



SEPARATING FACT FROM FICTION IN DATA CENTER ELECTRICITY FORECASTS

A GUIDE FOR REGULATORS

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GridLAB

Table of Contents

Preamble	1
Executive Summary	2
Historical parallels: Concern about electricity demand growth mirrors the early days of the Internet age	3
US and state-level electricity consumption growth in recent years	5
Aggregate electricity consumption of computing equipment	8
Historical compute data center electricity demand growth	10
US utilities project increasing demand	12
Lessons learned from historical load forecast analysis	16
The bottom line	17
Further reading	18
References cited	20
Appendix. Utilities and balancing authorities included in aggregate forecast tallies in Figure 6	24

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Preamble

US electric utilities are currently facing the challenge of integrating new loads into their power systems, including those from data centers. Given that recent forecasts project significant electricity load growth from this sector, industry leaders, utility planners, and regulatory bodies are intensely focused on understanding the implications of this expected growth.

To provide a clear, informed perspective, GridLab commissioned this white paper from Koomey Analytics. This report reviews recent load forecasts and industry announcements to rigorously assess the impact of new data center demand. Researchers Jonathan Koomey and Zachary Schmidt bring considerable historical experience to this review; they have observed and analyzed multiple distinct phases of the data center industry, including the rapid growth period of the early 2000s, the subsequent slowdowns through 2018, and the renewed, faster growth seen since.

In collaboration with the GridLab team, Koomey and Schmidt offer their expert perspective on current industry trends. They also provide key recommendations for regulators, policymakers, and other stakeholders who are responsible for accurately reviewing and planning for future data center load growth.

Executive Summary

Reports of “unprecedented” and “explosive” growth in electricity demand from data centers—facilities that host websites, store data, stream media, mine cryptocurrency, and train and deploy AI models—have focused public attention on these facilities as large-scale electricity consumers [1, 2, 3, 4, 5, 6, 7, 8]. The anticipated growth of the data center industry in coming years presents an opportunity for utility planners and regulators in regions with limited prior experience to deepen their understanding of these large-scale computing facilities.

Key takeaways from this white paper include:

- All computing (including compute data centers) was responsible for about 6% of electricity consumption globally in 2024, and while compute data centers appear to be growing, they’re starting from a relatively small base (about 1.5% of the world’s electricity in 2024). For the US, which has a higher concentration of data centers (and particularly AI facilities) total data center electricity use was about 4.4% in 2023, up from about 2% in 2020.
- For forecasts of data center electricity use, there is uncertainty on both the potential growth in service demand (the amount of compute we’ll use) and the increase in efficiency of delivering that service demand. There are also open questions about potentially inflated or duplicate interconnection requests submitted by data center developers, which may lead to over-estimation of future electricity loads.
- Future projections of data center electricity demand are highly uncertain, so it’s critical for regulators and utilities to examine carefully the assumptions driving forecasts of demand growth in the regions where these projections are emerging.
- Analysts, researchers, and policy makers should avoid the common tendency to overestimate the energy and environmental effects of information technology, which has been well documented for decades. They should also avoid citing or using “amazing factoids” until they’ve analyzed such claims independently.

This report also includes a list of follow-on resources and references for those who want to learn more.

HISTORICAL PARALLELS:

Concern about electricity demand growth mirrors the early days of the Internet age

Reports of “unprecedented” and “explosive” growth in electricity demand from data centers – facilities that house computing capacity needed to host websites, store data, stream media, mine crypto currency, and train artificial intelligence (AI) models – have appeared in several major US news outlets in recent months.

Here is a sampling of recent article headlines along these lines:

“A new surge in power use is threatening U.S. climate goals: A boom in data centers and factories is straining electric grids and propping up fossil fuels.” – *NY Times* ^[6]

“Amid explosive demand, America is running out of power.” – *Washington Post* ^[2]

“Internet data centers are fueling drive to old power source: Coal.” – *Washington Post* ^[5]

“US electric utilities brace for surge in power demand from data centers.” – *Reuters* ^[4]

“Booming AI demand threatens global electricity supply.” – *The Financial Times* ^[3]

“Our stressed-out power grids need help.” – *The Financial Times* ^[7]

“AI Power Consumption Exploding.” – *Semiconductor Engineering* ^[1]



These articles express two concerns: First, that rising energy demand from data centers could further burden the nation's aging power infrastructure; and second, that this new source of demand could jeopardize decarbonization trends in the US power sector.

Similar concerns emerge in recent reports by influential management consulting and investment advising firms such as McKinsey^[9], Boston Consulting Group^[10], Goldman Sachs^[11], The Brattle Group^[12], Brownridge^[13], JP Morgan^[14], Grid Strategies^[15], and others. Together they have contributed to a sense that a power crisis could be looming and that energy requirements should be added to the long list of things that worry policy makers and citizens about AI more broadly.

