

Chapter 15: Data Centers and Power

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13 System Hardware & Components. Nvidia · Accessed 9 September 2026 [\[A\]](https://docs.nvidia.com/enterprise-reference-architectures/nvl72-ai-factory/latest/components.html) docs.nvidia.com/enterprise-reference-architectures/nvl72-ai-factory/latest/components.html

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15 OpenAI Stargate: where the US sites stand. Epoch AI · 17 April 2026 [\[A\]](https://epoch.ai/publications/openai-stargate-where-the-us-sites-stand) epoch.ai/publications/openai-stargate-where-the-us-sites-stand

9 Large Power Transformers from South Korea, Investigation No. 731-TA-1189 (Second Review), Publication 5531. U.S. International Trade Commission · August 2024 · p. 90 [\[A\]](https://www.usitc.gov/publications/701_731/pub5531.pdf#page=90) www.usitc.gov/publications/701_731/pub5531.pdf#page=90

21 GE Vernova Inc., Form 8-K current report for the period ended 2026-07-22 (8-K). U.S. Securities and Exchange Commission (filing by GE Vernova Inc.) · 22 July 2026 [\[A\]](https://www.sec.gov/Archives/edgar/data/1996810/000199681026000147/gevpressrelease2q26.htm) www.sec.gov/Archives/edgar/data/1996810/000199681026000147/gevpressrelease2q26.htm

Data Centers and Power

By mid-2026, Texas had requests to connect about 474 GW of new demand, mostly data centers, but only about 205 GW had the engineering studies to plan for it. The large transformers that connect such sites to the grid commonly took three years to arrive in 2024.

IN PLAIN TERMS

A data center feeds electricity to the machines inside it and carries away the heat they give off. One rack of AI chips, a cabinet taller than a door, can draw 142 kilowatts¹³. Every watt of it comes back out as heat, and liquid piped through the rack carries the heat away¹³. A large training site already holds more than a hundred thousand chips¹⁴. The newest sites are planned in gigawatts¹⁵. One gigawatt is the whole output of a large power station, and OpenAI's seven Stargate sites in the United States add up to more than nine of them by 2029¹⁵. Getting that much electricity to the site is harder than putting up the building. Transformers and heavy switches connect a site to the grid, and turbines make the power. All of them come from a few suppliers and take years to arrive.

¹³ System Hardware & Components. Nvidia · Accessed 9 September 2026 [\[A\] docs.nvidia.com/enterprise-reference-architectures/nvl72-ai-factory/latest/components.html](https://docs.nvidia.com/enterprise-reference-architectures/nvl72-ai-factory/latest/components.html)

¹⁴ Colossus 1, AI data centers directory. Epoch AI · Accessed 9 September 2026 [\[A\] epoch.ai/data/ai-data-centers/directory/colossus-1](https://epoch.ai/data/ai-data-centers/directory/colossus-1)

¹⁵ OpenAI Stargate: where the US sites stand. Epoch AI · 17 April 2026 [\[A\] epoch.ai/publications/openai-stargate-where-the-us-sites-stand](https://epoch.ai/publications/openai-stargate-where-the-us-sites-stand)

IN SHORT

Measured by capacity, US factories supplied 29.2 percent of the large power transformers bought in the US in 2023, and imports the rest ⁹. GE Vernova's gas equipment backlog and reserved factory slots stood at 116 GW in mid-2026, against planned output of 20 GW a year from the third quarter ²¹.

ERCOT, the grid operator for most of Texas, counted 9,456 MW of big power users approved to energize in its overview for September 2026 ³⁰. Judging by peak monthly use in September, it believed 4,132 MW of that was operating ³⁰. On 3 August 2026 Governor Greg Abbott ordered an audit of every data center seeking a connection before any data center project moves forward ³². In September 2026 ERCOT said it had paused approvals to energize data centers of 75 MW or more until the audit and a review of their impact on local communities are complete ³³.

