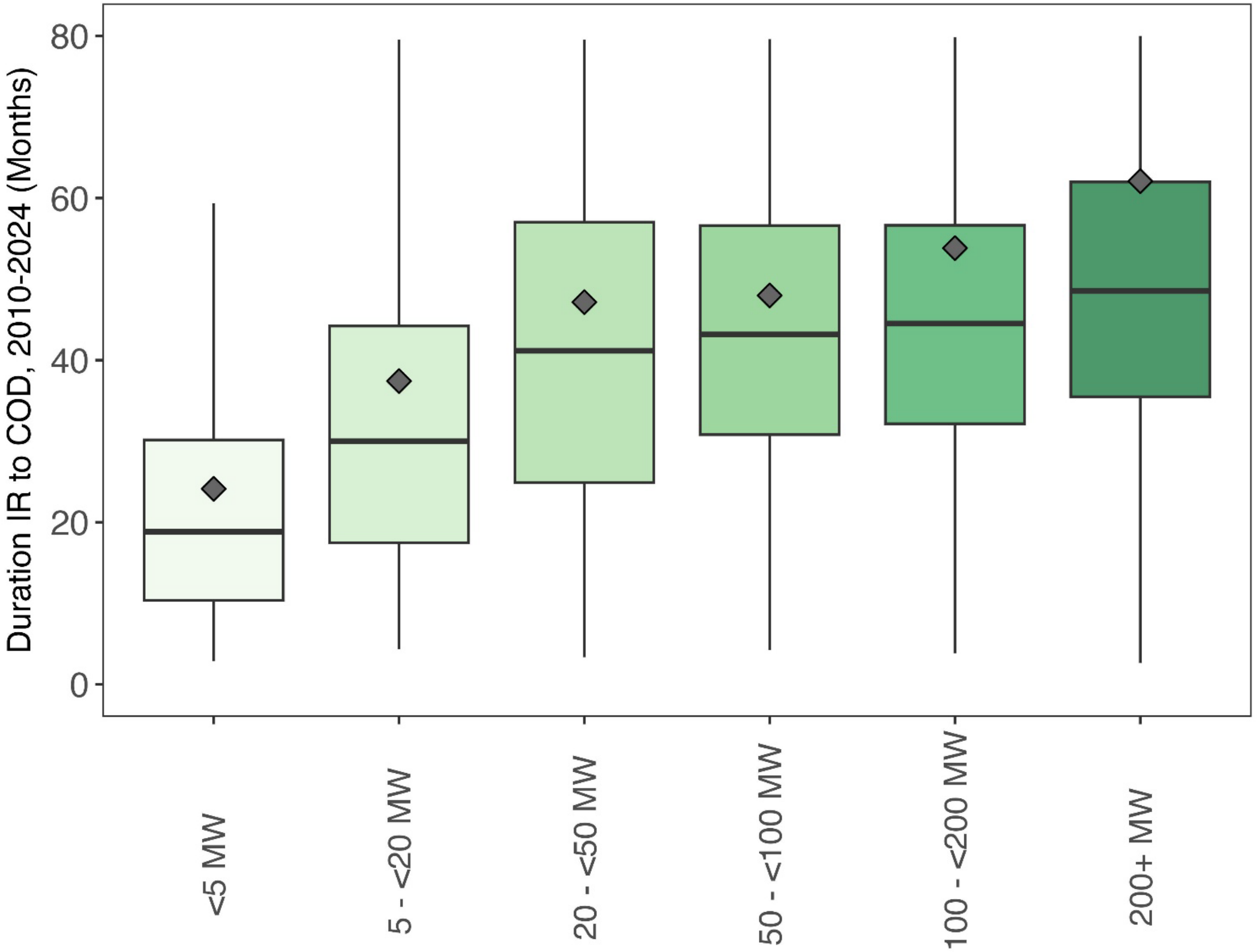
Duration Analyzed:	Interconnection Request (IR)	→	Interconnection Agreement (IA)	→	Commercial Operations (COD)





Notes: (1) Includes data from 5 ISOs and 17 non-ISO BAs representing 72% of all operational projects in our sample. (2) Duration is calculated as the number of months from the queue entry date to the commercial operations date.

Larger projects have longer development timelines: The average IR to COD duration increases by project size (MW) – especially up to the 20 MW LGIP limit



- For the smallest projects in our sample (<5 MW), the median project came online less than 2 years (18 months) after the interconnection request
- The median 5-20 MW project, meanwhile, takes nearly 3 years (32 months) from IR to COD
- Larger projects spend even more time in the interconnection and development process, with the median 100-200 MW project taking >4 years (49 months) and the median 200+ MW project taking nearly 5 years (56 months) from IR to COD

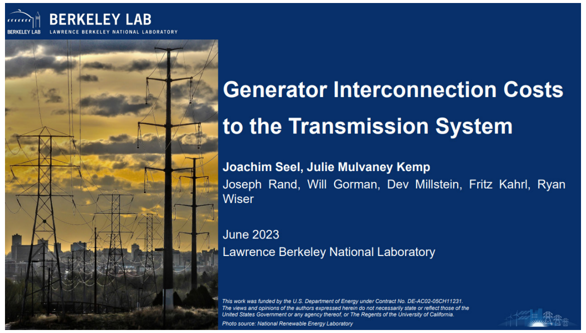
Notes: (1) Box-plot includes projects reaching commercial operations from 2010-2024. (2) Includes data from 5 ISOs and 17 non-ISO BAs representing 72% of all operational projects in our sample. (3) Duration is calculated as the number of months from the queue entry date to the commercial operations date.

As of the end of 2024, there were ~10,300 projects actively seeking grid interconnection across the U.S., representing 1,400 GW of generation and approximately 890 GW of storage.