This concern is not a new one. In the late 1990s and early 2000s, a similar set of concerns arose around the electricity used by computers and the Internet^[16, 17, 18, 19, 20, 21]. Hyperbolic headlines like those above were commonplace, with consulting firms, trade organizations, politicians, and other respected authorities raising the alarm about ostensibly unprecedented electricity demand growth for computers.

This period coincided with the California electricity crisis, leading to erroneous claims that electricity used by computers was hampering grid reliability (it turned out to mostly be manipulation of markets by Enron and others^[22], enabled by structural flaws in the design of California's power markets). The rapid expansion of the Internet fueled alarming projections, including estimates that data center peak power densities were approaching 300 watts per square foot and that information technology's total electricity use would soon balloon to 50% of US demand. These claims were overblown, as peer reviewed research showed at the time^[17, 18, 19, 20, 21].

That furor created a rush to build new fiber optic capacity, driven by the mistaken belief that Internet data flows "double every 100 days"^[23]. While this rate of increase held for about six months in 1995, data from before and after that six-month period suggest that data flows only doubled every year. The fiber industry used this erroneous factoid to argue that they couldn't possibly build enough fiber capacity to meet the demand, resulting in several high-profile corporate bankruptcies. By 2000, nearly 97% of the fiber network sat idle^[17].

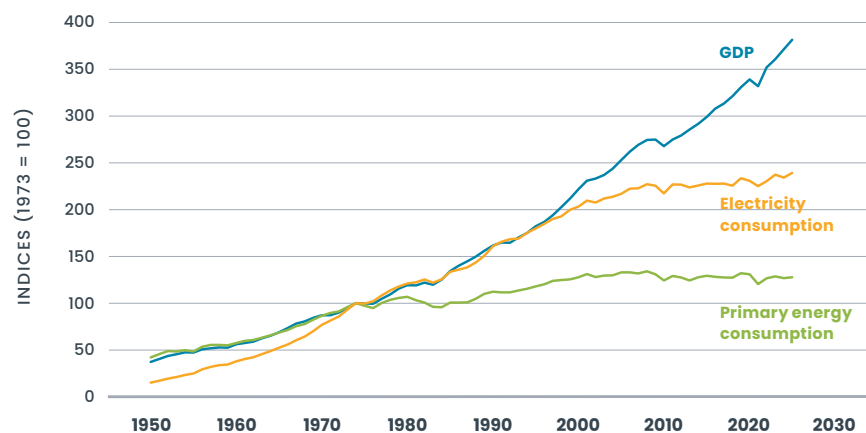
Just because it was hype last time doesn't mean it's hype this time. That's why it's worth looking carefully at the data and evidence to separate fact from fiction.

US and state-level electricity consumption growth in recent years

How seriously should decisionmakers take claims of “explosive” demand growth in the US in the years ahead? Let’s begin with historical electricity consumption data from the US Energy Information Administration.

Changes in the composition and geographic distribution of different industries and economic activities have always influenced US electricity consumption, as have a host of other hard-to-predict factors, from technological developments and behavioral changes to short-term weather variations. Analysis of national US electricity demand shows that there is no evidence for explosive demand growth in recent years, although some states have seen demand growth. Consider **Figure 1**, which shows that US electricity demand growth has been modest in recent years in spite of significant increases in real GDP. Electricity use in 2023 was about the same as in 2018, while 2024 showed about 2.1% growth from 2023.

FIGURE 1. Historical US electricity use, primary energy use, and economic output (GDP) from 1950 to 2024

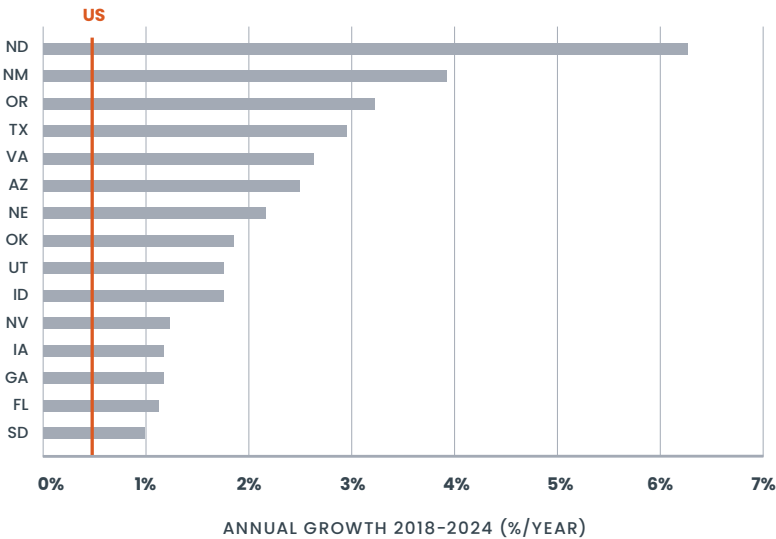


Source: www.eia.gov/opendata/

Average annual electricity sales growth rates varied significantly by state over the period 2018 to 2024, which is the period bracketing the recent pandemic (it also coincides with the latest period of growth in data center electricity use, see below). **Figure 2** shows those data for the top 15 states as ranked by average annual growth rate in sales from all sectors.