9 Large Power Transformers from South Korea, Investigation No. 731-TA-1189 (Second Review), Publication 5531. U.S. International Trade Commission · August 2024 · p. 90 [\[A\]](https://www.usitc.gov/publications/701_731/pub5531.pdf#page=90)

21 GE Vernova Inc., Form 8-K current report for the period ended 2026-07-22 (8-K). U.S. Securities and Exchange Commission (filing by GE Vernova Inc.) · 22 July 2026 [\[A\]](https://www.sec.gov/Archives/edgar/data/1996810/000199681026000147/gevpresrelease2q26.htm)

30 Electric Reliability Council of Texas, ERCOT Monthly Operational Overview (September 2026). Electric Reliability Council of Texas · 16 October 2026 · p. 9 [\[A\]](https://www.ercot.com/files/docs/2026/10/16/ERCOT-Monthly-Operational-Overview-September.pdf#page=9)

32 Governor Abbott Directs Comprehensive Data Center Audit. Office of the Texas Governor · 3 August 2026 [\[A\]](https://gov.texas.gov/news/post/governor-abbott-directs-comprehensive-data-center-audit)

33 Electric Reliability Council of Texas, Item 14: Batch Zero Update, Board of Directors meeting, 14-15 September 2026. Electric Reliability Council of Texas · 11 September 2026 [\[A\]](https://www.ercot.com/files/docs/2026/09/11/14-Batch-Zero-Update.pdf)

CHOKEPOINT CARD		HIGH CONCENTRATION
		MODERATELY HARD TO SUBSTITUTE
CONCENTRATION	SUBSTITUTABILITY	PRICE OR MARKET SIZE
High	Moderate Nvidia named nine data center power system providers for its 800-volt gigawatt designs in October 2025 ¹ .	\$580 billion of data center investment expected worldwide in 2025, in the International Energy Agency's November 2025 outlook ²
WHO LEADS	US GE Vernova Gas equipment, transformers and switchgear, including through Prolec GE³ CH Hitachi Energy Power transformers and switchgear³ DE Siemens Energy Grid technologies, transformers, turbines³ JP Mitsubishi Power Power generation equipment, including gas turbines³ US Vertiv Data center power systems¹ FR Schneider Electric Cooling, through its Motivair division⁴	
WHERE IT IS MADE	US United States The largest data center operators, and GE Vernova turbines and grid equipment CH Switzerland Hitachi Energy transformers and switchgear, and ABB switchgear DE Germany Siemens Energy grid technologies and turbines JP Japan Mitsubishi Power equipment, including gas turbines	
WHY SUBSTITUTION IS POSSIBLE	Buyers of grid equipment can choose among suppliers, and GE Vernova's 2025 annual report names Hitachi Energy, Siemens Energy, Schneider Electric and ABB among its key competitors ³ . But in 2024 the longest large power transformer lead times reached 60 months ⁵ . An International Energy Agency survey published in 2025 found waits of up to four years worldwide ⁶ .	
WHERE CHINA STANDS	China used 25 percent of the world's data center electricity in 2024, second to the United States, by the International Energy Agency's estimate ⁷ . Data centers made up around 3 percent of the growth in China's electricity demand from 2022 to 2024 ⁸ .	WHERE THE US STANDS
		US factories supplied 29.2 percent of the large power transformers bought in the United States in 2023, measured by capacity ⁹ . Constellation said in August 2026 that it expects to restart the Crane nuclear plant in 2027 ¹⁰ . Microsoft has agreed to buy its power ¹¹ .

1 NVIDIA, Partners Drive Next-Gen Efficient Gigawatt AI Factories in Buildup for Vera Rubin. Nvidia · 13 October 2025 [\[A\]](https://blogs.nvidia.com/blog/gigawatt-ai-factories-ocp-vera-rubin)
blogs.nvidia.com/blog/gigawatt-ai-factories-ocp-vera-rubin

2 Executive summary – World Energy Outlook 2025. International Energy Agency · 12 November 2025 [\[A\]](https://www.iea.org/reports/world-energy-outlook-2025/executive-summary)
www.iea.org/reports/world-energy-outlook-2025/executive-summary

3 GE Vernova Inc., Form 10-K annual report for the period ended 2025-12-31 (10-K). U.S. Securities and Exchange Commission (filing by GE Vernova Inc.) · 29 January 2026 [\[A\]](https://www.sec.gov/Archives/edgar/data/1996810/000199681026000015/gev-20251231.htm)
www.sec.gov/Archives/edgar/data/1996810/000199681026000015/gev-20251231.htm

A wafer passes through a leading-edge fab in months, but in 2024 a large power transformer commonly took three years to arrive ⁵. Before the pandemic, the same order took under a year ¹².

How it works

The rack is the basic unit of AI compute. Nvidia's GB300 NVL72 rack draws up to 142 kW through eight 33 kW power shelves, the rack's own power supplies ¹³. Colossus 1, an AI data center in Memphis, Tennessee, held an estimated 230,000 Nvidia GPUs by July 2025 ¹⁴.

