GLOBAL X INSIGHTS

AI Hinges on Rapid Electrification

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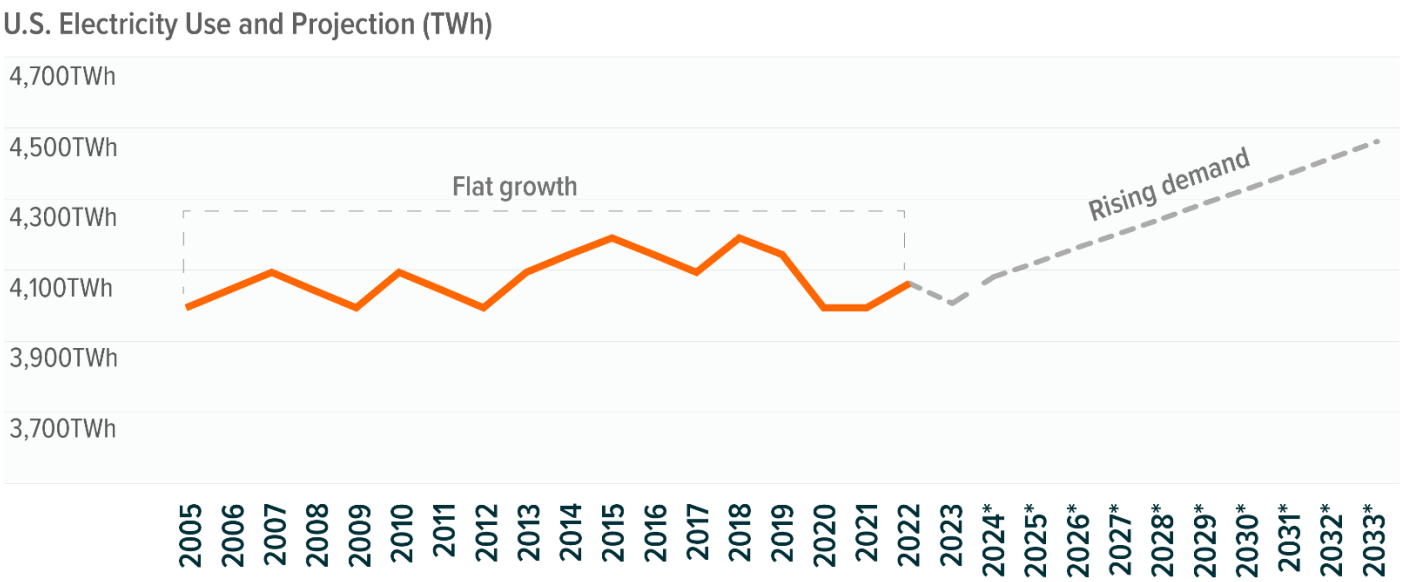
We believe the adoption of efficient lighting offers a blueprint to understand AI's future. When energy-efficient lightbulbs entered the market, many expected a dramatic reduction in electricity consumption. Instead, efficiency and lower costs spurred widespread adoption, unlocking new applications and ultimately increasing power consumption and infrastructure needs. Today, AI startups like China's DeepSeek are achieving similar breakthroughs in efficiency, prompting some to anticipate a decline in infrastructure needs. But history suggests otherwise—as AI becomes more affordable and efficient, we expect adoption to surge and generate novel use cases, driving unprecedented demand for computing power and infrastructure.

Rapidly unfolding demand for AI is likely to drive a fundamental shift in power infrastructure planning and demand that will compel utilities to accelerate grid modernization and power generation capacity. This transformation has only begun to take shape, and creates opportunities across the ecosystem, including center developers, power producers, and electrical and cooling component suppliers. For investors, the Global X Artificial Intelligence and Technology ETF (AIQ), the Global X Data Center and Digital Infrastructure ETF (DTCR), and the Global X U.S. Electrification ETF (ZAP) are potential ways to capture this transformation.

