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Grid Strategies

Strategic Industries Surging: Driving US Power Demand

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DECEMBER 2024

EXECUTIVE SUMMARY

Findings, Context and Implications

Five-Year Load Growth Up Five-Fold to 128 Gigawatts

THE ERA OF FLAT POWER DEMAND IS BEHIND US …

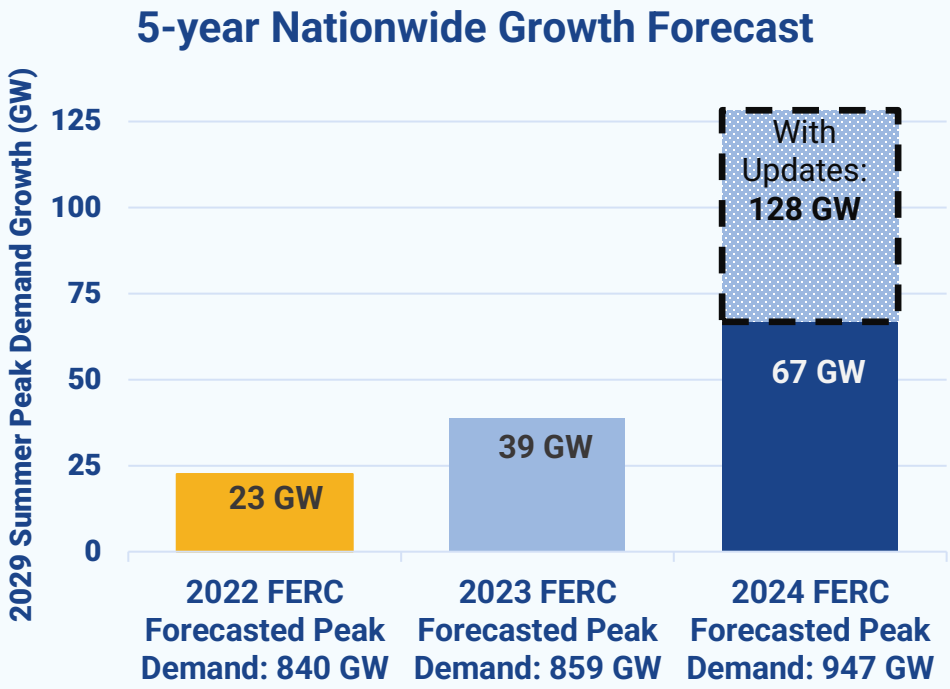
Over the past two years, the 5-year load growth forecast has increased by almost a factor of five, from 23 GW to 128 GW, including Grid Strategies' estimate of recent update reports.

- The official nationwide forecast of electricity demand shot up from 2.8% to 8.2% growth over the next five years to 66 GW through 2029 -- but with an additional 61 GW of growth in preliminary updates, **nationwide electric demand is forecast to increase by 15.8% by 2029**.
- While some of the additional growth merely reflects corrections to last year's incomplete forecast update, major changes have occurred in several regions. In particular, Texas (ERCOT) has recently added about 37 GW to its 2029 forecast – **resulting in an updated forecast of 43 GW in load growth through 2029**.

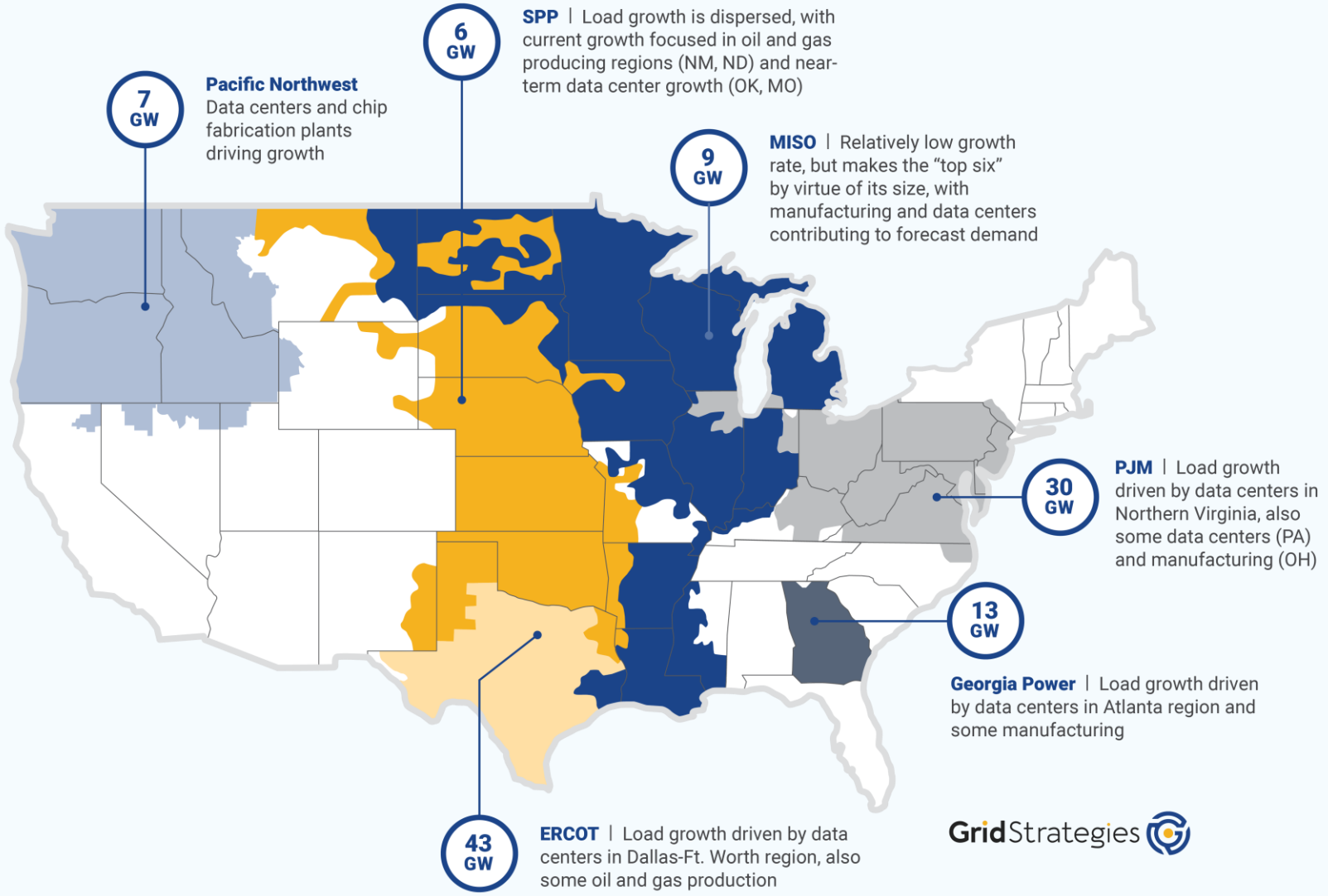
The main drivers are investment in data centers and manufacturing. High-end sector forecasts suggest current load forecasts may not have caught up with growth.

- Data center growth forecasts vary, with some tech industry analysts anticipating growth of 65 GW, while updated utility forecasts suggest over 90 GW.
- Manufacturing demand forecasts are unavailable – indicators suggest up to 20 GW growth.
- Other sources of load growth, including electrification, could be another 20 GW.

AND THE FORECASTS ARE MORE SHOCKING …



Six Regions Driving Load Growth Through 2029



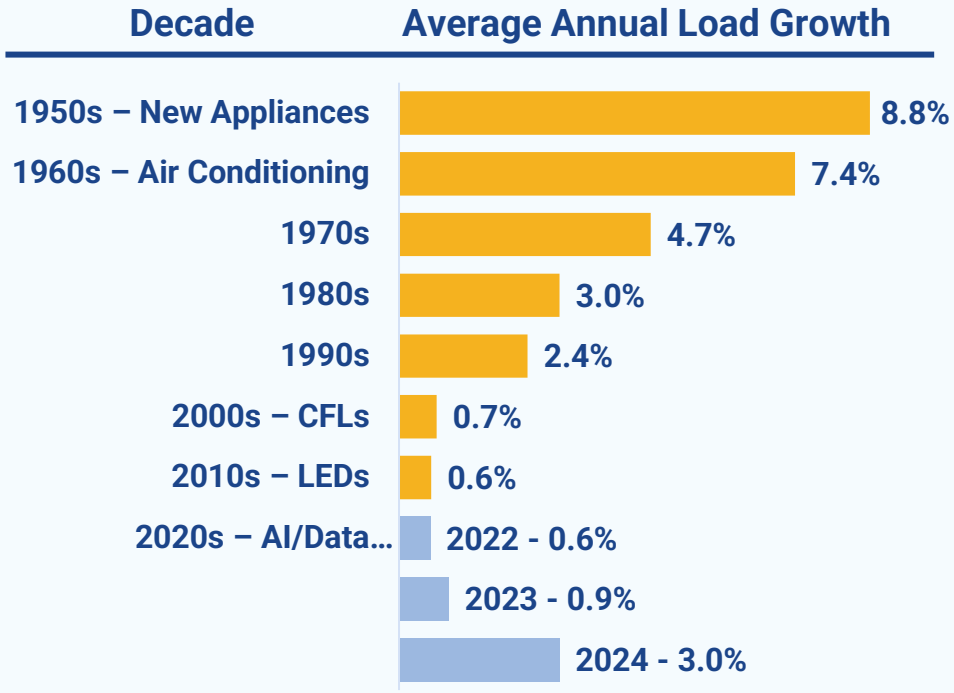
A Scramble to Respond to Growing Load

For over two decades, the utility industry has been in a low growth period, well below 1% per year. If the updated forecast is correct, annual peak demand growth will average 3% per year over the next five years. While 3% growth may seem small to some, it would mean six times the planning and construction of new generation and transmission capacity.

Expanding the grid is critical to sustaining high load growth driven by strategic industries, meeting new large customer technology requirements, and maintaining reliability.

- Low transmission construction rates and low transfer capability between regions challenge transmission owners' ability to maintain reliability and accept all forecast power demand.
- For example, according to FERC data, the U.S. only built 55 miles of high-capacity transmission (greater than 345 kV and up) in 2023, but this trend may be reversing, as planned transmission expansion investments have increased to $15.1 billion for 2024 compared to $9.2 billion just two years ago.
- Additionally, certain data center technologies can respond to power variations in ways that make reliable grid operation more difficult.

These numbers may be an underestimate – or an overestimate. **Greater uncertainty creates its own challenges**, making it difficult to agree on planning scenarios, finance manufacturing, and complete the construction of transmission and generation.



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Edison Electric Institute, *EEI Industry Capital Expenditures with Functional Detail*, published October 2021, September 2022, September 2023 and September 2024.
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Power Demand Growth Could Impact U.S.'s Global Leadership

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Meeting rising demand for electricity has significant strategic importance for the U.S. In just two years, the forecast of cumulative electricity growth over the next five years appears to have increased by a factor of five, from 2.8% to 15.8%. This growth is driven by **geopolitically and nationally strategic industries such as semiconductor chip manufacturing, artificial intelligence (AI), and battery manufacturing.**

However, there is often a mismatch between development of these strategic industries and the procurement of new generation and transmission to meet load growth. It may take only one or two years to connect new load to the grid, while it may take over four years to bring new generation online and even longer to build new transmission, including connections between regions to enable power sharing during peak periods. Ample generation resources are under development across the country, but projects are often bogged down in technical review processes that were created for a different age and different technologies.