Between the grid and the rack, a substation steps the high voltage down with transformers. Switchgear, the building's heavy circuit breakers, can cut any part of the site off in a fault. Battery-backed supplies keep the racks running for the seconds it takes backup generators to start. Distribution boards split the feed among the rows of racks.

At the back of each rack, a busbar carries the current down to the server trays. It is a solid copper bar, because an ordinary cable would overheat at that current. Every piece of equipment from the substation to the busbar is heavy and has its own lead time, the wait between order and delivery.

3 GE Vernova Inc., Form 10-K annual report for the period ended 2025-12-31 (10-K). U.S. Securities and Exchange Commission (filing by GE Vernova Inc.) · 29 January 2026 [\[A\]](https://www.sec.gov/Archives/edgar/data/1996810/000199681026000015/gev-20251231.htm) www.sec.gov/Archives/edgar/data/1996810/000199681026000015/gev-20251231.htm

1 NVIDIA, Partners Drive Next-Gen Efficient Gigawatt AI Factories in Buildup for Vera Rubin. Nvidia · 13 October 2025 [\[A\]](https://blogs.nvidia.com/blog/gigawatt-ai-factories-ocp-vera-rubin) blogs.nvidia.com/blog/gigawatt-ai-factories-ocp-vera-rubin

4 Hotter Than a Hot Tub: The 45°C Breakthrough to Cool AI's Biggest Machines. Nvidia · 22 June 2026 [\[A\]](https://blogs.nvidia.com/blog/liquid-cooling-ai-factories/) blogs.nvidia.com/blog/liquid-cooling-ai-factories/

5 U.S. Department of Energy Large Power Transformer Resilience Report to Congress, July 2024. U.S. Department of Energy · 10 July 2024 · p. 8 [\[A\]](https://www.energy.gov/sites/default/files/2024-10/EXEC-2022-001242%20-%20Large%20Power%20Transformer%20Resilience%20Report%20signed%20by%20Secretary%20Granholtm%20on%207-10-24.pdf#page=8) www.energy.gov/sites/default/files/2024-10/EXEC-2022-001242%20-%20Large%20Power%20Transformer%20Resilience%20Report%20signed%20by%20Secretary%20Granholtm%20on%207-10-24.pdf#page=8

6 Executive summary – Building the Future Transmission Grid. International Energy Agency · 2025 [\[A\]](https://www.iea.org/reports/building-the-future-transmission-grid/executive-summary) www.iea.org/reports/building-the-future-transmission-grid/executive-summary

7 Executive summary – Energy and AI. International Energy Agency · 10 April 2025 [\[A\]](https://www.iea.org/reports/energy-and-ai/executive-summary) www.iea.org/reports/energy-and-ai/executive-summary

8 Executive summary – Electricity 2025. International Energy Agency · 14 February 2025 [\[A\]](https://www.iea.org/reports/electricity-2025/executive-summary) www.iea.org/reports/electricity-2025/executive-summary

9 Large Power Transformers from South Korea, Investigation No. 731-TA-1189 (Second Review), Publication 5531. U.S. International Trade Commission · August 2024 · p. 90 [\[A\]](https://www.usitc.gov/publications/701_731/pub5531.pdf#page=90) www.usitc.gov/publications/701_731/pub5531.pdf#page=90

10 Constellation Reports Second Quarter 2026 Results. Constellation Energy · 6 August 2026 [\[A\]](https://www.constellationenergy.com/news/2026/08/constellation-reports-second-quarter-2026-results.html) www.constellationenergy.com/news/2026/08/constellation-reports-second-quarter-2026-results.html

11 Constellation Ahead of Schedule for Launch of Crane Clean Energy Center. Constellation Energy · 19 February 2025 [\[A\]](https://www.constellationenergy.com/news/2025/constellation-ahead-of-schedule-for-launch-of-crane-clean-energy-center.html) www.constellationenergy.com/news/2025/constellation-ahead-of-schedule-for-launch-of-crane-clean-energy-center.html

12 U.S. Department of Energy Large Power Transformer Resilience Report to Congress, July 2024. U.S. Department of Energy · 10 July 2024 · p. 18 [\[A\]](https://www.energy.gov/sites/default/files/2024-10/EXEC-2022-001242%20-%20Large%20Power%20Transformer%20Resilience%20Report%20signed%20by%20Secretary%20Granholtm%20on%207-10-24.pdf#page=18) www.energy.gov/sites/default/files/2024-10/EXEC-2022-001242%20-%20Large%20Power%20Transformer%20Resilience%20Report%20signed%20by%20Secretary%20Granholtm%20on%207-10-24.pdf#page=18