The two biggest states in this grouping in terms of absolute total sales were Texas and Virginia. Most of the other states on this list are smaller so higher growth rates are less surprising. The average annual growth rate for the US over this period was 0.5%/year, while for Texas it was almost 3%/year and for Virginia about 2.5%/year.

FIGURE 2. Historical annual growth/year in total electricity sales by state (2018 to 2024) for the top 15 states by growth rates

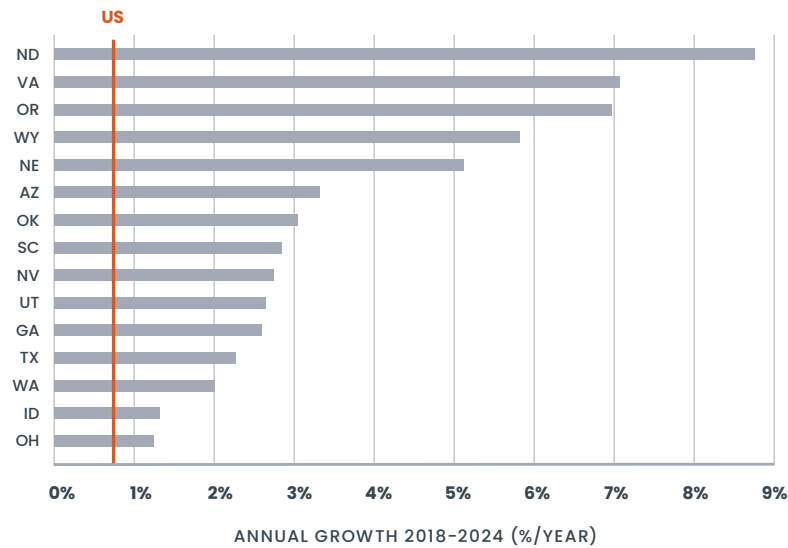


Source: www.eia.gov/opendata/

A similar picture emerges when considering commercial sector growth rates over that same period (2018 to 2024). Most data centers are situated in the commercial sector, though that varies by state. **Figure 3** shows the top 15 states ranked this time by commercial sector growth rates over the same period. The average annual growth rate for the US commercial sector over this period was 0.8%/year.

Virginia and Texas are still the two largest states in a set of fast-growing states, but when considering just the commercial sector, Virginia jumps up in the rankings to second place, with a growth rate of about 7%/year. Commercial sector growth in Texas was a little over 2%/year.

FIGURE 3. Historical annual growth/year in commercial sector electricity sales by state (2018 to 2024) for the top 15 states by commercial-sector growth rates



Source: www.eia.gov/opendata/

In sum, overall US electricity demand is growing, but the pace is moderate and growth is highly uneven, driven largely by specific regions and sectors such as data centers.

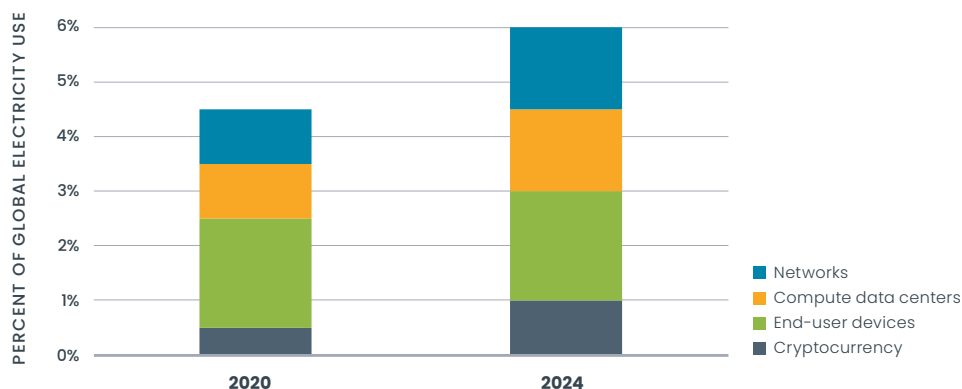
Aggregate electricity consumption of computing equipment

Centralized information technologies can be broadly divided into two categories: compute data centers, which run AI and other cloud services, and networks, which focus on transmitting and routing data. While these categories may overlap, their energy profiles can differ.

According to Malmodin et al. ^[24], compute data centers and networks each consumed about 1% of global electricity in 2020, with compute centers rising to 1.5% by 2024 according to the IEA ^[25]. End-user devices—such as laptops, desktops, smartphones, and printers—account for an additional 2% of global electricity use, a figure that has remained relatively steady. Cryptocurrency mining, dominated by Bitcoin, has fluctuated between 0.5% and 1%, with large year-to-year variations.

