



The Era of Flat Power Demand is Over

2024 “Early Release” for the Federal Reserve Bank

Rob Gramlich

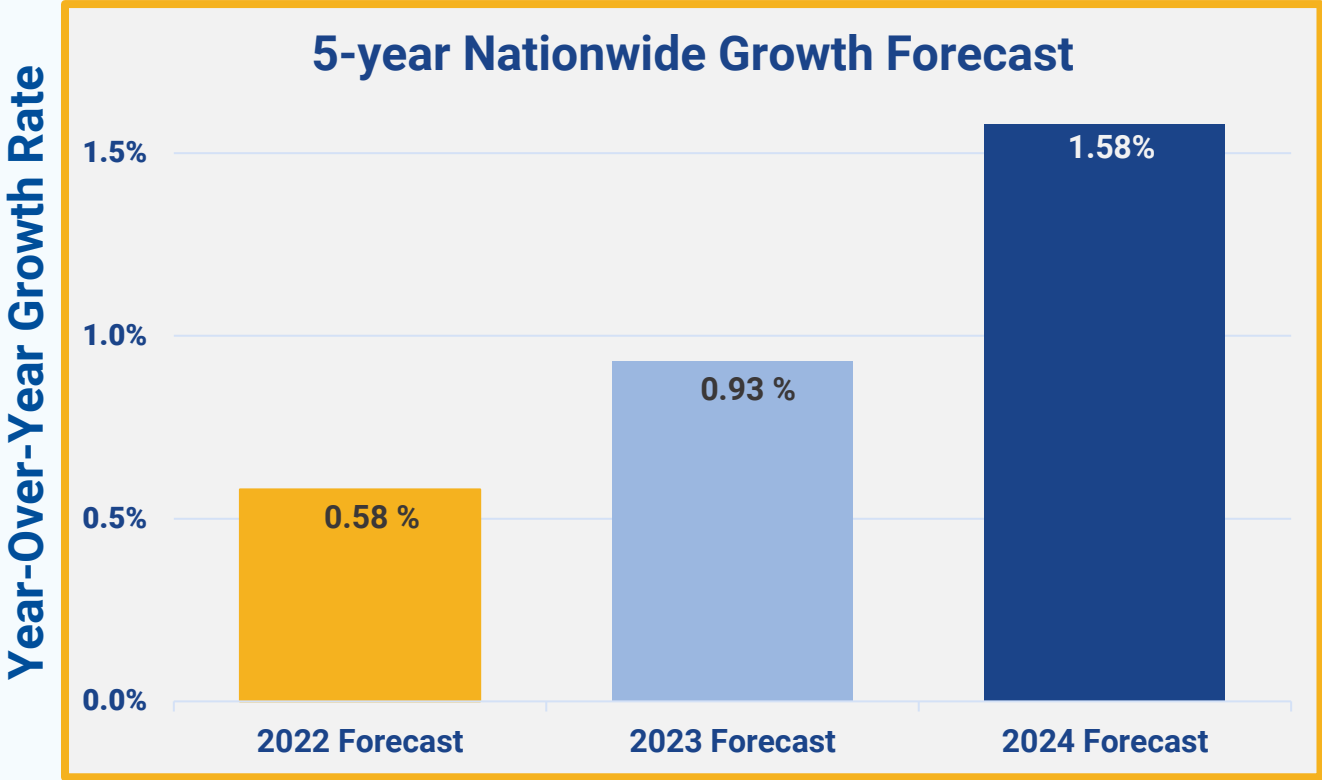
November 2024

The Era of Flat Power Demand is Over

Power demand is a race between efficiency and new uses of electricity

Decade	Average load growth
1950s (new appliances)	8.8%
1960s (AC)	7.4%
1970s	4.7%
1980s	3.0%
1990s	2.4%
2000s (CFLs)	0.7%
2010s (LEDs)	0.6%
2020s (data centers)	2%?

Flat demand era



\$630 Billion in Near-Term Investment in “Large Loads” is Increasing Expectations for Load Growth

THE STORY IS SIMPLE ...

In 2 years, grid planners have **tripled the 5-year forecast**

- Energy demand forecast: **Up from 2.8% to 8.1% growth**
- Peak demand **growth of 66 GW (~10% national)**

Main drivers are investment in new manufacturing, industrial, and data center facilities.

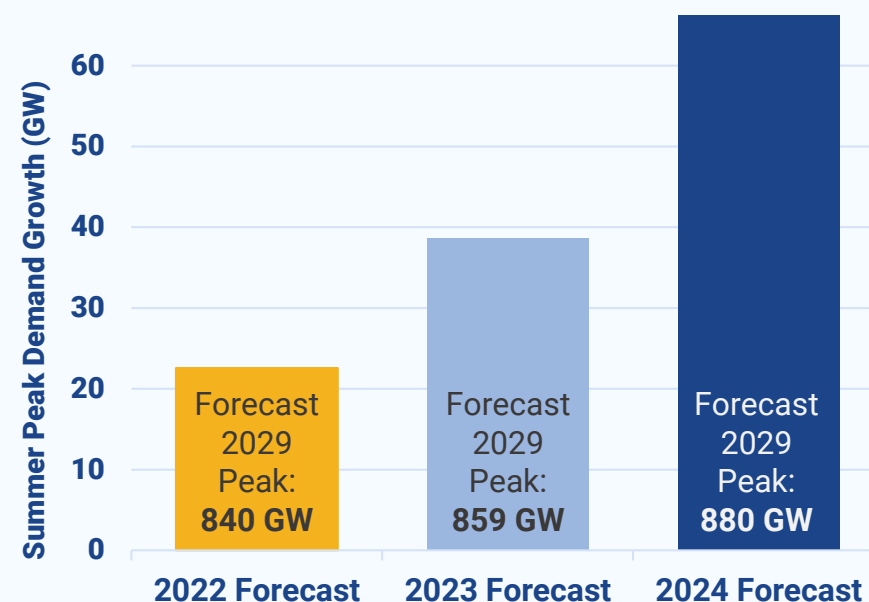
- **\$481 billion in commitments** since 2021 - over 200 manufacturing facilities announced in 2023
- Data center growth expectations vary widely, from **15 to 60 GW by 2030**

The U.S. electric grid is not prepared for significant load growth.

- New transmission line additions falling over last 15 years

AND THE FORECASTS CONTINUE TO GROW

5-year Nationwide Growth Forecast



Data Centers and Industrial Facilities Driving Load Growth

	Data Centers	Industrial Facilities	Hydrogen Plants	Electrification
Texas	●	●		
PJM	●			
Duke Energy	●	●		
Georgia Power	●	●		
New York	●	●	●	●
Arizona Public Service	●	●		
California ISO				●
Portland General Electric (OR)	●	●		

Growth varies widely by region

- Not all regions of the country are growing.
- Ten planning areas report most of the increase

Key Changes from our 2023 Report:

- MISO and PacifiCorp are now on the top-ten list
- Puget Sound Energy and CAISO dropped off the top-ten list and now show **negative growth** over the next five years

[This is an “early release” of data that we will publish in our updated report]

Planning areas with greatest increase in summer 2029 peak demand

Planning Area	2029 Peak Demand			Forecast Increase (GW)	Percent Increase
	2022 Forecast (GW)	2023 Forecast (GW)	2024 Forecast (GW)		
PJM	153.3	156.9	165.7	12.3	8.1%
Georgia Power	16.3	17.3	22.4	6.2	38.0%
MISO	132.4	133.0	138.4	6.1	4.6%
SPP	56.6	59.5	62.5	5.9	10.4%
ERCOT	84.4	89.6	88.1	3.7	4.4%
Duke Energy (North & South Carolina)	33.9	36.2	36.6	2.7	7.8%
Arizona Public Service	8.7	9.8	9.9	1.2	13.6%
PacifiCorp	14.1	14.2	15.2	1.1	7.7%
NYISO	31.5	32.3	32.3	0.9	2.8%
Tennessee Valley Authority	31.8	32.4	32.5	0.7	15.7%
All other planning areas	277.5	277.6	276.1	-1.4	-0.5%
Total	840.5	858.9	879.8	39.3	4.7%