It is worrisome that strategic industries, such as the development of an American advanced manufacturing sector or AI leadership, may face headwinds from the limited ability of the nation's electricity systems to respond. Electricity systems need to supply new generation, connect that generation to load, and – of course – connect new load to the system. **There are real risks to America's economic, technological, and geopolitical leadership if the grid can't keep up with demand.**

Sustaining growth in strategic economic sectors will require significant new investments in electric power sector infrastructure. Meeting the electricity requirements of new advanced manufacturing and data centers through new nearby generation could result in capital investments of billions of dollars per GW of new load. A more valuable and less costly approach to ensuring reliability is ensure the same reliability with increased transmission capacity to transfer power from one region to another. Capacity delivered through interregional transmission is likely to cost less than $300 million per GW of new load. With this added reliability, less new generation is required and it doesn't need to be located close to new facilities.

Power Demand Growth Could Impact U.S.'s Global Leadership

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Transmission is a particular challenge for unlocking significant growth from strategic industries. Large-scale transmission investments are needed to reliably and affordably meet demand. But high-capacity and interregional transmission takes years to develop, and current planning and regulatory practices make these lines particularly difficult to build.

Investing in large-scale transmission is the lowest-cost way to address load growth and could save tens of billions of dollars in bringing on the new 128 GW of electricity demand, but changes in policy and practice, such as permitting reform, are required to make this possible.

The drivers of electricity demand growth are diverse but strategically important to the U.S.'s global technological and economic leadership:

- The rise of **artificial intelligence** is supercharging data center growth;
- Increased industrial load, particularly from **advanced manufacturing**, is being driven by federal legislation encouraging 'domestic content';
- **Electrification of transportation and buildings** is building momentum, already the dominant source of growth in some regions;
- **Oil and gas production** is driving power demand in the Permian and Bakken fields; and
- **Hydrogen fuel plants** could emerge as a major factor in future electric load forecasts.

Furthermore, increases in the frequency and severity of **extreme weather events** are driving record peak demands in many regions.

If policymakers and grid planners are not accounting for these drivers, load forecasts will be too conservative, and the country will not be ready to meet growth in electricity demand. Transmission planners need long-term forecasts of both electricity demand and sources of electricity supply to ensure sufficient transmission will be available when and where it is needed.

Such a failure of policymaking and planning could have real consequences for American leadership globally in strategic industries, negatively impacting domestic investments, jobs, and system reliability for all electric customers.

SECTION ONE

Overviews of Key Drivers of Load Growth

Strategic Industries Driving Load Growth Across Regions

… a surge in data center and industrial development caused sudden, shockingly large increases in 5-year load growth expectations.

Up until 2022, most utility and regional load forecasts identified general economic growth, population growth, temperature trends, and electrification (building and transportation) as drivers of load growth.

However, beginning in 2022**,** a surge in development in strategic industries, such as data centers and domestic industrial facilities, has driven large increases in 5-year load growth expectations. By 2024, those increases were truly shocking in scale, due primarily to AI data centers and new manufacturing facilities for semiconductor chips and batteries.

Hydrogen plants and development of oil/gas fields are regionally significant sources of load growth in the near-term. Hydrogen plants may be a larger national factor in the long term, but most regions are uncertain how these plants will impact power system demand. A change in tax policy could contract or expand hydrogen plant development.

Electrification of buildings (heat pumps, water heaters) and transportation (EV charging) will likely be less volatile and more impactful in the 2030s. A few regions forecast electrification at a gigawatt-scale in the 2020s. A change in the status of tax credits for heat pumps and EVs would likely affect this portion of forecasts.

Near-Term Load Drivers	Data Centers	Manufacturing	Electrification
Arizona Public Service	●		
CAISO	●		●
Duke	●	●	
ERCOT	●	●	
Georgia Power	●	●	
ISO-NE			●
MISO	●		●
NYISO	●	●	●
Pacific Northwest	●	●	
PJM	●	●	●
SPP	●		

Scale of Data Center Development

Tech industry estimates for future data center demand vary from as little as 10 GW to as much as 65 GW – but utility forecasts include at least 90 GW of future data center load.

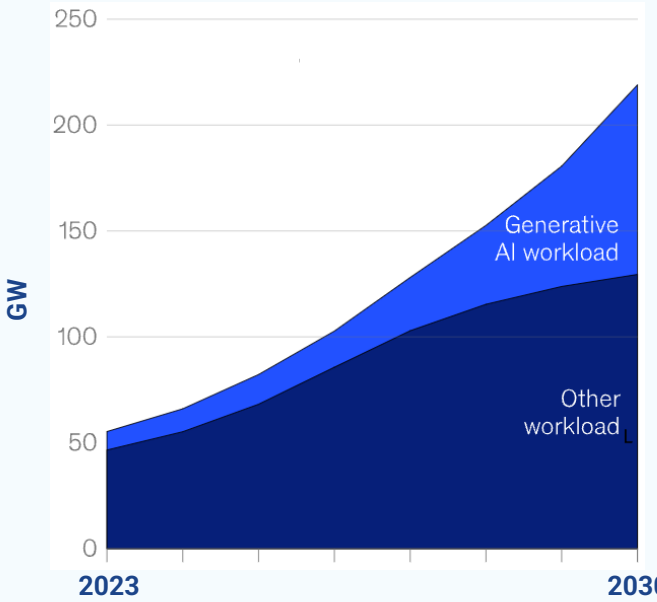
The power industry does not have a clear understanding of how much demand will come from data centers. Industry specialists estimate five-year data center demand growth from as little as 10 GW to as much as 65 GW through 2029. While only some utilities break out data centers from other large load drivers, aggregate utility data center load forecasts may exceed 90 GW. This is almost 10% of forecast 2029 load of 942 GW.

Another challenge is that the power industry does not have clear information about current and future breakouts of distinctive data center load types, including enterprise, artificial intelligence (AI), and crypto mining. Over the next five years AI will represent a larger share of data center load. Currently, AI represents approximately 10-20% of total data center demand. According to McKinsey, from 2023 to 2030, AI will represent 70% of total new data center power demand. If McKinsey is correct, AI power demand will grow to about 40% of total data center demand.

Some investor analysis suggests that AI power demand could even *exceed* current power industry expectations. Barclays suggests that **AI demand is large enough to drive $3.3 trillion in chips-only investment through 2028**. While Barclays acknowledges that "demand should continue to outstrip supply," its analysis suggests that even consensus "street" estimates of data center investment indicate even more than the 90 GW forecast by utilities.

Notably, demand from crypto mining could diminish over the next five years. While some analysts estimate that 20% of bitcoin mining power capacity may be repurposed for AI by the end of 2027, others believe that such conversions will be cost prohibitive.

Global Data Center Demand Forecast (McKinsey)



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Is Data Center Efficiency a Solution?

Improving energy efficiency may only lead to more computing demand, not reduced energy demand.

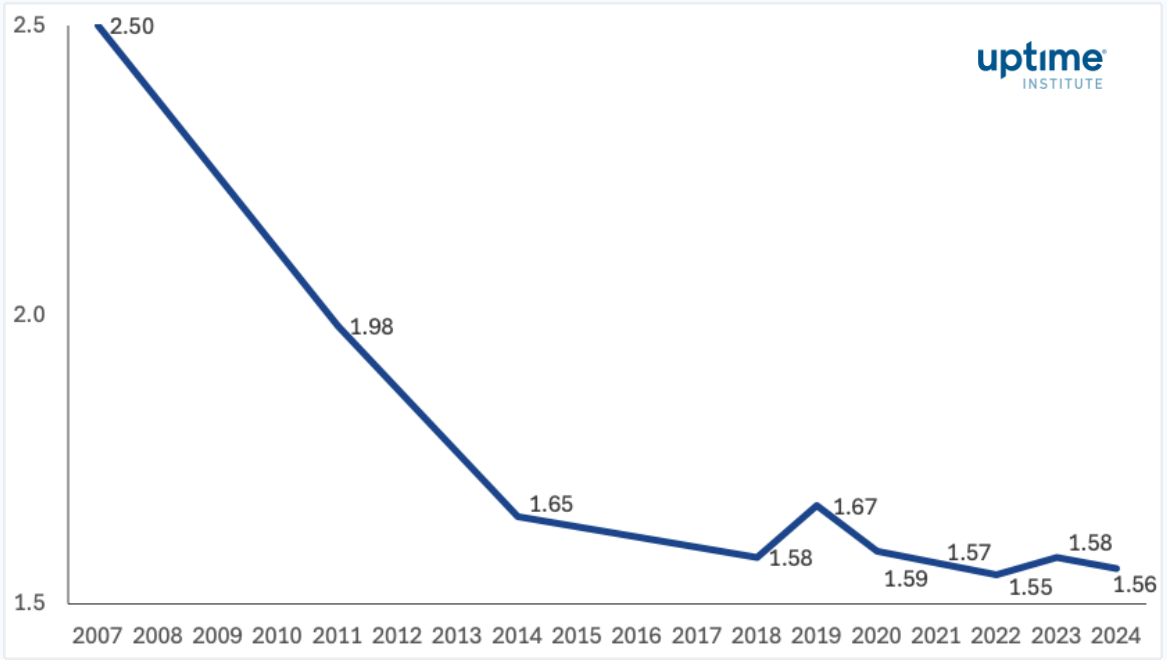
With the growing concern about the scale of load growth to serve data centers, many experts have considered whether increased energy efficiency at data centers could be a solution.

One of the challenges to assessing future efficiency gains is that artificial intelligence (AI) data centers have higher rack power densities than conventional data centers. In other words, AI data centers use more energy in the same floor area than conventional data centers. This difference is driven by the graphics processing units that distinguish AI from other data center designs.

Barclays' analysis of potential AI data center load growth – 10 GW by 2027 – is based on a bottom-up analysis of near-term AI chips and an assumption of data center efficiency, as measured by power usage effectiveness (PUE) of 1.2. Uptime Institute reports an industry average PUE of more than 1.5, which has not improved since 2021. It is worth noting that the PUE metric does not account for improvements in efficiency of the IT systems themselves, just the overall data center facility efficiency.

As Barclays' analysis opines, improving energy efficiency may only lead to more computing demand, not reduced energy demand.

Data Center Efficiency (PUE) Flat Since 2020



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Masanet. et al, "To Better Understand AI's Growing Energy Use, Analysts Need a Data Revolution," Joule (2024).

Geographic Concentration of Data Center Development

Estimates for additional data center demand vary from as little as 10 GW to as much as 65 GW.

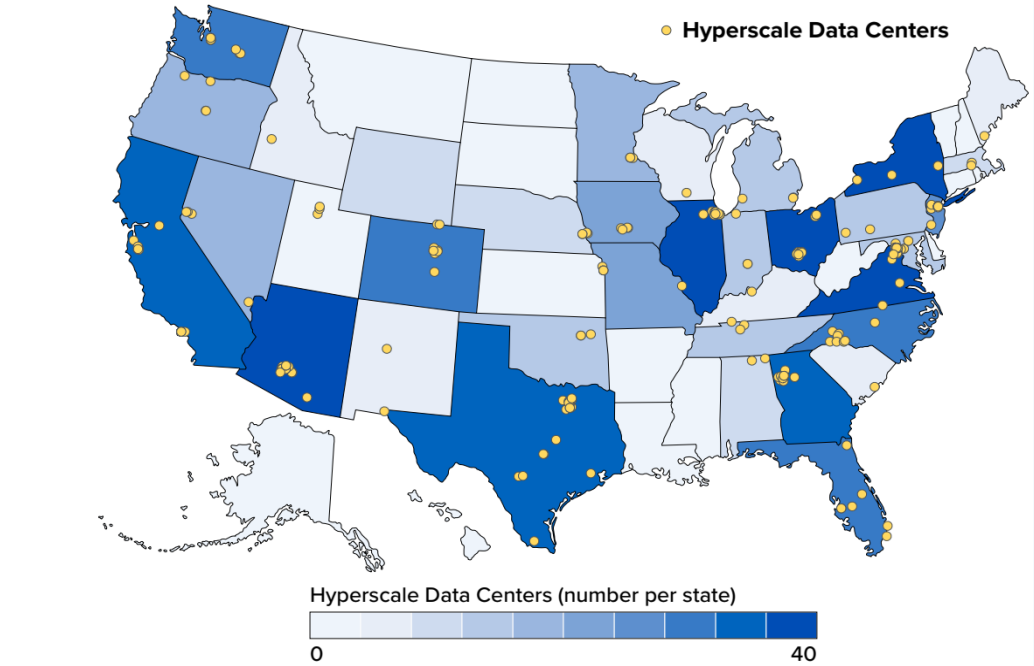
The rapid pace of development makes it difficult to forecast the geographic distribution of data center load even in the next five years. According to EPRI, fifteen states accounted for 80% of data center load in 2023. EPRI's projections – reflecting the collective understanding of the power sector – use a simple uniform scaling across all states.