- Historic withdrawal rates alongside relatively fewer requests resulted in a 12% decrease in total active queue volume in 2024.
- Active natural gas capacity (136 GW, +72% year-over-year) increased in 2024, while solar (956 GW, -12%), storage (890 GW, -13%), and wind (271 GW, -26%) capacity decreased.
- Capacity in queues is widespread across the U.S., but some states dominate: Texas has 15% of all solar capacity, 19% of gas, 17% of storage, and 19% of wind; California has 19% of storage and 8% of solar.
- There is a relatively modest amount of nuclear (~5 GW) and geothermal (~2 GW) capacity active in the queues.
- Hybrid power plants comprise a large share of proposed projects, particularly in CAISO and the West. 451 GW of solar hybrids (primarily solar+battery) are active. Roughly half of all active solar and storage capacity is in hybrid plant configurations[1].
- 408 GW of capacity already has a draft or executed interconnection agreement (IA) but has not yet reached commercial operations, including 199 GW of solar, 129 GW of storage, 54 GW of wind, and 26 GW of gas.
- The time projects spend in queues before reaching COD is increasing. For the regions with available data[2], the median duration from IR to COD has doubled from <2 years for projects built in 2000-2007 to over 4 years for those built in 2018-2024.
  - The full interconnection process timeline (from IR to IA) has also increased, though moderated somewhat in 2024.
  - Larger projects have longer development timelines; interconnection study duration increases notably for projects >20 MW.
  - Generally, timelines are increasing across resource types and regions, though ERCOT and the non-ISO regions tend to be faster.
- Ultimately, most of this proposed capacity will not be built. Only 13% of capacity that submitted interconnection requests from 2000-2019 had reached commercial operations by the end of 2024; 77% of that capacity had been withdrawn and 10% was still active.
- FERC Order 2023 and various other reforms are being implemented. These are important measures to reduce interconnection bottlenecks and enhance grid system reliability, but it is too early to measure and assess their full impact.

Notes: (1) Hybrid storage capacity is estimated using storage:generator ratios from projects that provide separate capacity data. (2) Data for this analysis were only available for 72% of all operational projects in our sample.

Related Berkeley Lab transmission interconnection research + resources

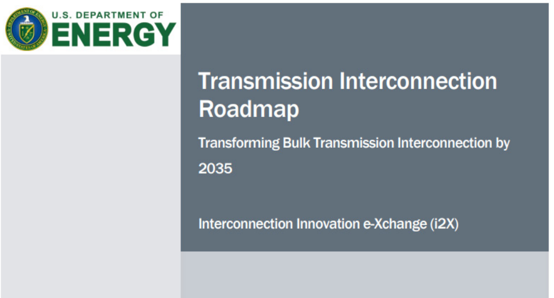

BERKELEY LAB
LAWRENCE BERKELEY NATIONAL LABORATORY

Generator Interconnection Costs to the Transmission System

Joachim Seel, Julie Mulvaney Kemp
Joseph Rand, Will Gorman, Dev Millstein, Fritz Kahrl, Ryan Wiser

June 2023
Lawrence Berkeley National Laboratory

- Collecting and analyzing the cost of interconnecting new resources
  - Analysis of interconnection cost data for projects in MISO, PJM, SPP, ISO-NE, NYISO, and CAISO for studies performed between 2010 and 2023. ISO-specific technical briefs and cleaned interconnection cost data files are available for download
  - New draft work on non-ISO BA interconnection costs (PACE, BPA, and Duke Utilities)


U.S. DEPARTMENT OF ENERGY

Transmission Interconnection Roadmap

Transforming Bulk Transmission Interconnection by 2035

Interconnection Innovation e-Xchange (i2X)

- Researching opportunities for interconnection solutions and reforms
  - Developed Transmission Interconnection Roadmap by engaging broad stakeholder community via DOE's i2X initiative through multiple webinars and workshops to identify 35 solutions enabling an improved interconnection process of new energy resources while enhancing reliability, resiliency, and security of our electric grid

i2X INTERCONNECTION INNOVATION e-XCHANGE
U.S. DEPARTMENT OF ENERGY

- Connecting stakeholders, improving data transparency, and developing solutions
  - i2X is a DOE program to enable simpler, faster, and fairer interconnection of electric resources while enhancing the reliability, resiliency, and security of our electric grid
  - Visit https://www.energy.gov/eere/i2x/ to find resources and find upcoming events

LAWRENCE BERKELEY NATIONAL LABORATORY

Contact:

Joseph Rand (jrand@lbl.gov)

More Information:

- Visit https://emp.lbl.gov/queues to download the data used for this analysis and access an interactive data visualization tool
- Visit https://emp.lbl.gov/interconnection_costs for related research on interconnection costs

Acknowledgements:

This work was funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE), in particular the Solar Energy Technologies Office and the Wind Energy Technologies Office, in part via the Interconnection Innovation eXchange (i2X). Additional support was provided by the EERE Strategic Analysis team. We thank Michele Boyd, Ammar Qusaibaty, Dexter Hendricks, Cynthia Bothwell, Jian Fu, Patrick Gilman, Gage Reber, Paul Spitsen, Colin Cunliff, and Patrick Bryant for supporting this project.
In addition, we thank our Technical Advisory Committee (TAC) for their helpful feedback on a draft of this report. The TAC includes representatives from 5 ISO/RTOs and 4 non-ISO utilities.

Appendix

Balancing areas included in data:

ISO/RTOs	Southeast (non-ISO)	
CAISO	Associated Electric Coop.	Jacksonville Electric Authority
ERCOT	Dominion	LG&E & KU Energy
ISO-NE	Duke Carolinas	Orlando Utilities Commission
MISO	Duke Florida	Santee Cooper
NYISO	Duke Progress	Seminole Electric Coop.
PJM	Duke/Progress	Southern Company
SPP	Florida Power & Light	Tampa Electric Co.
	Georgia Transmission Corp.	Tennessee Valley Authority