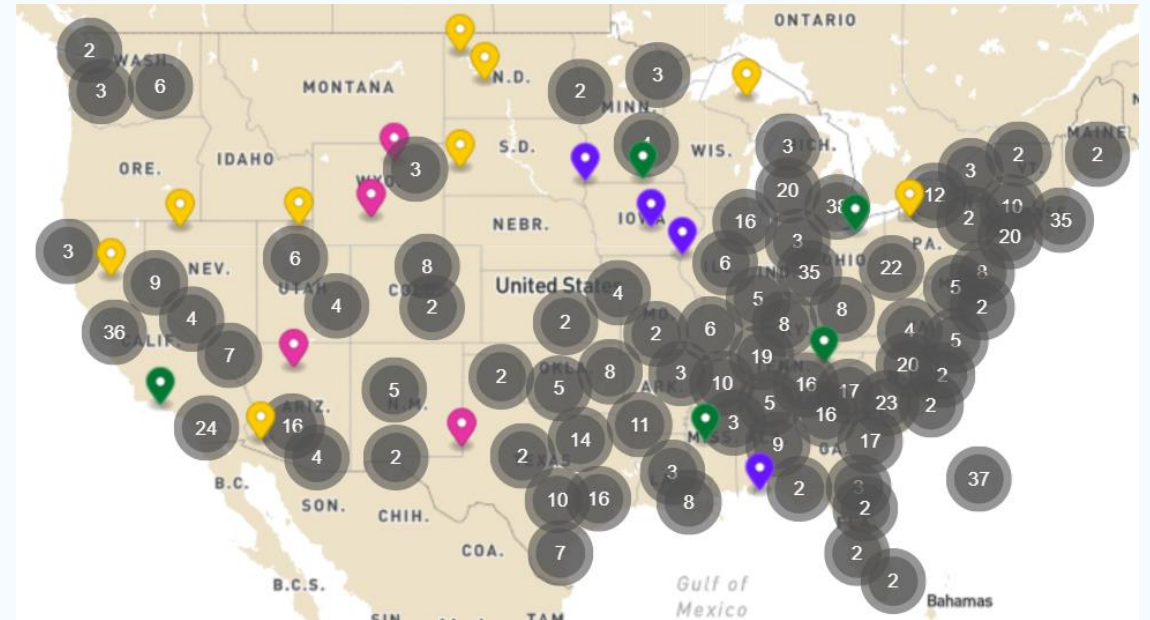
Industrial and Manufacturing Loads Continue to Grow

Investments are concentrated in:

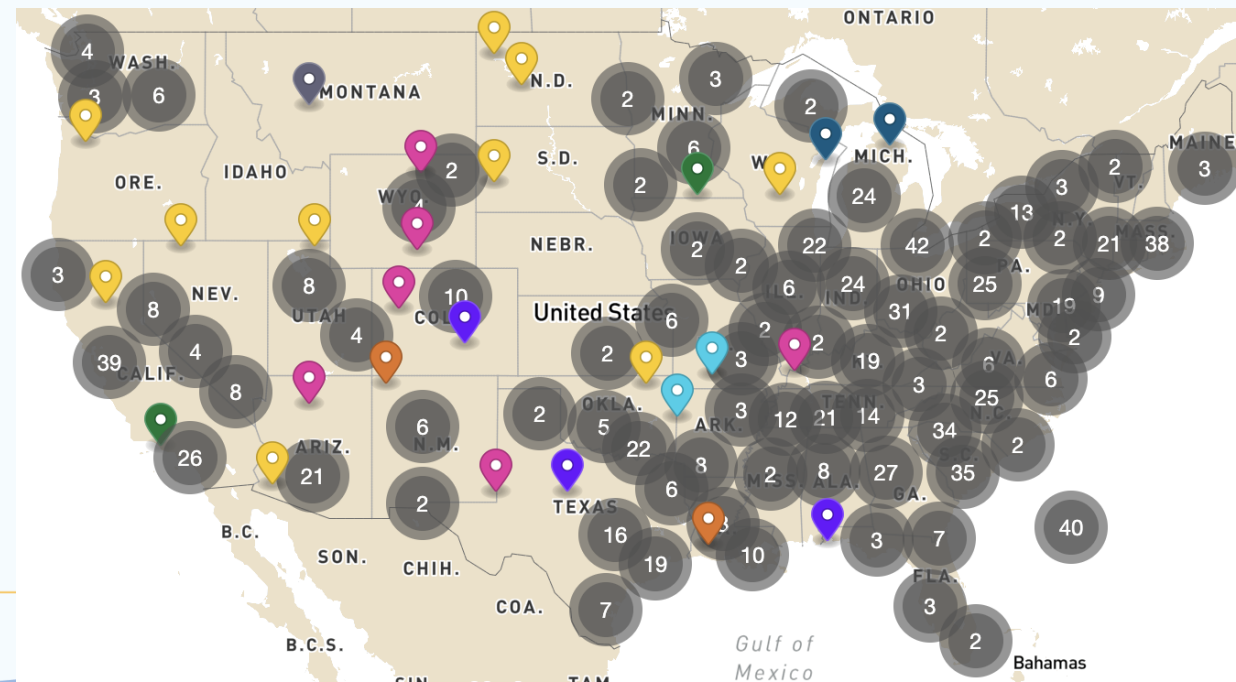
- **Southeast**, especially Georgia, the Carolinas, Tennessee and Kentucky
- **Midwest**, especially Michigan, Indiana and Ohio
- **Southwest**, especially Arizona and Nevada

Near-term load growth associated with these facilities is now appearing in all of these regions.

Announced Manufacturing Facilities since August 2022 (2023)



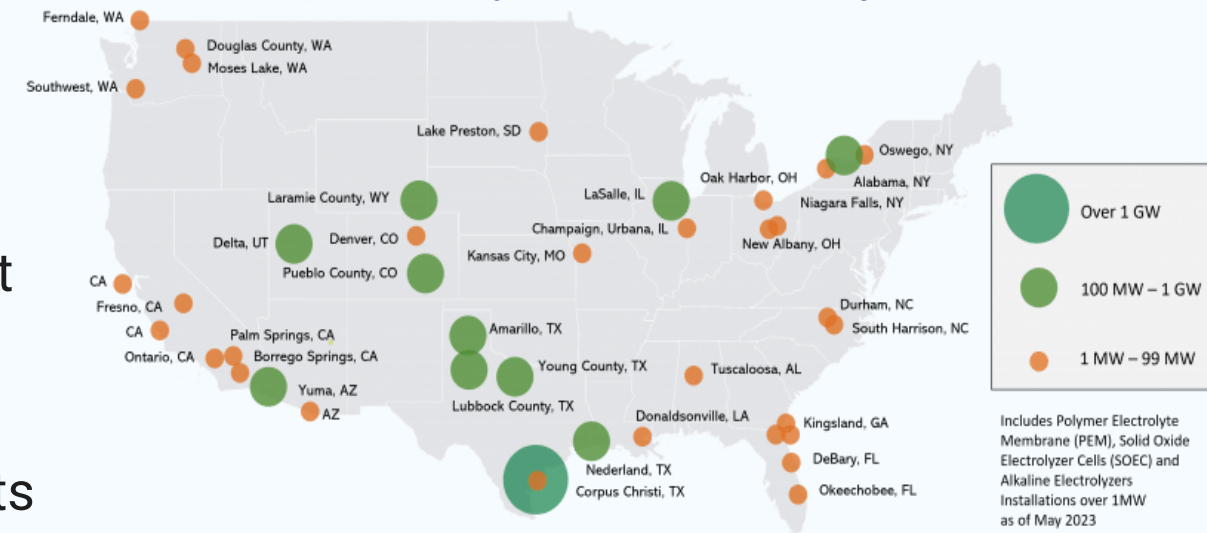
Announced Manufacturing Facilities since August 2022 (2024)



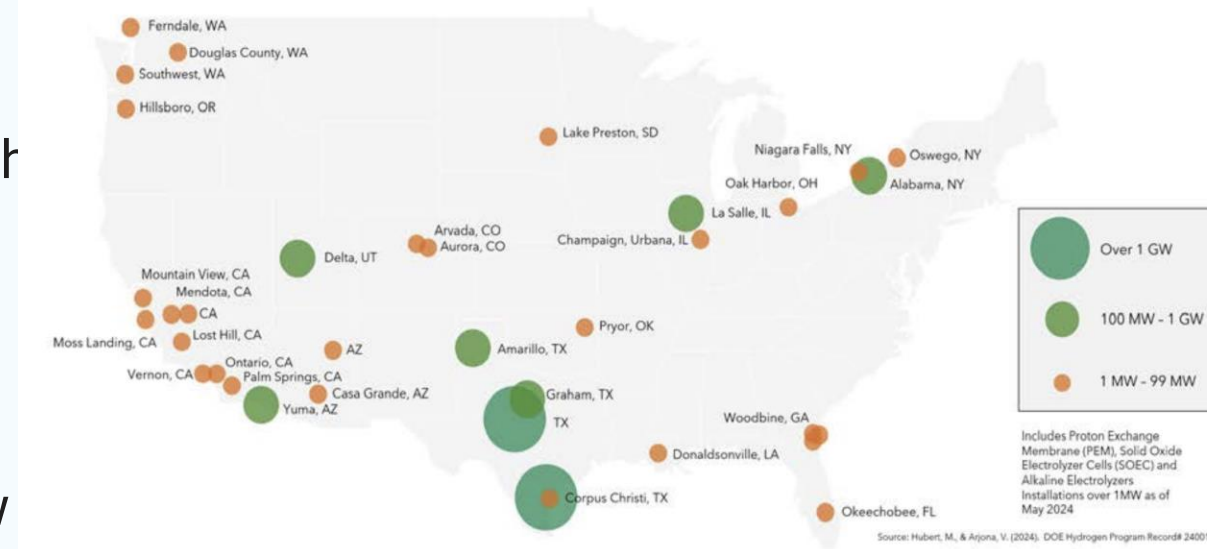
Hydrogen could be large load, but outlook slowed

- In 2024, McKinsey cut its hydrogen demand forecast ~25% by 2050, citing cost increases and regulatory uncertainty as barriers.
- Hydrogen load growth in ERCOT and NYISO forecasts
- IRA included tax credit which provides up to \$3/kg of hydrogen produced.
- DOE awarded \$7 billion from the Bipartisan Infrastructure Law to 7 regional hydrogen hubs which could have increased hydrogen production 1000x
- Under new administration, federal hydrogen production incentives will have some key support, and changes to 3 Pillars framework could lead to substantial new demand for power over the next few decades.

