DATA CENTERS AND THE POWER SYSTEM

A Primer

Spring 2024

NESCOE

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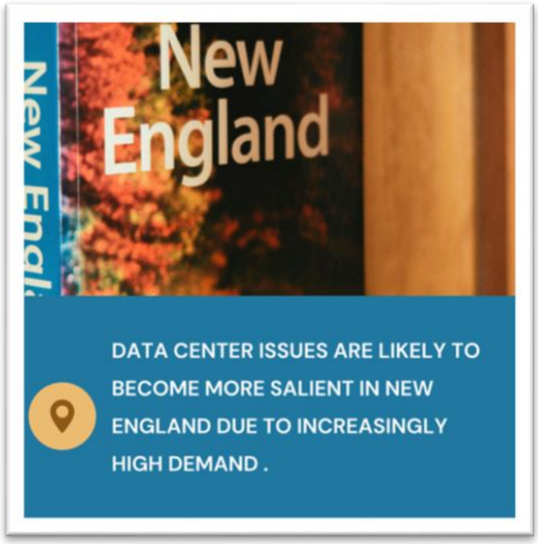
New England States Committee on Electricity

Executive Summary

The U.S. is the world's leader in data center development, accounting for roughly 40 percent of the global data center market.[1] Fueled by changing work habits during the pandemic, the growth of cloud-based technologies, and the explosion of use of artificial intelligence (AI) technology, data center growth in the U.S. shows no signs of slowing down.[2] Many state and local governments have offered incentives to lure in computing operations, which tend to have extremely large physical footprints and can boost state and community budgets through the hefty property taxes they pay.[3] However, the siting of data centers also presents challenges because they require massive amounts of reliable power to operate 24 hours per day. In fact, power often constitutes the largest operating cost for a data center, as electricity is required to run a data center's servers, cooling systems, storage systems, networking equipment, backup systems, security systems, and lighting. While power requirements for a data center can vary significantly depending on the facility's scale and design, the largest data centers can range from 100,000 square feet to several millions of square feet and can demand anywhere from 20 to over 100 MW of power.[4]



This magnitude of required power presents a host of challenges related to grid capacity and transmission infrastructure. Recently, data center operators have been shifting demand towards around the clock behind-the-meter power with back up capability from the grid, which adds to the grid management challenges. A key issue related to these grid-related challenges is the question of who should pay for data center-related grid improvement costs and whether these costs outweigh data centers' economic development benefits.

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1 McKinsey & Company, *Investing in the Rising Data Center Economy*, available at https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/investing-in-the-rising-data-center-economy.

2 In 2023, primary market supply grew 26% year-over-year to 5,174.1 MW. An all-time high of 3,077.8 MW was under construction in primary markets, a 46% year-over-year increase. CBRE, *North America Data Center Trends H2 2023*, available at https://www.cbre.com/insights/reports/north-america-data-center-trends-h2-2023.

3 Evan Halper, *Amid Explosive Demand, America is Running out of Power*, The Washington Post (Mar. 7, 2024), available at https://www.washingtonpost.com/business/2024/03/07/ai-data-centers-power/.

4 DGTL Infra Real Estate 2.0, *Data Center Power: A Comprehensive Overview of Energy*, available at https://dgtlinfra.com/data-center-power/.

To date, New England has remained mostly out of the fray when it comes to the issue of data centers. Unlike Northern Virginia, which hosts the greatest number of data centers in the U.S., New England may offer comparably fewer locational benefits and incentives. While Virginia was an early adopter of tax incentives for data centers, Connecticut is the only state in New England that offers data center tax incentives, having done so in 2021.[5] Likewise, where Virginia offers many locational advantages, including low latency,[6] large amounts of space, and relatively inexpensive real estate, New England real estate is harder to come by and comparatively expensive. New England is also located far from large swaths of the East Coast's population centers, creating latency issues. Finally, Virginia offers relatively cheap access to readily available power sources while power in New England is more expensive than in other areas of the country for a variety of reasons.

Although New England currently has relatively few data centers and is not today a major market for data center development, data center issues are likely to become more salient due to increasingly high demand for new data centers. Already, this growing demand has led to increased data center development in secondary markets as primary markets become saturated and power and land availability becomes an issue.[7]

As the potential for data center development eventually spreads further into New England, the New England states, and the region as a whole, will have to weigh the costs and benefits of data center development and grapple with issues such as whether or not to offer data center tax incentives, how to deal with data center sustainability issues, how regional system planning will account for data center demand, and how the region will allocate costs for any necessary transmission infrastructure upgrades. As explained further below, some states that have historically offered tax incentives for data centers are rethinking their policies as the costs and benefits of data center development shift with increased demand and industry growth. Thus, New England states will be well-served to think through data center issues and implications at this early stage.

NESCOE offers the following data centers primer to the New England states for the purpose of becoming more familiar with the topic. This primer was developed as part of an information gathering exercise and is not intended to be exhaustive in terms of topics covered or to be relied upon as an expert-level guidance document. Further, this primer does not express a point of view about data centers and none should be inferred. NESCOE hopes that by providing this high-level background information, the New England states can better understand the potential challenges and opportunities associated with data center development in the region as

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5 *See* Francisco Uranga, *Plans for Massive Data Center Linked to Nuclear Power Spark Debate on Connecticut's Energy Future*, CT Examiner (Apr. 8, 2024), available at https://ctexaminer.com/2024/04/08/plans-for-massive-data-center-linked-to-nuclear-power-spark-debate-on-connecticuts-energy-future/. There may be cases where municipalities have offered data centers incentives to locate within their boundaries.

6 "Latency" refers to the delay that occurs when a system has to wait for data to complete its transit. When a data center is located too far from its customers, latency becomes an issue. Equinix, *What is Latency and How Can You Address It?*, available at https://blog.equinix.com/blog/2023/03/01/what-is-latency-and-how-can-you-address-it/.

7 Data Center Knowledge, *Data Centers Push into New Territories in Pursuit of Energy, Space*, available at https://www.datacenterknowledge.com/buildconstruction/data-centers-push-new-territories-pursuit-energy-space.

governments play a vital role in ensuring that any data center development is undertaken in a sustainable way via policies, incentives, and regulations.

What is a Data Center?

Data centers have their roots in the huge computer rooms of the 1940s when early computer systems were complex to operate and maintain and required a special environment in which to function. During the boom of the microcomputer industry in the 1980s, computers could be used almost anywhere, but companies needed to house networking equipment and servers in specialized rooms—the first "data centers." The boom in modern data centers occurred during the dot-com bubble of 1997–2000 when companies needed fast internet connectivity and non-stop operation to deploy systems and establish a presence on the fast-growing internet. For many companies, installing such equipment on-site was not viable. Many companies started building very large facilities called "Internet Data Centers," which provided enhanced capabilities such as cooling and backup connectivity.

Today, a data center is a physical facility that organizations use to house their critical network of computing and storage resources that enable the delivery of shared applications and data. The key components of a data center design include routers, switches, firewalls, storage systems, servers, and application-delivery controllers. Data center components require significant infrastructure to support the center's hardware and software. These include power subsystems, uninterruptable power supplies (UPS), ventilation, cooling systems, fire suppression, backup generators, and connections to external networks.[8]

There are several different types of data centers, including on-premises data centers, colocation data centers, and hyperscalers/cloud service providers.[9] On-premises data centers are becoming a thing of the past as most data center growth in the U.S. today is focused on hyperscalers/cloud service providers and colocation facilities.

A **colocation data center**, also known as a multitenant data center, is a vast facility that numerous organizations use and share. Colocation in a data center refers to the practice of placing privately-owned servers and networking hardware in a facility owned by a third party. Under this type of arrangement, an organization can own and control its own physical assets. For example, Bridgewater State University houses

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8 Cisco, *What is a Data Center?*, available at https://www.cisco.com/c/en/us/solutions/data-center-virtualization/what-is-a-data-center.html.

9 Equinix, *What is a Data Center? What are Different Types of Data Centers?*, available at https://blog.equinix.com/blog/2022/10/13/what-is-a-data-center-what-are-different-types-of-data-centers/#.

some of its computing infrastructure at an offsite colocation data center in Boston.[10] Additionally, prominent cloud companies such as Amazon Web Services and Google Cloud have long been major customers for co-location companies.[11] Such arrangements provide advantages such as cost reduction, improved security, reliability, capacity for growth, and adherence to industry regulations.

Hyperscalers provide cloud computing and data management services to organizations that require vast infrastructure for large-scale data processing and storage. There is no universal standard for what should be classified as a hyperscaler, but major cloud providers such as Amazon Web Services, Google Cloud, Microsoft Azure, IBM Cloud, and Alibaba Cloud fit the description.

Data Center Emergence & Growth Projections

Today, the demand for new data center development in the U.S. (measured by power consumption to reflect the number of servers a data center can house) is soaring and was expected to reach 35 gigawatts (GW) by 2023, up from 17 GW in 2022.[12] Some experts project an estimated 10–12 percent increase in global data center demand between 2020 and 2030, with global data center demand potentially reaching 126–152 gigawatts (GW) by 2030, driving approximately 250 terawatt hours (Twh) of new electricity demand over the period, reaching eight percent of total U.S. power demand in 2030.[13]

The U.S. accounts for roughly 40 percent of the global data center market.[14] This demand is being fueled by exponential growth in data volumes, with a predicted tenfold increase in data levels between 2018 and 2025.[15] The demand for data center development is also being driven by the rise of AI and continued growth in the

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10 *See* https://www.markleygroup.com/bridgewater-state-case-study.

11 McKinsey & Company, *Investing in the Rising Data Center Economy*, available at https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/investing-in-the-rising-data-center-economy.

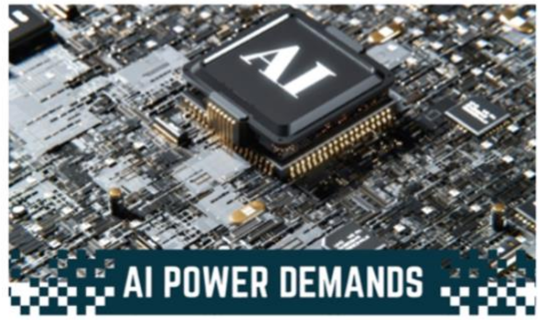
12 McKinsey & Company, *Investing in the Rising Data Center Economy*, available at https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/investing-in-the-rising-data-center-economy.

