U.S. National Power Demand Study

Executive Summary
March 2025

The Following Study from S&P Global Commodity Insights was commissioned by

The American Clean Power Association (ACP), with the support of its partners: the American Petroleum Institute, Alliance to Save Energy, Clean Energy Buyers Association, Nuclear Energy Institute, the U.S. Chamber of Commerce, and the National Electrical Manufacturers Association.

S&P Global
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CI Consulting

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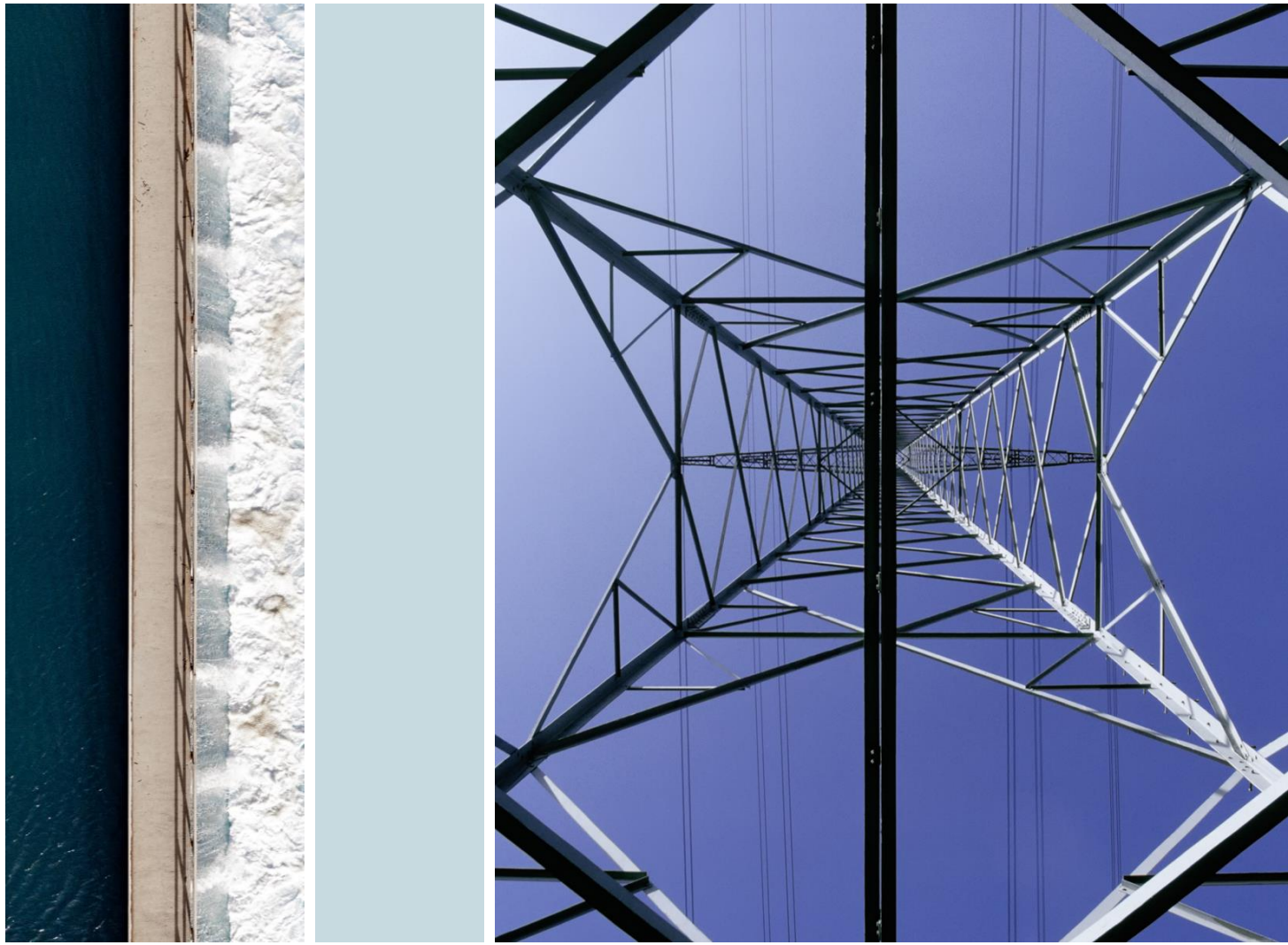
– Executive Summary