2023 Planned or Operational Hydrogen Production Projects



2024 Planned or Operational Hydrogen Production Projects



Data Center Load Growth Forecasts Vary But Consistently Predict Large Growth

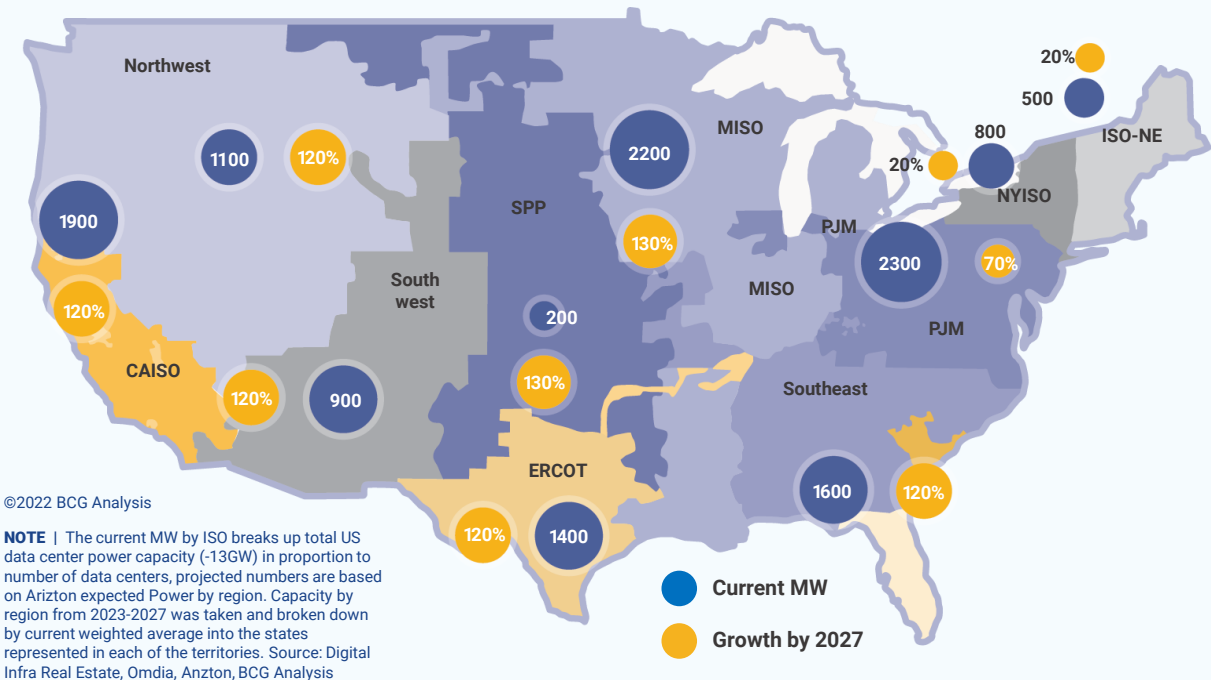
By 2030, BCG expects energy use to grow from 126 TWh to 335 TWh, or demand of 17 GW to 45 GW.

Recent national forecasts project a wide range of Compound Annual Growth Rates (CAGRs) for data center demand

- In 2022, **BCG** projected **28 GW** of data center load growth nationally (2022 and 2030)
- In early 2023, **McKinsey** predicted **18 GW** of new data center load nationally by 2030
- **Brattle's** recent load growth report projected a 9% CAGR through 2030 and **16 GW** new load nationally
- A June 2024 **Barclays** report forecast **>15 GW of data center load in N. Virginia alone** by 2030

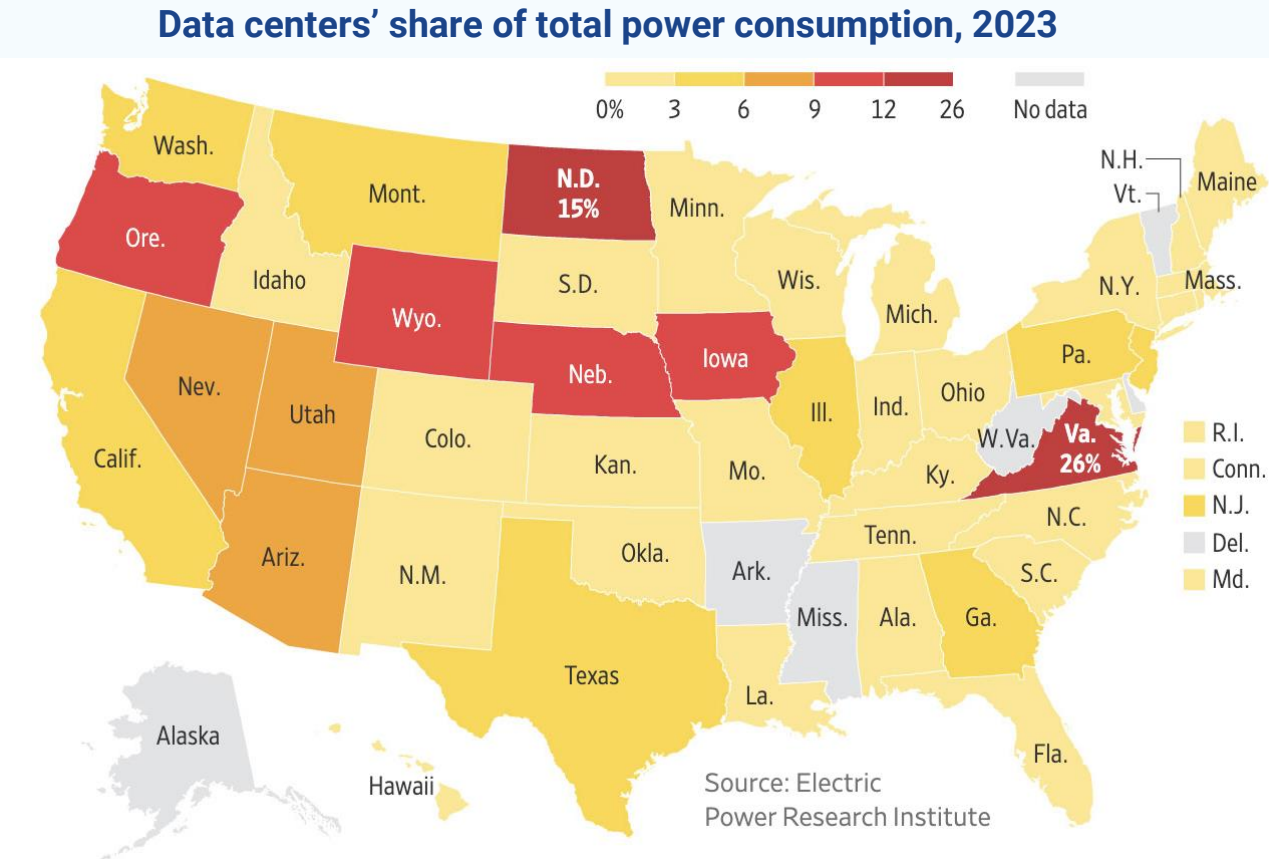
Data availability is improving as utilities update their load forecasts to include new AI trends but significant uncertainty remains

>60% of Data Centers Expected in MISO, CAISO, PJM, and Southeast by 2027



Data Center Load Growth Spreading to More Areas

- No. VA, then Atlanta area, then...
- Dallas, NW Oregon, San Fran, Chicago, more
- NIPSCO (IN): 344% increase in peak load by 2035, driven in large part by data centers
- Four regions in PJM contributed to higher 2024 Load Forecast.
- PPL signed over 3 GW of data center capacity deals in 2024



Significant Uncertainty Remains Around the Size of Data Center Load Growth and the Extent of Constraints

The extent of data center efficiency improvements could significantly impact power demand

- Historically, predicted > actual demand growth
 - Cooling technologies, chip designs reduce use
- However, AI model sizes are increasing rapidly, outpacing efficiency improvements

The degree to which data centers can be flexibly sited is unclear

- Some data centers indicate willingness to consider remote locations that feature excess renewable resource or transmission capacity; proximity to population centers remains crucial for others

The extent of the flexibility of data center loads remains untested

- Some AI activities, such as model training, can be interrupted, which could allow data centers to provide demand services or power down during periods of grid stress
- However, there is wear and tear on expensive equipment when dispatching load.

Elections may raise some sectors' demand and decrease others'

EVs have a target on them

- Tax credits likely to be reduced or eliminated.