13 System Hardware & Components. Nvidia · Accessed 9 September 2026 [\[A\]](https://docs.nvidia.com/enterprise-reference-architectures/nvl72-ai-factory/latest/components.html) docs.nvidia.com/enterprise-reference-architectures/nvl72-ai-factory/latest/components.html

14 Colossus 1, AI data centers directory. Epoch AI · Accessed 9 September 2026 [\[A\]](https://epoch.ai/data/ai-data-centers/directory/colossus-1) epoch.ai/data/ai-data-centers/directory/colossus-1

Heat leaves in water. Cold plates, metal blocks with coolant running through them, sit on the GPU packages and pass the heat to the building's water loop, which releases it outdoors ⁴. Nvidia's Rubin racks run coolant at up to 45 °C, warm enough that in many climates the loop can release its heat without turning on chillers, the refrigeration machines that cool water ⁴.

Nvidia is also moving the power that feeds its racks to 800 volts of direct current. Raising the voltage cuts the current needed for the same power, and the heat in copper comes from current. Nvidia said in October 2025 that at 800 volts the same wire can carry 157 percent more power than at 415 volts of alternating current ¹⁶. Inside racks such as the GB300 NVL72, power runs at 54 volts, and at that voltage a one-megawatt rack would need up to 200 kg of copper busbar ¹⁷.

Variants and trade-offs

Cooling

- **Air.** Heat exchangers in the rack door work when density, the power each rack draws, is moderate, but Nvidia's GB300 NVL72 rack is liquid cooled ¹³.
- **Direct-to-chip liquid.** Nvidia's Rubin platform is 100 percent liquid cooled, and every cloud provider and data center operator building for it is moving to liquid ⁴.
- **Immersion.** The servers sit in a bath of fluid, which makes them hard to service.

Nvidia says the cooling supply chain is keeping pace with the move to liquid ⁴. Motivair, Schneider Electric's cooling division, has worked alongside Nvidia's product roadmap for nearly a decade ⁴.

Rack power

Nvidia's 800-volt DC architecture is designed for racks from 100 kW to more than a megawatt, with megawatt racks from 2027 ¹⁷. Nvidia is making the change because

⁴ Hotter Than a Hot Tub: The 45°C Breakthrough to Cool AI's Biggest Machines. Nvidia · 22 June 2026 [\[A\]](#)
blogs.nvidia.com/blog/liquid-cooling-ai-factories/

¹⁶ Building the 800 VDC Ecosystem for Efficient, Scalable AI Factories. Nvidia · 13 October 2025 [\[A\]](#)
developer.nvidia.com/blog/building-the-800-vdc-ecosystem-for-efficient-scalable-ai-factories/

¹⁷ NVIDIA 800 VDC Architecture Will Power the Next Generation of AI Factories. Nvidia · 20 May 2025 [\[A\]](#)
developer.nvidia.com/blog/nvidia-800-v-hvdc-architecture-will-power-the-next-generation-of-ai-factories/

¹³ System Hardware & Components. Nvidia · Accessed 9 September 2026 [\[A\]](#) docs.nvidia.com/enterprise-reference-architectures/nvl72-ai-factory/latest/components.html

the 54-volt distribution in existing racks begins to hit physical limits once racks exceed 200 kW ¹⁷.

Nvidia names nine data center power system providers for its 800-volt gigawatt designs, among them ABB, Eaton, Hitachi Energy, Mitsubishi Electric, Schneider Electric, Siemens and Vertiv ¹.

A megawatt rack changes the busbar, the floor loading, the coolant flow, the leak detection and the energy stored in the rack. Nvidia's Vera Rubin NVL72 rack design holds 20 times more energy storage to keep power steady ¹.

Where the electrons come from

- **Grid interconnection.** The slow path in the United States, where the queues to connect are long ¹⁵.
- **Behind-the-meter gas,** generation on the site itself. The fast path, which at least three of OpenAI's seven US Stargate sites will use to avoid grid queues ¹⁵.
- **Nuclear.** Existing plants already sell power to data centers ¹⁸. Talen Energy supplies Amazon's data center campus next to the Susquehanna nuclear plant in Pennsylvania under a June 2025 contract expected to reach 1,920 MW no later than 2032 ¹⁸. Restarts and new reactors are still to come. Constellation signed a power purchase agreement with Microsoft to restart Three Mile Island Unit 1 as the 835 MW Crane Clean Energy Center ¹¹. The plant shut in 2019 ¹⁹. A \$1 billion federal loan that closed in November 2025 partly finances its restart, which is subject to licensing approvals from the US Nuclear Regulatory Commission ¹⁹. No restarted reactor is serving data centers yet.