U.S. ELECTRICITY DEMAND SET TO SURGE AFTER YEARS OF STAGNATION



Sources: EIA. (2024). Electricity 2024, Executive Summary; Grid Strategies. (2024, December). Strategic Industries Surging: Driving US Power Demand; S&P Insights. (2024, December 4). AI and energy: The big picture; Statista. (n.d.). Electricity end use in the United States from 1975 to 2023, accessed on February 10, 2025.

*Forecast

Key Takeaways

- The AI boom puts U.S. data centers on track to potentially consume 12% of U.S. electricity by 2028.[1]
- After two decades of flat electricity growth, utilities could be tasked with meeting up to 47% higher demand by 2040, underscoring the urgency for grid upgrades and power generation.[2,3]
- Decarbonizing the grid while modernizing the power infrastructure will require substantial investments, compelling innovation in areas such as nuclear power and energy storage systems.

AI Comes with High Power Costs

The global economy, led by the U.S. technology industry, is rapidly transitioning from the Information Age to the Automation Age, an era where machines, software, and systems no longer just process data but act on it autonomously. The Automation Age promises to unleash a boom in efficiency and productivity, powered by smart, agile, accessible AI. But this progress has a built-in power cost as the technology industry rushes to train, test, and deploy AI, and to manufacture the semiconductors necessary for AI.

Training Large-Scale AI Models

Training foundational AI models exemplifies the power cost of AI. To train GPT-4, OpenAI used approximately 50 gigawatt hours (GWh) of electricity – enough to power 6,000 U.S. homes for an entire year, and fifty times more electricity than it took to train the previous iteration, GPT-3.[4] Since GPT-4's public release in March 2023, infrastructure demands have only intensified as companies deploy increasingly larger AI-GPU clusters to train next-generation models.

This trend can particularly be noticed across big tech. Meta Platforms plans to invest at least $60 billion in capital expenditure in 2025, expecting to operate a total of 1.3 million GPUs by the end of the year.[5] In the coming years, xAI plans to spend $35–40 billion to grow its Colossus supercomputer, the largest AI super cluster in the United States, to operate on 1 million GPUs.[6] Microsoft plans to spend $80 billion on AI infrastructure in fiscal 2025.[7]

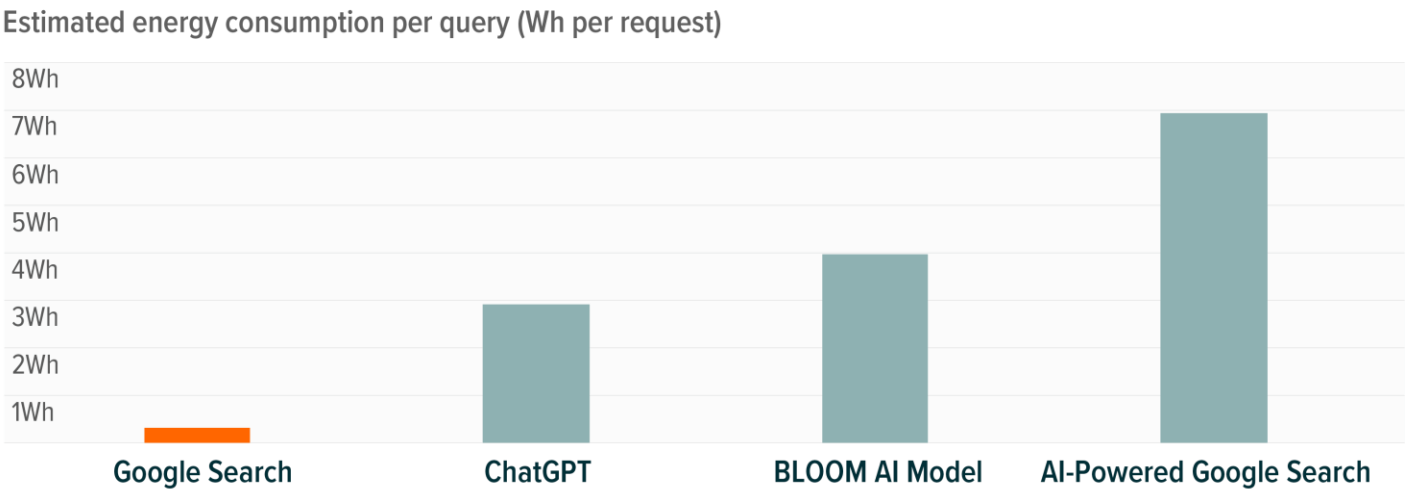
Individual GPUs are becoming more power hungry as well. Nvidia's Blackwell (GB200) chip, although significantly more power efficient, is designed for nearly seven times the power draw of the A100 chips used to train GPT-3.[8] By 2030, U.S. data centers could house millions of such advanced GPUs, also requiring significant energy for cooling.