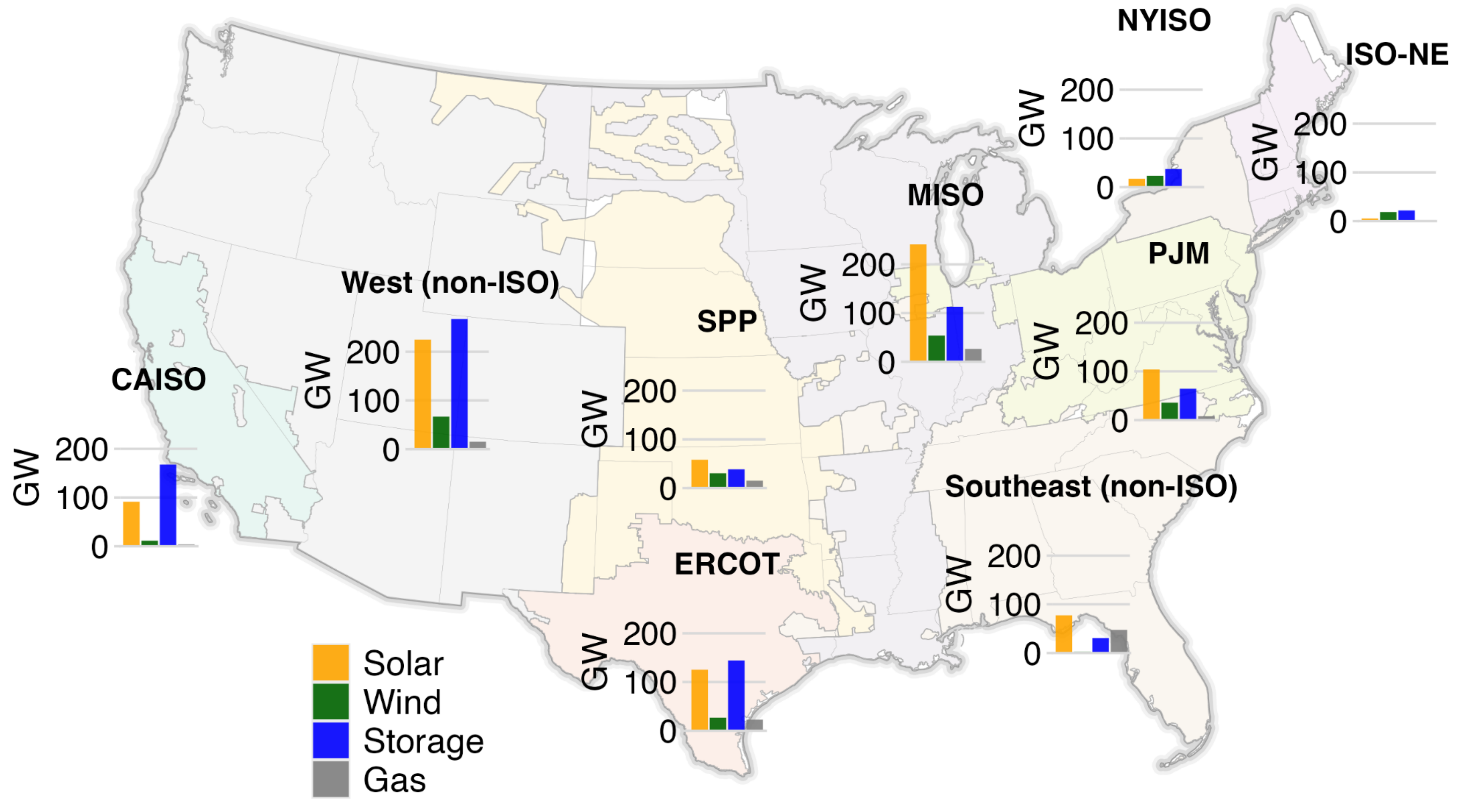
West (non-ISO)		
Arizona Public Service	Idaho Power	Portland General Electric
Avista	Imperial Irrigation District	Public Service Co. of CO / Public Service Co. of NM
Black Hills / Black Hills Colorado	L.A. Dept. Water & Power	Puget Sound Energy
Bonneville Power Admin.	Minnkota Power Cooperative	Sacramento Municipal Utility District
Chelan PUD	Navajo-Crystal	Salt River Projects (5 entities)
Cheyenne Light Fuel & Power	NorthWestern	Tacoma Public Utilities
Colorado Springs Utilities	NV Energy	Tri-State G&T
El Paso Electric	PacifiCorp	Tucson Electric Power
Grant PUD	Platte River Power Authority	WAPA (5 entities)

Number of active interconnection requests by capacity

Count of Active Requests by Capacity and Type						
Capacity	**Gas**	**Solar**	**Storage**	**Wind**	**Offshore Wind**	**Other**
<5 MW	10	139	37	10	0	86
5 - <20 MW	60	335	101	36	2	154
20 - <50 MW	57	516	168	49	1	236
50 - <100 MW	49	838	384	83	2	333
100 - <200 MW	41	1090	929	226	2	715
200+ MW	189	979	1033	472	53	1123