13 Bank of America, *2024 Power x Data Center Conference Recap: Harder to Achieve than it Looks* (Mar. 27, 2024), available at https://urldefense.proofpoint.com/v2/url?u=https-3A__rsch.baml.com_r-3Fq-3DJmNbgpL2xURaSYu0iR4h-21Q-26e-3Djulien.dumoulin-2Dsmith-2540bofa.com-26h-3DrKvysg&d=DwMDaQ&c=euGZstcaTDllvimEN8b7jXrwqOf-v5A_CdpgnVfiiMM&r=SpoDmtyOxm-iwg6Mj5MSrkbEUN8LrcwoLfWd-p8v9Nk&m=3hTHQb1_sFeRroH123dU0B8hq4Cir4VluE_6GmU3eYJojSjwk7zGTJjSmH7seXCU&s=l4GEPeNDx3kBpyPneebGRmQ6qYOp7hB05BfaDIv-1Yo&e=.

14 *Id.*

15 Some predict that 175 zettabytes of data will be in existence by 2025, which, if one attempted to download at the current average internet speed, would take 1.8 billion years. *See* Fortinet, *What is a Data Center?*, available at https://www.fortinet.com/resources/cyberglossary/data-center.

cloud and hyspercale markets.[16] For example, large language AI models like ChatGPT grew from 100 million monthly users in January 2023 to 100 million active weekly users by November 2023.[17] Synergy Research Group has forecasted that over the next six years, the average capacity of hyperscale data centers will be more than double that of current operational hyperscale facilities.[18] As buildouts continue, providers must now consider the ability of a data center's surrounding energy grid to support a steep increase in AI-related workloads.[19] While hyperscalers have typically accounted for around 40% of overall server market volumes, some project that hyperscalers and other service providers will account for 76% of AI server units in 2024.[20]



The average power draw of a full stack of servers in an AI data center can reach 50 kW or more per rack, compared with roughly 7 kW in a conventional data center. AI data centers must be built with added infrastructure capable of supplying a much higher amount of power.

As AI becomes a defining characteristic for hyperscale data center operations in 2024, it will involve the large-scale deployment of Graphics Processing Units (GPUs). In other words, AI data centers have far more servers running high-performance chips than conventional data centers.[21] As a result, the average power draw of a full stack of servers in an AI data center can reach 50 kilowatts (kW) or more per rack, compared with roughly 7 kW per rack in a conventional data center.[22] Due to their large power draw, AI data centers must be built with added infrastructure capable of supplying a much higher amount of power. Because the extra power usage creates more heat, AI data centers also need alternative cooling methods, such as liquid cooling systems, to prevent equipment from overheating.[23]

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16 Data Center Knowledge, *New Markets Opening Up Amid US Data Center Boom*, available at https://www.datacenterknowledge.com/buildconstruction/new-markets-opening-amid-us-data-center-boom-jll.

17 *Id.*

18 Data Center Knowledge, *Hyperscalers in 2024: Where Next for the World's Biggest Data Center Operators?*, available at https://www.datacenterknowledge.com/buildconstruction/hyperscalers-2024-where-next-world-s-biggest-data-center-operators.

19 *Id.*

20 *Id.*

21 Angus Loten, *AI-Ready Data Centers Are Poised for Fast Growth*, The Wall Street Journal (Aug. 3, 2023), available at https://www.wsj.com/articles/ai-ready-data-centers-are-poised-for-fast-growth-fadae952.

22 *Id.*

23 *Id.*

To date, data center development in the United States has been concentrated primarily in a handful of states, with the core data center market having been centered in Northern Virginia and California.[24] For example, as of March 2024, Virginia has 245 data centers owned by 52 operators, covering 25,000,000 square feet, and consuming 3.6 GW of power. In fact, Northern Virginia has the most data centers in the country and handles more than a third of the world's online traffic.[25] Initially, Northern Virginia's proximity to the nation's capital made it ideally situated to host data centers, with a federally funded precursor to the internet, created to link the Department of Defense with research institutions and universities, creating a need for data storage.[26] America Online later moved its corporate headquarters to Loudoun County, Virginia bringing investments in fiber-optic cable and energy infrastructure.[27] Add to these factors the fact that it had plenty of affordable land, low-cost energy, little threat of natural disasters, and one of the only data center incentives when it enacted its first data center tax exemption in 2009, Northern Virginia became an ideal place to site data centers.[28]

California is another data center hotspot, with 208 data centers owned by 63 operators—53 of which are located in Santa Clara alone.[29] Because these markets are becoming tapped out in terms of available power, new secondary markets have popped up in places like Columbus, Ohio, Salt Lake City, Reno, and Austin, Texas.[30] In choosing a data center location, the availability of power is the first and foremost consideration, ahead of all other considerations such as fiber backbones, tax incentives, and available land.[31] However, the cost of power in different locations can also be a determinant in terms of data center location. For example, Silicon Valley is powered by Pacific Gas & Electric (PG&E), except for the city of Santa Clara, which has its own power company and where power is about 25% cheaper than PG&E (despite the fact that the area is seismically active, which

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24 Bank of America, *2024 Power x Data Center Conference Recap: Harder to Achieve than it Looks* (Mar. 27, 2024), available at https://urldefense.proofpoint.com/v2/url?u=https-3A__rsch.baml.com_r-3Fq-3DJmNbgpL2xURaSYu0iR4h-21Q-26e-3Djulien.dumoulin-2Dsmith-2540bofa.com-26h-3DrKvysg&d=DwMDaQ&c=euGZstcaTDllvimEN8b7jXrwqOf-v5A_CdpgnVfiiMM&r=SpoDmtyOxm-iwg6Mj5MSrkbEUN8LrcwoLfWd-p8v9Nk&m=3hTHQb1_sFeRroH123dU0B8hq4Cir4VluE_6GmU3eYJojSjwk7zGTJjSmH7seXCU&s=l4GEPeNDx3kBpyPneebGRmQ6qYOp7hB05BfaDIv-1Yo&e=.

25 Governing, *The Data Center Capital of the World is in Virginia*, available at https://www.governing.com/infrastructure/the-data-center-capital-of-the-world-is-in-virginia.

26 *Id.*

27 *Id.*

28 *Id.*

29 Data Center Knowledge, *Data Centers Push into New Territories in Pursuit of Energy, Space*, available at https://www.datacenterknowledge.com/buildconstruction/data-centers-push-new-territories-pursuit-energy-space.

30 *Id.*

31 *Id.*

would normally be a deterrent).[32] The availability of relatively cheaper power had led to the heavy concentration of data centers in Santa Clara.

Another factor that plays into the location of data centers is the type of data center and its associated needs. For example, cloud service providers tend to pick isolated areas with cheap, plentiful, and renewable energy sources (e.g., the tiny town of Quincy in Washington has almost a dozen data centers because it has plenty of room and lots of hydroelectric power from the Columbia River).[33] However, colocation providers tend to stick to cities because customers tend to want to be close to their equipment.[34] The closer a data center is to an end user, the lower the latency.[35]

Economic Incentives

Across the country, several state and local governments have offered incentives to lure in computing operations, which, while generating few jobs,[36] tend to have extremely large physical footprints and can boost state and community budgets through the hefty property taxes they pay.[37]

Historically, most tax incentives were offered by state governments and were designed to encourage business development and job creation. The federal government was not a major player in offering tax advantages to the data center industry. A typical example is Maryland's sales and use tax exemption for data centers. Data center providers who build new facilities in Maryland or expand existing ones and who also create full-time jobs are exempted from paying sales and use tax on data center equipment.[38] North Carolina has a similar offering that extends to sales and use tax breaks on electricity consumed by data centers in addition to data center equipment.[39] For a more detailed list of tax incentives by state, see Appendix A. There are limited examples of

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32 *Id.*

33 *Id.*

34 *Id.*

35 *Id.*

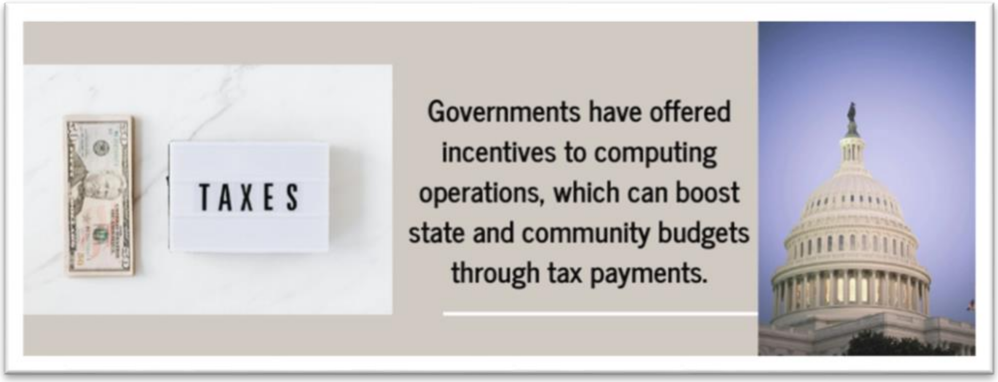
36 Typical headquarters, manufacturing, or shared service operations can have between 200 and 1,000 jobs onsite. By comparison, the number of jobs at a typical data centers can be anywhere between five and 30. *See* Area Development, *The Mystery Impact of Data Centers on Local Economies Revealed*, available at https://www.areadevelopment.com/data-centers/Data-Centers-Q1-2015/impact-of-data-center-development-locally-2262766.shtml. Additionally, it seems as though many data center employees are hired for short-term work through contractors rather that by the computing companies that are developiong large data centers. *See* Alana Samuels, *Big Tech is Coming to Sma-Town America, But There's a Catch*, TIME (Aug. 4, 2021), available at https://time.com/6085525/big-tech-data-centers/.

37 Evan Halper, *Amid Explosive Demand, America is Running out of Power*, The Washington Post (Mar. 7, 2024), available at https://www.washingtonpost.com/business/2024/03/07/ai-data-centers-power/.