Figure 4 summarizes approximate fractions of global electricity use for these components in 2020 and 2024, based on the references cited in the caption. While compute data centers have grown, they are starting from a small base (1.5% of the total) so the absolute effect of this growth on total demand has been small so far. Total electricity consumption from all computing equipment and networks globally was about 6% of electricity use in 2024.

FIGURE 4. Approximate fractions of total global electricity use represented by different types of computing and network equipment in 2020 and 2024



Sources: Compute data centers and networks in 2020: Malmodin et al. ^[24]. Compute data centers in 2024: IEA ^[25]. networks in 2024 assumed to match compute data center total from IEA (1.5%). End-user devices in 2020 from Malmodin et al. ^[24], with percentage assumed constant to 2024. Cryptocurrency (Bitcoin) totals from Cambridge Bitcoin Energy Consumption Index (<https://ccaf.io/cbnsi/cbeci>) divided by electricity consumption totals from IEA ^[26].

Electricity use for compute data centers in the US is higher, because the US has expanded its data centers faster than have many other places. According to the Lawrence Berkeley National Laboratory's December 2024 report ^[27], US data centers used about 4.4% of US electricity in 2023, up from about 2% in 2018. Unfortunately, we don't have comparable data on end-user devices, cryptocurrency, and networks for the US as we do for the world.



Historical compute data center electricity demand growth

Most estimates of data centers' electricity use have been conducted at the global level, with some regional disaggregation. **Figure 5** summarizes the most important global estimates for data centers in recent years. These data only include compute data centers and exclude network providers and cryptocurrency. AI data centers are implicitly included within the category of compute data centers, and are sometimes explicitly identified, but have been relatively small until recently.

The peer reviewed estimates are those by Koomey ^[28], Masanet et al. ^[29], and Malmudin et al. ^[24]. These are shown as circles of different colors. From 2000–2005, data centers' electricity use doubled, then growth moderated between 2005–2010, and significantly slowed down in the decade after that. By 2018–2020, data centers used a little under 1% of the world's electricity.

The second group of data is from two organizations with some topic knowledge that produced nonpeer-reviewed estimates for 2021 from iMasons ^[30, 31] and for 2022 and 2024 from the International Energy Agency (IEA) ^[25, 26, 32]. iMasons is an industry group of the world's top data center designers, builders, and operators. IEA is a government-sponsored institution that tracks energy consumption and production trends globally and regionally. These data points are colored squares.

The iMasons estimate for 2021 is close to the 2020 data point from Malmudin et al. The IEA 2024a estimate for 2022 ^[32] is about 50% higher than Malmudin's 2020 data point. Unfortunately, the IEA report does not give enough information to determine how it arrived at this figure. It could indicate substantial recent growth, or it could be anomalous; nobody knows yet.

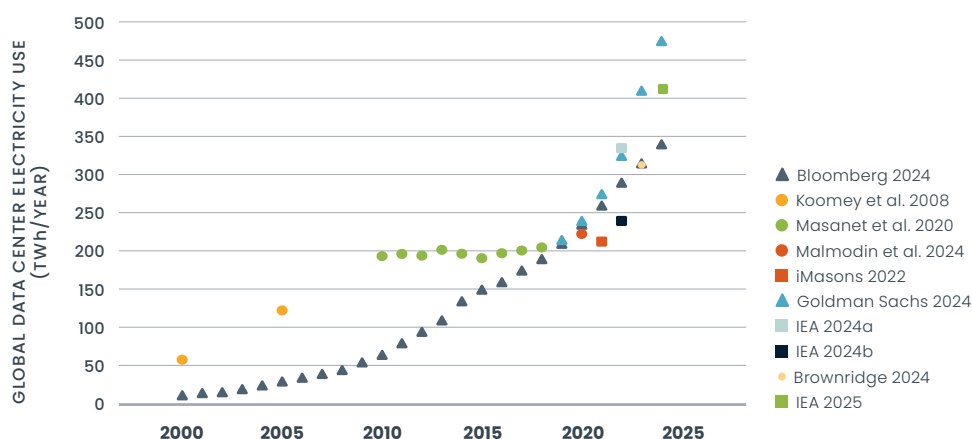
In October 2024, IEA released its World Energy Outlook ^[26], which gave a range of 240 to 340 TWh/year for total compute data center electricity use in 2022 (p. 186). This report is IEA 2024b in Figure 5. The top end of that range corresponds to the earlier IEA estimate, while the bottom end is closer to iMasons' and Malmudin's estimates. This report also does not give enough detail to determine how it arrived at these figures. The IEA 2025 report gives ^[25] a figure of 415 TWh/year for 2024, which is about 1.5% of global electricity use in that year. It is not clear exactly how this number was derived or how it relates to the range for 2022 given in one of the earlier IEA reports.