Data center load growth is the single largest component of growth in utility load forecasts. Based on those load forecasts, it appears that data center load growth will be concentrated in just a few areas:

- **Texas** – Dallas
- **PJM** – Northern Virginia and Pennsylvania
- **Georgia** - Atlanta

Understanding this clustering is important for power industry planning. Data centers are, of course, being developed in many other utility service areas. And for those utilities, data centers could be driving grid investments well above recent experience – even if they are a small share of projects across the country.

Number of Hyperscale Data Centers by State (Through 2023)



SOURCE | EPRI, Powering Intelligence (May 2024).

Four Regions Hosting Most New Industrial Load

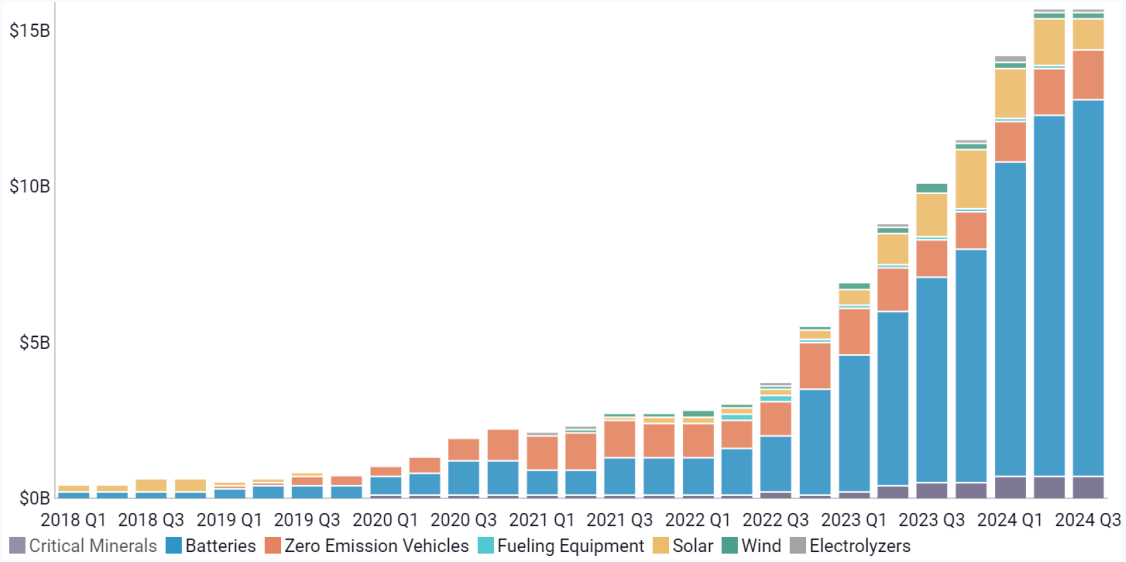
According to the U.S. Department of Energy, almost 900 new manufacturing projects for transportation and clean energy industries have been announced since the Inflation Reduction Act (IRA) was passed. According to the Clean Investment Monitor, $114 billion has been spent on construction of new manufacturing plants, with the Peterson Institute estimating 60% of manufacturing investments are now for semiconductor chip facilities and battery factories.

These investments are concentrated in four regions:

- **Southeast**, especially the Carolinas, Georgia, Kentucky, and Tennessee
- **MISO**, especially Illinois, Indiana and Michigan
- **PJM**, especially Ohio
- **West**, especially Arizona, California, and Nevada

However, some load forecasts do not show high growth in manufacturing-related power demand. In the MISO region, reported new manufacturing load totals less than 1 GW. States with substantial new manufacturing but total five-year load growth less than 1 GW include California, Kentucky, Nevada and Tennessee. It appears that in many regions, manufacturing expansion projects do not yet require enough power to strongly influence demand forecasts.

Clean Energy Manufacturing, Actual Investment ($ billions)



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Peterson Institute for International Economics, US Chips Construction Spending Skyrocketed (August 2024)

Planned Hydrogen Fuel Plants Aren't in Most Load Forecasts

A majority of the projects in the figure, 3.8 GW, are announced or planned, 30 times present capacity.

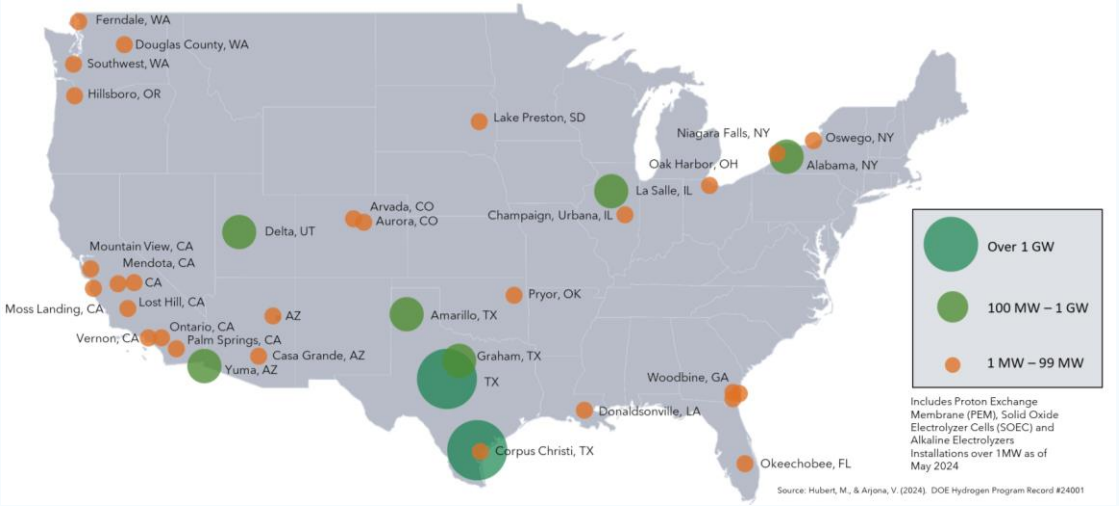
Federal hydrogen production incentives could lead to substantial new power demand over the next few decades, depending on decisions made by the new administration and technology deployment. Currently, hydrogen production is a driver in the 5-year peak demand forecasts for Texas and (to a smaller extent) New York.

The Inflation Reduction Act includes a hydrogen production tax credit and the US Department of Energy (DOE) has awarded $7 billion from the Bipartisan Infrastructure Law to seven different regional hydrogen hubs. The hubs could increase hydrogen production 1000 times over today's levels.

The figure at right shows hydrogen production projects greater than 1 MW that are operational or have been announced as of May 2024. Installed capacity in the U.S. is currently 116 MW, equal to one orange bubble, with 657 MW under construction. Most of the projects in the figure, 3.8 GW, are announced or planned, 30 times present capacity. However, in 2024, McKinsey cut its hydrogen demand forecast ~25% by 2050, citing cost increases and regulatory uncertainty as barriers.

Over three-quarters of planned investments are in Texas, with the vast majority of ongoing construction in Texas and New York.

Planned or Operational Hydrogen Production Projects



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Building and Transportation Electrification Impacts Coming

After the switch to winter peaking, building electrification could represent 35% of New York's annual peak.

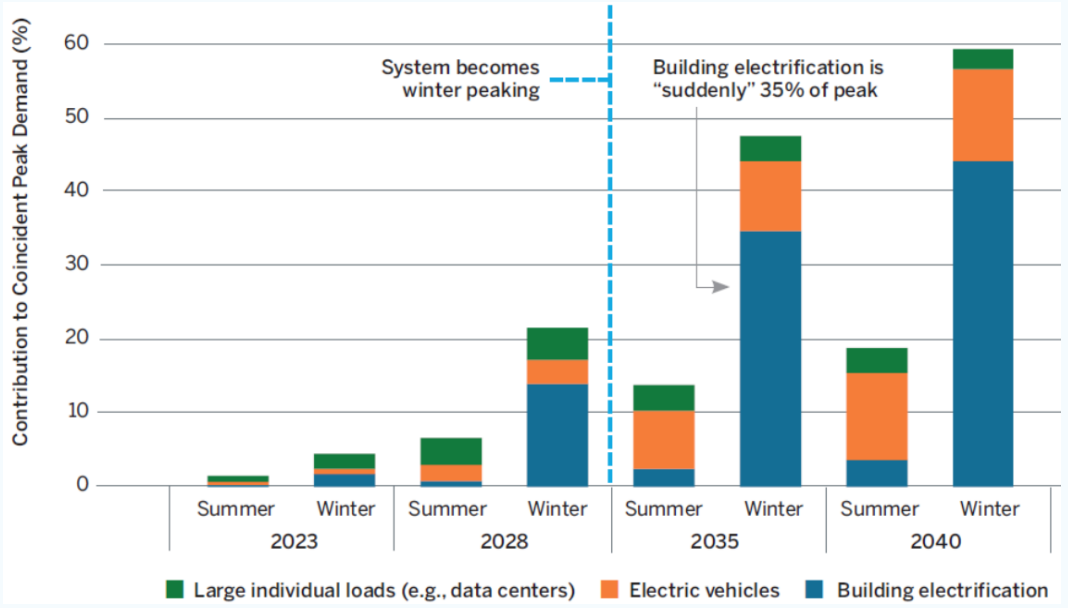
In some high-growth regions, building and transportation electrification impacts are not a major driver of load growth over the next five years. But after 2030, many more regions anticipate substantial load growth due to electrification.

Building electrification will likely have greater impacts during the winter. A recent report by ESIG found that building electrification could switch the New York system from summer to winter peaking by 2035. Before the switch, building electrification represents less than 15% of the annual peak. But once enough heating demand drives the system peak up in the winter, building electrification could represent 35% of New York's annual peak. ISO-NE reports similar trends.

Forecasts of transportation electrification are challenged by:

- **Uncertainty about vehicles** – The rate and types of electric vehicle adoption are affected by costs, policies, consumer preferences, and fleet electrification planning.
- **Uncertainty about charging behavior** – Where and when vehicles are charged will significantly affect utility planning. Customers charging at work during the daytime will require significantly different investments than overnight charging.

Electrification and Large Load Impacts on New York's Peak Power Demand



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SECTION TWO

Power Industry Response

New Large Load Tariffs to Reduce Revenue Risks and Improve Forecasts

Common themes in new large load tariffs include minimum take requirements, exit fees, and direct contract with generation suppliers.

Utilities have long prioritized their obligation to affordably and reliably serve load. Yet the surge in new large loads drives a need for large investments in generation and transmission infrastructure that was not anticipated just two years ago.