38 *Id.*

39 Data Center Knowledge, *The State of Data Center Tax Incentives and Legislation in 2023*, available at https://www.datacenterknowledge.com/business/state-data-center-tax-incentives-and-legislation-2023#close-modal.

local governments providing tax breaks for data centers. For instance, Loudoun County, Virginia offers sales and use tax reductions comparable to the state tax breaks described above.[40]



Connecticut is currently the only state in New England offering incentives[41] for data centers. Under current rules, developers in Connecticut can apply for a 20-year sales and property tax exemption on data center projects with at least $200 million in investment, or $50 million if the center is built in a state-designated enterprise zone. The benefit can extend to 30 years if the investment reaches $400 million, or $200 million in an enterprise zone.[42]

Despite wide-ranging availability of tax incentives for data centers, many lawmakers have become increasingly skeptical of data center construction incentives. For example, Virginian legislators have proposed laws that would place various restrictions on data center siting and increase scrutiny of data center energy and water use.[43] In Idaho, one lawmaker proposed placing limits on how many financial benefits data center companies can reap from existing tax incentives in the state.[44] And in Georgia, both houses of the state legislature recently passed a bill suspending Georgia's sales tax exemption for certain high-technology data centers and creating a Special Commission on Data Center Energy Planning, though this measure was ultimately vetoed by Governor Brian Kemp.[45] These examples may reflect a growing realization that the economic benefits of data center

40 *Id.*

41 The tax incentives were approved in 2021. *See* Francisco Uranga, *Plans for Massive Data Center Linked to Nuclear Power Spark Debate on Connecticut's Energy Future,* CT Examiner (Apr. 8, 2024), available at https://ctexaminer.com/2024/04/08/plans-for-massive-data-center-linked-to-nuclear-power-spark-debate-on-connecticuts-energy-future/.

42 *Id.*

43 Data Center Knowledge, *The State of Data Center Tax Incentives and Legislation in 2023*, available at https://www.datacenterknowledge.com/business/state-data-center-tax-incentives-and-legislation-2023#close-modal.

44 *Id.*

45 *See* Thompson Hine, *Georgia Suspends Tax Break and Creates Special Committee to Study Energy-Intensive Data Centers*, available at https://www.thompsonhine.com/insights/georgia-suspends-tax-break-and-creates-special-committee-to-study-

construction are limited. Modern data centers are largely automated and do not require much maintenance personnel and thus do not create many new jobs or spur major revenue generation that benefits local businesses.[46] Some countries, such as Sweden and the Netherlands have eliminated or are reconsidering tax incentives for data centers because the facilities have not created the number of jobs advertised and do not pay much in taxes, thus failing to serve as growth engines for local communities.[47]

Another notable trend in tax incentive policy is an increased push by the federal government to reward data center operators which prioritize sustainability. For example, several provisions in the Inflation Reduction Act of 2022 advanced this goal by providing financial rewards for purchasing carbon-reducing equipment inside data centers.[48]

Data System Power Needs

With the explosive growth of digital data, data centers have become essential for organizations to stay competitive and meet the needs of their users.[49] Data centers enable businesses to store and access data securely and efficiently, while also providing the processing power needed to run complex applications and services.[50] Additionally, data centers can be configured to provide high levels of redundancy[51] availability, ensuring that critical business operations remain uninterrupted even in the event of a hardware failure or power outage.[52] The key attributes of power supply that data center operators are increasingly focused on include: immediacy of power, scalability of the campus, cost, and carbon-free attributes.[53] Data systems cannot

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energy-intensive-data-centers/; Data Center Dynamics, *Georgia Governor Vetoes Bill to Pause Data Center Tax Breaks as Tennessee Expands its Data Center Tax Breaks*, available at https://www.datacenterdynamics.com/en/news/georgia-governor-vetoes-bill-to-pause-data-center-tax-breaks/.

46 *Id.*

47 *Id.*

48 *Id.*

49 Zscaler, *What is a Data Center?*, available at https://www.zscaler.com/zpedia/what-is-data-center#:~:text=Why%20Are%20Data%20Centers%20Important,Networks.

50 *Id.*

51 Nearly all data centers have onsite backup diesel generation intended to provide for customer reliability. *See* Stack Infrastructure, *The Future of Backup Energy Storage is a Mixed Bag of Challenges and Opportunities for Data Centers*, available at https://www.stackinfra.com/resources/blog/the-future-of-backup-energy-storage-is-a-mixed-bag-of-challenges-and-opportunities-for-data-centers/.

52 *Id.*

53 Bank of America, *2024 Power x Data Center Conference Recap: Harder to Achieve than it Looks* (Mar. 27, 2024), available at https://urldefense.proofpoint.com/v2/url?u=https-3A__rsch.baml.com_r-3Fq-3DJmNbgpL2xURaSYu0iR4h-21Q-26e-3Djulien.dumoulin-2Dsmith-2540bofa.com-26h-3DrKvysg&d=DwMDaQ&c=euGZstcaTDllvimEN8b7jXrwqOf-v5A_CdpgnVfiiMM&r=SpoDmtyOxm-iwg6Mj5MSrkbEUN8LrcwoLfWd-

function without power and power often constitutes the largest expenditure for operating a data center. Electricity is required to run the servers, cooling systems, storage systems, networking equipment, backup systems, security systems, and lighting that allow for data storage, management, and distribution.

The power requirements for a data center can vary significantly depending on the scale and design of the facility, as well as its equipment's efficiency. Small data centers, which span from 5,000 to 20,000 square feet and host between 500 and 2,000 servers, may only require 1 to 5 MW of power.[54] Hyperscale data centers, on the other hand, which range from 100,000 square feet to millions of square feet and include tens of thousands of servers, can demand anywhere from 20 to over 100 MW of power.[55]

Data Center Size	Small	Medium	Large (Hyperscale)
Building footprint	5,000 - 20,000 sq ft	20,000 - 100,000 sq ft	100,000 sq ft - millions of sq ft
Server count	500 - 2,000	2,000 - 10,000	10,000 - 100,000+
Power consumption	1 - 5 MW (megawatt = one million watts)	5 - 20 MW	20 - 100+ MW
Design and efficiency	Basic cooling and power management.	Advanced cooling and power management, partial efficiency.	Highly optimized and efficient.

Source: DGTL Infra Real Estate 2.0, *Data Center Power: A Comprehensive Overview of Energy*, available at https://gdtlinfra.com/data-center-power/.

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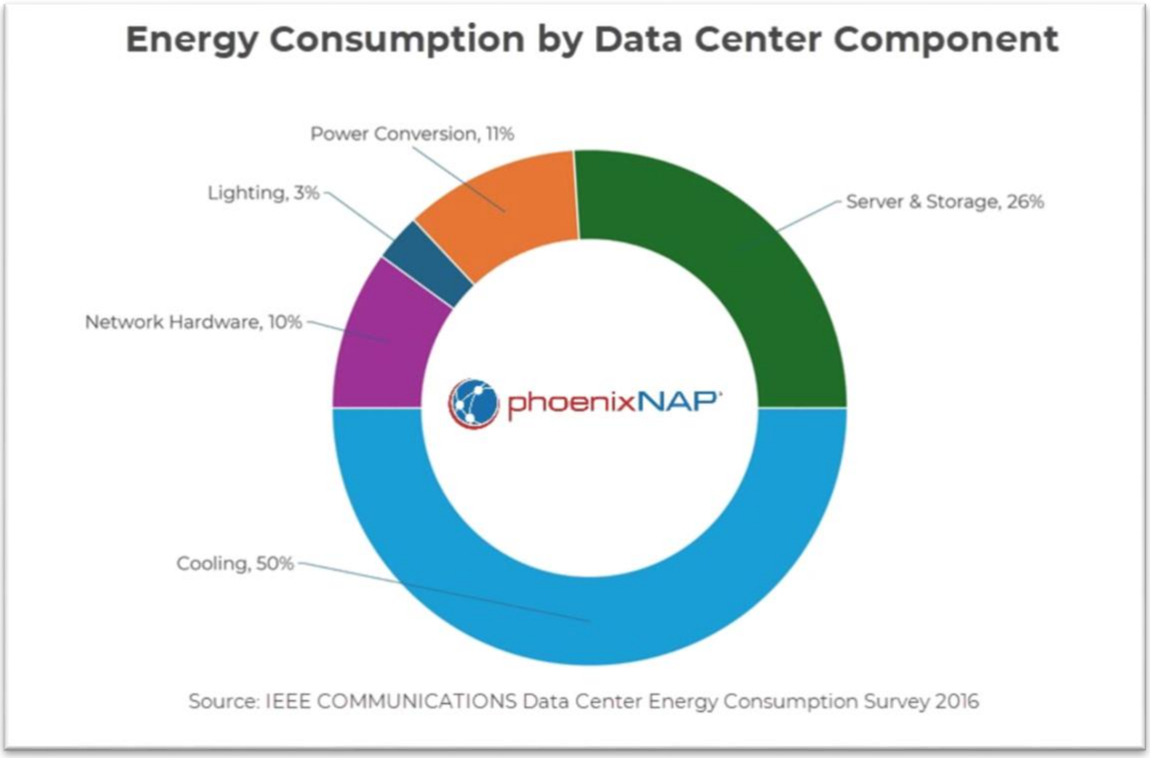
54 DGTL Infra Real Estate 2.0, *Data Center Power: A Comprehensive Overview of Energy*, available at https://dgtlinfra.com/data-center-power/.

55 *Id.*



Existing power markets are already struggling to meet the growing demand created by data centers.[56] For example, in Georgia, demand for industrial power is at a record high, with new electricity use for the next decade estimated to increase dramatically.[57] Arizona Public Service, the largest utility in Arizona, projects that it will run out of transmission capacity before the end of the decade absent major upgrades.[58] Northern Virginia needs the equivalent of several large nuclear power plants to serve all of the new data centers planned and under construction.[59] Texas, which already experiences electricity shortages on hot summer days, faces the same dilemma.[60] Amid the soaring demand, some commercial customers are going to extraordinary lengths to secure energy sources, such as building their own power plants.[61]

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56 Data Center Dynamics, *Newmark: US Data Center Power Consumption to Double by 2030*, available at https://www.datacenterdynamics.com/en/news/us-data-center-power-consumption/.