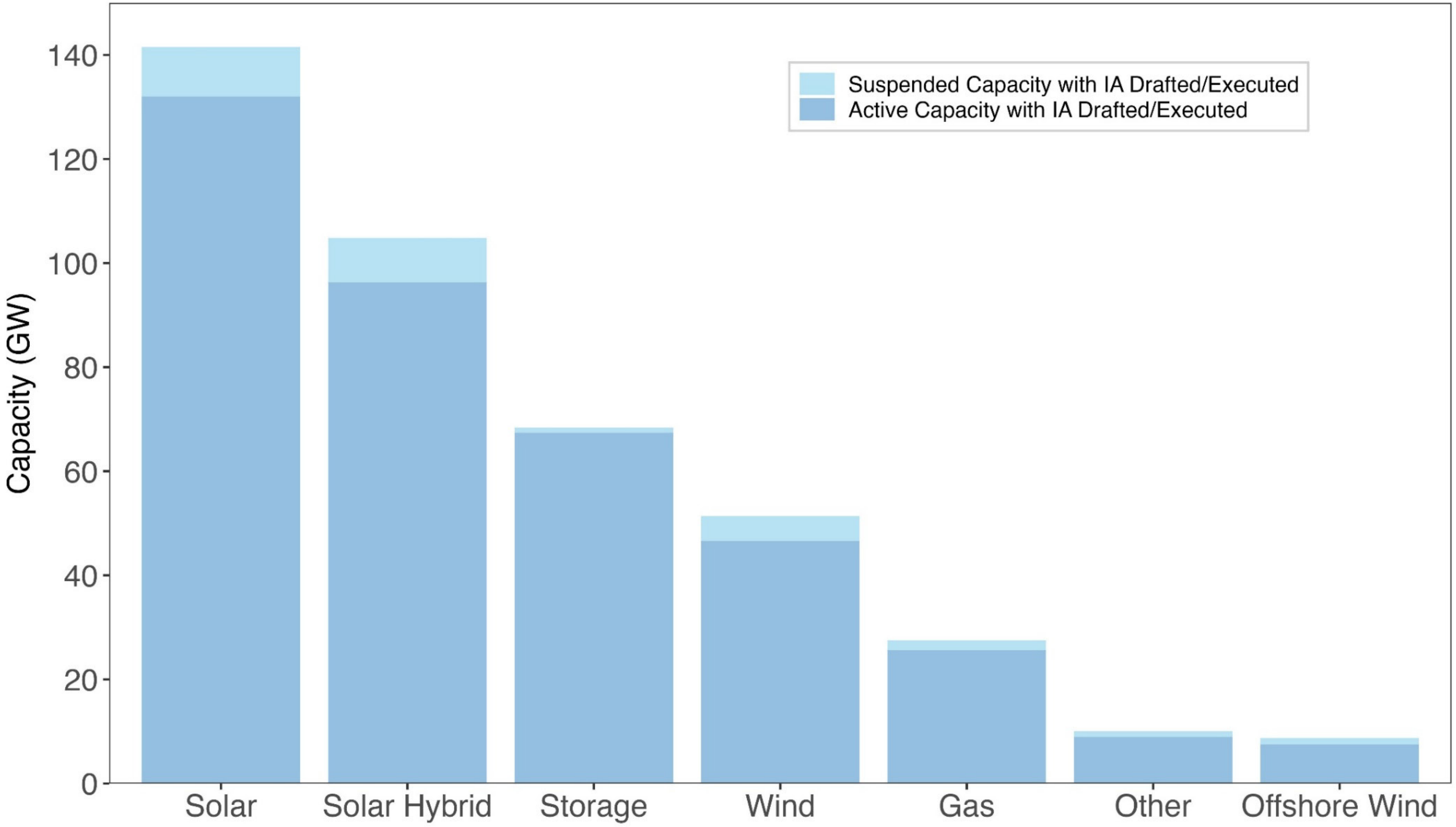
Count of Active Requests by Capacity and Region									
Capacity	**CAISO**	**ERCOT**	**ISO-NE**	**MISO**	**NYISO**	**PJM**	**SPP**	**Southeast**	**West**
<5 MW	4	12	105	20	0	60	0	29	52
5 - <20 MW	8	78	121	32	7	323	4	64	51
20 - <50 MW	18	46	43	106	67	519	18	82	128
50 - <100 MW	50	164	18	259	85	421	91	427	174
100 - <200 MW	120	559	48	917	149	380	212	192	426
200+ MW	438	823	64	879	94	239	318	208	786

Active solar, storage, wind, and gas capacity by region



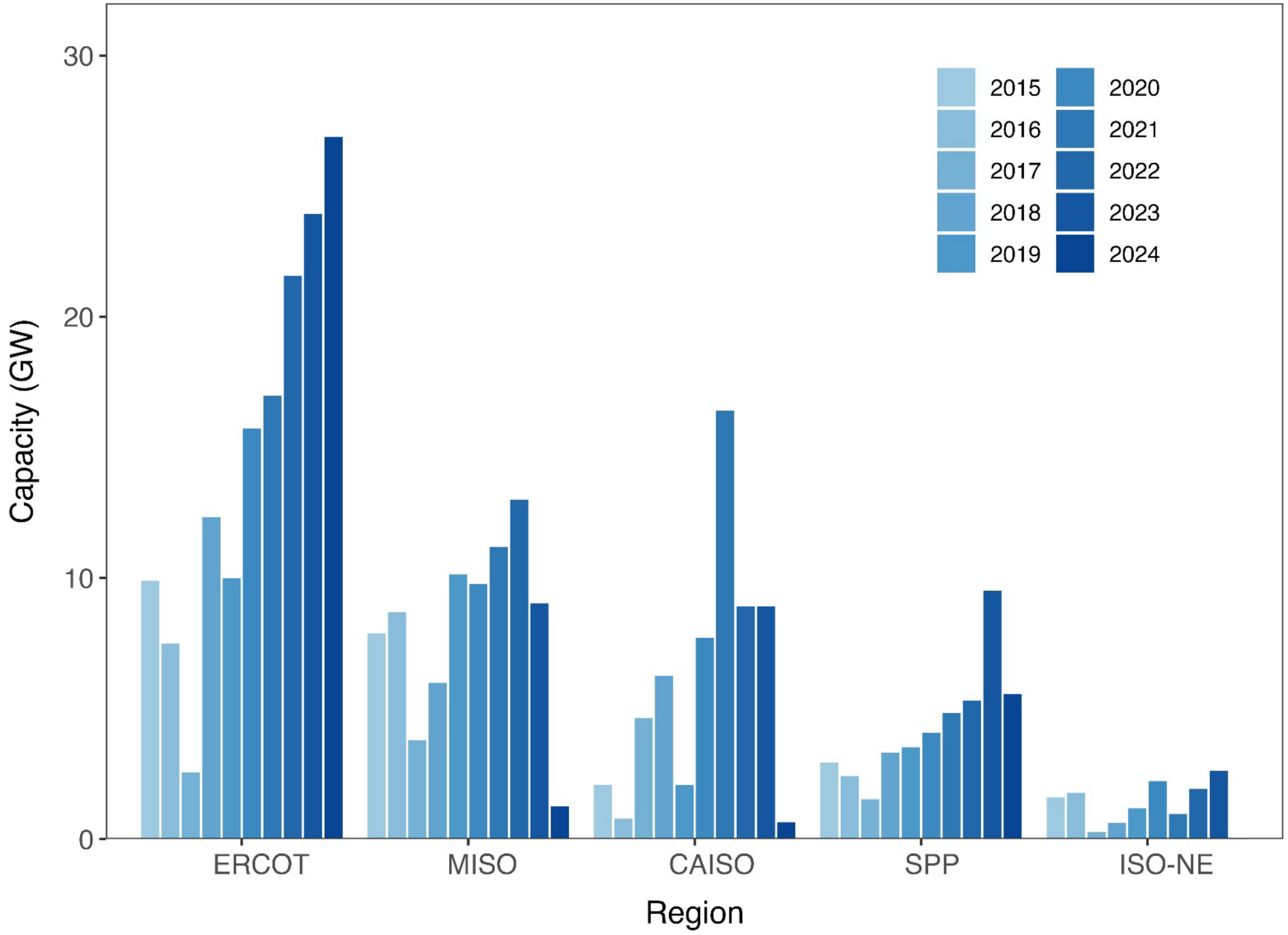
Note: "Active" requests include those that are actively requesting or undergoing grid interconnection studies, as well as those that have already executed interconnection agreements but have not yet reached commercial operations.