Using AI Applications

Simply putting an AI model to work is energy intensive. A single ChatGPT query can consume 10 times more energy than a Google Search, which is enough electricity to power a light bulb for 20 minutes.[9] More complex tasks like generating videos or high-quality AI images can require hundreds of times more energy.[10] One minute of interaction with an AI voice assistant could consume up to 20 times the energy of a traditional phone call.[11]

ChatGPT's 180 million monthly users showcase today's AI power demands, but the real surge is expected to come from agentic AI models interacting with each other.[12] By 2030, the agentic AI market is projected to reach $47 billion, with billions of AI agents working autonomously on human-directed tasks.[13] Anticipating this surge, hyperscalers are already committing over $300 billion in capital expenditures for 2025, primarily focused on AI infrastructure.[14]

ELECTRICITY CONSUMPTION OF LARGE LANGUAGE MODELS VS. GOOGLE SEARCH



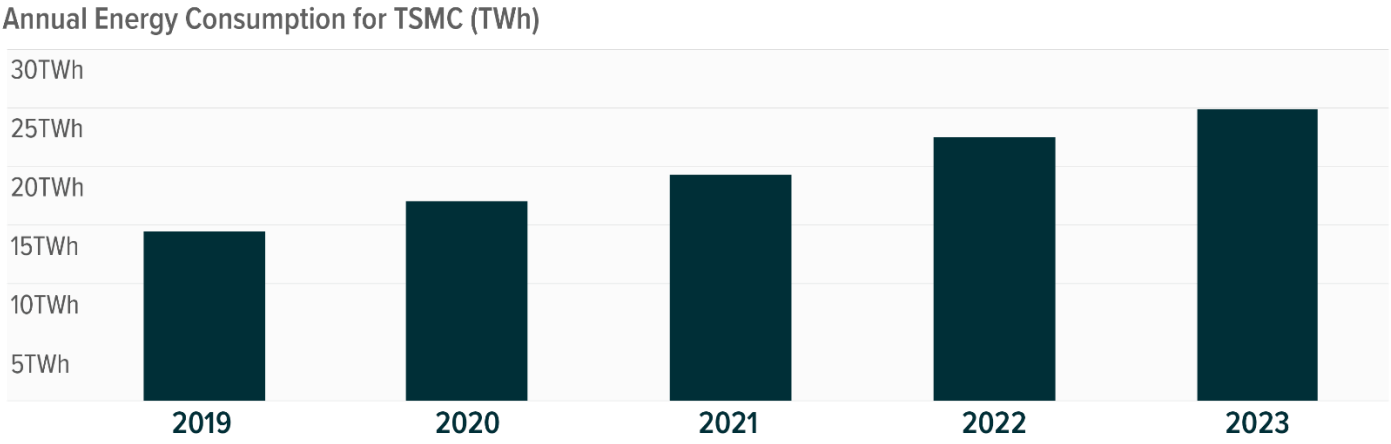
Sources: EPRI Whitepaper, 2024: Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption.
Note: the source provides two data points for "AI-Powered Google Search". Above utilizes the lower of the two for a conservative comparison.