Hydrogen could go either way

- Looser IRS regs likely, but credit could be trimmed or repealed

Crypto and AI have friends in high places

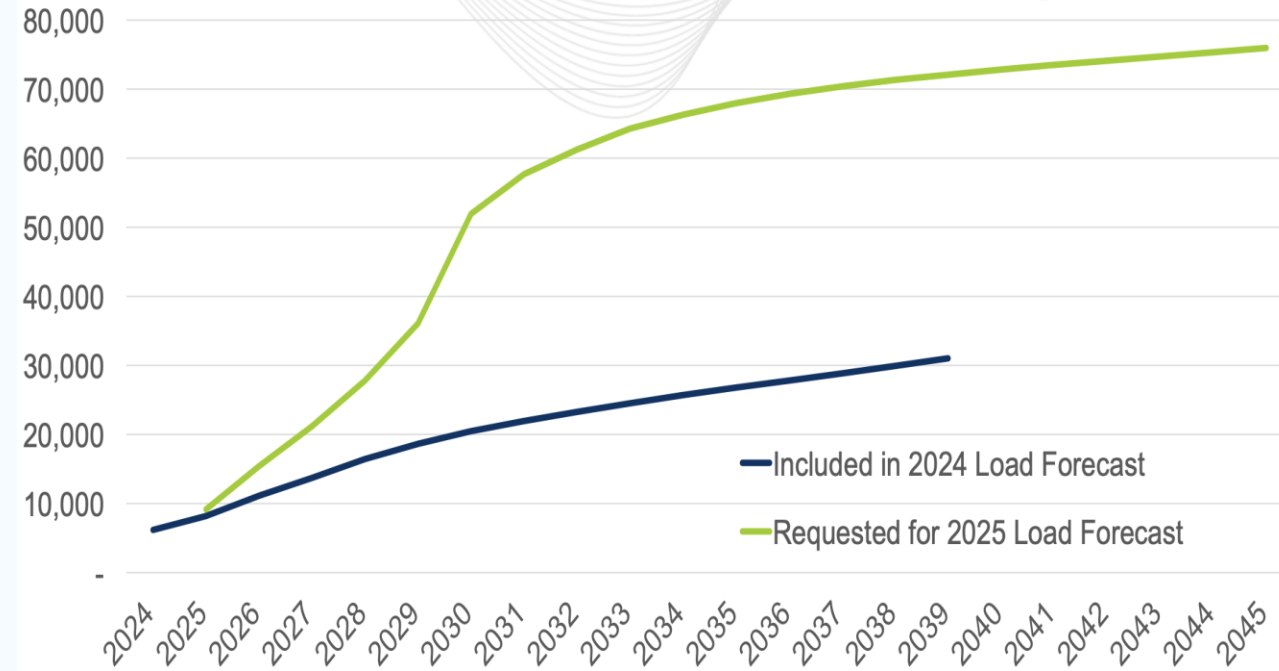
- Will that translate into more federal support for infrastructure expansion to meet that demand? Clearly the grid is a primary constraint on those industries.

Mid-Atlantic (PJM)

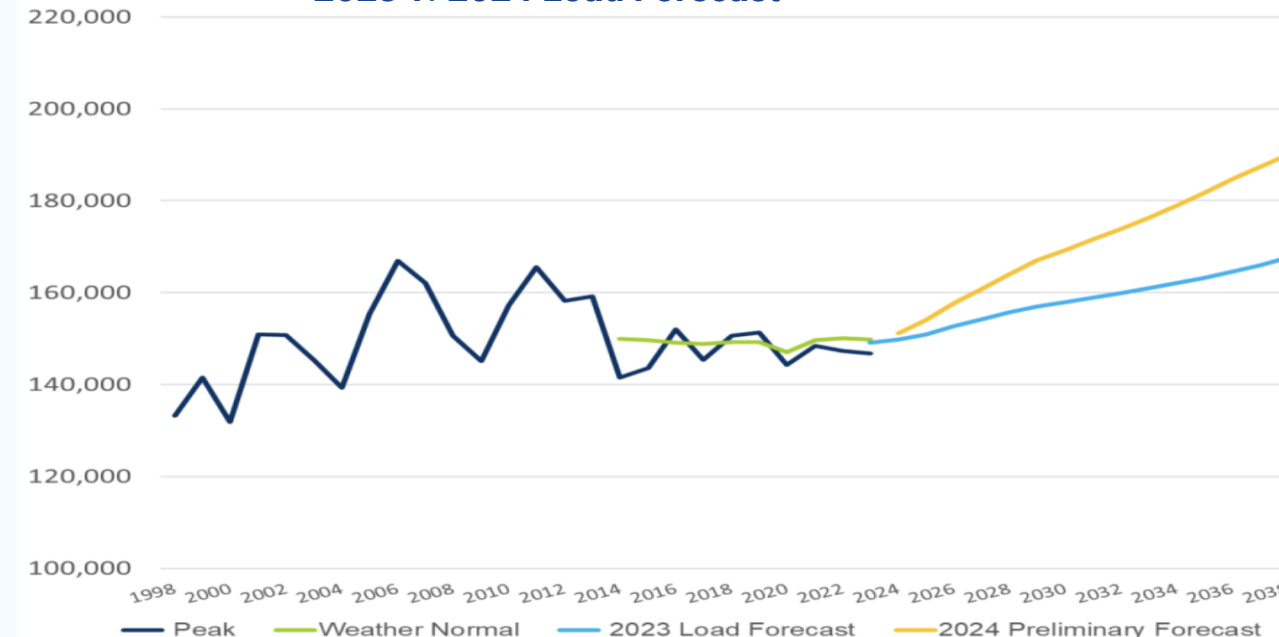
Data centers and manufacturing drive growth

- PJM has “observed unprecedented data center load growth” in multiple areas, with the potential for “all remnant capacity on the transmission system” to be utilized, resulting in regional reliability issues.
- PJM’s 15-year forecast increased 14% from the 2023 to 2024 forecasts
- 2025 load growth looks to be even higher. Utilities are requesting to add ~70 GW of large loads by 2038, an ~40 GW increase over the 2024 forecast
- Load growth is primarily being driven by data centers and manufacturing

PJM 2025 Requested Load Adjustments



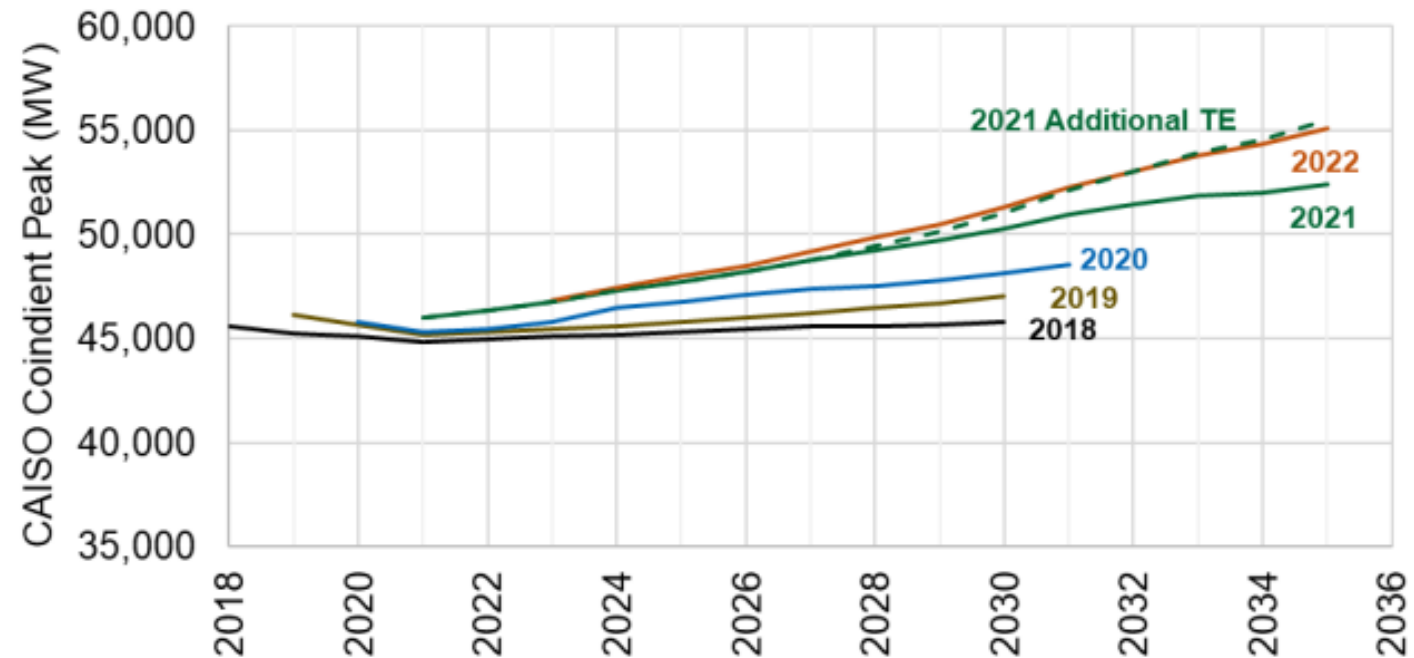
2023 v. 2024 Load Forecast



Electrification Driving Load Growth

- CEC: Raised CAISO's 2030 demand forecast by more than 5 GW.
- Drivers: decarbonization of the transportation and building sectors key drivers of the increase in forecasted load.
- Peak reduction impacts expected from behind-the-meter solar.
- But, by 2035 the 2023 peak load forecast exceeds the 2022 forecast by 3.3% due to additional electrification impacts.