Electricity Demand Returns to Growth

Prepared for The American Clean Power Association (ACP)

March 7, 2025



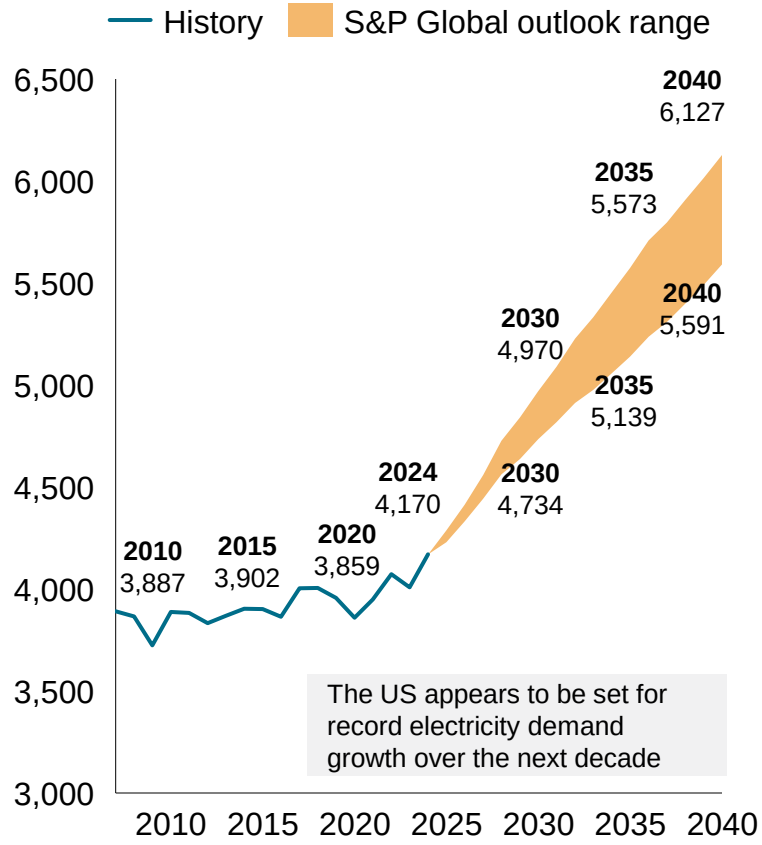
After two decades of nearly stagnant power demand, growth has returned to the sector

Key takeaways from the US National Power Demand Study

- Sustained power growth through 2040 is driven by manufacturing and data centers in the near-term, and electrification of heating and transportation in the long-term. General economic and population growth underpin the outlook along the way
- The next five years pose a major risk of supply and demand imbalance, as datacenter buildout is expected to go through major development, while near-term supply response is constrained. Load flexibility and co-location stand out as the few options to help meet rising demand in the short-term
- The supply pathways involve renewables providing the bulk of energy volume, while natural gas-fired capacity and other firm resources like batteries will be critical to provide capacity and balancing support
  - By 2040, the US will require net additions of between 60 and 100 GW of gas, and over 900 GW of renewables and batteries, while continuing to support energy efficiency savings remain essential to maintain reliability
  - All current generation technologies face differing challenges in deployment, and load profiles across the grid are diverse, therefore, a diversified portfolio of generation technologies will be needed to ensure planning reserve margins are met and grid reliability is maintained.
  - Additionally, there is a role for clean firm technologies not currently deployed at scale (advanced nuclear and geothermal), especially if carbon emission mitigation is prioritized
- Significant challenges remain to quickly bring online large amounts of generation, as the supply response is constrained by outdated interconnection processes, local opposition, siting/permitting delays, ongoing challenges in developing economic transmission projects, supply chain constraints, and other limitations to deploying energy delivery infrastructure
  - Thoughtful policy reforms and a diversified supply response portfolio will be needed to reduce the demand/supply tension
- The stakes are high. Successfully navigating these challenges will unlock economic growth (e.g., generative AI) and efficient, lower carbon emission trajectories for the sector. Electricity supply shortfalls in the near term could translate into longer-term missed economic opportunities.