Manufacturing AI Chips

Producing semiconductors requires significant energy. For instance, Taiwan Semiconductor Manufacturing Company (TSMC) uses 8% of Taiwan's electricity to run its chip fabrication facilities in the country, which could jump to 24% by 2030.[15] As the United States reshores chip production, starting with high-value chips, energy demand could rapidly increase.

Just the first phase of TSMC's fab facility in Phoenix, Arizona, requires 200 megawatts (MW) of peak connected load, enough to power roughly 30,000 homes. [16] By 2030, that power need could grow nearly six times. Seventy-five semiconductor facilities are planned or are currently under construction in the United States, and by 2030 the country could produce 20% of the world's most advanced chips, further amplifying power needs coming from manufacturing.[17, 18]

IN TAIWAN, TSMC'S FOUNDRIES ACCOUNT FOR 8% OF THE COUNTRIES ENTIRE POWER USE

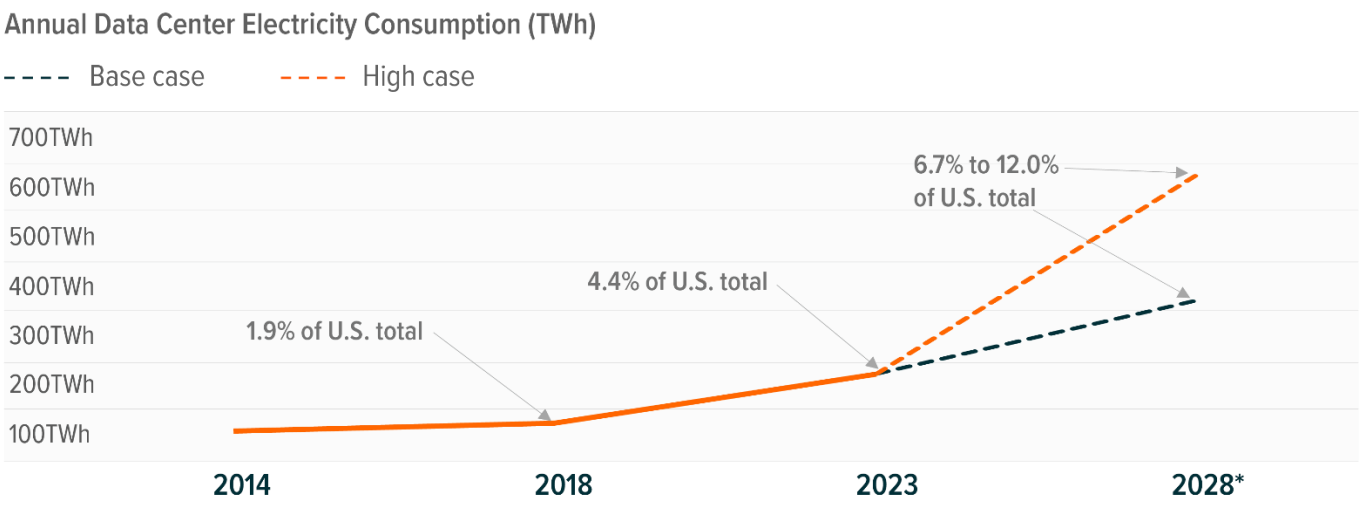


Sources: TSMC. (2024, July 30). 2023 Sustainability Report; Statista. (2024, August). Annual energy consumption Taiwan Semiconductor Manufacturing Company (TSMC) from 2016 to 2023.

Data Center Energy Demand Exposes Infrastructure Challenges

U.S. data center electricity consumption is set to surge from 176 terra-watt hours (TWh) in 2023 to as high as 580TWh by 2028.[19] Meeting just this demand will require U.S. power producers to add roughly 50GW of new production capacity by 2030, a challenge compounded by rising power needs from semiconductor manufacturing and EV adoption, which could cost nearly $60 billion in investments in new power generation.[20]

DATA CENTERS MAY CONSUME 12% OF U.S. ELECTRICITY BY 2028



Source: Berkeley Lab. (2024, December 19). 2024 United States Data Center Energy Usage Report. *Forecast