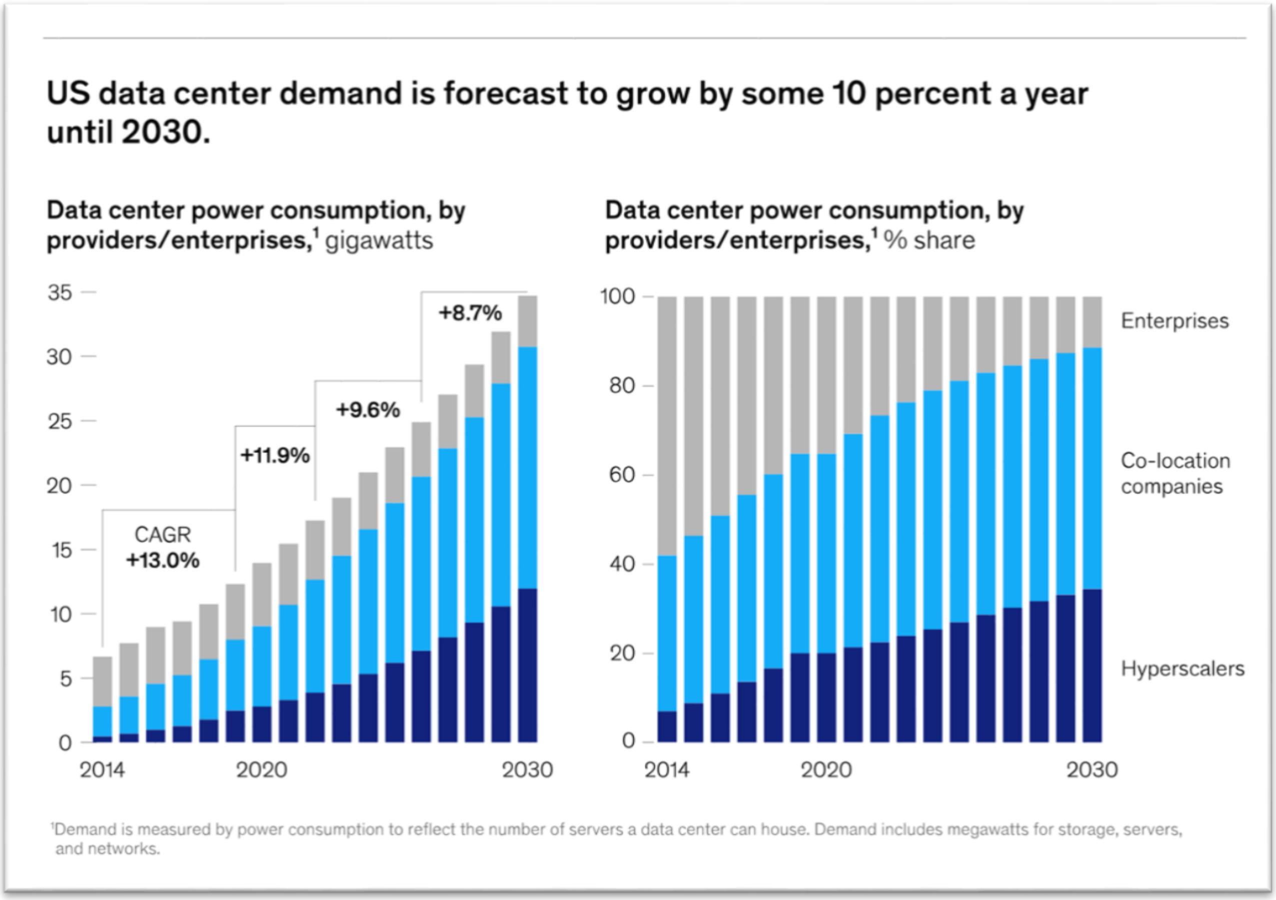
57 Evan Halper, *Amid Explosive Demand, America is Running out of Power*, The Washington Post (Mar. 7, 2024), available at https://www.washingtonpost.com/business/2024/03/07/ai-data-centers-power/.

58 *Id.*

59 *Id.*

60 *Id.*

61 *Id.*



Source: McKinsey & Company, Investing in the Rising Data Center Economy (Jan. 17, 2023).

Off-the-Grid Power

With snowballing industrial growth and limited power supplies, some data center developers are turning to off-the-grid sources of power. For example, a data center planned for Portland, Oregon that requires 60 MW of electricity, will be powered in large part by high-tech fuel cells that convert natural gas into low-emissions electricity.[62] This technology will supplement whatever power it can draw from the grid.[63] The same developers are also planning a project in Texas that will be powered by geothermal energy.[64]

Behind-the-Meter Power

There seems to be a shifting demand from data center operators for around the clock behind-the-meter power. As an example, Talen Energy Company (TLNE), a nuclear-focused independent power producer, recently

62 *Id.*

63 *Id.*

64 *Id.*

announced an agreement with Amazon Web Services (AWS) where it sold the attached data center campus at their Susquehanna nuclear station and signed a long-term power supply agreement for carbon-free power from the plant.[65] The TLNE deal highlights an inflection point in the data center space, shifting towards a growing demand for around-the-clock behind-the-meter power. This type of arrangement adds multiple layers of redundancy as a solution to transmission scarcity and reliability issues. Traditionally, redundancy has been achieved via the use of diesel generators. Given recent growing calls for sustainability in data center development and operation, the around the clock power generation capabilities of nuclear power make it an obvious choice for data center operators given the fact that other forms of low-carbon energy, such as solar and wind, cannot produce power 24 hours per day. The deal also highlights that buy in at the state and local level is important for data center operator success. TLNE has worked with state and local stakeholders, including PJM, for years. The estimated economic development benefits in the Pennsylvania region are estimated to be approximately $10 billion.[66]

Small Nuclear Reactors[67]

As noted above, data center operators face two energy-related challenges in building data center capacity: a shortage of available energy and increasing desire/requirements to reduce carbon emissions. Some data center developers are looking at an emerging nuclear technology known as small modular reactors (SMRs) in an attempt to solve both of these issues.[68] SMR vendors plan to launch commercially available SMRs sometime in the late 2020s to the early 2030s, though a number of hurdles remain (e.g., perfecting the technology, gaining regulatory approval, and developing viable business models).[69]

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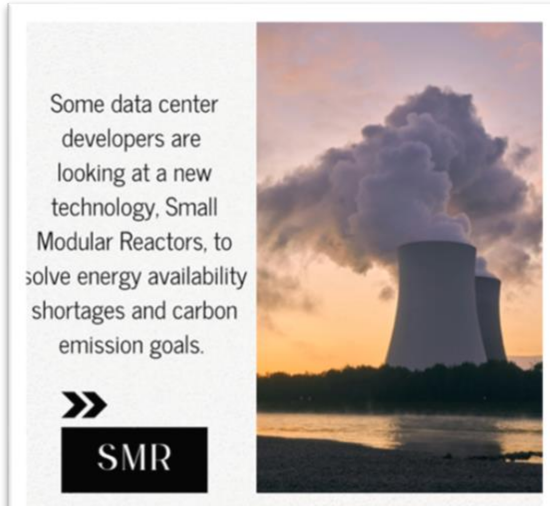
65 Bank of America, *2024 Power x Data Center Conference Recap: Harder to Achieve than it Looks* (Mar. 27, 2024), available at https://urldefense.proofpoint.com/v2/url?u=https-3A__rsch.baml.com_r-3Fq-3DJmNbgpL2xURaSYu0iR4h-21Q-26e-3Djulien.dumoulin-2Dsmith-2540bofa.com-26h-3DrKvysg&d=DwMDaQ&c=euGZstcaTDllvimEN8b7jXrwqOf-v5A_CdpgnVfiiMM&r=SpoDmtyOxm-iwg6Mj5MSrkbEUN8LrcwoLfWd-p8v9Nk&m=3hTHQb1_sFeRroH123dU0B8hq4Cir4VluE_6GmU3eYJojSjwk7zGTJjSmH7seXCU&s=l4GEPeNDx3kBpyPneebGRmQ6qYOp7hB05BfaDIv-1Yo&e=.

66 *Id.*

67 In a recap of its recent 2024 Power x Data Center Conference, Bank of America listed as one of the key themes the fact that "[d]ata center developers are too focused on nuclear SMRs" and suggests that carbon capture and sequestration used with Combined Cycle Gas plants seem ideally positioned for long term offtake deals with data centers, particularly for data centers keen to avoid interconnection challenges. *See id*.

68 Data Center Knowledge, *Going Nuclear: A Guide to SMRs and Nuclear-Powered Data Centers*, available at https://www.datacenterknowledge.com/energy/going-nuclear-guide-smrs-and-nuclear-powered-data-centers#close-modal.

69 *Id.*



SMRs are advanced nuclear reactors with a power capacity of up to 300 MW

SMRs are advanced nuclear reactors with a power capacity of up to 300 MW.[70] There is also an even smaller type of SMR, called a microreactor, which generates up to 20 MW.[71] SMRs are small, modular prefabricated units that can be transported and installed on-site.[72] Multiple units can be installed at a site to get to scale, somewhat like Lego blocks.[73] Since 2014, the DOE has provided more than $600 million to companies to support SMR development efforts. Since 2016, the Energy Department's Gateway for Accelerated Innovation in Nuclear (GAIN) has awarded $31.8 million in funding grants to 52 private companies in the form of vouchers that provide the SMR companies with access to resources and scientific expertise at the Energy Department's national laboratories.[74] There have been several recent SMR developments. For example, in April 2023, Green Energy Partners, a property and project development company, purchased 641 acres for a project that includes using four to six SMRs to power 20 to 30 data centers, generate hydrogen fuel and provide backup power for Virginia's grid.[75] Challenges to adoption include the costs associated with getting the technology supply chain up and running, management of nuclear waste (though much less than large, traditional nuclear plants), and community buy-in to build SMRs in both rural and urban locations.[76] Indeed, one company's plan to launch a six-reactor, 462 MW project with Utah Associated Municipal Power Systems collapsed in early November when several towns withdrew from the project after costs increased.[77]

There are currently no SMRs in commercial operation, but China is building the world's first.[78] In 2023, the U.S. Nuclear Regulatory Commission (NRC) issued its final rule to certify NuScale Power's small modular reactor.[79]

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70 *Id.*

71 *Id.*

72 *Id.*

73 *Id.*

74 *Id.*

75 *Id.*

76 Data Center Knowledge, *Going Nuclear: A Guide to SMRs and Nuclear-Powered Data Centers*, available at https://www.datacenterknowledge.com/energy/going-nuclear-guide-smrs-and-nuclear-powered-data-centers#close-modal.