US Lower 48 net on-grid electricity demand

TWh



Source: S&P Global Commodity Insights

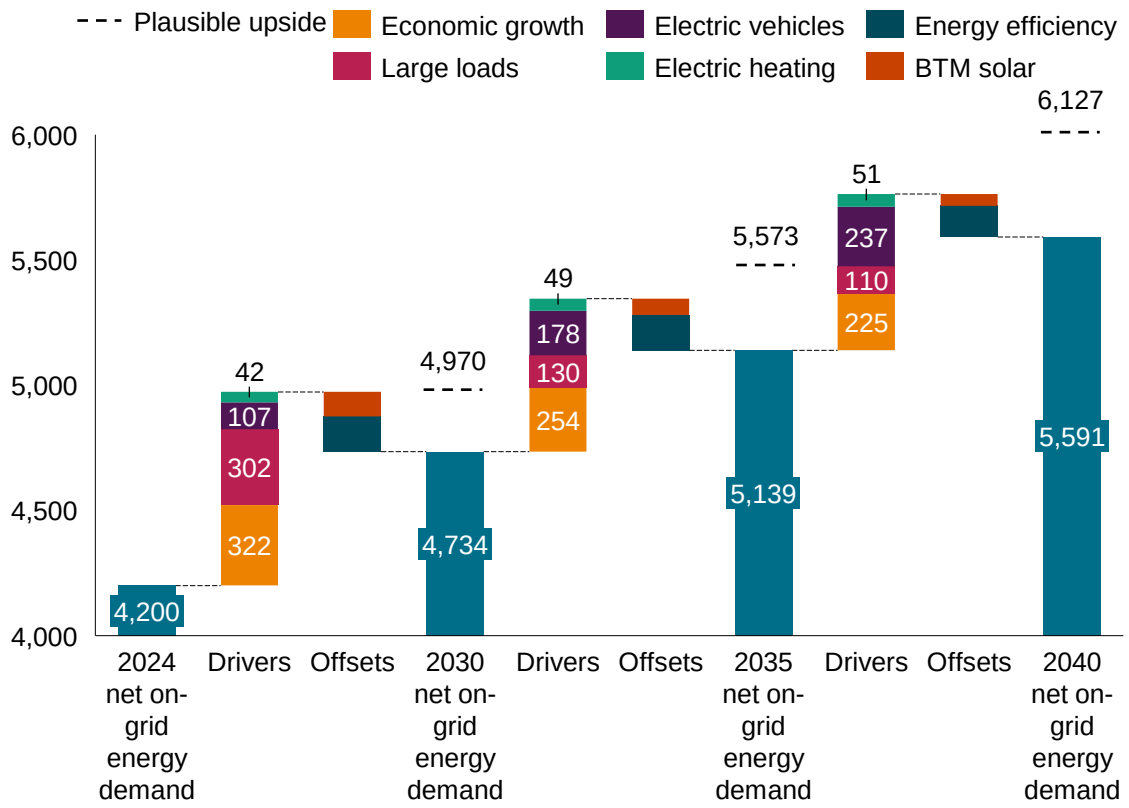
The diversity of sequential demand drivers provides confidence that this growth will be maintained into the future

The next decade demands more new electricity than any ten-year period in the nation's history