Active capacity with draft or executed interconnection agreement by resource type



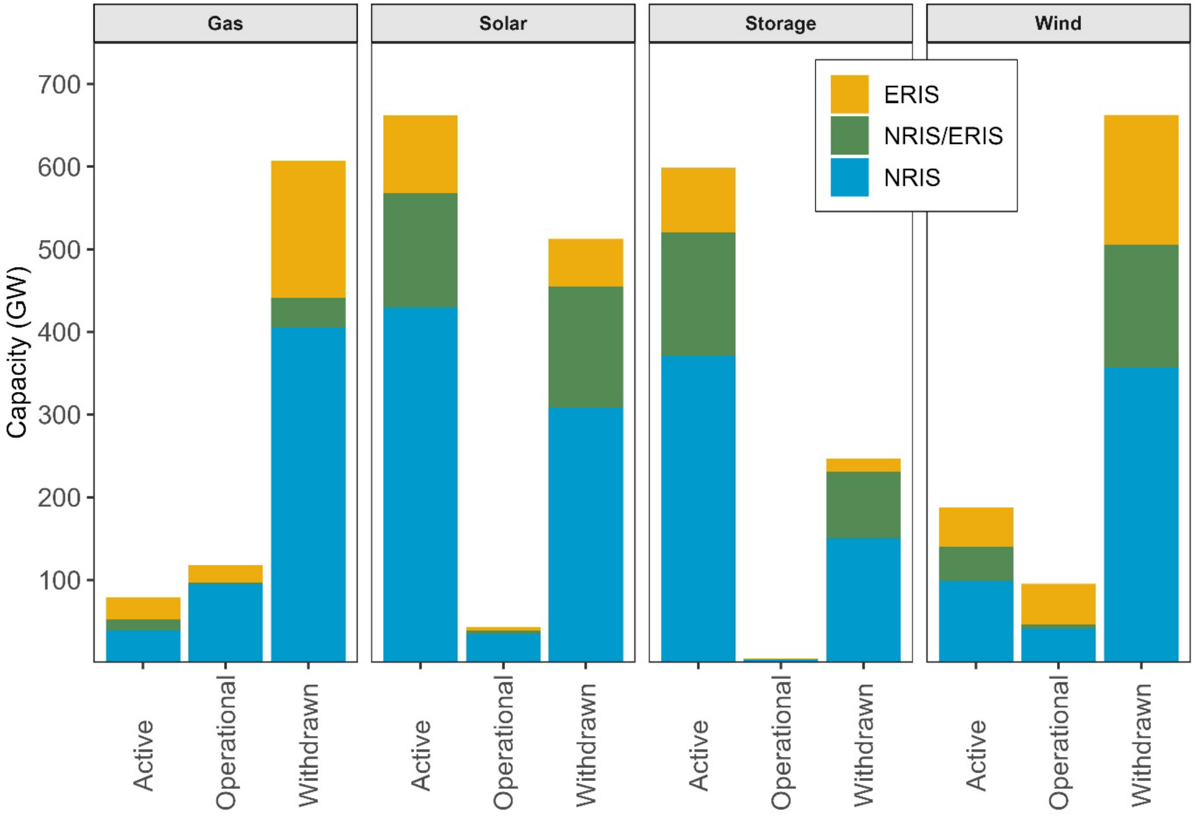
Notes: (1) IA capacity bars include capacity in the queues that has either a draft or fully executed interconnection agreement but has not yet reached commercial operations. The darker blue portion of the bar includes only active capacity; light blue portion includes suspended queue requests with an executed/drafted IA. The implication of "Suspended" queue status differs by ISO. e.g., in PJM it is voluntary and elected by the developer; in MISO it requires a force majeure event to suspend a project.

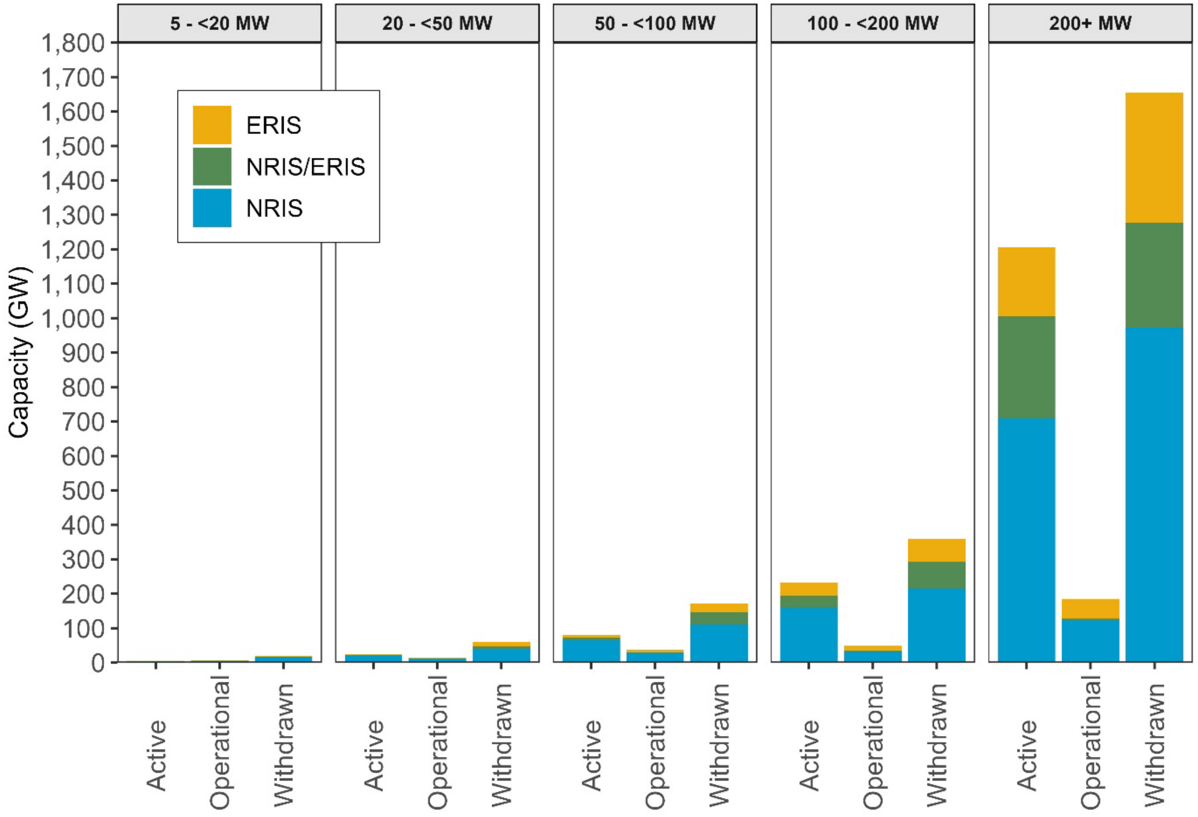
Annual volume (GW) of interconnection agreements executed by region