77 *Id.*

78 Michael Dempsey, *Future Data Centres May Have Built-In Nuclear Reactors*, BBC (Feb. 14, 2024), available at https://www.bbc.com/news/business-68238330.

79 *Id.*

The company's power module becomes the first SMR design certified by the NRC and the seventh reactor design cleared for use in the U.S.[80]

Data Center Sustainability

As noted above, data centers are big energy consumers—a hyperscaler's data center can use as much power as 80,000 households.[81] Likewise, data centers use large amounts of land, create large amounts of e-waste, and require large amounts of water for cooling purposes. Pressure to make data centers sustainable is therefore high, and some regulators and governments are imposing sustainability standards on newly built data centers.[82] Accordingly, many companies are attempting to mitigate cloud facilities' environmental impact. In fact, all the major hyperscale data center operators have some form of sustainability pledges and direction to optimize energy consumption.[83] For example, Microsoft has a sustainability goal to be carbon negative, water positive, and zero waste by 2030.[84] Oracle is committed to matching all worldwide Oracle Cloud Regions with 100% renewable energy by 2025.[85] Google has announced power purchase agreements for more than 700 MW of clean energy and has introduced a water risk framework to evaluate the health of a local community's watershed and establish a data-driven approach to advancing responsible water use in data centers.[86] Governments will play a vital role in ensuring that continued data center development is undertaken in a sustainable way via policies, incentives, and regulations.

Data Center Growth Implications – Power Systems and State Policies

As noted above, data center energy demand has increased dramatically in the last decade and is projected to continue to increase rapidly in the coming years. One data center can require 50 times the electricity of a typical office building according to the U.S. Department of Energy.[87] Multiple-building data center complexes,

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80 *Id.*

81 McKinsey & Company, *Investing in the Rising Data Center Economy*, available at https://www.mckinsey.com/%7E/media/mckinsey/industries/technology%20media%20and%20telecommunications/high%20tech/our%20insights/investing%20in%20the%20rising%20data%20center%20economy/investing-in-the-rising-data-center-economy_final.pdf.

82 Singapore and the Netherlands are examples. *See id.*

83 Data Center Knowledge, *Hyperscalers in 2024: Where Next for the World's Biggest Data Center Operators?*, available at https://www.datacenterknowledge.com/buildconstruction/hyperscalers-2024-where-next-world-s-biggest-data-center-operators.

84 *Id.*

85 *Id.*

86 *Id.*

87 Data Center Knowledge, *Data Centers are Fueling Drive to Old Power Source: Coal*, available at https://www.datacenterknowledge.com/energy/data-centers-are-fueling-drive-old-power-source-coal.

which have become the norm, require as much as 14 to 20 times that amount.[88] Additionally, interconnection and transmission infrastructure issues are pervasive across the country.[89] There is 50–60 GW of new data center power demand that is projected to come online in the near term, but the grid lacks the capacity and transmission infrastructure to deliver it.[90] Accordingly, massive upgrades to existing infrastructure are necessary to meet near-term data center demand.[91] One utility in Pennsylvania estimates that each new data center in its footprint would require $50 to $150 million in grid investment depending on its size and needs.[92] The question of who pays for these massive upgrades remains open but the costs would likely fall on all ratepayers.

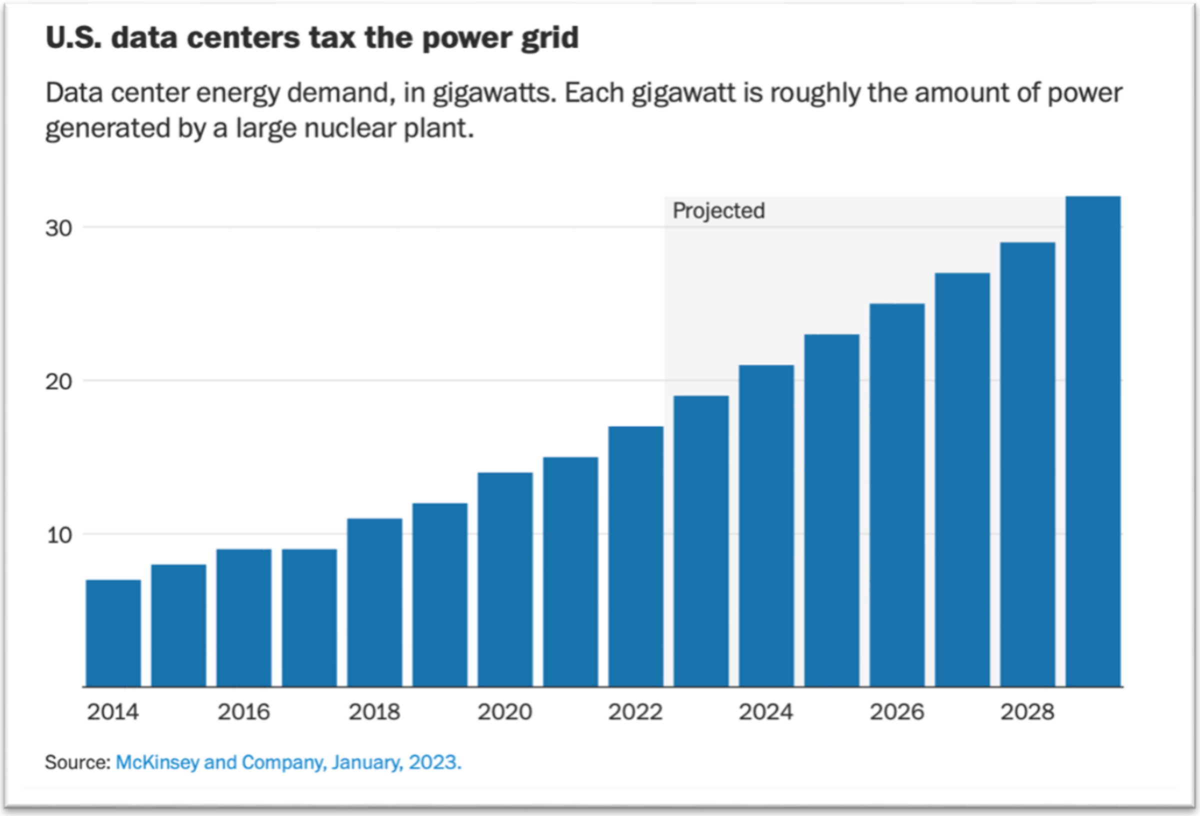
88 *Id.*

89 Bank of America, *2024 Power x Data Center Conference Recap: Harder to Achieve than it Looks* (Mar. 27, 2024), available at https://urldefense.proofpoint.com/v2/url?u=https-3A__rsch.baml.com_r-3Fq-3DJmNbgpL2xURaSYu0iR4h-21Q-26e-3Djulien.dumoulin-2Dsmith-2540bofa.com-26h-3DrKvysg&d=DwMDaQ&c=euGZstcaTDllvimEN8b7jXrwqOf-v5A_CdpgnVfiiMM&r=SpoDmtyOxm-iwg6Mj5MSrkbEUN8LrcwoLfWd-p8v9Nk&m=3hTHQb1_sFeRroH123dU0B8hq4Cir4VluE_6GmU3eYJojSjwk7zGTJjSmH7seXCU&s=l4GEPeNDx3kBpyPneebGRmQ6qYOp7hB05BfaDIv-1Yo&e=.

90 *Id.*

91 *Id.*

92 RTO Insider. *Data Load Growth Driving PPL's Plans* (May 2, 2024), available at https://www.rtoinsider.com/77757-ppl-details-work-data-centers-first-quarter-call/?utm_source=ActiveCampaign&utm_medium=email&utm_content=Today%20%40%20RTO%20Insider&utm_campaign=Daily%20News%20for%20Paid%20%26%20Trial%20Subscribers%3A%2005%2F02%2F2024.



The rapid growth of data center power demand has raised concerns that the U.S. electric utility industry, known for slow and steady returns, will be unable to respond quickly to the expected rise in power demand because of a swelling backlog of power generation and transmission projects in line to connect to the grid.[93] The increase in overall demand has added to a nationwide queue of requests for power generation and energy storage projects to connect to the grid, which ballooned to 2,600 GW in 2023 from 2,000 GW in 2022 according to the latest data from Lawrence Berkeley National Laboratory.[94]

All of these factors have led to increased scrutiny from some state legislators who have grown concerned about how data centers strain the power grid, increase emissions, and sometimes fail to boost state economies.[95] The following case studies from select states help illustrate how the implications of the growing demand on power systems and state policies are playing out across the country.

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93 Reuters, *US Electric Utilities Brace for Surge in Power Demand from Data Centers*, available at https://www.reuters.com/business/energy/us-electric-utilities-brace-surge-power-demand-data-centers-2024-04-10/.