The other three estimates are from Bloomberg ^[33], Goldman Sachs ^[11], and Brownridge ^[13]. These data points are colored triangles. The three firms are analysis shops that are ostensibly credible, but some of these estimates should give one pause. The Bloomberg numbers pre-2020 are particularly concerning, given how low these estimates are compared with the peer-reviewed literature. The estimates for all three of these sources post-2020 are in the same ballpark as the first IEA number but given the lack of transparency for the data and methods for these estimates, it is impossible to know how accurate they are.

As time passes, more data will become available to determine whether the projected short-term growth post-2020 is a real phenomenon. Credible analysis always lags events in this space, which is often frustrating to policymakers.

In sum, the peer-reviewed literature on the electricity use of compute data centers points to a previous period of rapid growth (2000 to 2005) followed by slowing growth to 2010, and then much slower growth to 2018. **Growth clearly picked up after that point, but the data and the literature are unclear on whether that growth will continue or will moderate or continue in coming years.**

FIGURE 5. Estimates of global compute data center electricity use for historical years



Brownridge and Bloomberg numbers are almost exactly the same for 2023.

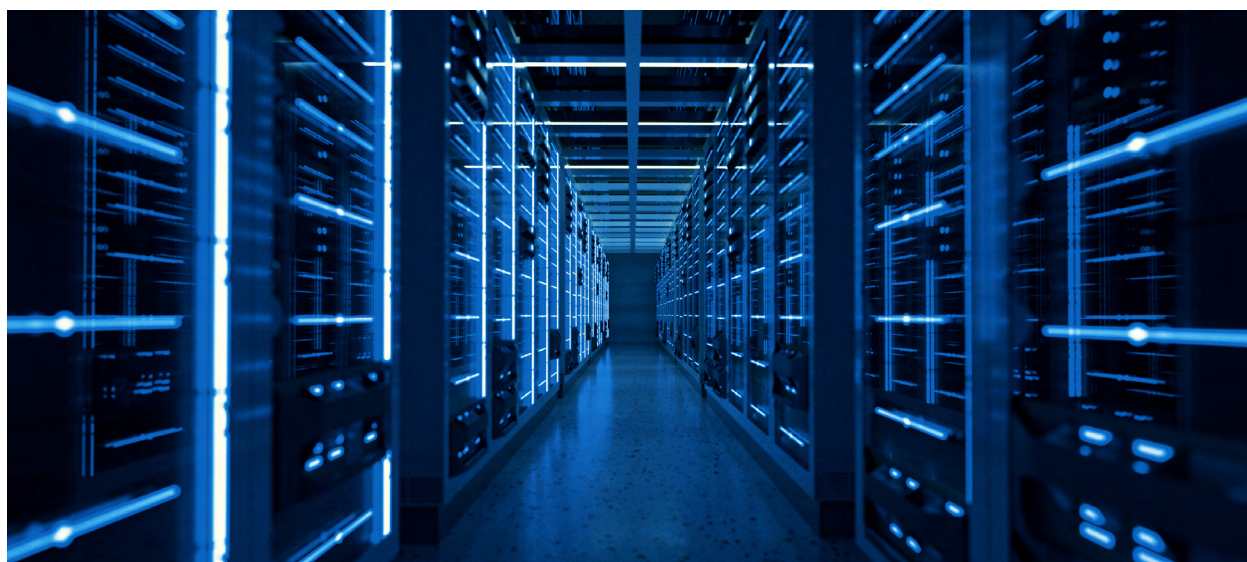
US utilities project increasing demand

While there's been relatively little recent growth in total US electricity demand, utility expectations of future demand growth have shifted since the pandemic.

To understand the relationship between historical electricity use trends and projections, we used data from the Federal Energy Regulatory Commission's Form 714, which compiles utility sector forecasts and historical generation every year for many utilities and most balancing authorities. Although no exhaustive database of forecasts covers the whole US, we compiled data for 14 utilities and balancing authorities representing about three-quarters of US generation in 2023 (see Appendix A for a complete list).