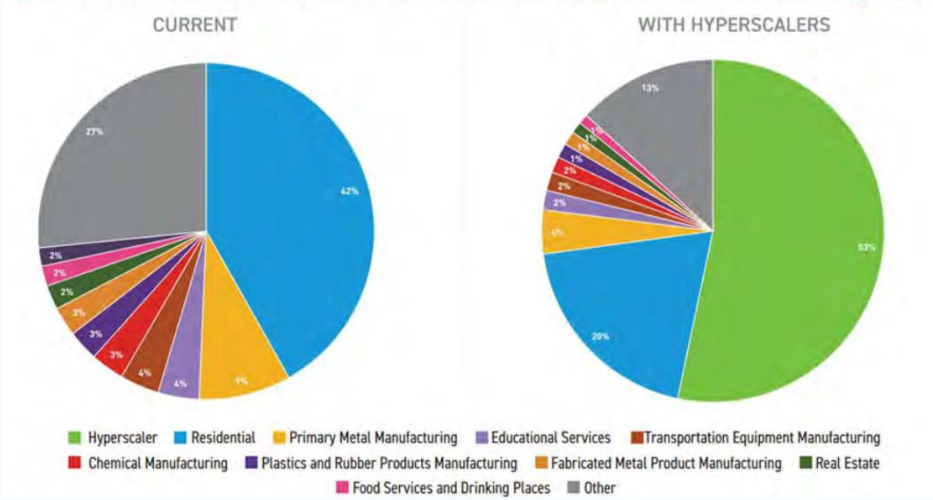
Utilities and regulators are turning to tariff measures to require additional financial commitments from large load interconnection requests to better share the infrastructure investment risk, ensure costs are not spread to existing customers, and improve forecast quality by relying more on known and certain facilities.

AEP has advanced new tariff designs in Indiana and Ohio. An all-party settlement for AEP's Indiana & Michigan Power illustrates three themes in new tariff designs being considered in several states. The settlement includes a 12-year contract with a minimum monthly charge, larger collateral requirements, and an exit fee capped at 5-years of the minimum charge.

In regions where utilities offer bundled service, proposed tariffs for new large loads have focused on **direct contracts between customers and generation suppliers**. NV Energy and Google have jointly proposed a Clean Transition Tariff (CTT). Pending regulatory approval, the CTT allows Google to select its power supplier, but it must do so for the life of the project and cover any premium compared to what NV Energy would have procured to serve the load.

In May 2024, Duke Energy partnered with several large companies to develop the conceptual Accelerating Clean Energy (ACE) tariff which will include minimum take requirements and a CTT. Indiana & Michigan Power, Arizona Public Service and the Virginia utility regulator have each initiated action on large load tariffs.

Hyperscale Data Centers Could Represent >50% of Indiana & Michigan Power Revenues



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Public Utilities Commission of Ohio, Case No. 24-508-EL-ATA.
Public Utilities Commission of Nevada, Docket No. 24-05022.
Utility Dive, Rising Data Center Loads Pose Grid Reliability, Residential Cost Risks (November 2024).
Duke Energy, Responding to Growing Demand, Duke Energy, Amazon, Google, Microsoft and Nucor Execute Agreements to Accelerate Clean Energy Options (May 2024).

NERC Large Load Reliability Standard

Planned data centers over 1 GW, totaling over 50 GW on individual systems, could cause severe reliability problems.

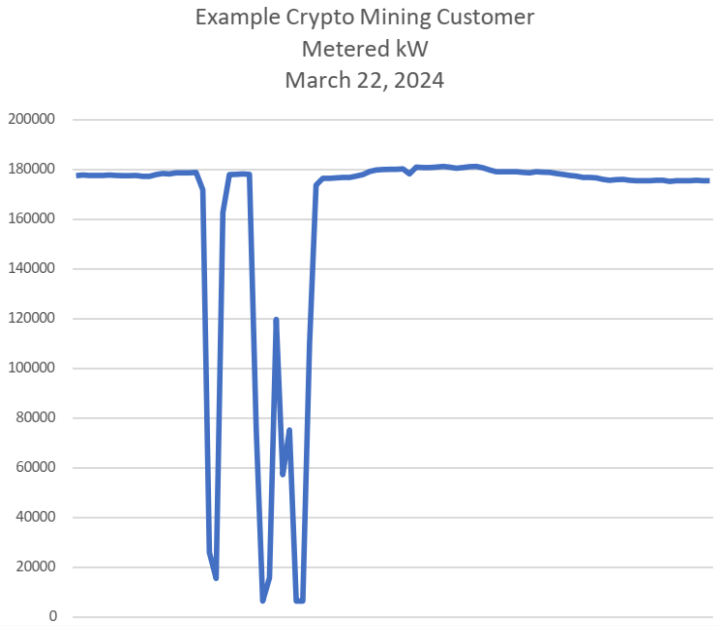
Large data centers are presenting new, unique challenges to grid reliability. To address these challenges, NERC has set up a task force to address the risks associated with large data centers, potentially leading to new reliability standards.

One new, unique risk posed by large data centers is the impact of large, rapid changes in load. Large, rapid changes in load can occur for a number of reasons, including:

- **Price response –** Crypto mining operations can increase or decrease load by almost 100%. When they respond collectively, the cumulative effect can be challenging to manage. Other large computing operations show little or no sensitivity to electricity price signals.
- **"Ride-through" –** Due to the sensitive nature of computer equipment, data centers automatically activate backup power systems in response to even small changes in voltage. Lightning strikes and other grid faults trigger voltage changes of this size.
- **Normal operations** – AI data center "training models" can vary load significantly on a scale of just seconds.

Where large amounts of load suddenly disappear (or reappear) due to any of these causes, it can require a large, almost instantaneous response by grid operators.

ERCOT has experienced sudden load reductions of up to 400 MW. Nonetheless, grid operators view existing data center behavior as manageable. However, some proposed projects could exceed 1 GW and some system expect aggregate demand of over 50 GW. At such a large scale, load drops could cause severe reliability problems.



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David Ball (AEP), Large Data Centric Flexible Load Operational Impact Review (October 8, 2024).
Agee Springer (ERCOT), Large Loads in ERCOT – Observations and Risks to Reliability (October 8, 2024).

Unlocking America's Energy: Generation Interconnection Reform

Speedy deployment of generation needs new entry fee and fast-track processes, plus optimizing the study and construction phases of interconnection.

A necessary complement to bringing new load online is bringing new generation online. Across the country, large backlogs of generation projects are moving slowly through interconnection study queues or awaiting construction of transmission upgrade projects.

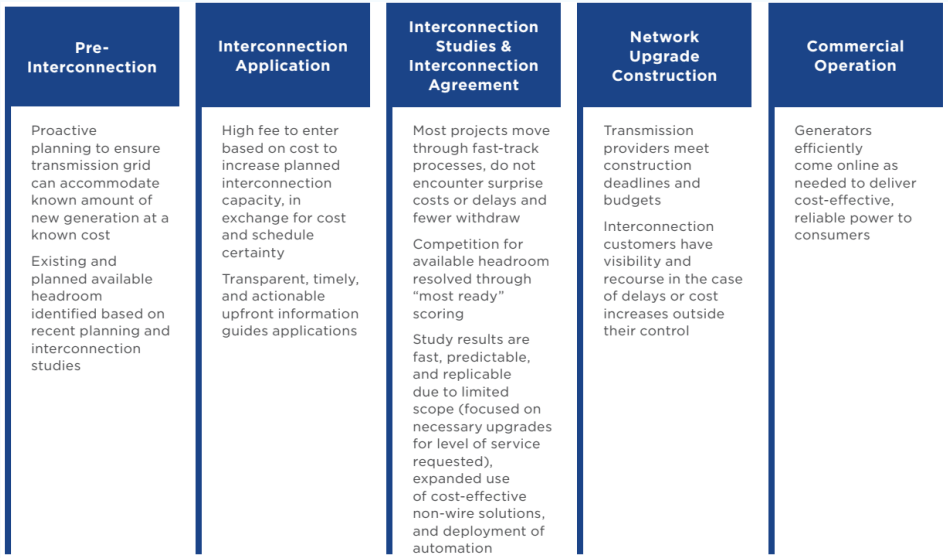
In July 2023, FERC issued Order No. 2023, moving all transmission providers to a cluster-based study process and increasing readiness requirements for a first-ready, first-served approach to studying new generators. In November 2024, FERC issued Order No. 1920-A, directing that the long-term transmission planning process become more proactive and utilize a broader cost allocation process.

FERC continues to study generation interconnection reform and to better understand issues raised by colocation of large loads and generation. Nearly half of project delays occur during the construction phase, caused by supply chain bottlenecks, lack of prioritization/project management by transmission owners, and delays by interconnection customers who may lack contracts with power customers or necessary permits.

Four reforms to address the generation interconnection backlog include:

- **Certainty**: Adopt a known and fixed interconnection entry fee for proactively planned capacity.
- **Utilization**: Implement a fast-track process to utilize existing and already-planned interconnection capacity.
- **Efficiency**: Optimize the interconnection study process.
- **Construction**: Speed up the transmission construction backlog.

Vision for an Efficient Generation Interconnection Process



SOURCE | Grid Strategies and The Brattle Group, Unlocking America's Energy: How to Efficiently Connect New Generation to the Grid (August 2024).

Decade-Long Transmission Expansion Investment Decline May Be Reversing

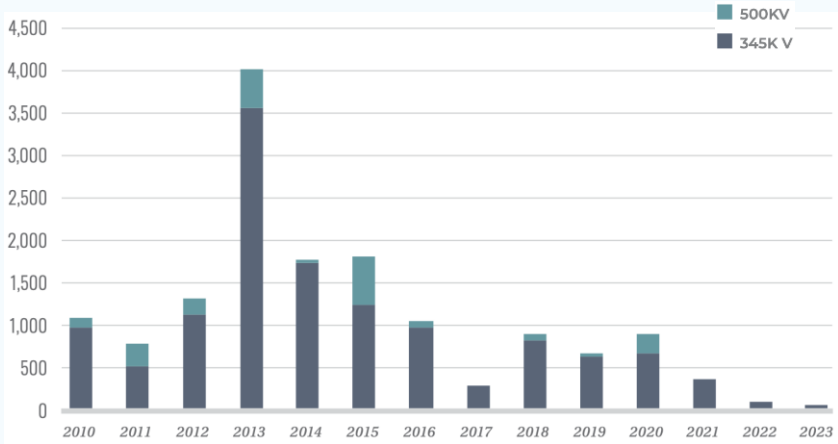
Over $50 billion in new transmission expansion investments were approved so far in 2024, while NERC study calls for greater investment in interregional transmission.

Large-scale transmission is the lowest-cost method to address load growth, but according to FERC data, only 55 miles of high-capacity transmission (345 kV and up) were built in 2023, with the beginning of the 2020s having much lower rates of high-capacity transmission construction than the beginning of the previous decade. That trend may be reversing. In 2024, investments in significant transmission expansion were approved across the country, with load growth often being cited as one of the key drivers of these investments.

- **MISO:** MISO is expected to approve Tranche 2.1, a $21.8 billion Long Range Transmission Planning investment, in December 2024.
- **Texas:** The Texas PUC approved an ERCOT plan for roughly $13 billion in transmission investments (September 2024).
- **SPP:** SPP's 2024 transmission plan includes a historic $7 billion investment.
- **CAISO:** CAISO's 2023-2024 transmission includes $6 billion in transmission investments.
- **Pacific Northwest:** BPA announced $3 billion in transmission investments to address regional load growth and new generation in October 2024.

While it is not clear how much investment is specifically intended for load growth, reliability and load growth are inextricably tied. NERC's Interregional Transfer Capability Study, released in November 2024, identified 35 GW of prudent interregional transmission additions. If built, interregional transmission will enhance access to energy, dispatching existing resources more efficiently. It should be noted that NERC's study was based on 2023 forecasts and could underestimate prudent transmission additions because it does not account for recent increases in load forecasts.

Miles of High-Capacity Transmission Lines Added Annually



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Is There a Load Growth Bubble?