- Between 2024 and 2040, electricity demand in the US is expected to grow by 35-50% driven by a combination of underlying economic growth, large industrial loads like datacenters and manufacturing, and the electrification of transport and heating
- The diversity of drivers and sequence of some of the major drivers point to sustained growth in the sector
  - Growth in large industrial loads is particularly important into the early 2030s
  - A trend towards electrification has already begun but is expected to accelerate significantly by the mid 2030s
- The heterogeneous load profiles emerging from evolving demand drivers emphasizes the need for a diversified generation portfolio to sustain grid reliability and resilience
- Regional considerations are also significant as the increase in demand, especially now through the early 2030s, is likely to be concentrated in the Eastern Interconnection and Texas, whereas demand growth in the latter half of the study is expected to be more disperse, following concentrations of population

Drivers and offsets of growth in US Lower 48 net on-grid electricity demand, 2024–40

TWh



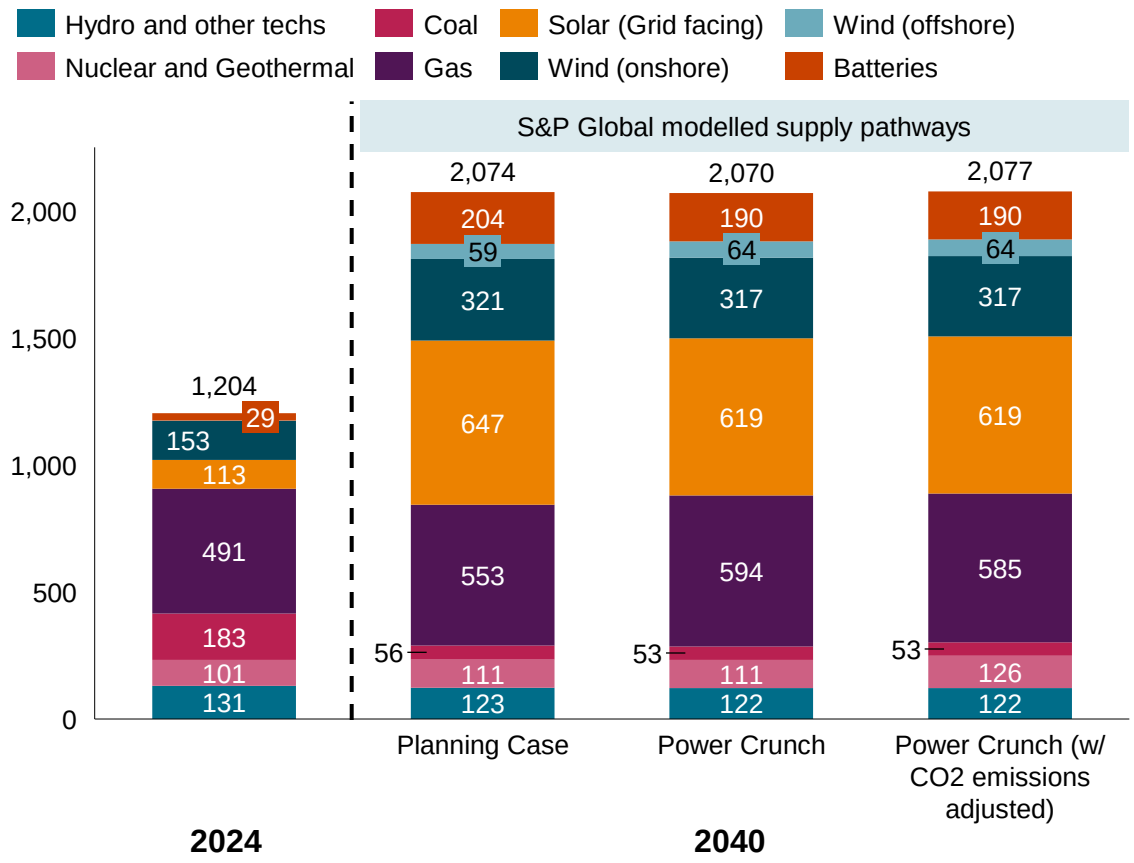
Economic growth is based on an econometric model that uses economic and demographic inputs. Energy efficiency reflect cumulative incremental growth relative to 2024.
Large load includes large industrial load (datacenters and manufacturing) and large flexible load (electrolyzer and cryptocurrency mining).
Source: S&P Global Commodity Insights