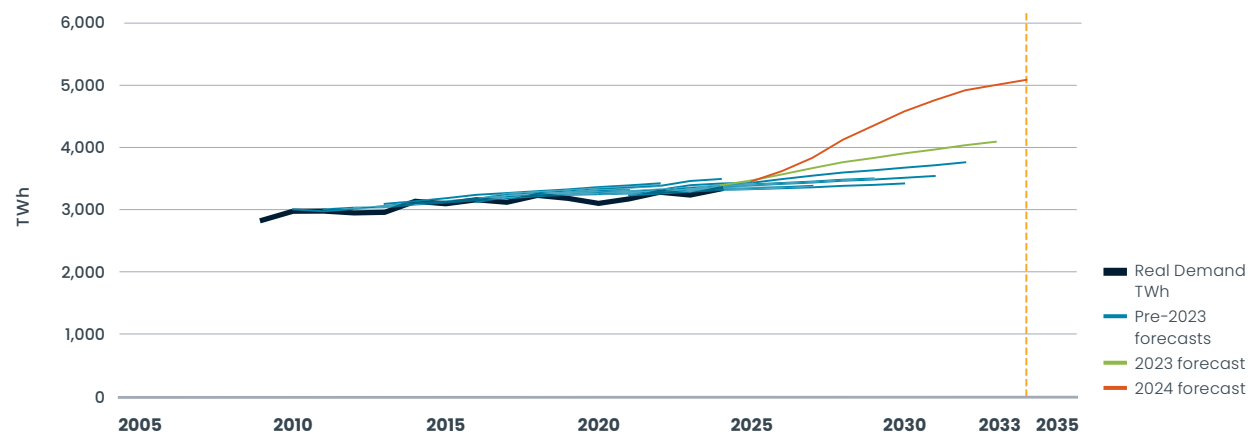
Figure 6 shows forecasts of total demand growth, including data centers (utilities in these balancing authorities often cite data centers as the main reason for growth ^[34]). The sum of 2023 forecasts for the year 2033 is several hundred TWh higher than the sum for 2022 forecasts in 2032 (the first blue line below the 2023 forecast), and the sum of the 2024 forecasts is more than 900 TWh above the 2023 forecasts for 2033. Clearly utilities expect more growth, but whether that growth will actually materialize is unclear.

This increase in projected growth is a local phenomenon. In our sample of 2024 forecasts for utilities and balancing authorities, only ERCOT (TX), PJM (Mid-Atlantic), California, and MISO



(Midwest) show significantly increased power projections from 2023 projections, and those account for 55%, 30%, 5.5%, and 4.8% of the 911 TWh/year increase, respectively (95% of the total growth). Understanding what’s driving that projected growth would involve digging into the forecasts for these regions, a task that no one has yet done.

FIGURE 6. Aggregate electricity generation (actual and projected) for a large sample of US utilities



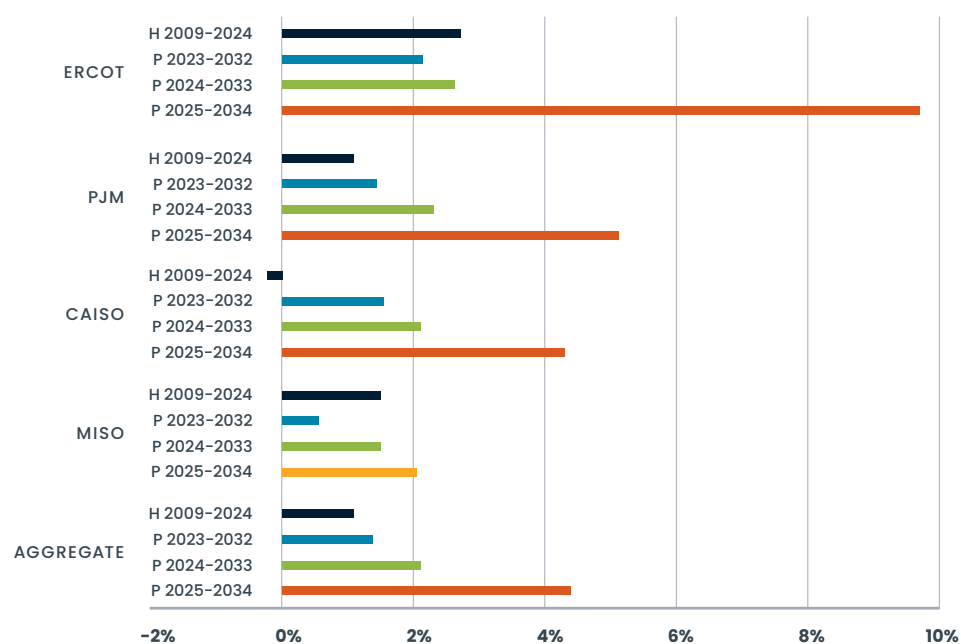
Source: FERC 714 data for utilities responsible for 75% of US net generation.

Figure 7 summarizes the projection data for the four regions showing the most growth plus the aggregate, using the same color coding as in Figure 3. Historical growth is in black, assessed from 2009 to 2024. The 2022 forecast is in blue, the 2023 forecast is in green, and the 2024 forecast is in red. It illustrates just how much the 2024 forecasts diverge from both historical trends and the two preceding forecasts.

For Texas (ERCOT), the latest projection is for more than 9%/year total annual growth, compared to almost 3%/year annual growth in the period 2018 to 2024 (see Figure 2 above). For PJM, which includes Virginia — home to “Data Center Alley” — as an important constituent part, projected growth is 4.5%/year, compared to 2.5%/year for Virginia from Figure 2. If average annual growth were measured relative to 2009 (as shown in Figure 7) that growth would be uniformly lower than what Figure 2 shows for the 2018 to 2024 period

Of course, this comparison doesn’t mean the forecasters are wrong. The forecasts could be picking up real new growth. But the rapid increase suggested by the 2024 forecast is striking enough that it is surely worthy of more detailed study.