Several utilities' announced data center demand totals 93 GW. Yet Wood Mackenzie studied a realistic nationwide five-year build-out at just 23 GW.

A recent Wall Street Journal article asked, "Internet Hype in the '90s Stoked a Power-Generation Bubble. Could It Happen Again With AI?" Overbuilding in the 1990s contributed to bankruptcy by major independent power generators, such as Calpine and NRG Energy.

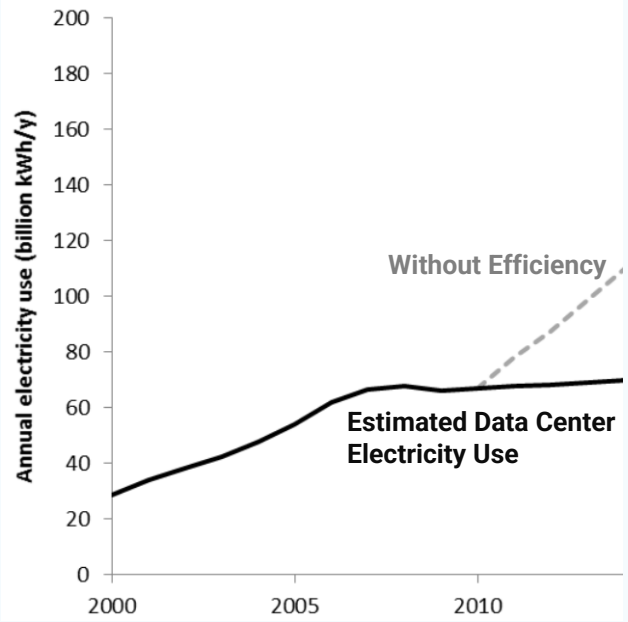
Yet the same article also notes that, "the drivers of electricity-demand growth are more tangible this time." Companies developing data centers are making both verbal and contract commitments to pay their "fair share" of generation and transmission expansion costs.

Wood Mackenzie sampled several utilities' announced data center demand, estimating 93 GW total through 2030. Based on bottom-up analysis of tech industry capacity, Wood Mackenzie forecasts a more realistic national five-year AI buildout to be just 23 GW.

Data center developers may have such a large appetite for growth that their projects could use up any and all currently-unused grid capacity over the next five to ten years. On the other hand, business revenues to cover the costs of the artificial intelligence investments have not yet been proven.

This combination of exuberance and uncertainty raises the question of whether these projects could fail to sustain anticipated power demand. Such a failure could leave other customers with responsibility to cover costs for transmission and, in some regions, generation investments. There are economic and energy reliability risks, both from under- and over-investment.

LBNL Study: Efficiency Allowed 2009-2015 Growth in Data Centers Without Increasing Energy Use



SOURCES | Jinjoo Lee, "Internet Hype in the '90s Stoked a Power-Generation Bubble. Could It Happen Again With AI?" Wall Street Journal (October 9, 2024).
Aaron Tinjum, Data Center Coalition Statement, Co-Located Load Technical Conference, FERC Docket No. AD24-11-000 (November 4, 2024).
Gimon et al., Meeting Growing Electricity Demand Without Gas, Energy Innovation (March 2024).
Shehabi et al., United States Data Center Energy Usage Report, LBNL-1005775 (June 2016).
Wood Mackenzie, Gridlock: The Demand Dilemma Facing the US Power Industry (October 2024).

Improving Load Forecasting

The power industry needs an initiative to develop standard data sources and load forecast methods.

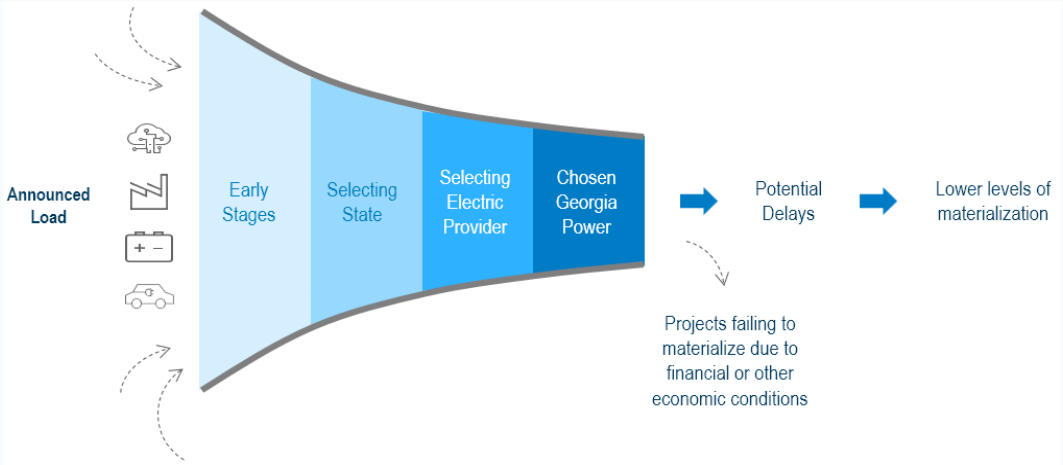
Utility load forecasts for residential and small/medium commercial load are generally reasonable, relying on well-established statistical methods. In contrast, the power industry is struggling to build medium- and long-term load forecasts around four load drivers:

- Data centers
- Large manufacturing expansions (new industries and onshoring)
- Electrification of existing industry
- Hydrogen production

As recently as 2022, nearly all utilities' ten-year load forecasts did not feature high load growth from any of these drivers.

The power industry needs an initiative to develop standard data sources and load forecast methods for these drivers, as well as **building and transportation electrification**. In addition, some utilities are beginning to implement medium- and long-term load forecasts for **climate trends and extreme weather**. In some cases, these forecasts extrapolate from recent trends. Ideally, those forecasts would reflect scientific forecasts of regional climate trends.

Georgia Power's large load forecast model



Georgia Power's large load forecast model is based on announced load. The model considers uncertainty due to selecting service from another utility as well as potentially not being completed or using as much power as expected.

SOURCE | Georgia Power Company, 2023 IRP Update Load and Energy Forecast (October 2023).

SECTION THREE

Case Studies

Planning Areas with Sharpest Increase in 2024 Load Forecast

Nearly two-thirds of the 107 GW increase in forecast load growth comes from recent updates for ERCOT, PJM and Georgia Power. These recent updates are preliminary and may be adjusted. Seven other regions comprise most of the rest of the growth.

Including both FERC 714 filed load forecasts and these recent updates, the planning areas now anticipate 128 GW in load growth over the next five years. This includes 23 GW forecast in 2022 FERC 714 filings, an increase of 39 GW in 2024 filings, and an additional 61 GW in forecast updates.

Key Changes from our 2023 Report:

- Forecast updates for four regions, reflecting preliminary data that will be refined over the next few months
- MISO and the Pacific Northwest are now on the top-ten list, while CAISO dropped off
- TVA had announced growth could increase to 1 GW per year, but as-filed load growth has instead decreased

Planning Areas with Greatest Increase in Summer 2029 Peak Demand

Planning Area	2029 Peak Demand						Total Growth Through 2029 (GW)
	2022 Forecast (GW)	2023 Forecast (GW)	2024 Forecast (GW)	Forecast Updates (GW)	Forecast Increase (GW)	Forecast Increase (Percent)	
ERCOT	84.4	89.6	88.1	+ 36.9	**40.6**	48.1%	**42.8**
PJM	153.3	156.9	165.7	+ 15.2	**27.5**	18.0%	**29.6**
Georgia Power	16.3	17.3	22.4	+ 7.3	**13.5**	83.1%	**13.0**
MISO	132.4	133.0	138.4		**6.1**	4.6%	**9.1**
Pacific Northwest	37.4	38.4	38.5	+ 2.0	**3.1**	8.2%	**7.4**
SPP	56.6	59.5	62.5		**5.9**	10.4%	**6.3**
Duke Energy (North & South Carolina)	33.9	36.2	36.6		**2.7**	7.8%	**2.6**
Arizona Public Service	8.7	9.8	9.9		**1.2**	13.6%	**1.5**
NYISO	31.5	32.3	32.3		**0.9**	2.8%	**4.6**
Tennessee Valley Authority	31.8	32.4	32.5		**0.7**	2.2%	**1.4**
All other planning areas	251.2	250.5	249.5		**-1.7**	-0.7%	**10.0**
Total	**840.5**	**858.9**	**879.8**	**+ 61.4**	**100.7**	**12.0%**	**128.2**

ERCOT

Dallas Area Data Center, Permian Basin Driving Enormous Load Growth

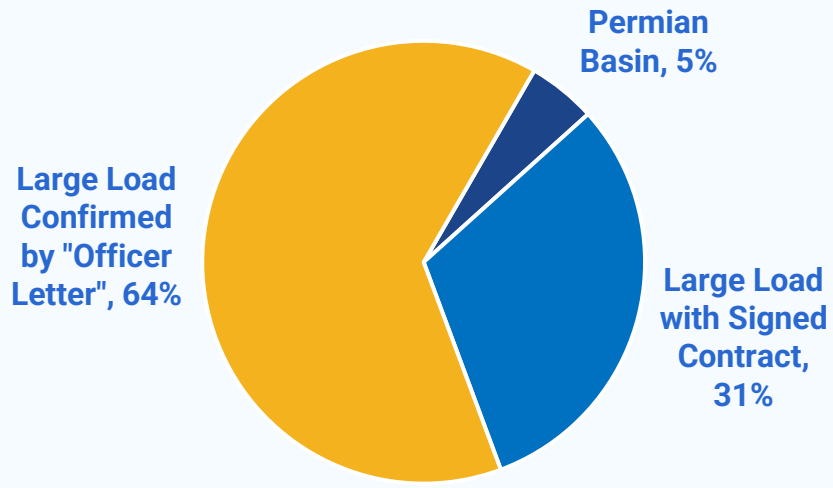
Although ERCOT filed a 2029 summer peak forecast of 88.1 GW with FERC this year, new forecast methods suggest that **the Texas load forecast for 2029 is now about 125 GW**. This is driven heavily by growth on the Oncor system, which has received 103 GW of new load requests, including 82 GW from new data centers.

The update was developed in two steps. First, ERCOT identified 52.7 GW in 2029 load growth. This includes about 6 GW of base system growth, 28 GW for new data centers (including crypto), and 18 GW for hydrogen and other industrial projects. This figure includes large loads without a signed contract, but with an "Officer Letter," as required by recent Texas legislation. The letters from transmission owners identify high-confidence loads where a customer shows interest and competence in developing its project.

Second, ERCOT includes 50% of "Officer Letter" loads in its forecast. Grid Strategies estimates that this reduces the mid-year forecast of 141 GW to 125 GW, reflecting an **increase of 36.9 GW over the as-filed forecast**.

ERCOT's new forecast will likely result in billons of dollars in transmission construction projects over the next five years. For example, a 500 MW hydrogen plant in Baytown, TX was recently studied and will require $142 million in transmission upgrades ($26 million paid by the customer). ERCOT is now receiving requests from individual customers with new loads as large as 4 GW.

ERCOT Sources of Large Load Growth Estimates



SOURCES | ERCOT, 2024 RTP Load Review Final Update (April 2024).
ERCOT, 2024 ERCOT System Planning Long-Term Hourly Peak Demand and Energy Forecast Mid-Year Update (July 2024).
ERCOT, 2024 Long-Term Load Forecast With Application of New Waterfalls, RPG Meeting presentation (August 13, 2024).
ERCOT, 2024 RTP Sensitivity Assumptions, RPG Meeting presentation (September 25, 2024).
CenterPoint Energy, Baytown Area Load Addition Project, RPG Meeting presentation (November 12, 2024).
Sempra, Third Quarter 2024 Earnings Results (November 6, 2024).