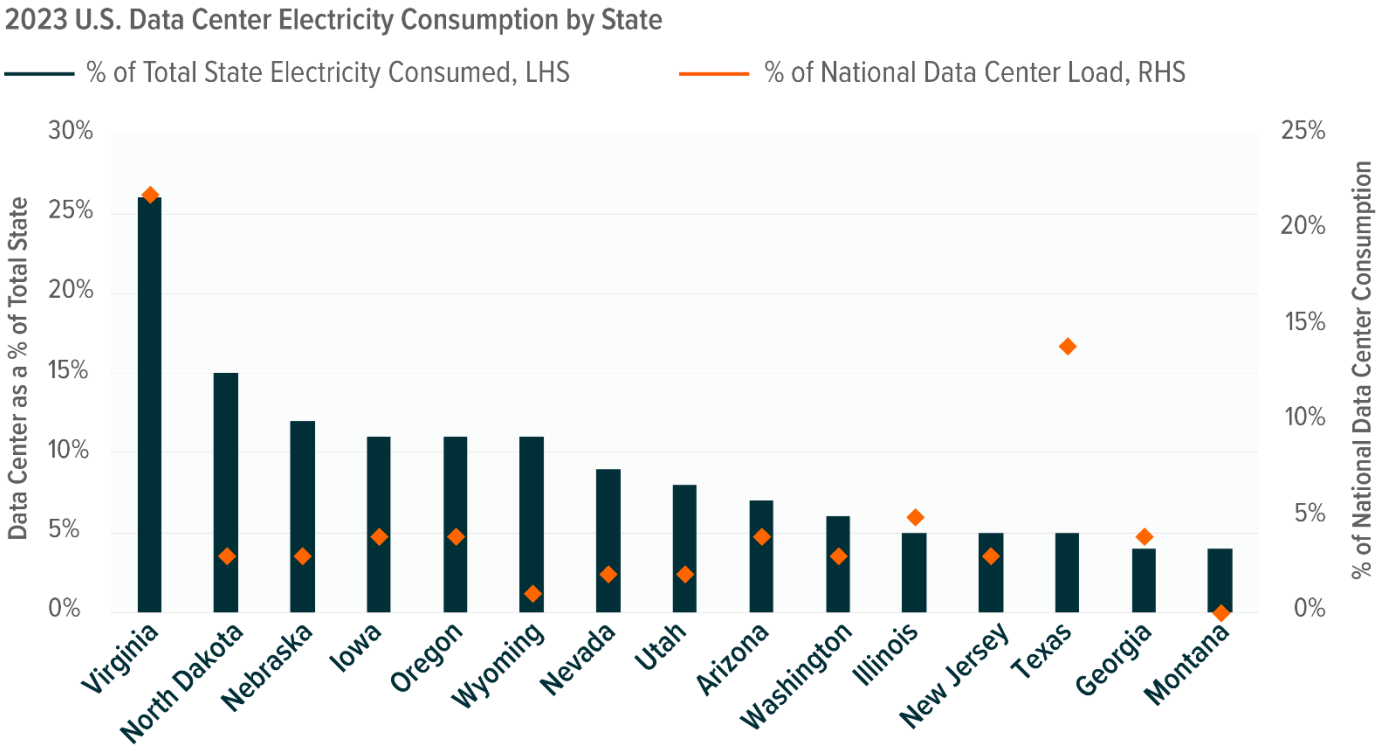
Complicating matters, much of the U.S. grid dates to the 1960s and faces growing stress. The average transformer is over 40 years old, and many power lines are operating beyond their capacity.[21] This results in frequent maintenance issues and power outages, highlighting the urgent need for a robust overhaul of the infrastructure to meet growing demand and ensure reliability.