US nameplate capacity is projected to almost double over the next 15 years in three examined supply pathways

- This study is built around three S&P Global cases: (1) Planning Case, (2) a case with faster demand growth and increased supply constraints, and (3) and a variation on the second case where more clean firm capacity is added
- Adding above 900 GW to the supply mix through 2040, renewables and batteries are by far the main source of supply in all three cases on a nameplate basis given their availability, low-cost, preference from consumers, and policy support
  - However, the ability of renewables and batteries to respond to new demand growth is constrained by siting and permitting barriers
- New firm capacity resources are required to meet peak demand growth, as older, less efficient fossil fuel-fired generation capacity is projected to be retired
  - Natural gas-fired generation capacity grows by 60 GW, supporting growing loads and providing needed capacity to balance intermittent resources
  - Deployment of gas-fired generation faces constraints, however, as the equipment supply chain adjusts to increased demand and gas delivery infrastructure bottlenecks are addressed. This pushes substantial new growth of unplanned natural gas plants to early next decade
  - 40 GW of additional gas could be needed with further constraints on the ability to build renewables and higher than expected load growth
- Advanced nuclear and other clean firm technologies remain an important part of the resource mix. A stronger emphasis on emissions reductions or a constrained ability to build renewables is expected to increase the role of nuclear, though the technology will not be ready at scale until next decade
- Other tools like demand response, load flexibility, and energy efficiency remain essential to meet and manage peak requirements

Operating/nameplate capacity (all technologies), US Lower 48

GW



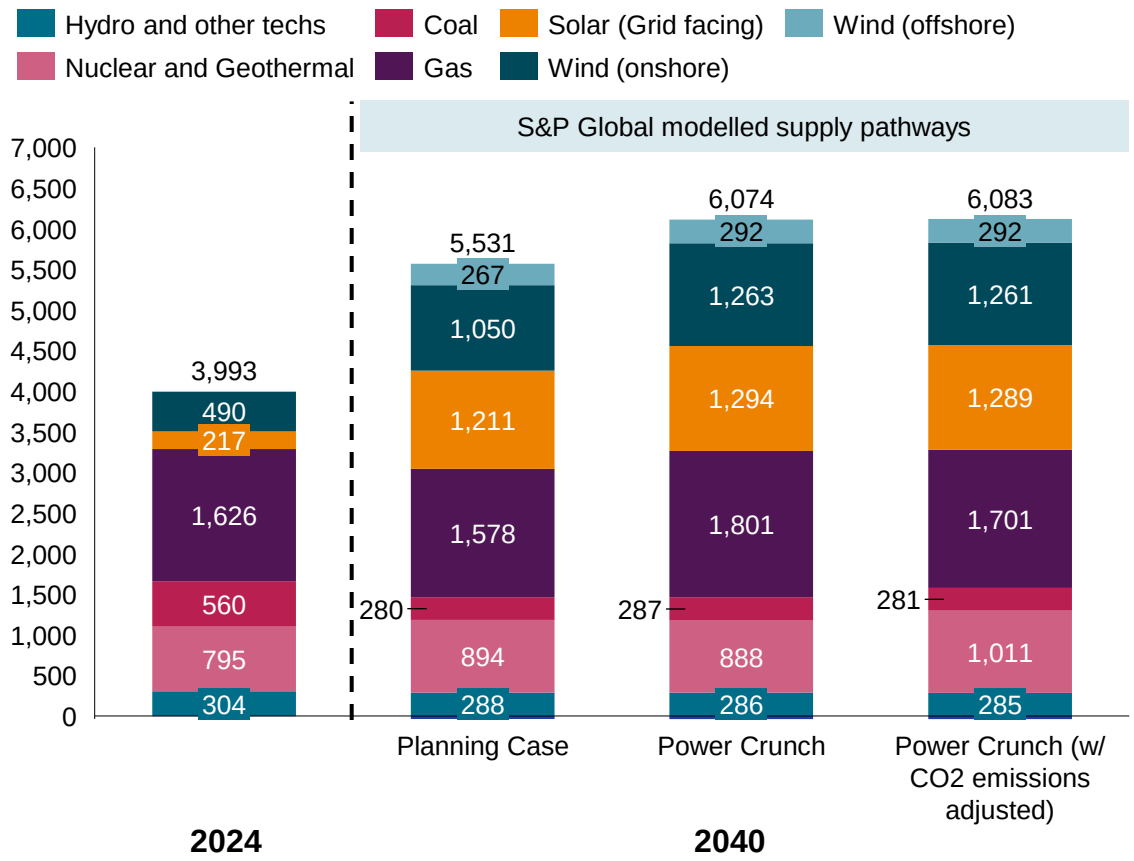
Other technologies include Oil, Geothermal, Biomass and Pumped Storage.
Source: S&P Global Commodity Insights