PJM

Unprecedented Data Center Growth

PJM member utilities have reported an increase of about 17 GW of large load demand through 2029 since PJM's last forecast.

PJM's 2029 forecast increased from 153.3 GW to 165.7 GW in the past two years, an 8.1% increase. However, since filing that forecast, PJM utilities have increased their forecast of large load additions for 2029 from 15 GW to 30 GW.

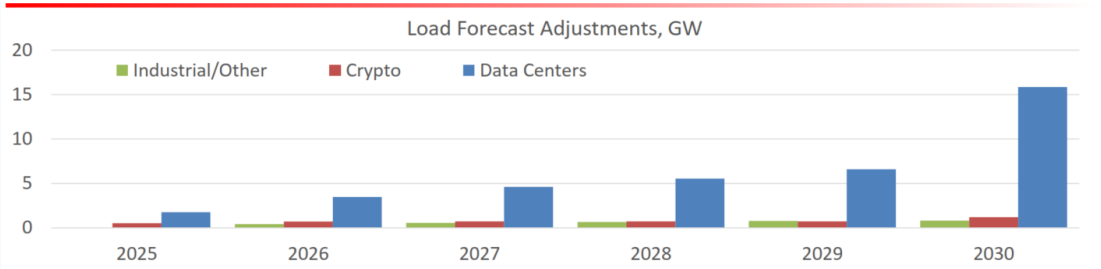
PJM has "observed unprecedented data center load growth" in multiple areas, with the potential for "all remnant capacity on the transmission system" to be utilized, resulting in regional reliability issues. In response, PJM plans to "identify necessary long-lead [extra-high voltage] reinforcements with sufficient time to construct."

While attention has focused on "Data Center Alley" in northern Virginia, served by Dominion Virginia, a similar amount of large load growth is forecast by utilities serving Pennsylvania, Ohio, and Indiana. Some of this growth in other areas is for manufacturing plants.

PJM's forecast also identifies about 5 GW of load growth due to electric vehicles and other factors.

AMERICAN ELECTRIC POWER

Forecast Adjustment Summary



Cumulative Additions (MW)	2025	2026	2027	2028	2029	2030
Appalachian Power	41	421	421	421	421	421
Indiana & Michigan Power	721	1,489	2,076	2,565	3,265	6,045
Kentucky Power	3	3	3	3	3	3
AEP Ohio	1,509	2,726	3,423	3,969	4,443	11,421
Total AEP	2,274	4,639	5,924	6,958	8,122	17,890

SOURCES | PJM, Enhanced Long Term Regional Transmission Planning (June 26, 2023).
PJM, 2024 Load Forecast Supplement (January 2024).
PJM, PJM Planning Load Data Needs (June 26, 2023).
PJM, Load Adjustment Requests Summary for 2025 Load Forecast - Preliminary (November 25, 2024).
AEP, 2024 Load Forecast Adjustments (October 25, 2024).

GEORGIA POWER

Large Load Forecast Grows Even Further

Georgia Power has reported an increase of about 3 GW in its large load forecast for 2029 since its last filing.

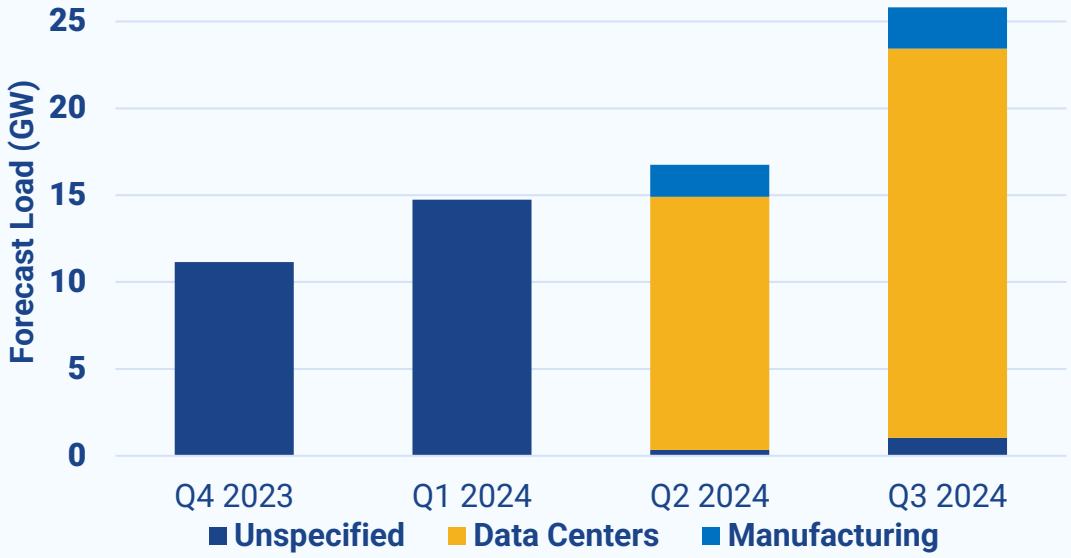
Georgia Power's 2029 summer peak forecast increased from 16.3 GW to 22.4 GW over the past two years, a 38% increase. This increase includes a 4 GW increase in Georgia Power's load forecast filed in late 2023 as part of an update to its integrated resource plan. Georgia Power filed the same late 2023 load forecast with FERC in 2024.

Georgia Power also reports on its large load "pipeline." Georgia Power now estimates 25.8 GW of new large loads in its pipeline for 2029. According to its reports, over 85% of the large load forecast is for data centers, with the remainder mostly manufacturing plants. Since filing its 2023 integrated resource plan, Georgia Power has reported an increase of almost 15 GW in its large load pipeline for 2029. It appears that Georgia Power includes about 50% of its 2029 "pipeline" load in its load forecast, suggesting that forecast load has increased by about 7.3 GW.

One controversial aspect of Georgia Power's large load forecast is that it is highly risk-adverse from the perspective of ensuring system capacity. By design, Georgia Power's load forecast has a 95% probability of being too high. This places high risk on customers who could bear the cost of unneeded generation and transmission investments.

Georgia Power's load forecast also indicates a significant amount of vehicle electrification, mainly in the heavy-duty vehicle class.

Georgia Power Large Load "Pipeline" for 2029



SOURCES | Georgia Power, 2023 Integrated Resource Plan Update (October 2023) and the Load and Energy Forecast Technical Appendix.
Georgia Power, Quarterly Large Load Economic Development Report (May 15, 2024, August 16, 2024 and November 18, 2024).
Georgia Public Service Commission Staff, Testimony of Trokey, Kelly and Pol, Docket No. 55378 (February 15, 2024).

MISO

Large Region with Relatively Low Growth

The MISO planning area's 2029 forecast increased from 132.4 GW to 138.4 GW over the past two years, a 4.6% increase. Compared to other planning areas, this increase is relatively low on a percentage basis. However, because MISO is so large, its total load growth increase is relatively large.

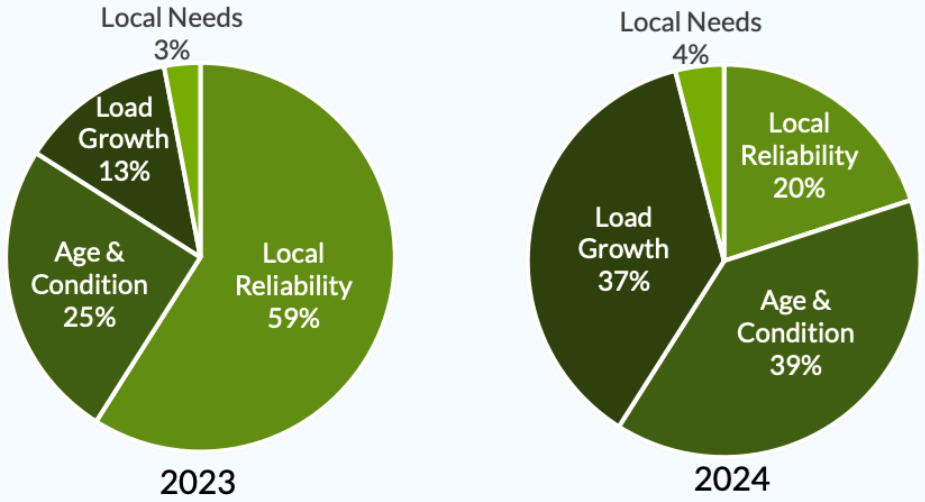
In its 2023 transmission planning cycle MISO approved a record setting $9 billion transmission expansion plan citing load growth as a driver of the increase and their draft 2024 plan includes even more projects to address load growth.

According to a draft version of MISO's upcoming load forecast update, data center load and transportation electrification are the main drivers of growth.

The forecast filed by MISO reflects members' self-reported load forecasts as completed in 2023. MISO is updating its load forecasting method with an anticipated release in December 2024. **Dependence on members' self-reported load forecasts may introduce a lag in the response of MISO's load forecast to the increased pace of load connections.**

MISO is an independent system operator that operates in 15 states from Minnesota to Louisiana. It has about 60 participating electric distribution utilities.

MTEP23 vs. MTEP24 Breakdown of Projects by Cost



SOURCES | MISO, MTEP 2023 (September 2024).
MISO, MTEP24 Report Preview (October 2024).

PACIFIC NORTHWEST UTILITIES

Regional Summaries: Load Growth Even Higher

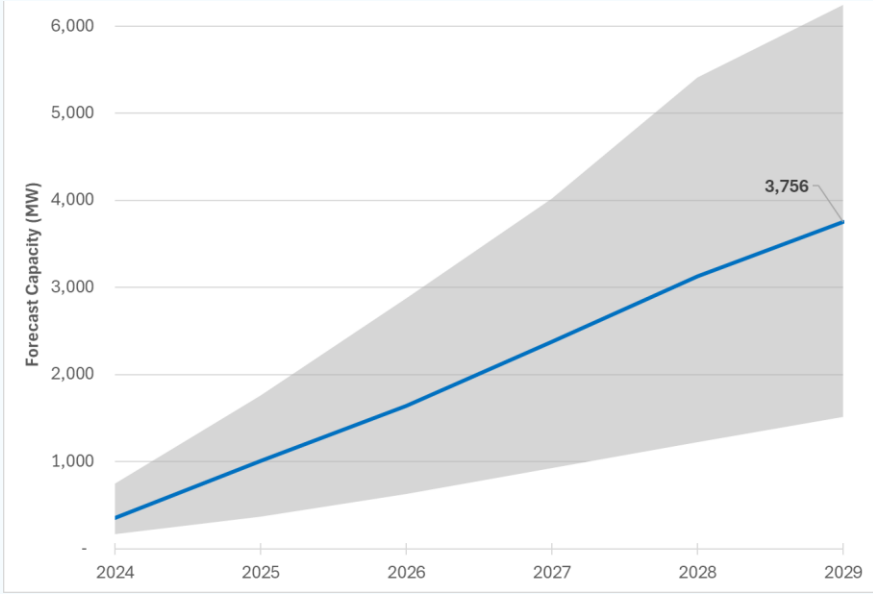
Reports suggest that utilities have identified another 2.5 to 4.2 GW of load growth.

The Pacific Northwest provides a good illustration of the uncertainty in forecasts of load growth related to data centers and manufacturing. Three regional organizations produce load forecasts for the same region (roughly Washington, Oregon, and Idaho but with portions of other states). In FERC filings, these utilities forecasted 3.1 GW of forecast load growth from 2024 to 2029. In comparison:

- **Bonneville Power Authority (BPA)** forecasts almost 3 GW of data center load growth, and less than 1 GW of load growth from other drivers.
- **Northwest Power and Conservation Council (NWPCC)** forecasts data center and chip fabrication plants to have potential load growth of 1.5 to 6.2 GW between 2024 and 2029, with a "mid" estimate of 3.8 GW.
- **Pacific Northwest Utilities Conference Committee (PNUCC)** forecasts load growth (from all sources) of 5.5 GW.