FIGURE 7. Annual growth rates in net generation, historical and projected for four balancing authorities and an aggregate representing ¾ of US generation



Source: FERC 714 data. Aggregate is a total for utilities responsible for 75% of US net generation.

There are reasons to be skeptical of these projections ^[35].

Data center developers consider multiple states as possible locations for data centers, and they query multiple utilities simultaneously for electricity rates and incentives prior to making a final selection. Therefore, counting data center project proposals to forecast load growth can result in overestimation of data centers likely to be built in a specific service territory. Only national or regional level tracking of these projects can give an accurate picture, but such tracking currently does not exist, at least in a publicly available form. Some double counting is likely.

In early 2025, the CEOs of Constellation Energy and Vistra Energy both raised concerns about forecasts overestimating data center growth.* James Burke, CEO of Vistra, is quoted as saying:

“We think these interconnect queues ... may be overstated anywhere from three to five times what might actually materialize either in regulated markets or competitive markets.”

* ieefa.org/resources/risk-ai-driven-overbuilt-infrastructure-real

On the other hand, compute data centers are not the only potential source of load growth. Crypto data centers, electric vehicles, electrification of heat in buildings, and electrification of industrial processes may all contribute to growth in the medium to longer term ^[25, 26].

The growth of two major factors will determine the impact of new computing applications on electricity demand:

- Service demand, as determined by the quantity of computations being performed
- Computing efficiency, as determined by the amount of energy required to perform each computation.

As segments of the computing industry grow rapidly, an additional third factor may come into play in the form of limits on industrial production capacity to supply AI chips and servers, to expand the infrastructure needed to build new data centers (such as backup power generators), and to modernize the electricity grid. These three drivers are interdependent, and their trajectory in coming years is difficult to predict ^[34].

Utility projections reflect the current conventional wisdom that demand for AI compute services is, if not infinite, at least so high that the technology industry will be able to use all the AI infrastructure they can build. That assertion is at best an untested hypothesis, not a certainty.

The conventional wisdom also assumes that training of AI models will continue to improve fastest by using scale, i.e., building the biggest models with the fastest computers and the largest datasets. That method has worked well in the recent past, with all efficiency gains plowed back into performance. It is an open question as to whether that will be the best or cheapest way to improve AI performance in the future, especially as new entrants like Deepseek and Z.ai demonstrate ways to produce comparable model results with one or two orders of magnitude less computing power ^[36].

In sum, data center electricity use forecasts contain inherent uncertainty on potential growth in service demand (the amount of compute we'll use) and growth in efficiency of delivering that service demand. There are also open questions about double counting of data center projects by different utilities ^[37].

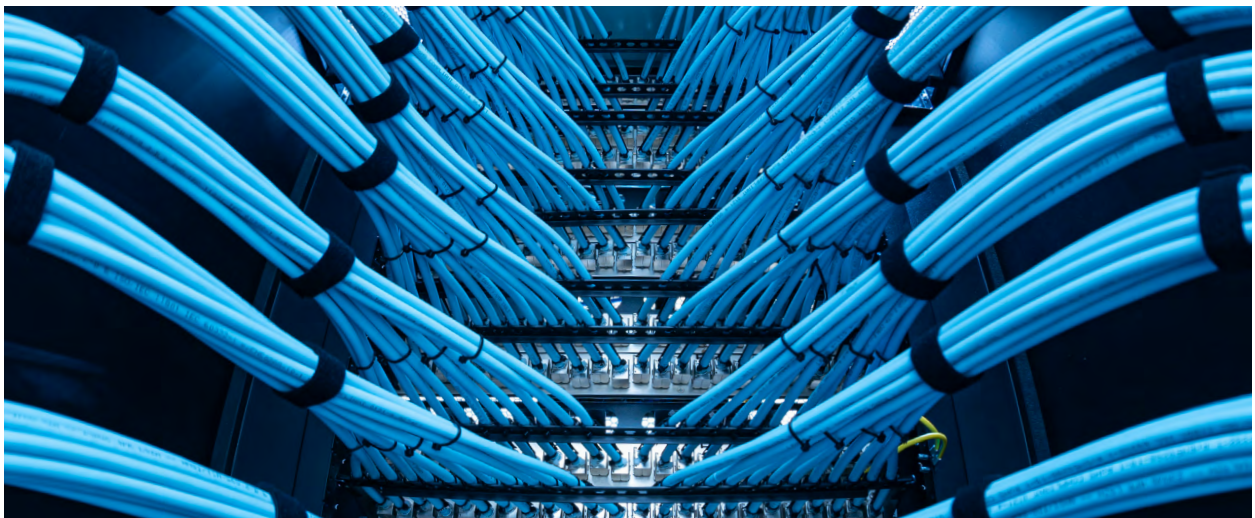
Nobody has any idea how much electricity data centers will use even a few years hence, so it's critical for regulators and utilities to carefully examine the assumptions driving forecasts of "explosive" demand growth in the regions where these projections are emerging.