Under three different supply pathways to 2040, the US generation mix is a balanced portfolio of renewables, clean firm power, and natural gas-fired generation

- **Renewables combine to reach almost half of total generation**
  - As the primary driver of new energy supply, wind and solar combined become the main source of generation in the US
  - In the Power Crunch case, developers respond to persistent challenges with siting and permitting new projects by accelerating plans to repower existing facilities. This helps to offset restrictions and support a modest growth of generation
- **Natural gas-fired generation remains around current levels through the outlook**
  - As load grows and coal generation decreases, natural gas-fired generation holds mostly steady through 2040
  - Additional upside of around 200 TWh in the Power Crunch case, due to higher load and constrained onshore renewables
- **Clean firm technologies have an essential role in the mix**
  - Through advanced nuclear and geothermal they see a modest increase of around 100 TWh by 2040
  - The added capacity in the Power Crunch (w/ CO2 emissions adjusted) case results in an additional 120 TWh by 2040

Generation (all technologies), US Lower 48

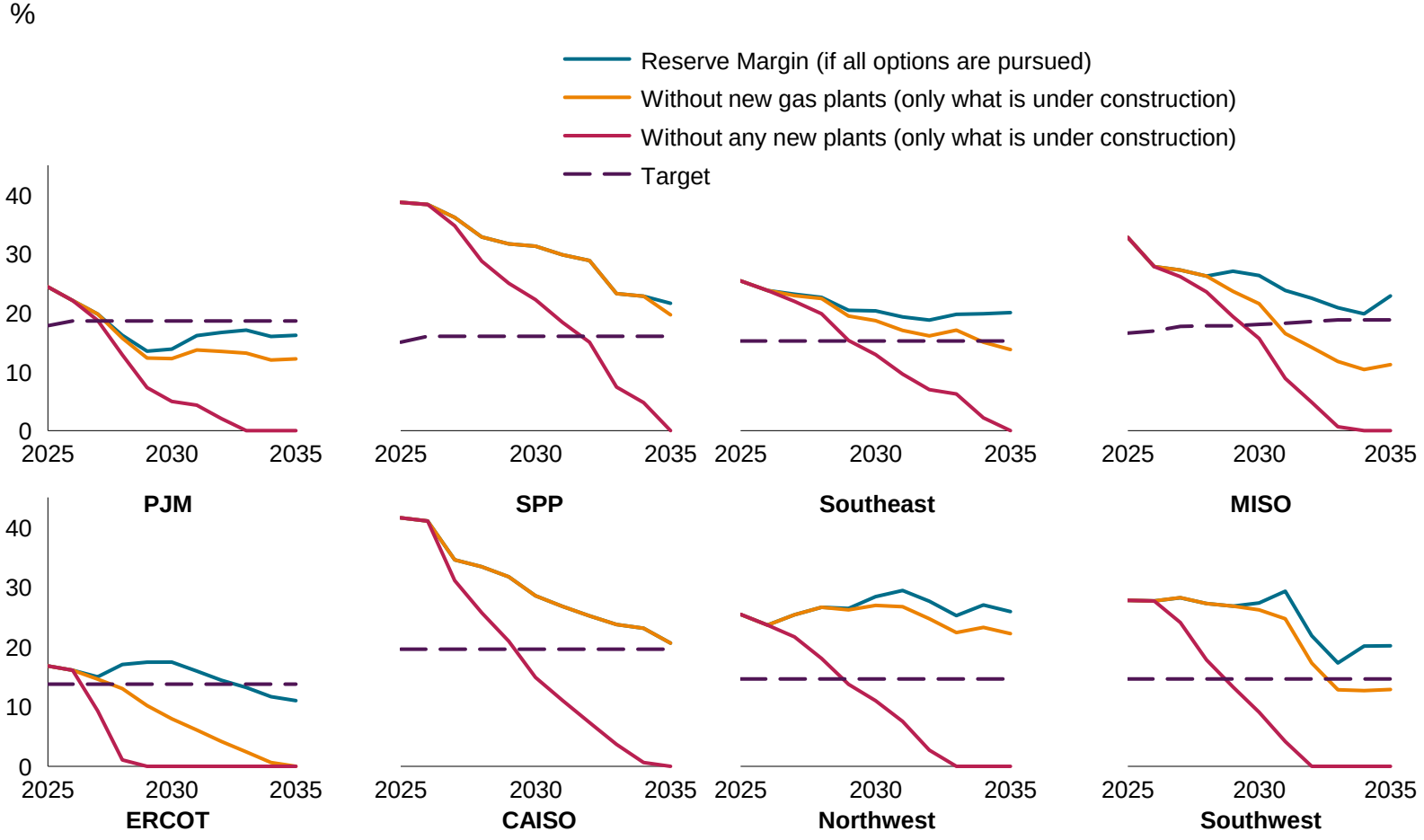
TWh



Other technologies include Oil, Geothermal, Biomass and Pumped Storage.
Source: S&P Global Commodity Insights

Renewables, battery energy storage, and gas-fired capacity build beyond what is under construction are required to meet planning reserve margin targets

Planning reserve margins by market



1. The target reserve margin is typically calculated with a 0.1 Loss of Load Events (LOLE) per year criterion

Source: S&P Global Commodity Insights

- The top priority for any electric system planner, market designer, or operator is maintaining reliability, with the primary benchmark being the planning reserve margin[1]
  - The planning reserve margin represents a buffer of excess capacity expected to be available to generate power during reliability-critical hours
  - A key challenge is balancing reliability, long-term economics, and other policy objectives
- In an era of rapidly rising demand and renewable additions, many of the processes that were put in place to maintain reliability in the past (the structure of interconnection queues and system studies, static transmission line ratings, transmission expansion planning, siting and permitting, and more) are ripe for reform

Large loads concentration in PJM and ERCOT

- Reserve margins in most markets stay above target in the short-term, however, PJM and ERCOT combine for above half of the planned large industrial load growth. These two markets face a major risk of demand and supply imbalance over the next five years

However, the response of new supply to quickly address demand growth is challenged by several factors