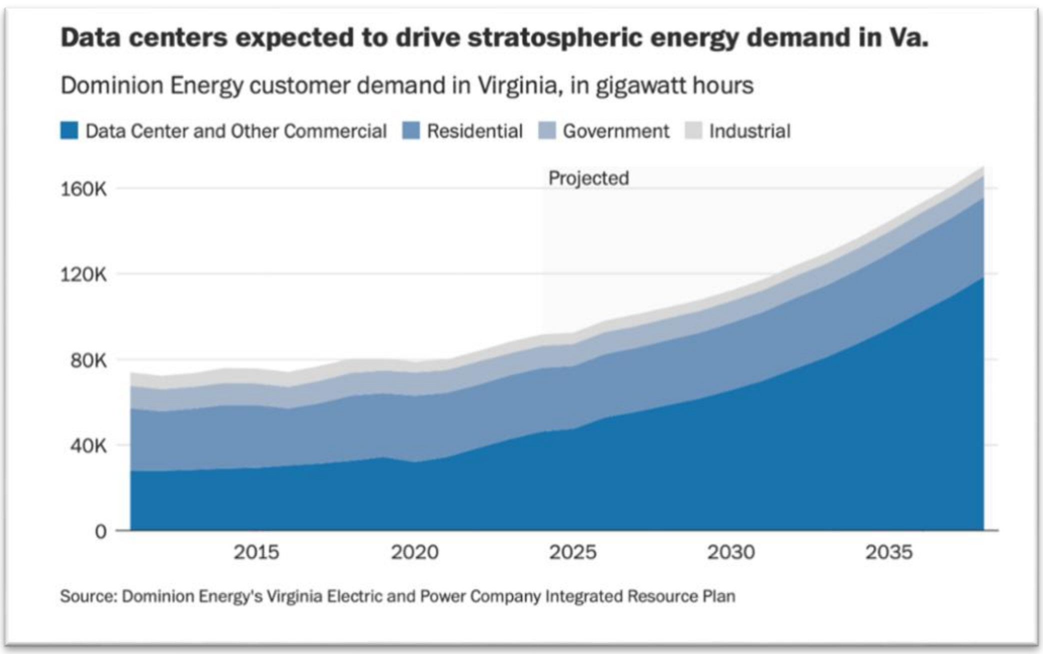
94 *Id.*

95 *Id.*

Power System Implication Case Study – Virginia

In 2010, Virginia enacted a law granting data centers retail sales and use tax exemptions in an effort to spur data center growth in the state. Today, in Northern Virginia, massive data centers process nearly 70 percent of global digital traffic[96] Loudoun County, Virginia, which offers sales and use tax reductions comparable to the state tax breaks described above, collects $600 million in annual taxes on the computer equipment inside the buildings. Prince Williams County, Virginia, the second-largest market, collects $400 million per year.[97]

Dominion Energy warned briefly in 2022 that it may not be able to keep up with the pace of the industry's growth.[98] The utility, which has since accelerated plans for new power lines and substations to boost its electrical output, predicts that by 2035 the industry in Virginia will require 11,000 MW, nearly quadruple what it needed in 2022, or enough to power 8.8 million homes.[99] The smaller Northern Virginia Electric Cooperative recently told PJM that the more than 50 data centers that it serves account for 59 percent of its energy demand.[100] It expects to need to serve about 110 more data centers by July 2028.[101]



96 Antonio Olivio, *Data Centers are Fueling Drive to Old Power Source: Coal*, The Washington Post (Apr. 17, 2024), available at https://www.washingtonpost.com/business/interactive/2024/data-centers-internet-power-source-coal/#.

97 *Id.*

98 *Id.*

99 *Id.*

100 *Id.*

101 *Id.*

Meanwhile, the amount of energy available is not growing quickly enough to meet that future demand.[102] FirstEnergy, owner of two coal power plants in West Virginia, announced that the plants will continue operating until 2035 and 2040, citing the need for grid reliability.[103] FirstEnergy previously had plans to significantly scale down operations at the plants to meet a company goal of reducing its greenhouse gas emissions.[104]

Local and state officials in Virginia are now reconsidering the data center industry's benefits.[105] The Virginia General Assembly has launched a study[106] that, among other things, will look at how the industry's growth may affect energy resources and utility rates for state residents, but some feel as though the study has held up efforts to regulate the industry.[107] Loudoun County, meanwhile, is moving to restrict where in the county data centers can be built.[108] Up until recently, data centers were allowed to be built without special approvals wherever office buildings are allowed.[109]

PJM Cost Allocation for Transmission Upgrades

A key issue related to data center policy is the question of who should pay for data center-related transmission upgrades that will be undoubtedly necessary in the booming data center market. In a related Federal Energy Regulatory Commission (FERC) docket (ER24-843), the Commission recently approved PJM's cost allocation for a $5 billion slate of transmission upgrades aimed at resolving reliability violations posed by growing data center load in Northern Virginia and generation retirements in Maryland.[110]

The Maryland Office of People's Counsel argued that the transmission projects related to Virginia's incentives for data centers should be paid for by Virginia ratepayers under PJM's "multi-driver" cost allocation formula.[111] FERC disagreed, finding that PJM followed its cost allocation rules for its regional transmission expansion plan

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102 *Id.*

103 *Id.*

104 *Id.*

105 *Id.*

106 *See* Joint Legislative Audit and Review Commission, Study Resolution (Dec. 11, 2023), available at https://jlarc.virginia.gov/pdfs/resolutions/2024_Data%20centers_JLARC.pdf.

107 Antonio Olivio, *Data Centers are Fueling Drive to Old Power Source: Coal*, The Washington Post (Apr. 17, 2024), available at https://www.washingtonpost.com/business/interactive/2024/data-centers-internet-power-source-coal/#.

108 *Id.*

109 *Id.*

110 Utility Dive, *FERC Approves PJM's $51.B Cost-Share Plan for Transmission to be Built by Dominion, Others*, available at https://www.utilitydive.com/news/ferc-pjm-cost-allocation-transmission-rtep-maryland-virginia/712768/#:~:text=The%20Federal%20Energy%20Regulatory%20Commission%20on%20Monday%20approved%20the%20PJM,Transource%20and%20PSEG%20Renewable%20Transmission.

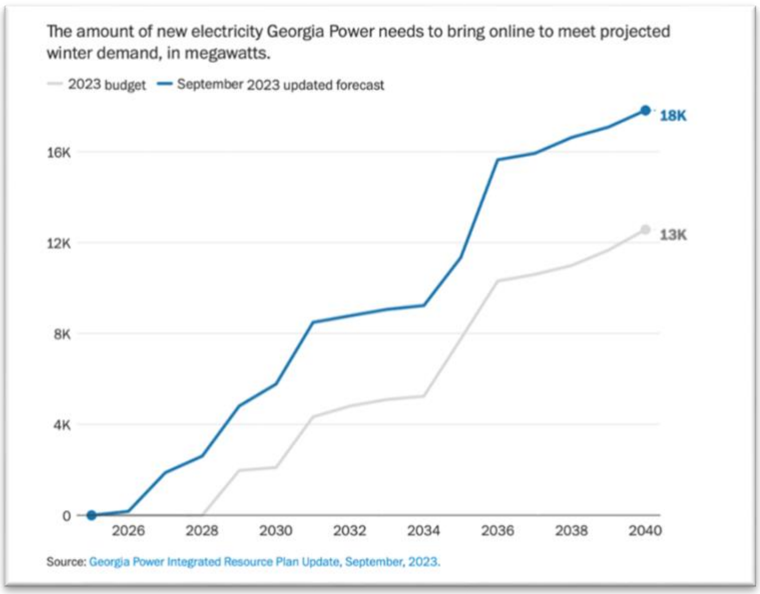
111 *Id.*

process and noting that challenges to those provisions should be made as complaints, not through protests to PJM's cost allocation reports.[112]

Even were a complaint to be filed, the Commission expressed skepticism regarding the concept of assigning states the cost of constructing transmission to serve growing load, even that which may be the result of state incentives.[113] It said the State Agreement Approach is the only structure for assigning transmission costs to an individual state and only if it voluntarily agrees to pay those costs to facilitate its public policy objectives.[114]

Commissioner Allison Clements wrote a concurrence going further, arguing that determining which transmission needs are the result of discrete state policies for the purpose of cost allocation would run contrary to the principals of regional transmission planning and would be "impractical and unworkable."[115]

Case Study – Georgia



On March 14, 2024, both houses of the Georgia state legislature passed a bill suspending Georgia's sales tax exemption for certain high-technology data centers.[116] If it had been signed by Georgia Governor Brian Kemp, developers of data centers may have opted not to pay premium prices to acquire underutilized land to build a data center or buy unused buildings to convert to data centers, given the proposed pause in the sales tax exemption and the uncertainty as to whether the exemption would have been available in the future

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112 *Id.*

113 *Id.*

114 *Id.*

115 *Id.*

116 *See* Thompson Hine, *Georgia Suspends Tax Break and Creates Special Committee to Study Energy-Intensive Data Centers*, available at https://www.thompsonhine.com/insights/georgia-suspends-tax-break-and-creates-special-committee-to-study-energy-intensive-data-centers/.

when potential projects would otherwise come online.[117] However, the bill was vetoed by Governor Kemp in early May.[118]

When the legislature enacted the tax break in 2018, companies flocked to Georgia to build data centers.[119] Currently, Atlanta is a nearly 400 MW market.[120] According to real estate group CBRE, in 2023 Atlanta had the highest increase in data center construction across the country, having grown by 211% with a total of 732.6 MW being under construction in the city.[121]

Enacting the tax exemption and the subsequent influx of data centers into the state ultimately created a double-edged sword effect.[122] Georgia Power, the state's largest utility company, testified before the state Public Service Commission (PSC) that 80% of the additional electrical power requested from the PSC will be consumed by the data centers.[123] Ultimately, the strain exerted by these data centers on the state's electrical supply prompted the enactment of the House Bill.[124]

The suspension would have been in effect from July 1, 2024, to June 30, 2026.[125] Certificates of exemption would have continued to be issued to any data center customer that was subject to a contract entered into prior to July 1, 2024.[126]

The House Bill would have created the Special Commission on Data Center Energy Planning.[127] The commission would have used the time during the two-year suspension to, among other things, review the existing grid and supply in the state, recommend future data center locations, and propose legislation related

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117 *Id.*

118 *See* Data Center Dynamics, *Georgia Governor Vetoes Bill to Pause Data Center Tax Breaks as Tennessee Expands its Data Center Tax Breaks*, available at https://www.datacenterdynamics.com/en/news/georgia-governor-vetoes-bill-to-pause-data-center-tax-breaks/.