Notes: (1) Chart limited to regions where "IA date" is at least 70% populated (see table on slide 9). See slide 25 to see IA executed volume as a fraction of each region's 2024 peak load. Available data for 2024 IAs may be lagging in some regions.

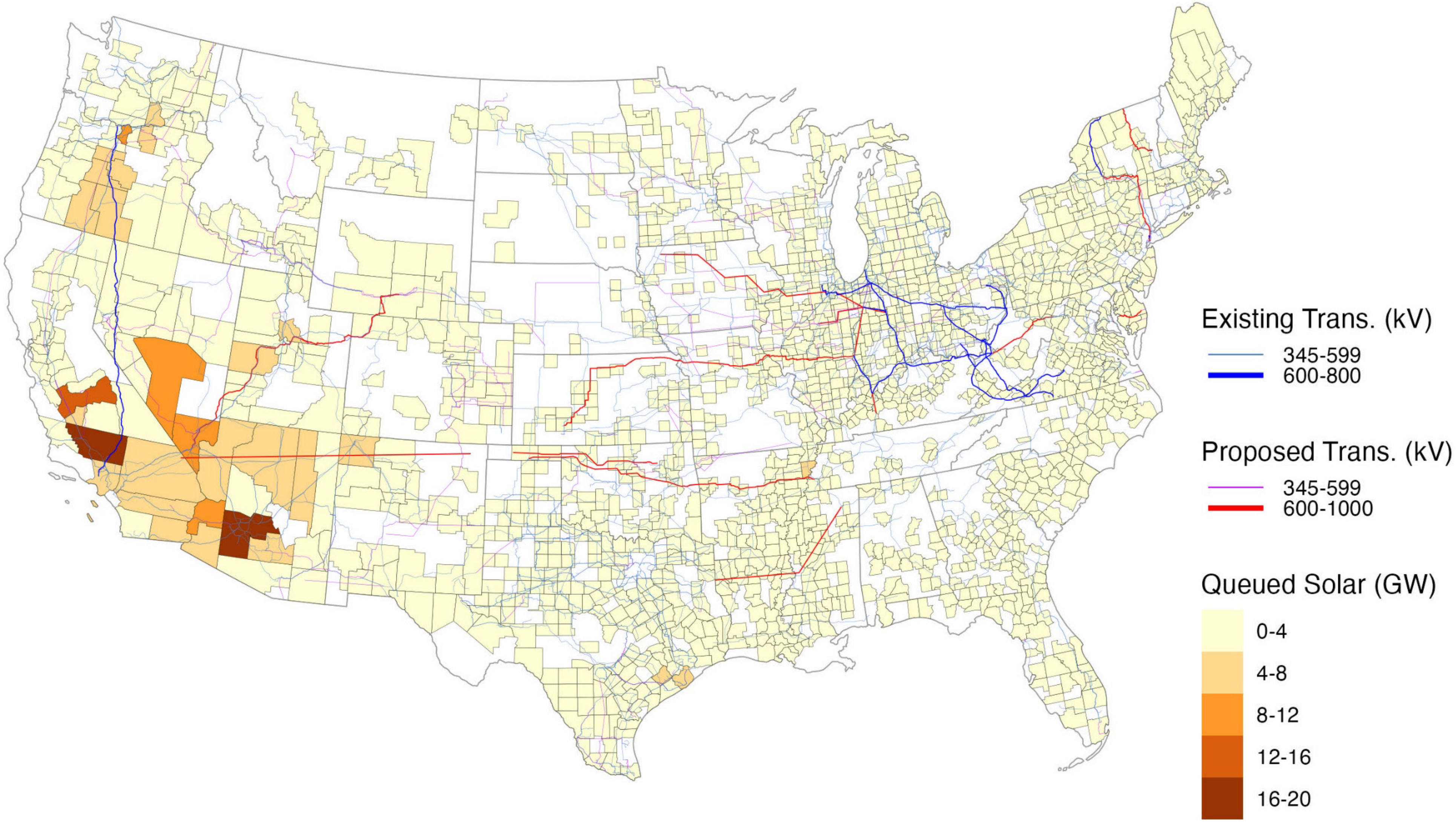
Interconnection service type (ERIS / NRIS) by status, resource type, and project size