- With a broad consensus about continued near-term demand growth, there are pressing questions about how to meet this new demand while maintaining reliability
  - These questions arise amid uncertainties about the long-term trajectory of rapid demand growth and the challenges of building supply against the backdrop of often conflicting policy, economic, and reliability considerations
- Gas additions have seen a surge in interest but given how additions were at a two-decade low in 2024, the industry faces challenges to quickly ramp up supply chains. Some coal retirement delays are likely, but technical and regulatory limits will prevent some coal plants from remaining online much longer
- Battery energy storage has the potential to expand quickly, but battery project economics are exposed to ongoing changes in capacity and ancillary markets
- Other technologies like advanced nuclear and geothermal have long lead times, reducing their relevance to addressing the coming power supply crunch
- The increasing difficulty, in nearly every jurisdiction, around siting, permitting and getting projects through interconnection queues adds uncertainty to the deployment of new generation projects
  - Local opposition has emerged as a major risk to the cost and pace of renewables deployment
  - As transmission grids run out of spare capacity, the network upgrades required to interconnect new projects tends to rise. This has created significant cost uncertainty for developers, adding to their incentive to submit speculative projects
- Transmission development will also be key to supporting grid reliability – but without major reforms the lack of new transmission expansion projects could turn into a significant barrier, particularly after 2030

Selected recent transmission and interconnection reforms and updates

Level	Description
FERC	▪ **Order 2023:** reform processes used by transmission providers to study and connect generating facilities, including a "first ready, first served" approach, which groups projects by location and queue dates. ▪ **Order 1920:** requiring all transmission providers to conduct long-term planning — a minimum of 20 years into the future — to ensure adequate transmission capacity is planned to reflect changes in future demand and supply.
ISO/RTO	▪ **MISO:** Increase milestones payments, automatic withdrawal penalty; cap on total queue size ▪ **CAISO:** Prioritize requests where transmission system has available existing or planned capacity ▪ **PJM:** First-ready, first-served clustered cycle approach, grouping projects into three-phase cluster cycles for interconnection costs studies and allocations ▪ **ERCOT:** “Connect and manage” approach to interconnecting new resources; Interconnection cost cap (HB 1500)

Although these reforms aim to alleviate backlogs, it is unclear if they will have a major impact for near-term supply response. Additionally, local opposition remains as a major risk that is difficult to address

Note: FERC orders do not apply to ERCOT, non-FERC-jurisdictional utilities, and vertically integrated utilities in non-FERC-jurisdictional states
Source: Lawrence Berkeley National Laboratory: Queued Up 2024 Edition, S&P Global Commodity Insights

Adding supply to meet surging electricity demand growth is challenging, but policy options exist that could make it easier

Optimize interconnection study process

- Standardize interconnection study process across ISO/RTOs
- Employ cluster studies where multiple interconnection requests are grouped together and studied collectively rather than individually
- Shift some of the responsibility for conducting interconnection studies from RTO/ISOs to developers
- Employ digital technologies/AI to expedite interconnection studies

Improve interconnection access and flexibility

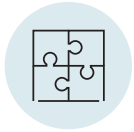
- Increase transparency on queue position, project ownership, location, and size
- Delink interconnection from deep network upgrade decisions
- Allow generators to initially gain ERIS access, but later obtain NRIS access
- Offer educational resources for stakeholders to better manage risks

Explore co-location of supply with large loads

- Expedite approvals for projects that integrate generation and large loads on the same site
- Support microgrids and off-grid solutions to serve large loads

Prevent speculative behavior in the queue

- Charge upfront interconnection entry fees commensurate with likely upgrade costs and project size
- Require developers to demonstrate capability in executing the proposed project
- Introduce penalties for withdrawal from the queue
- Introduce a mechanism to remove nonviable projects from the queue



Conduct grid upgrades

- Improve reporting on the transmission project construction phase
- Reduce supply chain bottlenecks for key equipment
- Streamline permitting and siting for high-voltage, long-distance transmission lines

Enhance energy efficiency as a grid resource and strengthen demand-side management to reduce grid strain

- Use fast track processing for flexible and high-efficiency loads
- Incentivize load flexibility and demand response capabilities for large loads

NRIS = Network Resource Interconnection Service. ERIS = Energy Resource Interconnection Service.

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