These reports suggest that utilities have identified another 0.7 to 2.4 GW of load growth since their FERC filings – the data center growth portion is likely between 1 and 2 GW.

NWPCC Data Center and Chip Fabrication Plant Demand Forecast



SOURCES | BPA, BPA Loads Presentation (March 12, 2024).
NWPCC, BPA Loads Presentation (March 12, 2024).
PNUCC, Northwest Regional Forecast of Power Loads and Resources (May 2024).

SPP

Load Growing Beyond Recent Forecasts

SPP does not collect information about the individual drivers of its load forecast from its members.

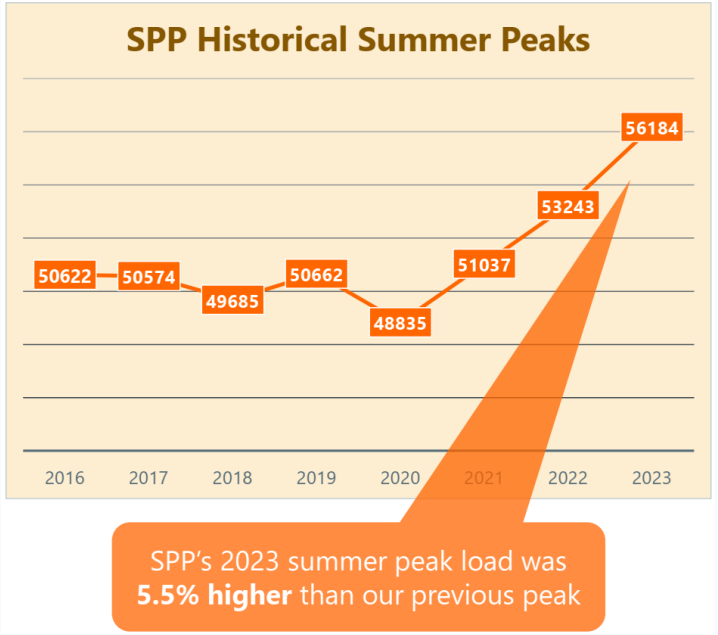
SPP's load forecast has increased by over 10% over the past two years, and in 2022 and 2023 under-forecast load for the first time since SPP began tracking forecast accuracy in 2017. SPP's 3.4% under-forecast in 2023 was its largest error other than the pandemic-influenced over-forecast in 2020.

Challenges to SPP's load forecast are associated with its role as a multi-state transmission organization. Load forecasts are developed by its member utilities, using a variety of methods and schedules. Case in point, the 2024 Transmission Plan is based on a 2022 load forecast, with some inputs created even further back depending on each member utility's schedule.

Another challenge is that SPP does not collect information about the individual drivers of its load forecast. For example, while SPP is informed about the size and location of "spot loads," a member's load forecast does not state whether the load is a data center or some other type of facility.

Industry data indicates that drivers of SPP's load forecast are oil and gas production (New Mexico, North Dakota) and data centers (Oklahoma and Missouri).

However, because new large loads have been constrained by limited generation capacity, SPP is creating a "provisional load service." This new process will allow for sequencing of transmission studies with utility provisioning of new generation.



SOURCES | SPP, 2024 Integrated Transmission Planning Assessment Report (Draft v. 0.6, October 7, 2024).
SPP, 2023 Post-Season Analysis (August 21, 2024).
SPP, SPP Regional Load Forecasting Strategies (April 17, 2024).
SPP, Provisional Load Process Proposal (October 15, 2024).
Wood Mackenzie, What Does the Future of Growth Look Like for SPP? (September 24, 2024).

New York (NYISO)

Near-Term Growth Offset by Efficiency

NYISO has received 890 MW of load requests from several data centers and two hydrogen plants with proposed in-service dates prior to 2026.

New York's 2029 peak load forecast increased from 31.5 GW to 32.3 GW in the past two years, a 2.8% increase. However, this modest growth conceals 2.8 GW in projected new large loads and electrification. These growth drivers are largely offset by forecast energy efficiency impacts.

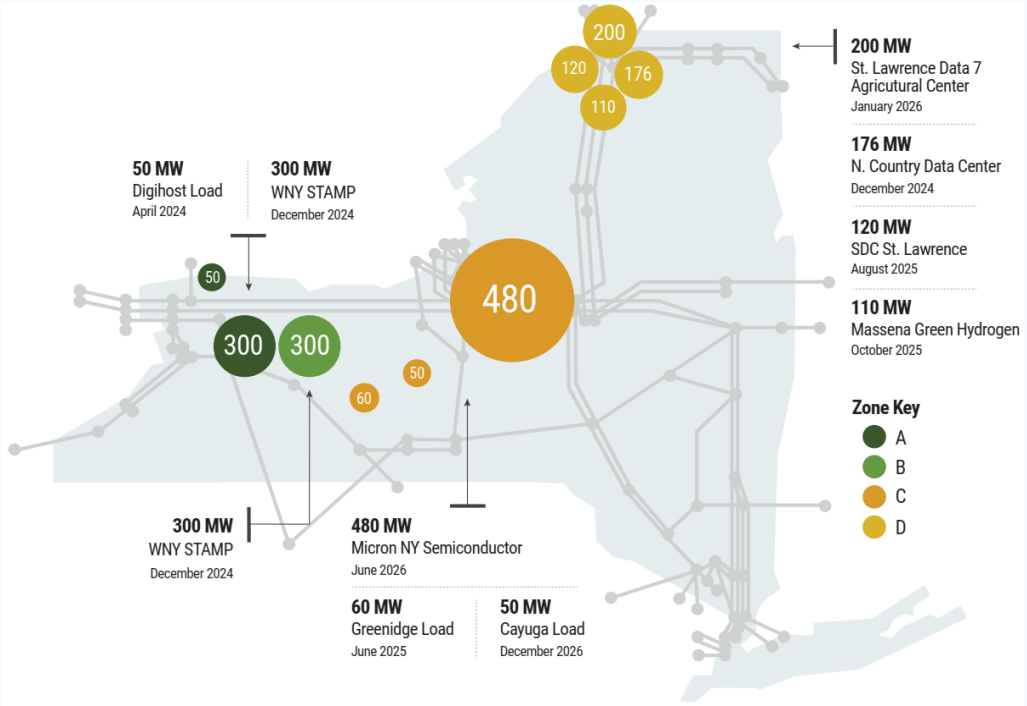
Currently, New York's annual peak occurs in the summer. However, by 2035 NYISO expects to shift to winter peaking. Its winter peak forecast is driven by a much stronger impact of building electrification due to plans to electrify space heating.

In contrast to other regions with substantial new large loads, NYISO does not forecast gigawatt-scale data center load growth. However, New York is planning for a 480 MW semiconductor manufacturing plant as well as other smaller non-data center loads.

New York's load forecast is prepared by NYISO, an independent system operator comprised of about 17 investor-owned and public utilities in New York. Prior to its 2023 forecast, the NYISO did not specifically identify "large loads" as a load forecast driver.

Large load project forecasts are subject to change. Notably, one hydrogen plant included in the 2023 forecast has been cancelled, but that load addition has been more than offset by other manufacturing and data center loads.

Large Load Projects Forecast in New York (1.8 GW illustrated)



SOURCES | NYISO, *2024 Load & Capacity Data* (April 2024). NYISO, *2024 Power Trends* (June 2024).

Appendix

Growth Rates Increasing Almost Everywhere

From 2022 to 2024, the 5-year national forecast for peak demand increased each year, with annual growth almost tripling from 0.6% to 1.6%. Including forecast updates (obtained from fast-growing planning areas), the national forecast now reflects a 3.0% annual growth rate.

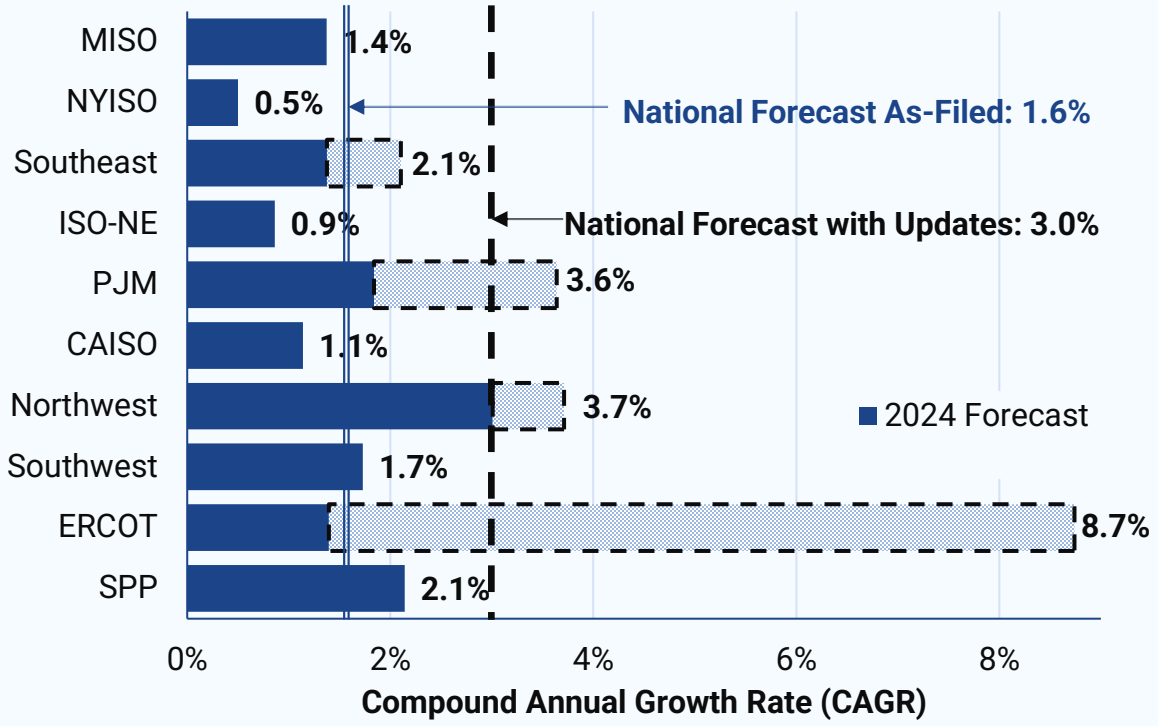
Annual growth rates are measured using the Compound Annual Growth Rate (CAGR). The CAGR represents the rate at which the initial load forecast or current load needs to grow annually to match the forecasted load in the final year assuming an annually compounded growth rate.

CAGRs can be useful to compare forecasted load growth of different utilities regardless of the size of the utility.

Including the forecast updates, ERCOT is now forecast to grow at an astonishing 8.7% per year. ERCOT's official 2024 forecast was only 1.4% per year, but load growth included in so-called "officer letters" has driven the planning forecast well beyond those in other regions.

There were only two regions where the CAGR decreased in 2024 compared to the 2023 forecast – CAISO and ISO-NE. However, as discussed in the report, changes to both forecasts reflect revisions to economic and population growth expectations. In both regions long-term load forecasts still project significant load growth.