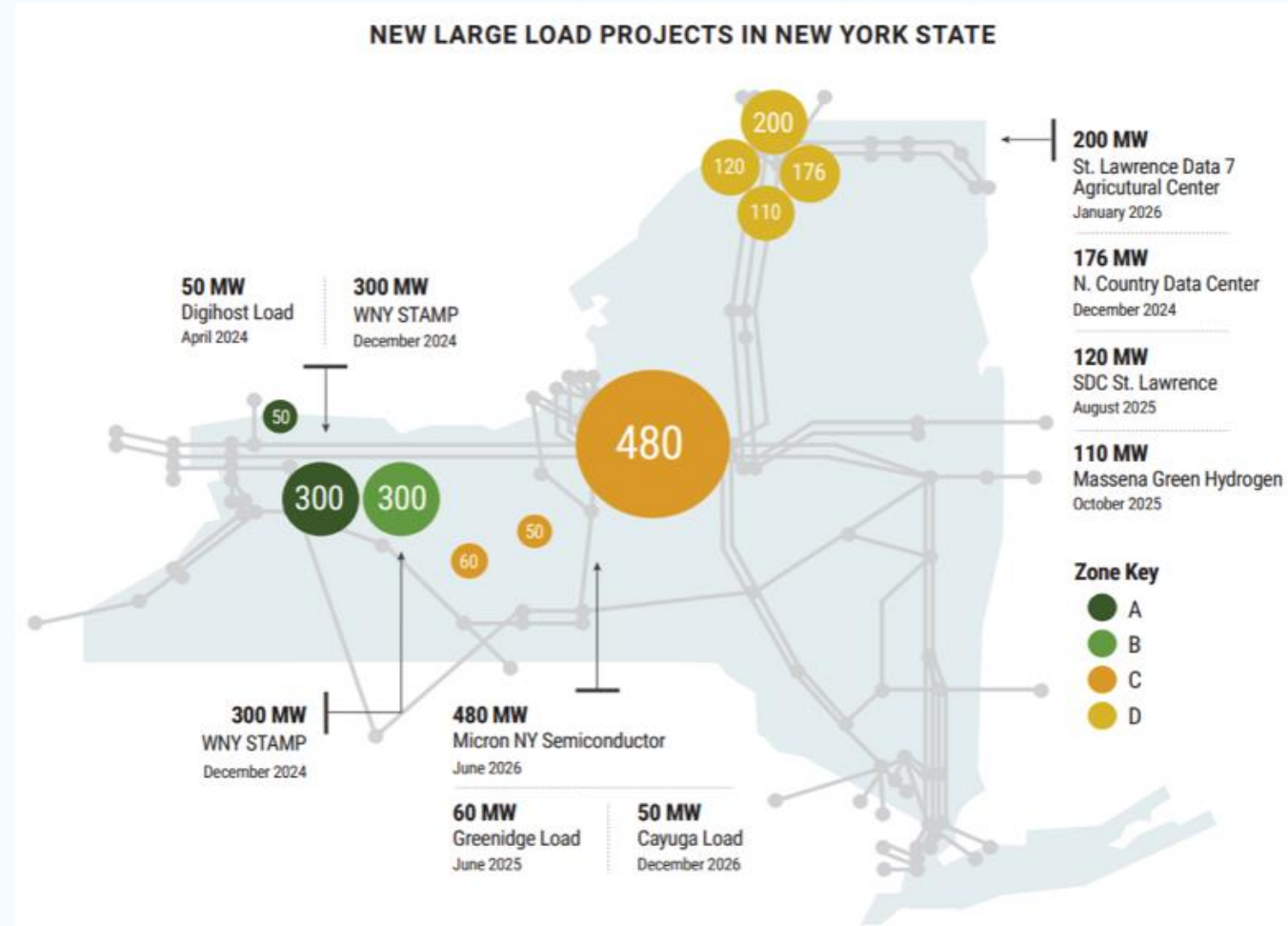
Figure ES-2: Forecasted Electricity Demand Has Increased Rapidly



NOTE | The net peak demand is the highest demand after accounting for the impacts of self-generation.

Data Centers and Industrial Load driving growth

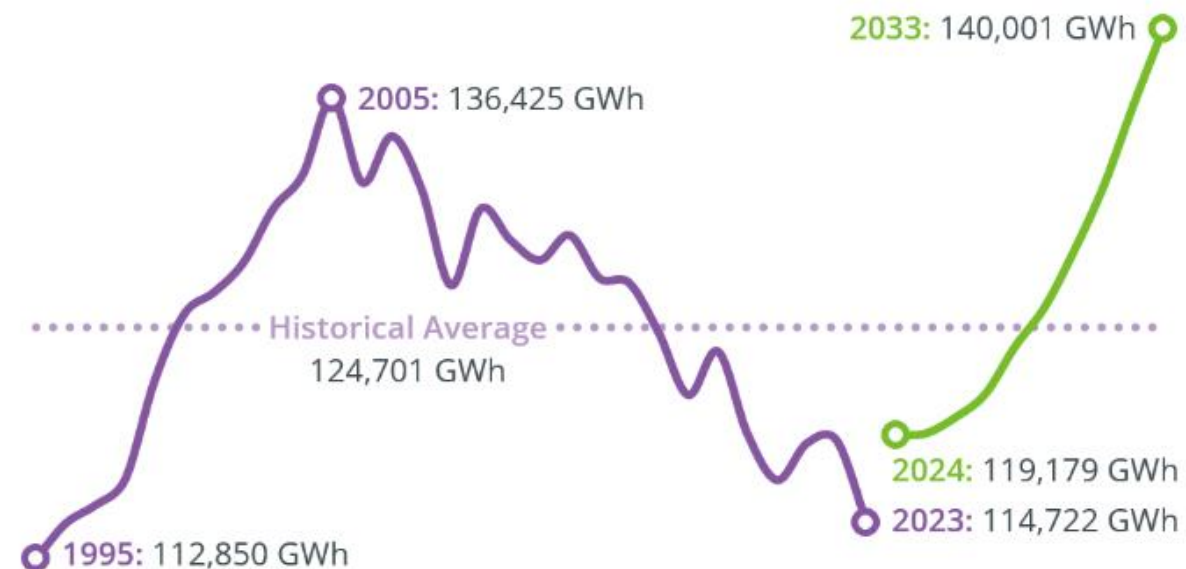
- NYISO 2024 load forecast projects a 2.2-3 GW increase in summer peak load from the interconnection of large loads through 2035.
- Prior to its 2023 forecast, the NYISO did not specifically identify “large loads” as a load forecast driver.
- NYISO: “addition of large load projects in the early forecast years, and electrification of space heating, non-weather sensitive appliances, and EV charging in the outer forecast years.” However, total load is not expected to grow much due to energy efficiency and behind-the-meter resources.



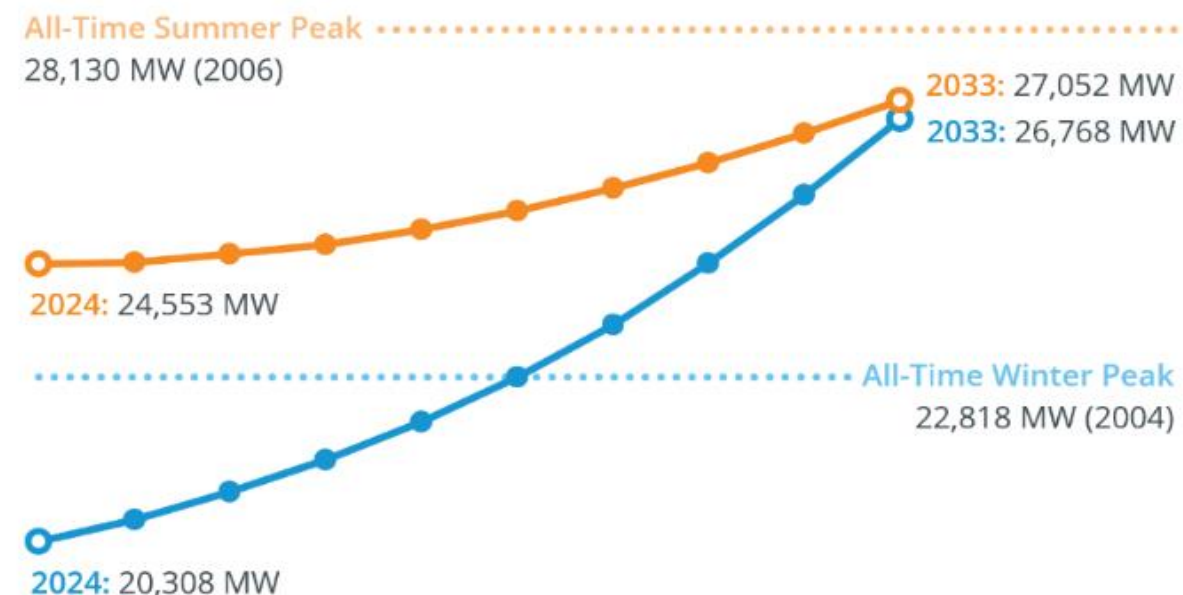
Electrification is expected to increase winter peak

- ISO-NE projects regional electricity consumption to grow 17% over the next decade.
- ISO-NE forecasts its net summer peak will increase **2.5 GW** and its net winter peak will grow **7 GW** through 2033.
- Since 2005, energy use has decreased due to improved energy efficiency and the increased prevalence of behind-the-meter solar generation.
- Now, ISO-NE 2024 forecasted load growth is being driven by increased electrification of heating systems and transportation.