Historically, though, power companies have expanded generation and transmission capacity at a measured pace, responding to gradual catalysts like population growth over multiple decades. Data centers operate on a different timeline—they often go from groundbreaking to full operation in under two years.[22]

Data center growth is also highly regionalized, and increased demand is likely to intensify localized energy bottlenecks, making targeted investments in substations, power redundancy, and fiber connectivity essential. In 2023, just 15 states accounted for 80% of U.S. data center energy consumption.[23] Virginia alone made up nearly 26%.[24]

Another challenge for the energy system is navigating decarbonization of the grid, which clashes with the need to rapidly scale power production infrastructure. In the United States, nearly 100GW of coal-fired power plant capacity was phased out over the last 15 years, and another 68GW will be phased out this decade.[25] Major data center regions may face significant power shortfalls by 2030.

MORE THAN A QUARTER OF VIRGINIA'S POWER NOW FUELS DATA CENTERS



Source: EPRI Whitepaper, 2024: Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption.

Investments in Energy Innovation Are Accelerating, Including Nuclear

Newly announced data centers primarily plan to utilize natural gas turbines for reliable, on-site power generation.[26] While these systems can deliver consistent electricity, their emissions conflict with tech companies' carbon neutrality commitments. Solar and wind power deployment is accelerating, but these intermittent sources can't yet match data centers' need for uninterrupted power—though advancing energy storage technologies are beginning to bridge this gap.

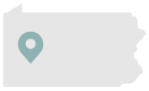
We believe the data center energy landscape of tomorrow is likely nuclear, driven by small modular reactors (SMRs). In our view, they are the most transformative development in energy. Unlike traditional nuclear plants, SMRs are compact, scalable, and faster to deploy with much quicker construction timelines. They offer a steady, low-carbon power supply that aligns with corporate sustainability goals while enhancing grid reliability. Innovation in SMR form factors, coupled with permitting and regulatory support to aggressively drive the industry, are critical to the evolution of the AI power story.

Tech companies are racing to secure nuclear power through partnerships with major utilities, signaling the urgency to scale energy infrastructure alongside growing AI demands.

MAJOR NUCLEAR DEALS ANNOUNCED BY DATA CENTER COMPANIES

Amazon Buys a Nuclear-Powered data Center From Talen

NAME/PROJECT	LOCATION	EXPECTED # OF BUILDINGS
CUMULUS DATA ASSETS	SALEM TOWNSHIP, PENNSYLVANIA	15



DETAILS

On March 4, 2024, Talen Energy sold Cumulus Data Assets to Amazon Web Services (AWS) for $650 million. The 1,200-acre campus is powered by the nearby 2.5-gigawatt Susquehanna Steam Electric Station, a nuclear plant operational since 1983 and licensed through 2044.[1]

Microsoft Signs 24/7 Nuclear Power Deal with Constellation

NAME/PROJECT	LOCATION	CURRENT # OF BUILDINGS
BOYDTON CAMPUS	BOYDTON, VIRGINIA	11

DETAILS

On June 20, 2023, Microsoft signed a deal with Constellation Energy to supply nuclear power to its Boydton, Virginia data center, targeting near 100% carbon-free operation. Constellation will provide up to 35% of the center's power through its carbon-free energy matching platform.[2]

Green Energy Partners and IP Form a Phased Joint Venture

NAME/PROJECT	LOCATION	EXPECTED # OF BUILDINGS
SURRY GREEN ENERGY CENTER	SURRY COUNTY, VIRGINIA	15

DETAILS

Approved on February 8, 2024, this data center campus is designed to be powered by the nearby Surry Nuclear Power Plant but the long-term plan includes the development of 4-6 small modular reactors (SMRs) to provide nuclear energy directly to the data centers.[3]

Amazon Data Center Campus to Abut Nuclear Power Stationt

NAME/PROJECT	LOCATION	EXPECTED # OF BUILDINGS
LAKE ANNA TECH CAMPUS	LOUISA COUNTY, VIRGINIA	7

DETAILS

Filed on September 26, 2023, this is one of two data center campuses Amazon plans to build as part of an $11 billion investment in the state. The first campus is expected to house 7 data center buildings and be located near the Lake Anna Nuclear Power Station.[4]

Sources: Text: 1. Nuclear News, Mar 2024; 2. Data Centre Dynamics, Jun 2023; 3. Data Centre Dynamics, Feb 2024; 4. Lake Anna Life, Jun 2024.