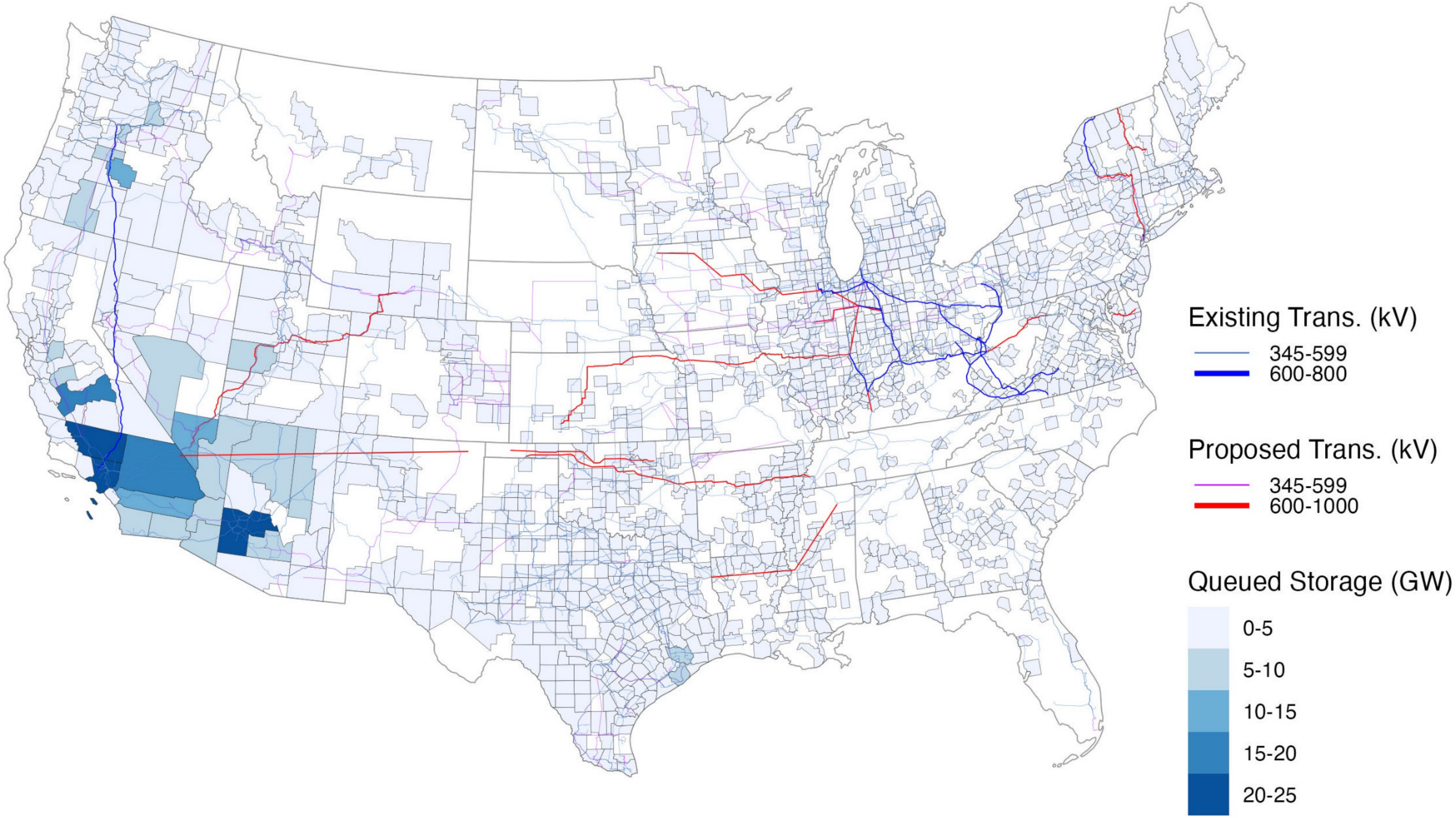
Notes: (1) NRIS and ERIS were developed under FERC Order 2003, and apply to FERC-jurisdictional transmission providers. (2) These charts exclude ERCOT.

Active solar capacity in queues at the end of 2024, by county



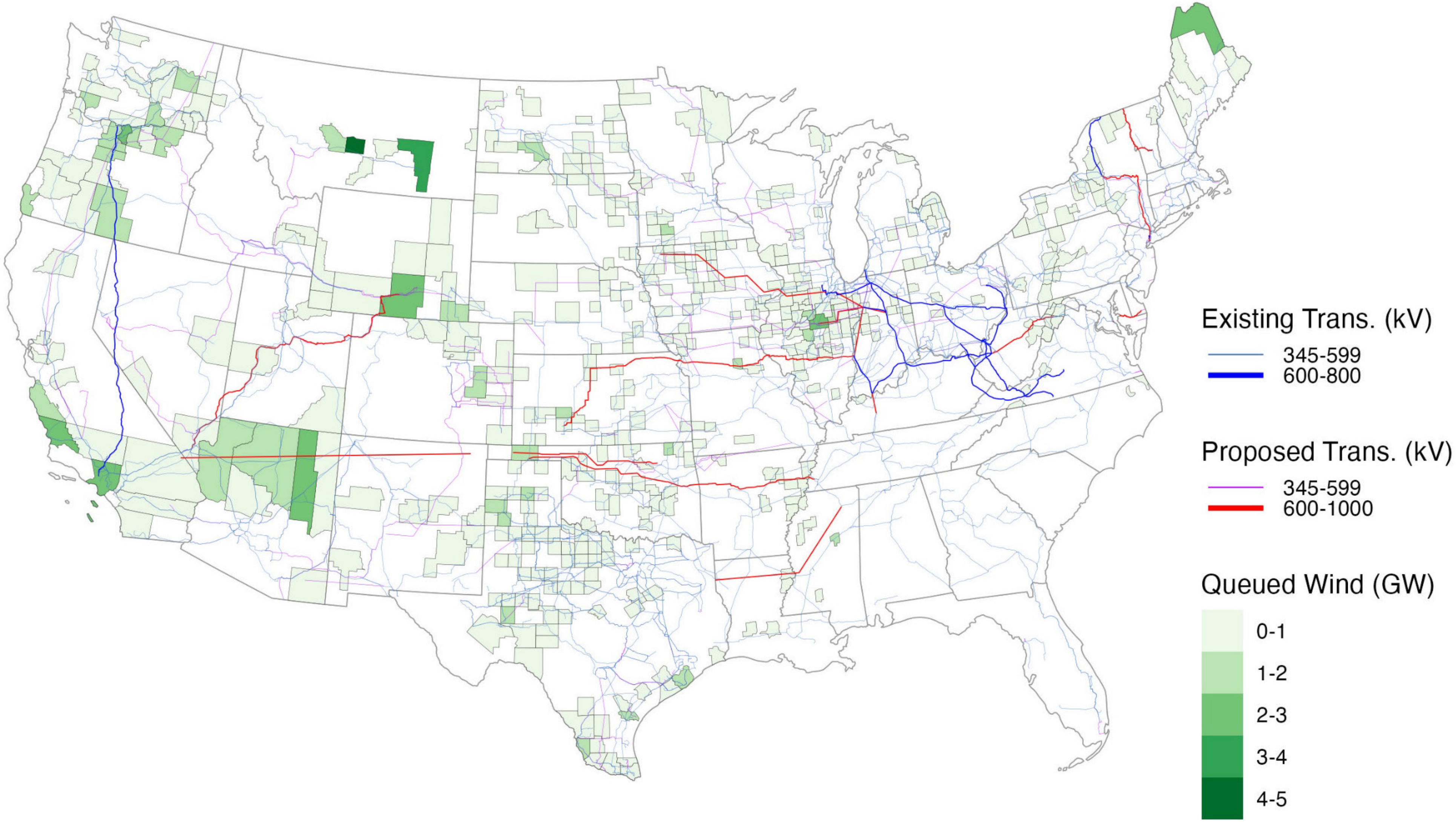
Notes: (1) Includes "active" interconnection requests only. (2) County was missing or could not be determined for 0.7% of active solar requests. (3) Transmission line data from Hitachi Velocity Suite. (4) See https://emp.lbl.gov/queues to access an interactive data visualization of these maps