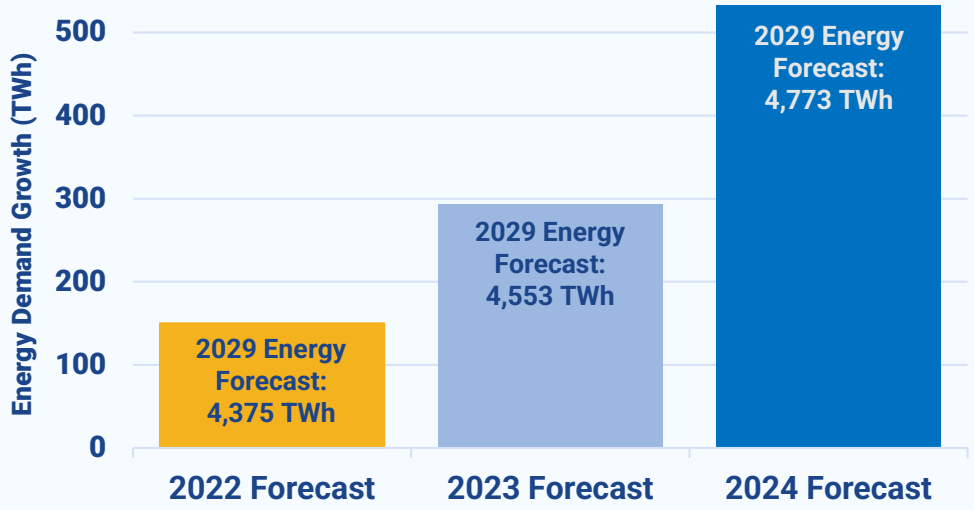
5-year CAGR Forecast (FERC Order No. 1000 Regions)



NOTE | The "Southwest" region includes some utilities that might be characterized as central western.

2024 National Energy Forecast

5-year Nationwide Energy Demand Forecast



The 2024 forecast's 5-year cumulative growth in base energy demand increases from 4,242 TWh in 2024 to 4,773 TWh in 2029. Comparing the 2022 FERC filings to 2024 FERC filings, forecasted base energy demand increases 398 TWh, more than tripling from 3.6% to 12.5% growth over the next five years.

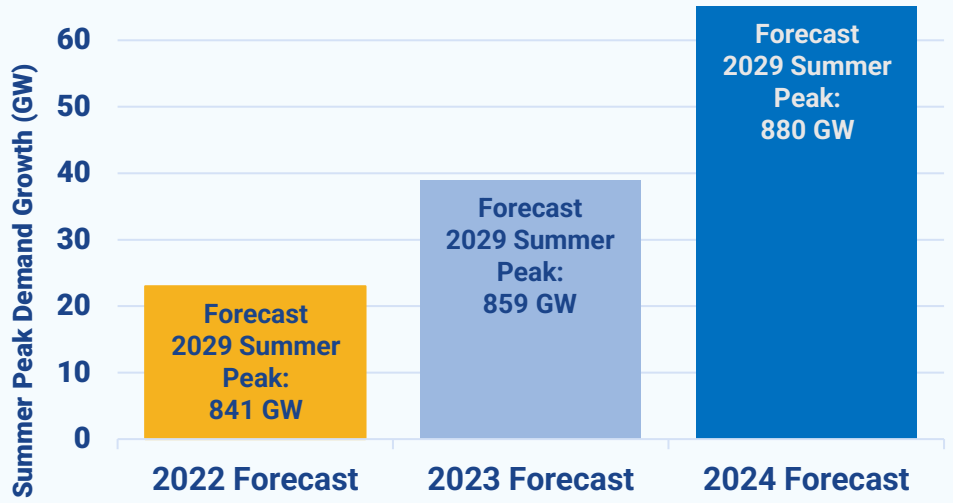
All data is sourced from FERC Form 714 filings, excluding more recent updates. The 2024 baseline varies across the forecasts.

Ten Planning Areas with Greatest Increase in 2029 Energy Demand

Planning Area	2022 Forecast (TWh)	2023 Forecast (TWh)	2024 Forecast (TWh)	2022 to 2024 Increase (TWh)	Percent Increase
PJM	826.4	867.8	933.1	**106.8**	12.9%
ERCOT	490.2	521.2	549.4	**59.2**	12.1%
MISO	691.5	696.8	750.0	**58.5**	8.5%
SPP	298.2	326.2	351.1	**52.9**	17.7%
Georgia Power	89.5	98.8	136.6	**47.1**	52.7%
Pacific Northwest	211.1	226.8	232.0	**20.9**	9.9%
Duke Energy Carolinas (DEC & DEP)	175.4	188.9	195.2	**19.8**	11.3%
NYISO	147.5	155.5	156.7	**9.1**	6.2%
Portland General Electric Company	23.8	30.4	30.9	**7.1**	30.0%
Central Electric Power Cooperative	21.4	21.7	26.8	**5.4**	25.4%
All other planning areas	1,384.4	1,402.7	1,392.8	**8.5**	0.6%
Total	**4,375**	**4,553**	**4,773**	**398.6**	**9.1%**

2024 Summer Peak Load Forecast

5-year Nationwide Summer Demand Growth Forecast



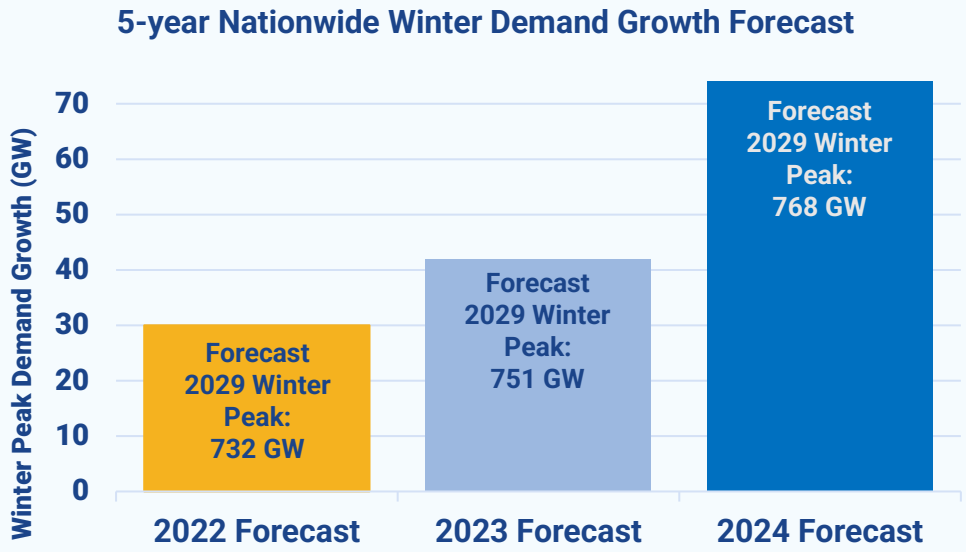
The 2024 forecast's 5-year cumulative summer peak demand increases from 813.5 GW in 2024 to 879.8 GW in 2029. Comparing the 2022 FERC filings to 2024 FERC filings, forecasted summer peak demand growth increases 39.3 GW, almost tripling from 2.8% to 8.1% growth over the next five years.

All data is sourced from FERC Form 714 filings , excluding more recent updates. The 2024 baseline varies across the forecasts.

Ten Planning Areas with Greatest Increase in Summer 2029 Peak Demand

Planning Area	2022 Forecast (GW)	2023 Forecast (GW)	2024 Forecast (GW)	2022 to 2024 Increase (GW)	Percent Increase
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 Carolinas (DEC & DEP)	33.9	36.2	36.6	**2.7**	7.8%
Arizona Public Service Company	8.7	9.8	9.9	**1.2**	13.6%
Pacific Northwest	37.4	38.4	38.5.2	**1.1**	2.9%
NYISO	31.5	32.3	32.3	**0.9**	2.8%
Tennessee Valley Authority	31.8	32.4	32.5	**0.7**	2.2%
All other planning areas	251.2	250.5	249.5	**-1.7**	-0.7%
Total	**840.5**	**858.9**	**879.8**	**39.3**	**4.7%**

2023 Winter Peak Load Forecast



The 2024 forecast's 5-year cumulative winter peak demand growth increases from 694.2 GW in 2024 to 767.9 GW in 2029. Comparing the 2022 FERC filings to 2024 FERC filings, forecasted summer peak demand growth increases 35.8 GW, almost tripling from 4.3% to 10.6% growth over the next five years.

All data is sourced from FERC Form 714 filings, excluding more recent updates. The 2024 baseline varies across the forecasts.

Ten Planning Areas with Greatest Increase in Winter 2028 Peak Demand

Planning Area	2022 Forecast (GW)	2023 Forecast (GW)	2024 Forecast (GW)	2022 to 2024 Increase (GW)	Percent Increase
ERCOT	69.3	77.4	81.3	**12.0**	17.32%
PJM	139.3	139.9	149.8	**10.5**	7.55%
SPP	46.5	49.7	52.8	**6.3**	13.65%
Georgia Power	15.8	16.9	20.6	**4.8**	30.40%
MISO	110.3	111.8	114.5	**4.3**	3.87%
Duke Energy Carolinas (DEC & DEP)	35.8	36.5	37.0	**1.2**	3.42%
Associated Electric Cooperative	4.6	5.1	5.5	**0.9**	19.79%
Nevada Power Company	3.5	4.2	4.2	**0.7**	20.17%
Xcel Colorado	6.7	7.2	7.3	**0.6**	9.41%
Pacific Northwest	39.1	39.6	39.5	**0.4**	1.00%
All other planning areas	259.2	260.6	253.0	**-6.2**	-2.38%
Total	**732.2**	**751.2**	**767.9**	**35.8**	**4.88%**

What's in a Load Forecast?

Counterintuitively, there can be more than one reasonable load forecast for the same region and the same year. This is because load forecasts are developed for different purposes.

As shown at right, MISO's reliability load forecast uses an average year with only committed customer load. Yet its long-term planning forecast includes additional projections and trends. Often, long-term transmission planning forecasts consider less probable, extreme load conditions such as a 1-in-10 peak demand forecast.

Perhaps the most dramatic illustration of judgement calls that are currently confronting the power industry is the decision in Texas to include large loads – without a contract – based on an "officer letter" from the transmission system owner. Currently, ERCOT discounts load identified in "officer letters" by 50% for its long-range planning purposes.

This report generally focuses on average year load forecasts as submitted to FERC or as updated in public documents by either a utility or a regional transmission planning organization.

SOURCES | MISO, MTEP 2023 (September 2024).
ERCOT, 2024 RTP Sensitivity Assumptions, RPG Meeting presentation (September 25, 2024).

Sources and Methods

The primary source for the load forecasts in this report is data filed by planning area authorities on FERC Form 714. The most recent data were published by early fall 2024. Grid Strategies added forecast updates for four fast-growing regions to the FERC Form 714 forecasts. Each of the four updates represents Grid Strategies' best estimate of the forecast update that would be applied today if the planning area published an updated forecast – none of the four updates have been officially finalized.

While Grid Strategies reviewed numerous utility and planning area forecast documents, we may not have located every publicly available update.

Data filed on FERC Form 714 require significant effort to obtain and interpret correctly. Grid Strategies appreciates the assistance of Catalyst Cooperative in making recent FERC 714 data available in an accessible format. Because FERC does not appear to review load forecast data filed on Form 714 for accuracy, numerous errors – such as reporting data using the wrong units – are apparent in the planning areas' filings.

Another challenge is that some planning areas are included within other planning areas. Including "sub-areas" in regional and national totals would effectively double-count some loads. Since FERC does not publish an official rollup of area data that addresses this issue, Grid Strategies staff used professional judgement to avoid such double-counting.

Many, but not all, planning areas make information on their load forecasts publicly available. Cited load forecast or related materials were obtained from publicly available sources. For most planning areas discussed in this report, Grid Strategies staff reached out to load forecast experts at the relevant utility or system operator to request further detail.

Grid Strategies chose to focus mainly on summer peak demand data in this report for two reasons. First, peak demand is most closely related to the need for transmission system buildout. Second, summer peak demand is larger at the national level. Focusing on summer peak demand may obscure important planning issues related to winter peak demand and overall energy resources. When considering the load forecast of any region or utility, Grid Strategies would take a more expansive view.