Historical and 2024 Forecasted Net Energy Use



Summer and Winter 50/50 Net Peak Forecast

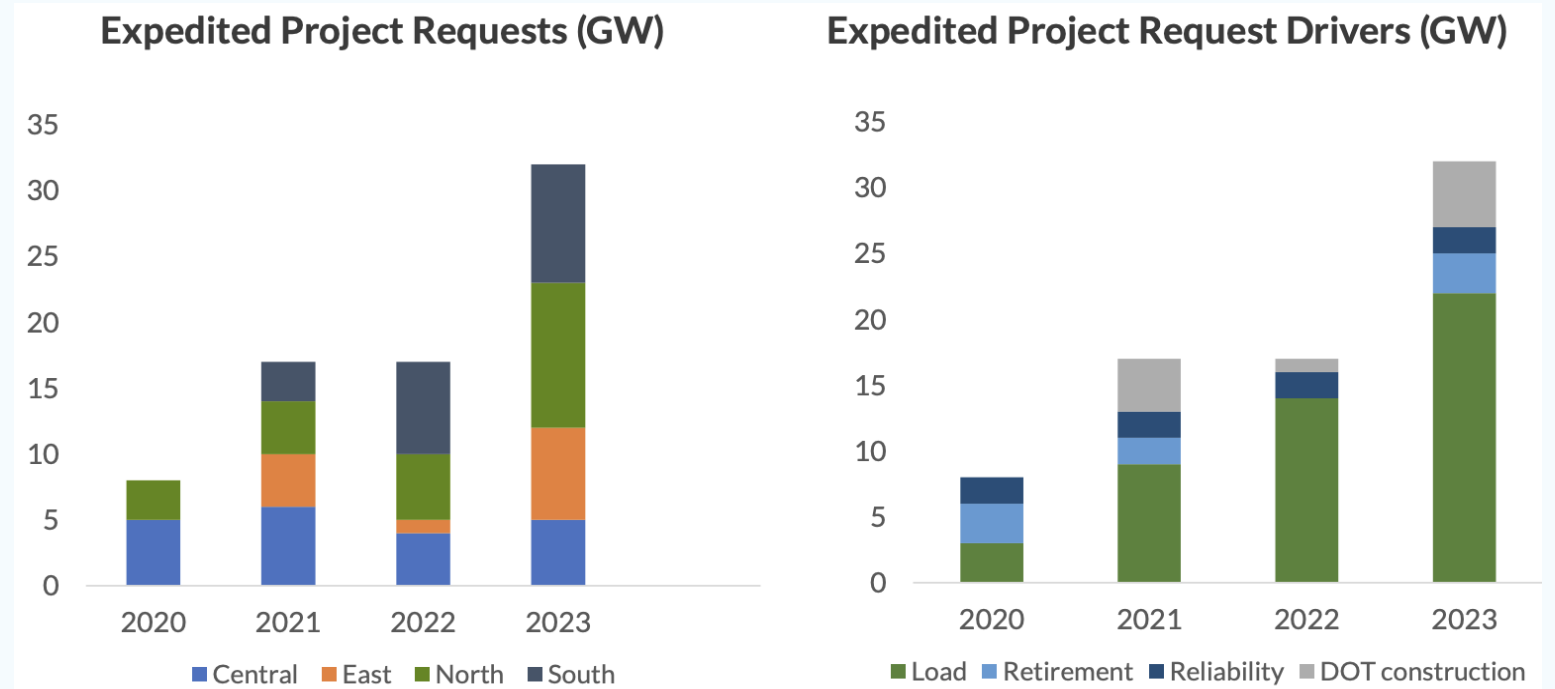


New Load Connections More than Quadrupled

Expedited Project Review (EPR) requests have more than quadrupled since 2020 and almost doubled since last year.

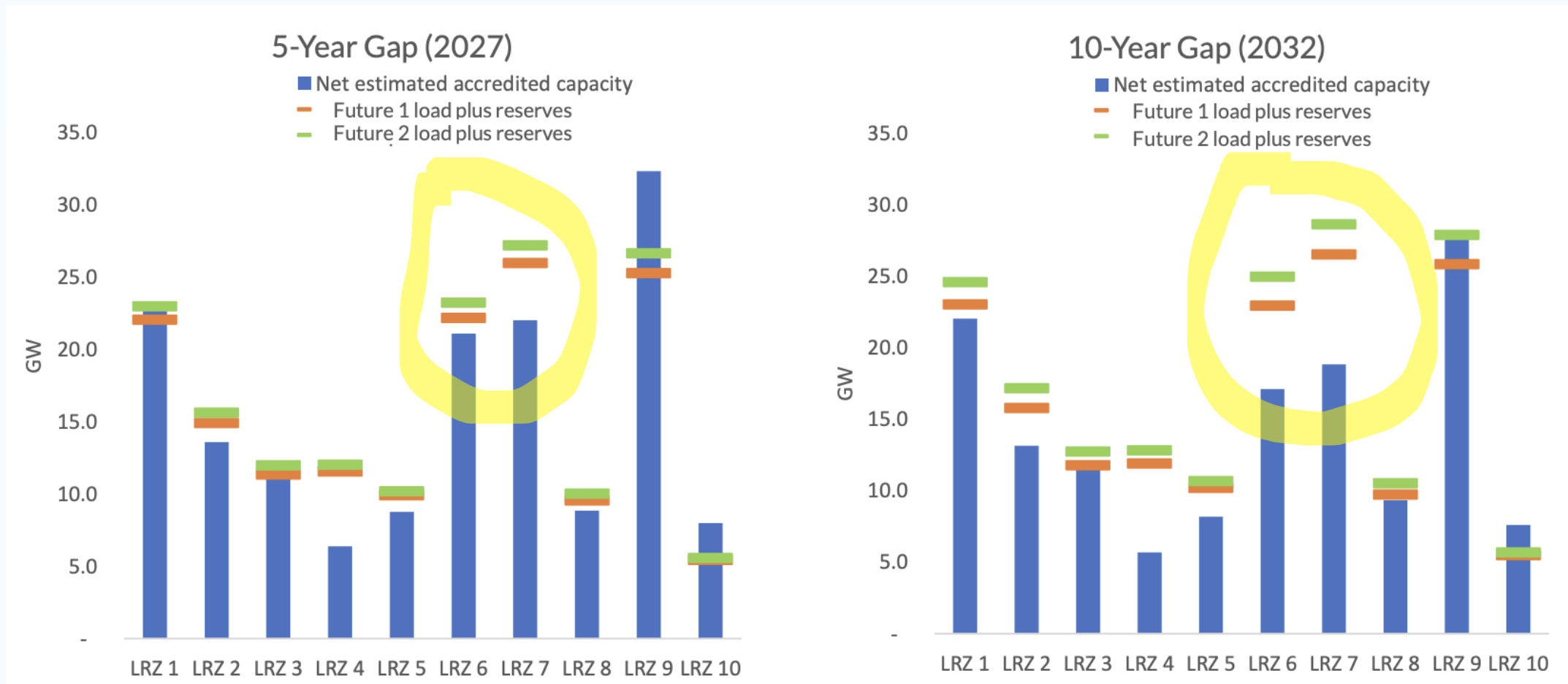
Dependence on members' self-reported load forecasts may introduce a lag to the response of MISO's load forecast to the increased pace of load connections.