Who makes it

The largest data center operators pay for the buildout. Capital spending by Alphabet, Amazon, Meta, Microsoft and Oracle came to \$448.2 billion in 2025, the sum of quarterly figures compiled by Epoch AI, a research group ²⁰. If the trend

17 NVIDIA 800 VDC Architecture Will Power the Next Generation of AI Factories. Nvidia · 20 May 2025 [\[A\]](https://developer.nvidia.com/blog/nvidia-800-v-hvdc-architecture-will-power-the-next-generation-of-ai-factories/)
developer.nvidia.com/blog/nvidia-800-v-hvdc-architecture-will-power-the-next-generation-of-ai-factories/

1 NVIDIA, Partners Drive Next-Gen Efficient Gigawatt AI Factories in Buildup for Vera Rubin. Nvidia · 13 October 2025 [\[A\]](https://blogs.nvidia.com/blog/gigawatt-ai-factories-ocp-vera-rubin)
blogs.nvidia.com/blog/gigawatt-ai-factories-ocp-vera-rubin

15 OpenAI Stargate: where the US sites stand. Epoch AI · 17 April 2026 [\[A\]](https://epoch.ai/publications/openai-stargate-where-the-us-sites-stand)
epoch.ai/publications/openai-stargate-where-the-us-sites-stand

18 Talen Energy Corp, Form 8-K current report for the period ended 2025-06-11 (8-K). U.S. Securities and Exchange Commission (filing by Talen Energy Corp) · 11 June 2025 [\[A\]](https://www.sec.gov/Archives/edgar/data/1622536/000162828025030559/a20250611pressreleasebusin.htm)
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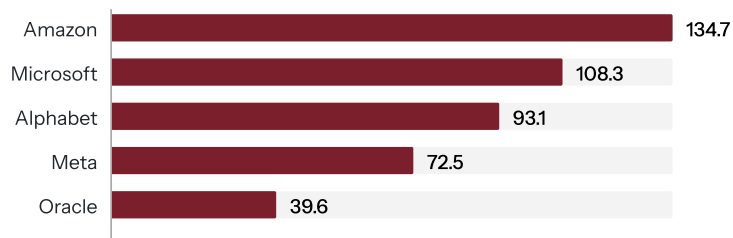
11 Constellation Ahead of Schedule for Launch of Crane Clean Energy Center. Constellation Energy · 19 February 2025 [\[A\]](https://www.constellationenergy.com/news/2025/constellation-ahead-of-schedule-for-launch-of-crane-clean-energy-center.html)
www.constellationenergy.com/news/2025/constellation-ahead-of-schedule-for-launch-of-crane-clean-energy-center.html

19 Energy Department Closes Loan to Restart Nuclear Power Plant in Pennsylvania. U.S. Department of Energy · 17 November 2025 [\[A\]](https://www.energy.gov/articles/energy-department-closes-loan-restart-nuclear-power-plant-pennsylvania)
www.energy.gov/articles/energy-department-closes-loan-restart-nuclear-power-plant-pennsylvania

20 Hyperscaler capex has quadrupled since GPT-4's release. Epoch AI · 26 February 2026 [\[A\]](https://epoch.ai/data-insights/hyperscaler-capex-trend)
epoch.ai/data-insights/hyperscaler-capex-trend

continues, it will reach \$770 billion in 2026 ²⁰. The International Energy Agency expected worldwide investment in data centers to reach \$580 billion in 2025 ².

Capital spending by five large US data center operators, 2025 \$B



Source: Epoch AI, hyperscaler capex trend, February 2026, quarterly figures from company filings summed for 2025

Epoch AI also projects that OpenAI's seven US Stargate sites will exceed 9 GW by 2029 ¹⁵. It expects the site in Abilene, Texas, to grow from an estimated 0.3 GW in April to 1.2 GW in the fourth quarter of 2026 ¹⁵.

Equipment makers limit how fast the buildout can go. GE Vernova builds large gas turbines, and its 2025 annual report names Siemens Energy and Mitsubishi Power among the key competitors of its power generation business ³. Its electrification business makes power transformers and switchgear, and the report names Hitachi Energy, Siemens Energy, Schneider Electric and ABB among that business's key competitors ³.