119 *Id.*

120 *Id.*

121 *Id.*

122 *Id.*

123 *Id.*

124 *Id.*

125 *Id.*

126 *Id.*

127 *Id.*

thereto.[128] The commission would have been required to produce a written report of its findings no later than June 2026.[129]

Proponents of the House Bill claimed that it would increase state revenue from expected sales tax on previously exempted data center equipment, with Georgia State University's Fiscal Research Center estimating that revenue would increase by approximately $5.5 million in fiscal year 2025 and increase annually thereafter.[130]

Opponents of the House Bill, however, stressed that the change in the law effected in 2018 and extended in 2022 would be generally bad for business and would send the wrong message, with the Director of Public Policy for the Data Center Coalition claiming that ninety percent of the investment in Georgia since 2018 would not have happened but for the incentive.[131]

While the bill was ultimately vetoed, the passage of the bill by both houses reflects a growing concern over the strain these energy-consuming facilities place on the state's electrical supply.[132]

In a separate policy development in Georgia, state utility regulators recently approved a plan by Georgia Power to use fossil fuels to power data centers.[133] Under the plan, Georgia Power will bypass the normal construction bidding process at Plant Yates in order to quickly construct units designed to produce electricity for another 40 years.[134]

Case Study – Tennessee

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128 *Id.*

129 *Id.*

130 *Id.*

131 *Id.*

132 *Id.*

133 Stanley Dunlap, *State Utility Regulators Approve Georgia Power Plan to use Fossil Fuels to Power Data* Centers, Georgia Recorder (Apr. 16, 2024), available at https://georgiarecorder.com/2024/04/16/state-utility-regulators-approve-georgia-power-plan-to-use-fossil-fuels-to-power-data-centers/?utm_source=ActiveCampaign&utm_medium=email&utm_content=Today%20%40%20RTO%20Insider&utm_campaign=Daily%20News%20for%20Paid%20%26%20Trial%20Subscribers%3A%2004%2F18%2F2024.

134 *Id.*

Tennessee, on the other hand, has expanded its data center tax exemptions via House Bill 2182, which was signed into law by Governor Lee in May.[135] The bill redefined a "qualified data center" for purposes of sales and use taxes to include a data center that previously made a capital investment in excess of $100 million during an investment period not to exceed three years and creates at least 15 net new full-time employee jobs.[136] The state previously defined a qualified data center as one that made a required more than $250 million capital investment over a three-year period and created at least 25 new full-time jobs paying at least 150 percent of the state's average occupational wage.[137]

Case Study – Ohio

There is about 600 MW of data center load in American Electric Power Service Corp. (AEP) Ohio's service territory in Central Ohio.[138] Owners of hyperscale data centers are attracted to Central Ohio because of reliable electric service, available fiber connectivity, water resources and retail choice for power supply.[139] The utility has agreements to connect an additional 4.4 gigawatts (GW) of data center load by 2030, which can be accommodated by the region's transmission system.[140] However, AEP Ohio has received inquiries from companies considering building data centers that could add an additional 30 GW of load, which would require new transmission (possibly 756-kV line) on the PJM Interconnection's system.[141] In March 2023, AEP paused accepting new service requests from data center customers so it could evaluate how they would affect the utility's power delivery system.[142]

In May 2024, AEP Ohio asked state utility regulators to approve a proposal that would set increased financial requirements for new data centers and cryptocurrency operations.[143] The proposed rates for data centers larger than 25 MW and crypto and mobile data centers bigger than 1 MW are intended to help insure that they pay for new transmission needed to serve them.[144] Under AEP Ohio's proposal, data centers would be required to

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135 *See* Data Center Dynamics, *Georgia Governor Vetoes Bill to Pause Data Center Tax Breaks as Tennessee Expands its Data Center Tax Breaks*, available at https://www.datacenterdynamics.com/en/news/georgia-governor-vetoes-bill-to-pause-data-center-tax-breaks/.

136 *Id.*

137 *Id.*

138 Utility Dive, *AEP Ohio Proposed Data Center, Crypto Financial Requirements Amid 30 GW in Service Inquiries*, available at https://www.utilitydive.com/news/aep-ohio-data-center-crypto-rates-puc/716150/.

139 *Id.*

140 *Id.*

141 *Id.*

142 *Id.*

143 *Id.*

144 *Id.*

commit to ten-year electric service contracts, with an option to pay an "exit fee" after five years.[145] Additionally, data centers would be required to pay minimum demand charges based on 90% of their contract capacity, up from 60% under the utility's current general service tariff. Mobile data centers, such a cryptocurrency mining operation, would be required to pay minimum demand charges based on 95% of their contract capacity.[146]

Case Study – Connecticut

In Connecticut, NE Edge is proposing to build a hyperscale data center next to Millstone Nuclear Power plant in Waterford.[147] The data center, if built, would be the single largest user of electricity in Connecticut, using more than 9% of the average power consumption in the state.[148] The project would require $1.6 billion in investment and would consume 300 MW of power once operational.[149] Given the high energy rates in Connecticut relative to other parts of the country, the project intends to connect directly to the Millstone plant.[150] NE Edge is proposing to contribute $1 billion over 30 years to the state's Renewable and Energy Assistance Programs in lieu of charges that would be avoided by NE Edge by connecting "behind the meter" at Millstone.[151] There are also plans for NE Edge to make an additional $1,440,000 annual payment to the state's Energy Assistance Program, with a 2.5% annual escalator, and offer data storage services to the state at a 27.5% discount, although none of these contributions are yet included in any written agreement.[152]

The scale and energy required for the NE Edge project prompted the state Legislature's Energy and Technology Committee to approve legislation requiring a study of the impact on the grid.[153] NE Edge opposed the study, which did not pass in the 2024 session.[154]

The NE Edge developers say that the Waterford project would hire as many as 1,500 workers during construction, 190 permanent employees when operating, and 300 temporary personnel every three years for a

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145 *Id.*

146 *Id.*

147 Francisco Uranga, *Plans for Massive Data Center Linked to Nuclear Power Spark Debate on Connecticut's Energy Future,* CT Examiner (Apr. 8, 2024), available at https://ctexaminer.com/2024/04/08/plans-for-massive-data-center-linked-to-nuclear-power-spark-debate-on-connecticuts-energy-future/.

148 *Id.*

149 *Id.*

150 *Id.*

151 *Id.*

152 *Id.*

153 *Id.*

154 *Id.*

year of refitting.[155] Waterford signed a host municipality fee agreement with NE Edge last year committing to pay $231 million over 30 years in lieu of taxes.[156]

Opponents of the data center argue that if NE Edge's planned data center is built, it will lead to an "egregious undermining of local property tax, grid scarcity, antitrust concerns, large increases to energy bills, and significant environmental damage at the hands of a developer with no proven track record of success."[157] These data center opponents contend that the NE Edge project size and proposed direct connection to the Millstone facility will thwart desirable competition.[158] The opponents point out that NE Edge seeks to siphon 300 MW, or 15 percent, of affordable nuclear production leaving only 85% of daily capacity to the wholesale market such that current and prospective developers will have to pay grid-supply prices everywhere else in Connecticut.[159] The NE Edge opponents express concern that the shortage will impact the wholesale electricity markets run by ISO-New England and will lead to Dominion being paid more expensive market-setting prices by way of ISO-New England's uniform clearing price design, resulting in greater profits to Dominion shareholders at the expense of regional electric customers.[160]

Wholesale Market Impacts

Increased data center load will impact requirements to interconnect to the transmission system as well as wholesale market prices. PJM has already begun incorporating changes to its interconnection process to account for data center load. PJM has recently issued guidelines that have requirements for co-located load that differ depending on that load's configuration on PJM's system.[161] For example, co-located assets must either be PJM Network Load (with applicable firm transmission service) or not PJM Network Load (load without applicable firm transmission service). Co-located load cannot change its configuration unless it is a permanent change. The co-located load configuration that PJM studies and memorializes in a PJM service agreement may

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155 *Id.*

156 *Id.*

157 Bryan Sayles, *Don't Let a Hyper-data Center Suck Up CT's Electric Power,* CT Mirror (Apr.19, 2024), available at https://ctmirror.org/2024/04/19/ct-data-center-nuclear-plant-bill/.

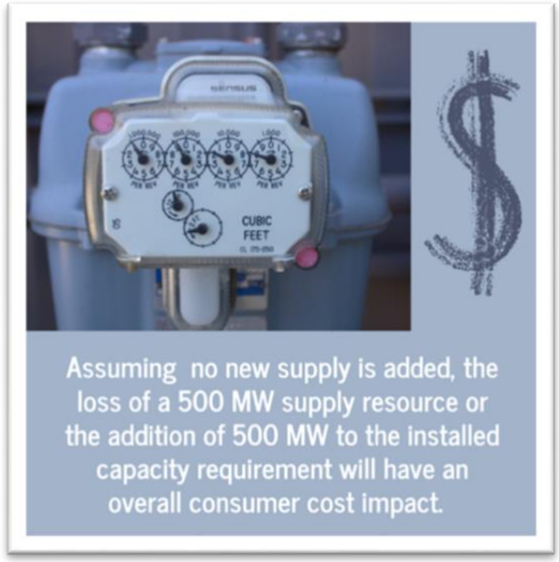
158 *Id.*

159 *Id.*

160 *Id.* NESCOE notes that this rate effect will likely be felt by all New England customers.

161 See https://www.pjm.com/-/media/markets-ops/rpm/rpm-auction-info/pjm-guidance-on-co-located-load.ashx

not be changed unless the interconnection customer undergoes a subsequent PJM study process and PJM memorializes the results of the process in an amended service agreement.[162]



PJM's guidelines create a process for PJM (1) to evaluate potential reliability impact of a proposed addition or reduction of a co-located load configuration and (2) determine what, if any, system reinforcements may be necessary before the planned co-located load configuration is added or reduced.[163]

Increased load from new data centers will also impact wholesale market prices, which may result in customer cost increases. At its simplest level, the addition of a large data center, whether in front of or behind the meter, results in load growth. As an illustrative example, consider the addition of a 500 MW data center. If the data center was behind the meter of a zero marginal cost resource, it would, all else being equal, decrease the amount of capacity available to other customers by the 500 MW and reduce the hourly energy available to serve current customers by the same amount, or in effect act as load growth.