Lessons learned from historical load forecast analysis

The early 2000s and the first Internet boom offer cautionary anecdotes and historical perspective on the fallacies of over forecasting electricity demand. While today's AI trends are surely unique, it is important to carefully vet industry claims and projected load growth forecasts. Regulators, policymakers, and industry stakeholders should remember:

- There is a well-documented tendency to exaggerate energy and environmental implications of data centers. Don't fall for it. ^[18] ^[38]
- Don't take any numbers at face value. Misinformation abounds, so every claim should be checked. Dig into the numbers! ^[21]
- Power utilization effectiveness (PUE) is a measure of infrastructure overhead energy use. Water Usage Effectiveness (WUE) is a measure of onsite data center water use. Extrapolating PUE and WUE results from one facility to many dissimilar facilities is a recipe for disaster.
- PUEs and WUEs vary significantly over time, across seasons, and across facilities

In sum, it is prudent to avoid spreading or acting on “amazing factoids” about energy and environmental implications of data centers until such forecasts and facts have been carefully and independently evaluated.



The bottom line

Projections of massive electricity demand growth driven by AI are widely circulated, but the industry faces serious real-world constraints that point to a more modest and gradual outcome. The core issue is a disconnect between the tech sector's aggressive timelines and the slow, capital-intensive nature of infrastructure development. Utilities and grid operators must invest billions in new power plants, transmission lines, and substations, but these projects are subject to long permitting processes and interconnection delays that can stretch for years or even decades. Moreover, available generation capacity varies by region and is often limited, along with the inability to rapidly upgrade the transmission and distribution infrastructure needed to deliver power to specific locations.

Beyond infrastructure, financial and commercial uncertainties (including likely double counting of data center projects by different utilities) also dampen expectations for runaway load growth. The uncertainty raises the risk of overbuilding utility infrastructure, a concern already voiced by utilities and industry observers who note a growing number of canceled data center proposals or “phantom loads” that never materialize. In response, utilities are increasingly implementing tariffs and minimum-bill obligations that shift financial risk back to developers. Combined with the high capital costs of building new data centers and rising electricity prices, this financial caution acts as a natural brake. Companies must weigh the need to scale against limited capital and the risk of investing ahead of uncertain long-term demand.

The rate of growth will likely be determined less by technological desire and more by the slowest elements of the infrastructure supply chain, specifically the speed at which utilities can secure financing, gain permits, and physically build new generation and transmission. Additionally, increasing energy efficiency in new AI hardware and cooling systems and possibly lower growth in AI service demand may also help to offset the energy appetite of the next generation of data centers, pushing the eventual load growth down from the more aggressive end of current forecasts.

Further reading

- IEA. 2025. *World Energy Outlook Special Report: Energy and AI*. Paris, France: International Energy Agency, Organization for Economic Cooperation and Development (OECD). April. [<https://www.iea.org/reports/energy-and-ai>]. The International Energy Agency creates authoritative reports on many topics, and this one is their latest on AI and energy. It is not possible to replicate all calculations in this report but it is still a useful reference and a great way to understand the global context.
- Koomey, Jonathan, Zachary Schmidt, and Tanya Das. 2025. *Electricity Demand Growth and Data Centers: A Guide for the Perplexed*. Washington, DC: Bipartisan Policy Center. February. [<https://bipartisanpolicy.org/report/electricity-demand-growth-and-data-centers/>]. This white paper gives a readable high-level view of data center load growth in the US, which has mostly been local, but hasn't yet visibly affected national statistics on electricity consumption.
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- NERC. 2025. *Characteristics and Risks of Emerging Large Loads: Large Loads Task Force White Paper*. Atlanta, GA: North American Electric Reliability Council. July. [https://www.nerc.com/comm/RSTCReviewItems/3_Doc_White%20Paper%20Characteristics%20and%20Risks%20of%20Emerging%20Large%20Loads.pdf]. NERC's focus is on power system reliability, and large loads have become a topic of increasing interest recently.
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two were in 2007 and 2016). It is well documented and the calculations are reproducible, which is not true of many reports on this topic. See also their center of expertise on data center energy efficiency: <https://datacenters.lbl.gov>.

Uptime Institute: <https://uptimeinstitute.com>. This organization, comprised of members who own and operate data centers, was founded at the beginning of the data center industry. It has historically focused on data center reliability, with some work on energy use over the years. They offer design services and collect industry statistics from their member organizations.

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APPENDIX

Utilities and balancing authorities included in aggregate forecast tallies in Figure 6

Arizona Public Service Company
Bonneville Power Administration
California Independent System Operator
Duke Energy Carolinas
ERCOT
Florida Power & Light Company
Georgia Power
ISO New England
MISO
NYISO
PJM
Puget Sound Energy
Southwest Power Pool
Tennessee Valley Authority



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