Expedited Project Review (EPR) requests and drivers

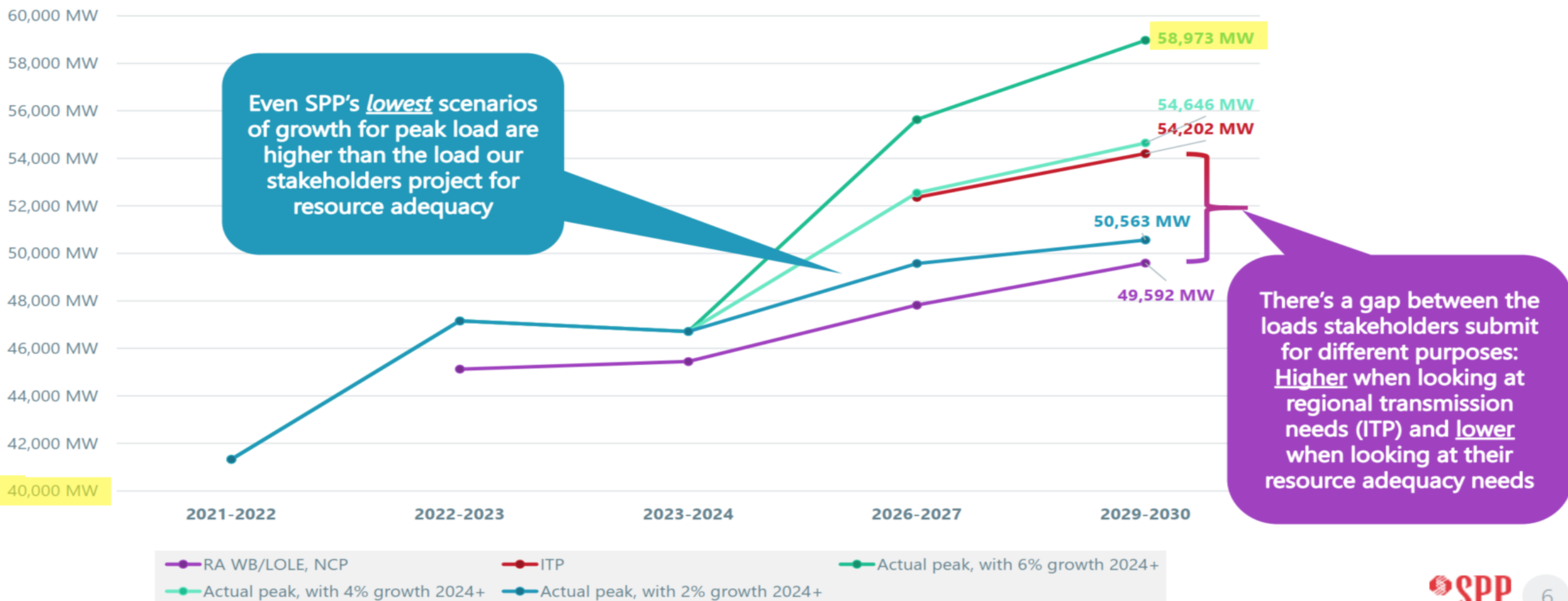


SOURCES | MISO, [Preliminary MTEP23 Review System Planning Committee of the Board of Directors](#) (September 12, 2023), p. 7.
MISO, [2023 Regional Resource Assessment](#), (November 2023), p. 16.
MISO, [MISO Futures Report: Series 1A](#), (November 2023), pp. 27, 31, 38-46.
Ethan Howland, ["MISO: 49 GW has received interconnection approval, but projects face major delays,"](#) *Utility Dive* (September 14, 2023).

MISO's Regional Resource Assessment survey (plus executed interconnection agreements) compared to MISO's Future 1 load growth trajectory shows potential resource gaps



WINTER LOAD FORECASTS: MEMBER-SUBMITTED COMPARED TO ACTUALS AND GROWTH SCENARIOS



Huge Large Load Numbers, But Forecast Challenges

In 2024, ERCOT's load forecast for 2029 is 88.1 GW, but it also has **contracts** for large load that would **add ~15 GW** to its summer coincident peak.

There is even further upward growth potential, with **new loads in ERCOT's queue currently total 56 GW!**

Currently ERCOT's transmission providers project **66 GW of new flat load and 4 GW of price-responsive load** over the next 10-15 years.

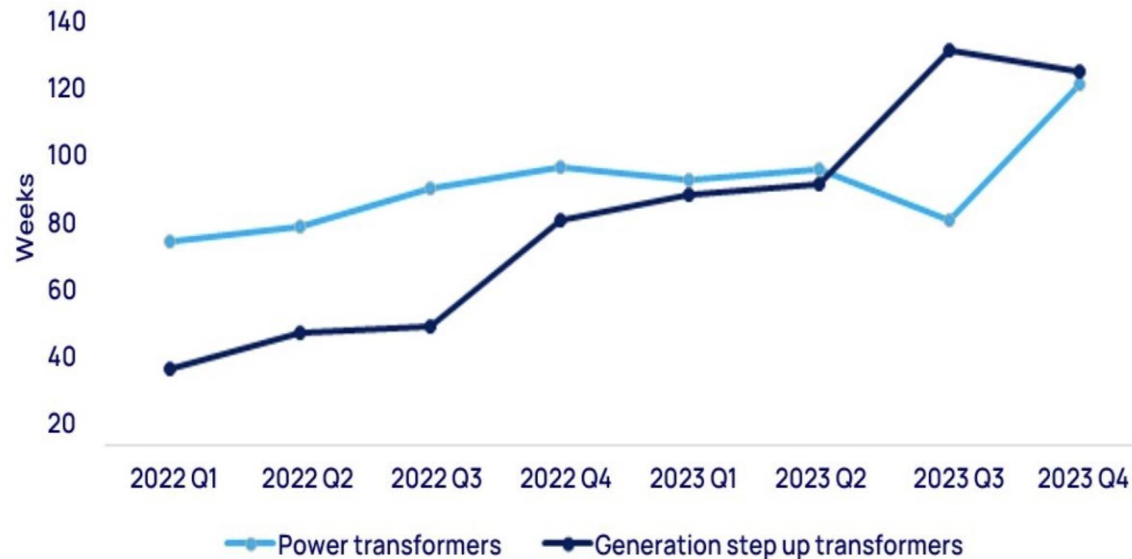
2024 ERCOT Large Load Queue



SOURCES | ERCOT, [Large Load Interconnection Status Update](#) (September 6, 2024), p. 3.
ERCOT, [NPRR1234 – Overview and Key Concepts](#) (August 20, 2024), p. 3-4.
ERCOT, [Large Loads – Impact on Grid Reliability and Overview of Revision Request Package](#) (May 6, 2024), p. 7-10.
ERCOT, [2024 Long-Term Load Forecast with Application of New Waterfalls](#) (August 13, 2024), p. 7.

Supply Chains not keeping up

Power transformer and GSU lead times benchmark: Q1 2022 – Q4 2023



Electrical equipment supply constraints

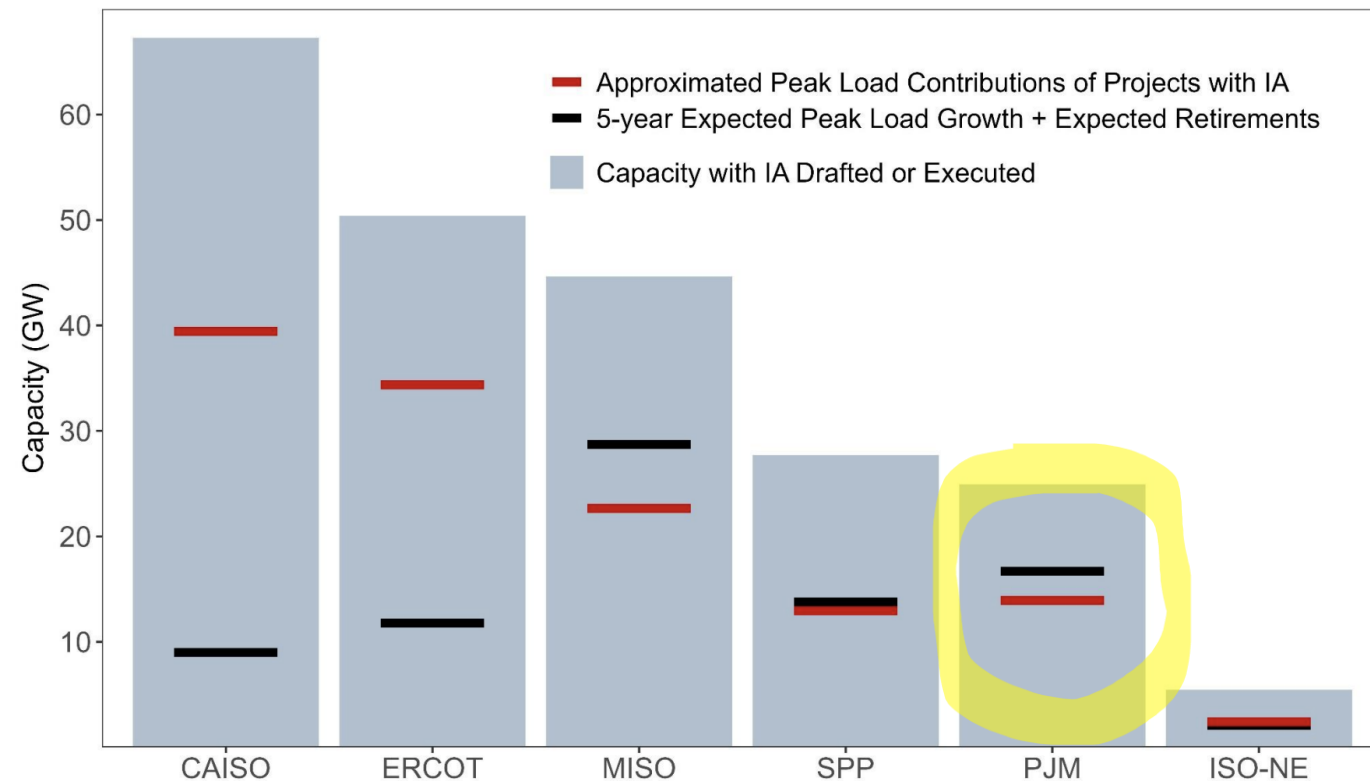
- Manufacturing atrophied in 2010s
- New generation and new large loads need high voltage (HV) substations (breakers, switches, transformers).