GE Vernova bought the remaining half of Prolec GE, a transformer maker, in the first half of 2026 ²¹. GE Vernova's gas equipment backlog and reserved factory slots grew from 100 GW to 116 GW in the second quarter of 2026 ²¹. In the first half of the year, data center orders for its electrification business, which makes grid equipment, passed \$5 billion, more than double its total for 2025 ²¹.

GE Vernova's planned annual gas turbine output GW/YR



Source: GE Vernova second-quarter 2026 results, July 2026

²⁰ Hyperscaler capex has quadrupled since GPT-4's release. Epoch AI · 26 February 2026 epoch.ai/data-insights/hyperscaler-capex-trend

² Executive summary – World Energy Outlook 2025. International Energy Agency · 12 November 2025 www.iea.org/reports/world-energy-outlook-2025/executive-summary

¹⁵ OpenAI Stargate: where the US sites stand. Epoch AI · 17 April 2026 epoch.ai/publications/openai-stargate-where-the-us-sites-stand

³ GE Vernova Inc., Form 10-K annual report for the period ended 2025-12-31 (10-K). U.S. Securities and Exchange Commission (filing by GE Vernova Inc.) · 29 January 2026 www.sec.gov/Archives/edgar/data/1996810/000199681026000015/gev-20251231.htm

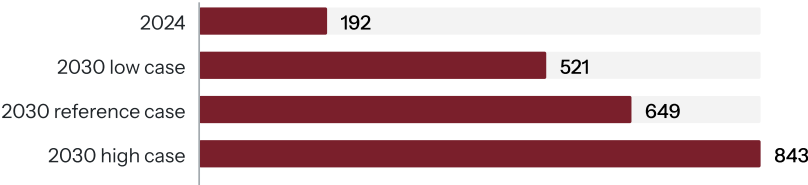
²¹ GE Vernova Inc., Form 8-K current report for the period ended 2026-07-22 (8-K). U.S. Securities and Exchange Commission (filing by GE Vernova Inc.) · 22 July 2026 www.sec.gov/Archives/edgar/data/1996810/000199681026000147/gevpressrelease2q26.htm

Capacity and demand

US data centers used 192 TWh in 2024, 4.7 percent of national electricity, according to a June 2026 estimate by Lawrence Berkeley National Laboratory that leaves out cryptocurrency mining ²². The lab's reference case, its main scenario, projects 464 TWh in 2028 and 649 TWh in 2030, which would be 11.8 percent of forecast US electricity use ²². Its scenarios for 2030 range from 521 to 843 TWh, or 9.5 percent to 15.3 percent ²³.

In its October 2026 Short-Term Energy Outlook, the US Energy Information Administration expects US electricity sales of 4,152.0 TWh in 2026 and 4,216.6 TWh in 2027 ²⁴. It expects electricity demand from the commercial sector, which includes data centers, to grow 2.8 percent in 2027 and demand from industry to grow 2.7 percent ²⁵. Its September outlook had lowered the 2027 electricity sales forecast for the region that includes Texas by 4.7 percent from August ²⁶. That outlook noted that Texas had paused connecting new data centers to the grid while it audits proposed projects ²⁷.

US data center electricity use, 2024 and 2030 projection range TWH



Source: Lawrence Berkeley National Laboratory, June 2026

By the International Energy Agency's estimate, China accounted for 25 percent of the world's data center electricity use in 2024, second to the United States at 45 percent ⁷. Data centers made up around 3 percent of the growth in China's electricity demand from 2022 to 2024, the agency found ⁸.

Chip efficiency is still improving. Google's Ironwood TPU, an AI chip, delivers twice the performance per watt of Trillium, the TPU before it ²⁸. A token is the

22 United States Data Center Energy Usage Report: 2025 Update. Lawrence Berkeley National Laboratory · 18 June 2026 · p. 10 www.energy.gov/documents/united-states-data-center-energy-usage-report-2025-update#page=10

23 United States Data Center Energy Usage Report: 2025 Update. Lawrence Berkeley National Laboratory · 18 June 2026 · p. 11 www.energy.gov/documents/united-states-data-center-energy-usage-report-2025-update#page=11

24 Short-Term Energy Outlook, October 2026. U.S. Energy Information Administration · 6 October 2026 · p. 46 www.eia.gov/outlooks/steo/archives/oct26.pdf#page=46