Conclusion: Increased Efficiency Can Lead to Increased Consumption

We believe that cheaper AI will fuel greater adoption, driving demand for AI infrastructure and amplifying power needs. Between now and 2030, industry estimates suggest nearly $1 trillion of capital investment is needed to modernize the U.S. power grid and to meet emerging power needs.[27] Utilities and competitive power producers are scaling investments, and private capital is expected to follow, cumulatively creating opportunities for companies delivering power, supplying transformers, power management systems, and grid modernization solutions. In our view, this intersection—AI applications, AI infrastructure, and electrification—is likely to remain a positive theme for investors to consider throughout the decade.

Related ETFs

AIQ – Global X Artificial Intelligence and Technology ETF

DTCR – Global X Data Center & Digital Infrastructure ETF

ZAP – Global X U.S. Electrification ETF

URA – Global X Uranium ETF

Click the fund name above to view current performance and holdings. Holdings are subject to change. Current and future holdings are subject to risk.

Footnotes

1. Berkeley Lab, Energy Analysis & Environmental Impacts Division. (2024, December 19). 2024 United States Data Center Energy Usage Report.
2. NextEra. (2024, October 23). Third Quarter 2024 Earnings Conference Call. [Presentation].
3. U.S. Energy Information Administration. (2024, December 10). Short Term Energy Outlook.
4. Forbes. (2024, May 23). AI Is Pushing The World Toward An Energy Crisis
5. TechCrunch. (2025, January 24). Mark Zuckerberg says Meta will have 1.3M GPUs for AI by year-end.
6. Data Center Dynamics. (2024, December 4). xAI targets one million GPUs for the Colossus supercomputer in Memphis.
7. CNBC. (2025, January 3). Microsoft expects to spend $80 billion on AI-enabled data centers in fiscal 2025
8. Fibermall. (2024, March 29). Analysis of NVIDIA's Latest Hardware: B100/B200/GH200/NVL72/SuperPod
9. Bloomberg. (2024, December 13). AI Wants More Data. More Chips. More Real Estate. More Power. More Water. More Everything.
10. MIT Tech Review. (2024, May 23). AI is an energy hog. This is what it means for climate change.
11. Global X Estimate with information derived from SlashPlan. (n.d.). Home Phone Energy Calculator (Cost and kWh Usage)
12. DemandSage. (2025, January 2). Number Of ChatGPT Users (February 2025)
13. Capgemini. (2025, January). Top tech trends of 2025.
14. Business Insider. (2025, February 7). Tech Giants Are Lining up Over $300 Billion in AI Spend
15. Data Center Dynamics. (2024, October 7). TSMC could account for 24% of Taiwan's electricity consumption by 2030
16. Arizona Technology Council. (2024). Utility company makes progress on infrastructure for Taiwan Semiconductor project in north Phoenix
17. Cognax Technologies. (2024, April 4). Where are the world's new semiconductor fabs being built?

18. Barron's. (2024, Feb 26). U.S. Projected to Make 20% of the World's Most Advanced Chips by 2030, Commerce Secretary Says
19. Berkeley Lab, Energy Analysis & Environmental Impacts Division. (2024, December 19). 2024 United States Data Center Energy Usage Report.
20. S&P Insights. (2024, October 22). Data Centers: Surging Demand Will Benefit And Test The U.S. Power Sector.
21. Niskanen Center. (2023, January 23). Powering the nation: how to fix the transformer shortage.
22. Green Mountain Data Centers. (2020, March 26). How long does it take to build a data center?
23. EPRI. (2024, May 5). Powering Intelligence
24. Ibid.
25. Institute of Energy Economics and Financial Analysis. (2024, October 24). Nowhere to go but down for U.S. coal capacity, generation.
26. Financial Times. (2025, January 13). AI set to fuel surge in new US gas power plants.
27. Bloomberg. (2024, July). The World's Power Grids Are Failing as the Planet Warms.