Transformer supply is particularly constrained

- Lead times average ~115 to 130 weeks, which can significantly impact project timelines
- Larger transformers ~120 to 210 weeks.
- Prices are up an average of 60% to 80% since the beginning of 2020
 - Largely driven by commodity price increases
- HV circuit breakers are also subject to long and highly volatile lead times: ~70 and 290 weeks in Q1 of 2024
- Human resource constraints—very specialized work, not very automated.
- Non-standard equipment orders reduces efficiency

Transmission and Interconnection Limitations

Peak Load Capacity with IA compared to 5-year Expected Load Growth



Interconnection timelines and bottlenecks limit generation expansion

- Interconnection queue backlogs exceed three years in many regions
- Delays make the sector less responsive to rapidly growing demand

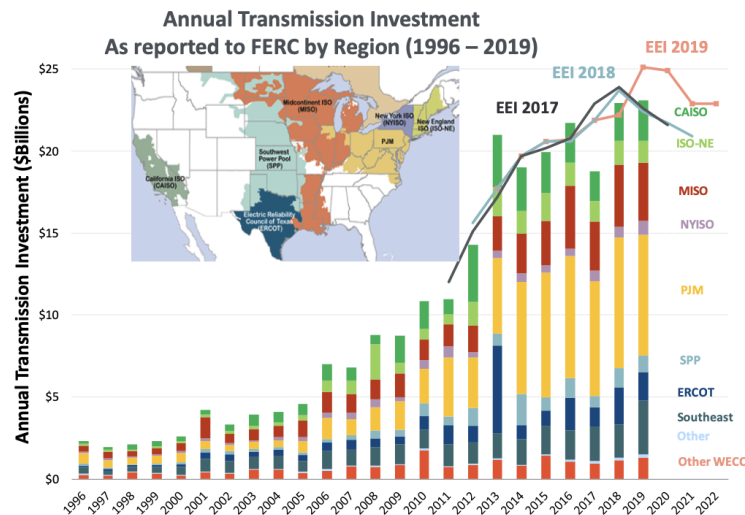
Transmission capacity limits the ability to bring renewables into load centers

- Investor-owned utility investment in transmission to serve new load has decreased over the past three years, according to EEI
- Long-distance transmission build-out has been limited in recent years
- US built 4000 miles of HV transmission in a single year a decade ago
 - FERC is enacting policies to expand transmission again

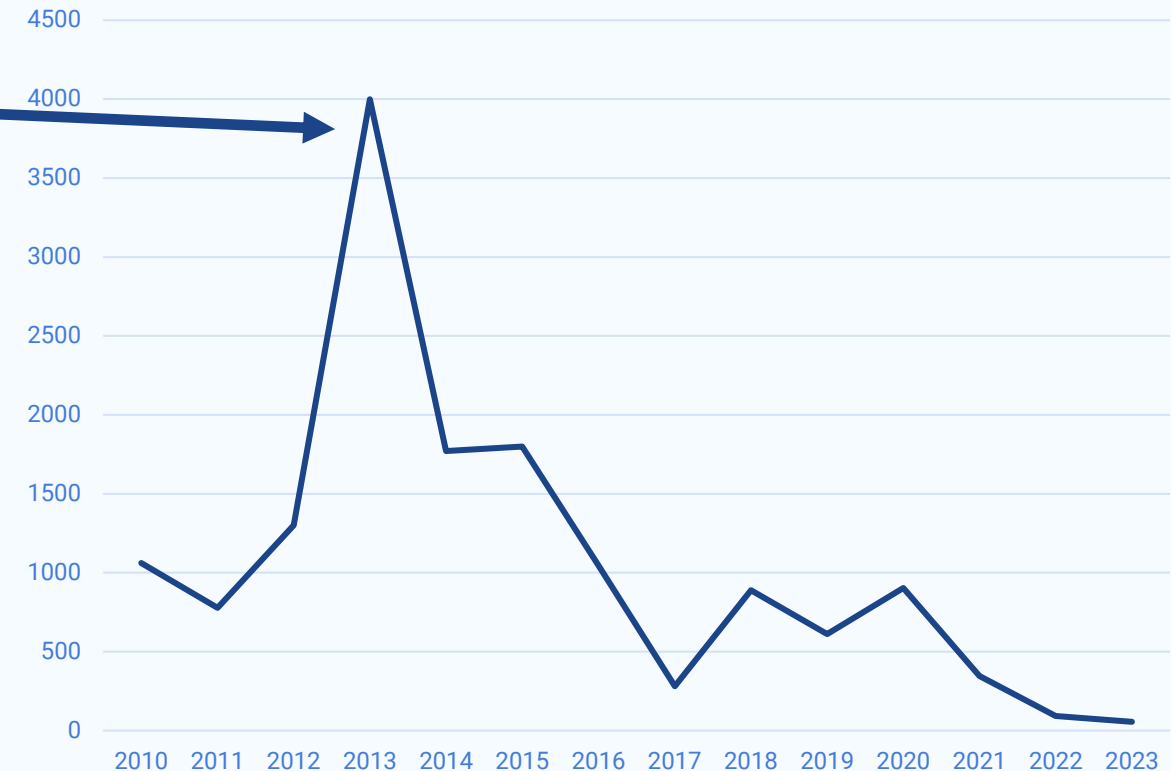
Both interconnection and transmission build-out timelines will be impacted by electrical equipment supply chain issues

Not much long-distance transmission built recently

- Many miles of new transmission in 2013, then dropped to a trickle
- Investment rising but capacity not increasing—mostly replacing aging assets



Miles of 345 kV + transmission lines added each year



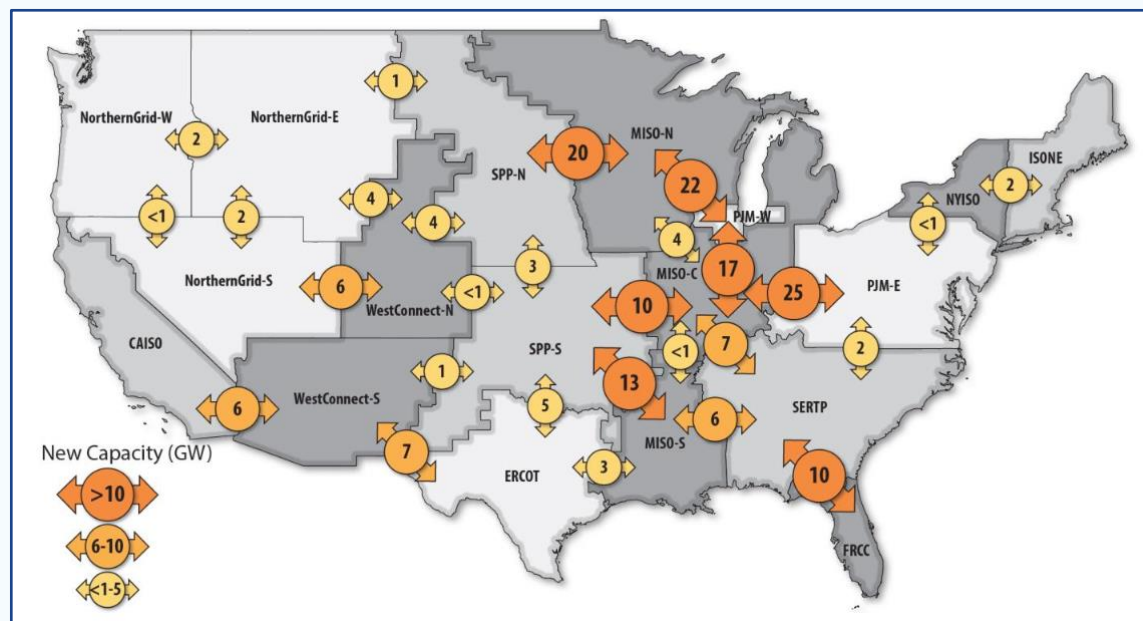
https://gridprogress.files.wordpress.com/2022/09/grid-strategies_fewer-new-miles_final.pdf

National Transmission Planning Study (NTPS) findings

Grid Reliability: Interregional transmission improves reliability particularly in response to extreme weather.

Consumer Savings: Would save the U.S. \$270-\$490 billion through 2050, approximately \$1.60 to \$1.80 in system cost savings for each \$ spent.

Integrating new, cleaner generation onto the grid: Enables the grid connection of new generation projects, balancing the variability of wind and solar.



High Opportunity Transmission (HOT) interfaces: potentially beneficial transmission capacity expansion between regions found across many future power system scenarios.

Thank you!

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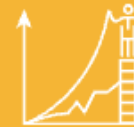
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Founded in 2017, Grid Strategies provides engineering, economic, and policy expertise on power systems