25 Short-Term Energy Outlook, October 2026. U.S. Energy Information Administration · 6 October 2026 · p. 12 www.eia.gov/outlooks/steo/archives/oct26.pdf#page=12

26 Short-Term Energy Outlook, September 2026. U.S. Energy Information Administration · 8 September 2026 · p. 4 www.eia.gov/outlooks/steo/archives/sep26.pdf#page=4

27 Short-Term Energy Outlook, September 2026. U.S. Energy Information Administration · 8 September 2026 · p. 10 www.eia.gov/outlooks/steo/archives/sep26.pdf#page=10

7 Executive summary – Energy and AI. International Energy Agency · 10 April 2025 www.iea.org/reports/energy-and-ai/executive-summary

8 Executive summary – Electricity 2025. International Energy Agency · 14 February 2025 www.iea.org/reports/electricity-2025/executive-summary

28 Inside the Ironwood TPU codesigned AI stack. Google Cloud · 6 November 2025 cloud.google.com/blog/products/compute/inside-the-ironwood-tpu-codesigned-ai-stack

chunk of text a model reads or writes. Energy per token can fall while total energy use still rises, if the number of tokens rises faster.

The chokepoint

On the Texas grid, far more capacity has been requested than is connected and running. ERCOT, the grid operator for most of Texas, was tracking about 474 GW of large loads (big power users) seeking a connection in June 2026, roughly 90 percent of it data centers ²⁹. In its operational overview for September 2026, ERCOT counted 9,456 MW approved to energize, but judging by peak monthly use in September, it believed only 4,132 MW of it was operating ³⁰.

In a preliminary review in July 2026, ERCOT found about 205 GW of the queue eligible for Batch Zero, its first study of connection requests as a group ³¹. On 3 August 2026 Texas Governor Greg Abbott ordered the state's Public Utility Commission and ERCOT to audit every data center in the interconnection process before any data center project moves forward ³². ERCOT then paused approvals to energize data centers and crypto mining sites of 75 MW or more until the audit and a review of their impact on local communities are complete ³³. In September 2026 ERCOT conditionally classed 66.4 GW of Batch Zero projects as base load and 127.9 GW as studied load, pending final decisions in December ³³. It will report on the audit and the community review to the Public Utility Commission by 10 December 2026 ³³.

Projects in that queue also wait on equipment.

- **Large power transformers.** In 2024, lead times of 36 months were commonly quoted and the longest reached 60 months, against under a year before the pandemic ⁵. By a US Commerce Department estimate, 82 percent of the units put into US service in 2019 were imported ³⁴. In an industry survey published in 2025, the International Energy Agency found that large power transformers

29 Electric Reliability Council of Texas, ERCOT update to the Senate Committee on Business and Commerce, 29 July 2026. Electric Reliability Council of Texas · 29 July 2026 · p. 6 [\[A\]](http://www.ercot.com/files/docs/2026/07/29/ERCOT-Senate-July-29-Panel-1-Assessing-The-Grid.pdf#page=6) www.ercot.com/files/docs/2026/07/29/ERCOT-Senate-July-29-Panel-1-Assessing-The-Grid.pdf#page=6

30 Electric Reliability Council of Texas, ERCOT Monthly Operational Overview (September 2026). Electric Reliability Council of Texas · 16 October 2026 · p. 9 [\[A\]](http://www.ercot.com/files/docs/2026/10/16/ERCOT-Monthly-Operational-Overview-September.pdf#page=9) www.ercot.com/files/docs/2026/10/16/ERCOT-Monthly-Operational-Overview-September.pdf#page=9

31 Electric Reliability Council of Texas, ERCOT update to the Senate Committee on Business and Commerce, 29 July 2026. Electric Reliability Council of Texas · 29 July 2026 · p. 10 [\[A\]](http://www.ercot.com/files/docs/2026/07/29/ERCOT-Senate-July-29-Panel-1-Assessing-The-Grid.pdf#page=10) www.ercot.com/files/docs/2026/07/29/ERCOT-Senate-July-29-Panel-1-Assessing-The-Grid.pdf#page=10

32 Governor Abbott Directs Comprehensive Data Center Audit. Office of the Texas Governor · 3 August 2026 [\[A\]](https://gov.texas.gov/news/post/governor-abbott-directs-comprehensive-data-center-audit) gov.texas.gov/news/post/governor-abbott-directs-comprehensive-data-center-audit