Active storage capacity in queues at the end of 2024, by county



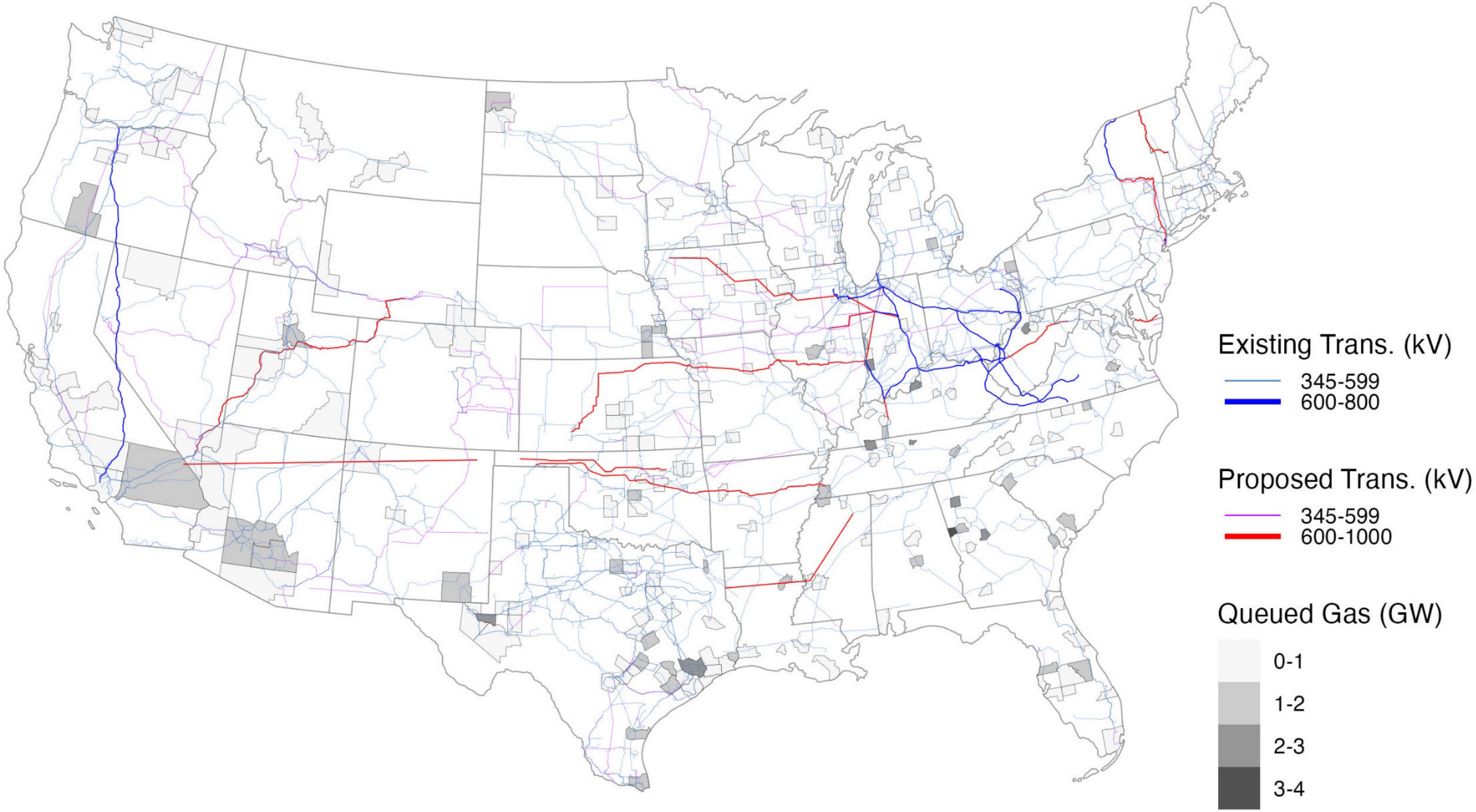
Notes: (1) Includes "active" interconnection requests only. (2) County was missing or could not be determined for 0.3% of active storage requests. (3) Transmission line data from Hitachi Velocity Suite. (4) See https://emp.lbl.gov/queues to access an interactive data visualization of these maps

Active wind capacity in queues at the end of 2024, by county



Notes: (1) Includes "active" interconnection requests only. (2) County was missing or could not be determined for 7.6% of wind requests. (3) Transmission line data from Hitachi Velocity Suite. (4) See https://emp.lbl.gov/queues to access an interactive data visualization of these maps

Active gas capacity in queues at the end of 2024, by county



Notes: (1) Includes "active" interconnection requests only. (2) County was missing or could not be determined for 1.1% of active gas requests. (3) Transmission line data from Hitachi Velocity Suite. (4) See https://emp.lbl.gov/queues to access an interactive data visualization of these maps