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5 U.S. Department of Energy Large Power Transformer Resilience Report to Congress, July 2024. U.S. Department of Energy · 10 July 2024 · p. 8 [\[A\]](https://www.energy.gov/sites/default/files/2024-10/EXEC-2022-001242%20-%20Large%20Power%20Transformer%20Resilience%20Report%20signed%20by%20Secretary%20Granholtm%20on%207-10-24.pdf#page=8) www.energy.gov/sites/default/files/2024-10/EXEC-2022-001242%20-%20Large%20Power%20Transformer%20Resilience%20Report%20signed%20by%20Secretary%20Granholtm%20on%207-10-24.pdf#page=8

34 U.S. Department of Energy Large Power Transformer Resilience Report to Congress, July 2024. U.S. Department of Energy · 10 July 2024 · p. 20 [\[A\]](https://www.energy.gov/sites/default/files/2024-10/EXEC-2022-001242%20-%20Large%20Power%20Transformer%20Resilience%20Report%20signed%20by%20Secretary%20Granholtm%20on%207-10-24.pdf#page=20) www.energy.gov/sites/default/files/2024-10/EXEC-2022-001242%20-%20Large%20Power%20Transformer%20Resilience%20Report%20signed%20by%20Secretary%20Granholtm%20on%207-10-24.pdf#page=20

took up to four years to secure worldwide ⁶. It also found that their average lead times had almost doubled since 2021 ⁶. Measured by capacity, US factories supplied 29.2 percent of the transformers of 60 MVA and above bought in the US in 2023, and imports supplied the rest ⁹.

- **Gas turbines.** In July 2026 GE Vernova expected its annual gas turbine output to reach 20 GW in the third quarter of 2026, 24 GW in 2028 and 30 GW in 2030 ²¹.
- **Firm new generation,** the kind that runs whatever the weather. The Nuclear Regulatory Commission has approved a fuel license amendment for the Crane plant, and Constellation expects to restart it in 2027 ¹⁰.

Memory chips are also in short supply. Micron's quarterly report for the period ended 28 May 2026 says AI-driven growth in demand for memory and storage is outpacing industry supply ³⁵. The memory shortage and the wait for power equipment both limit how much of the 2026 capital spending turns into working compute.

FOUR THINGS TO REMEMBER

- One AI rack can draw 142 kilowatts, too much heat for air, so racks are cooled with liquid.
 - The newest AI sites are planned in gigawatts, and each gigawatt is the output of a large power station.
 - Power equipment is one of the slow parts of building a data center. In 2024 lead times of 36 months were commonly quoted for a large transformer.
 - The United States used 45 percent of the world's data center electricity in 2024 and China 25 percent, by the International Energy Agency's estimate.
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Made by **Yashvardhan Sharma** with Claude. Corrections and questions: contact@chipsupplychain.org.

⁶ Executive summary – Building the Future Transmission Grid. International Energy Agency · 2025 [\[A\]](https://www.iea.org/reports/building-the-future-transmission-grid/executive-summary)
www.iea.org/reports/building-the-future-transmission-grid/executive-summary

⁹ Large Power Transformers from South Korea, Investigation No. 731-TA-1189 (Second Review), Publication 5531. U.S. International Trade Commission · August 2024 · p. 90 [\[A\]](https://www.usitc.gov/publications/701_731/pub5531.pdf#page=90)
www.usitc.gov/publications/701_731/pub5531.pdf#page=90

²¹ GE Vernova Inc., Form 8-K current report for the period ended 2026-07-22 (8-K). U.S. Securities and Exchange Commission (filing by GE Vernova Inc.) · 22 July 2026 [\[A\]](https://www.sec.gov/Archives/edgar/data/1996810/000199681026000147/gevpressrelease2q26.htm)
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¹⁰ Constellation Reports Second Quarter 2026 Results. Constellation Energy · 6 August 2026 [\[A\]](https://www.constellationenergy.com/news/2026/08/constellation-reports-second-quarter-2026-results.html)
www.constellationenergy.com/news/2026/08/constellation-reports-second-quarter-2026-results.html

³⁵ MICRON TECHNOLOGY INC, Form 10-Q quarterly report for the period ended 2026-05-28 (10-Q). U.S. Securities and Exchange Commission (filing by MICRON TECHNOLOGY INC) · 25 June 2026 [\[A\]](https://www.sec.gov/Archives/edgar/data/723125/000072312526000015/mu-20260528.htm)
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A company filings, governments, standards bodies, universities and research institutions; **B** SemiAnalysis, Reuters, the Financial Times and Nikkei Asia.

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