Assuming that no new supply is added, the loss of a 500 MW supply resource or the addition of 500 MW to the installed capacity requirement will have an overall consumer cost impact. In New England,[164] if capacity prices remained the same, this additional 500 MW of growth would cause region-wide capacity costs to increase by approximately $21 million[165] and would also cause the hosting state's share of capacity costs to increase due to the load increase. If, and more likely, there was a price increase, each state would be responsible for its individual capacity percentage of the price increase. For every $0.10 increase (or ~2%), capacity costs would increase by approximately $38.5 million per year.

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162 *Id.*

163 *See also* Bank of America, *2024 Power x Data Center Conference Recap: Harder to Achieve than it Looks* (Mar. 27, 2024), available at https://urldefense.proofpoint.com/v2/url?u=https-3A__rsch.baml.com_r-3Fq-3DJmNbgpL2xURaSYu0iR4h-21Q-26e-3Djulien.dumoulin-2Dsmith-2540bofa.com-26h-3DrKvysg&d=DwMDaQ&c=euGZstcaTDllvimEN8b7jXrwqOf-v5A_CdpgnVfiiMM&r=SpoDmtyOxm-iwg6Mj5MSrkbEUN8LrcwoLfWd-p8v9Nk&m=3hTHQb1_sFeRroH123dU0B8hq4Cir4VluE_6GmU3eYJojSjwk7zGTJjSmH7seXCU&s=l4GEPeNDx3kBpyPneebGRmQ6qYOp7hB05BfaDIv-1Yo&e=.

164 In New England, we have cleared the last few capacity auctions at a de-list price. The de-list price is a price at which an existing capacity resource has decided to not participate in the capacity market but not retire. NESCOE has no insight into what those quantity/price levels are in the most recent auctions.

165 500 MW times the FCA18 clearing price of $3.58/kw-month.

A 500 MW year-round load increase would also increase the locational marginal price (LMP), the cost of energy, in New England. A load increase of this magnitude would cause ISO-NE to dispatch the next higher cost available unit(s) to provide the additional megawatt hours (MWh) of load. Because New England generally has a flat supply curve during "average" loads, the amount of additional costs would be less during average loads but much greater in times of peak load conditions and during winter periods when gas may be constrained. Additional sophisticated modeling would be required to accurately estimate the cost increase of the additional load. Directionally, a one-percent overall LMP increase to the average 2023 LMP would increase energy costs by approximately $50 million per year, excluding the cost to the data center itself. This cost increase may also result in reductions in out-of-market costs for state policy resources under contract.

If the increased load incentivizes a new more efficient gas plant or other zero or low marginal cost energy entry the cost increase could be materially reduced or possibly create an overall price decrease.[166] In addition, increases in load in winter can heighten the energy adequacy risk.

Emissions Impacts

Data centers account for one percent of global carbon emissions (equal to 330 million tons of carbon dioxide equivalent), with 50 percent of those emission coming from data centers in the US.[167] In fact, the cloud has a greater carbon footprint than the airline industry.[168] While some of the most advanced hyperscale data centers have pledged to make their sites carbon-neutral through carbon offsetting and investment in renewable energy infrastructures like wind and solar, many smaller-scale data centers lack the resources and capital to pursue similar sustainability initiatives.[169] Since the emergence of hyperscale facilities, many companies, universities, and others who operate their own small-scale data centers have begun to transfer their data to hyperscalers or cloud colocation facilities, citing energy cost reductions.[170] According to a Lawrence Berkeley National Laboratory report, if the entire cloud shifted to hyperscale facilities, energy usage might drop by as much as 25 percent.[171]

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166 See Bank of America, *2024 Power x Data Center Conference Recap: Harder to Achieve than it Looks* (Mar. 27, 2024), available at https://urldefense.proofpoint.com/v2/url?u=https-3A__rsch.baml.com_r-3Fq-3DJmNbgpL2xURaSYu0iR4h-21Q-26e-3Djulien.dumoulin-2Dsmith-2540bofa.com-26h-3DrKvysg&d=DwMDaQ&c=euGZstcaTDllvimEN8b7jXrwqOf-v5A_CdpgnVfiiMM&r=SpoDmtyOxm-iwg6Mj5MSrkbEUN8LrcwoLfWd-p8v9Nk&m=3hTHQb1_sFeRroH123dU0B8hq4Cir4VluE_6GmU3eYJojSjwk7zGTJjSmH7seXCU&s=l4GEPeNDx3kBpyPneebGRmQ6qYOp7hB05BfaDIv-1Yo&e=.

167 Facilities Dive, *Soluna Touts 18% Data Center Emissions Reduction with Project Dorothy*, available at https://www.facilitiesdive.com/news/soluna-data-center-emissions-reduction-alternative-energy-strategy/703934/.

168 The MIT Press Reader, *The Staggering Ecological Inmpacts of Computation and the Cloud*, available at https://thereader.mitpress.mit.edu/the-staggering-ecological-impacts-of-computation-and-the-cloud/.

169 *Id.*

170 *Id.*

171 *Id.*

As noted above, data centers create a large amount of heat and require extensive energy use to keep their equipment cool. Beyond cooling, the energy requirements of data centers are vast.[172] To provide data and cloud services 24 hours per day, data centers are designed to be hyper-redundant: if one system fails, another is ready to take its place immediately.[173] In some cases, only 6 to 12 percent of energy consumed at a data center is devoted to active computational processes, with the remainder allocated to cooling and maintaining many levels of fail-safes to prevent costly downtime.[174]

The addition of data center load to a power system will likely increase local carbon emissions, especially if not matched up with zero-carbon incremental supply. For example, adding a 500 MW data center that is served for all hours of the year would increase CO_2 emissions by approximately 5–7% (the higher end assumes that the new load is always served by an emitting unit) based on historical emissions rates. If the data center is located behind the meter of an existing clean energy resource, the data center would also divert clean MWh that may be currently counted toward compliance with state emission mandates.

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NESCOE hopes this primer assists the New England states in sorting through the emerging complexities of data centers and power system implications. NESCOE welcomes additional data or requests for further analysis as associated challenges and opportunities continue to unfold.

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172 *Id.*

173 *Id.*

174 *Id.*

APPENDIX

The following table is a non-exhaustive summary of state data center incentives. Full tables and cites available at https://www.taxnotes.com/special-reports/tax-technology/tricks-and-traps-data-center-state-tax-incentives/2023/12/28/7hmb7; *see also* https://www.streamdatacenters.com/glossary/tax-incentives-for-data-centers/; https://www.areadevelopment.com/data-centers/Data-Centers-Q1-2017/credit-and-incentive-trends-in-landing-a-data-center-KPMG.shtml

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
AL	Sales and use tax and property tax	Sales and use: materials, equipment, and other capitalized costs. Property: Real and personal property incorporated into project.	10-30 yrs. depending on investment.	At least $200 million for 10-yr. abatement; $200 million to $400 million for 20-yr. abatement; over $400 million for 30-yr. abatement.	At least 20 new jobs paying at least $40,000.	N/A	July 31, 2028
AR	Sales and use tax	Data center equipment, eligible data center costs, services purchased	As long as it meets the qualifying criteria	At least $500 million within five years of the issuance of a certificate of occupancy.	Must pay an aggregate annualized compensation of at least $1 million to	N/A	N/A

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
		for the purpose of an in conjunction with developing, acquiring, constructing, expanding, renovating, refurbishing, and operating a qualified data center, and electricity.	as determined on an annual basis.		employees within the state over the two calendar years following commencement of operations.		
AZ	Transaction privilege tax and use tax	Equipment, including water conservation systems, software, equipment, and other tangible personal property.	10 yrs., or 20 yrs. if the data center is a "sustainable redevelopment project."	At least $25 million if county population is 800,000 or less or $50 million if county population is more than 800,000.	N/A	N/A	Dec. 31, 2033

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
FL	Sales and use tax	Construction material, machinery, equipment, component parts, other tangible personal property, and electricity.	Indefinite until sunset.	At least $150 million.	N/A	N/A	June 30, 2027
GA	Sales and use tax	Computer equipment and data center equipment, including machinery, hardware, software, etc. Data center exemption includes temperature control, security,	10 yrs.	Equipment exemption: $15 million per calendar yr. Data center equipment: $100 million to $250 million based on county population.	Equipment exemption: N/A Data center: 20 quality jobs.	Jobs credit not available for qualifying data centers.	Equipment: Dec. 31, 2028. Data Center: Dec. 31, 2031.

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
		and power equipment.					
ID	Sales and use tax	Eligible server equipment and purchases associated with constructing new data center facilities.	Indefinite.	At least $250 million.	30 new jobs.	Not available to taxpayers receiving incentive under the Idaho Reimbursement Incentive Act.	N/A
IL	Use tax, service use tax, service occupation	Tangible personal property, including electrical, climate control, and	20 yrs.	At least $250 million.	20 jobs with wages at least 120% of median county wage.	N/A	No certificates issued after July 1, 2029.

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
	tax, and state and local retailer's occupation tax	monitoring systems; equipment; telecommunications infrastructure; building materials; etc.					
IN	Gross retail and use tax Local property tax	Equipment, including water conservation systems, monitoring systems, software, other tangible personal property, and all electricity, excluding electricity used in administration of facility.	25 yrs., or 50 yrs. if investment is at least $750 million.	$150 million if county population greater than 100,000; $100 million if county population greater than 50,000 but not more than 100,000; or $25 million if county population is not more than 50,000.	No	N/A	N/A

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
IA	Sales and use tax Property	Computers and equipment, power generation, backup power generation fuel, and electricity. Property: Follows sales tax eligibility.	Indefinite.	At least $200 million.	No	N/A	N/A
KY	Sales and use tax	Computer systems, which includes system composed of personal computers, laptops, computer software, computer servers, processors, co-processors, memory devices, storage devices, input and output devices, and	Indefinite.	At least $100 million.	No	N/A	N/A

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
		other similar devices deployed as part of the system configuration but excludes repair, replacement, and installation materials.					
MD	Sales and use tax Property tax approved by local governing body	Computer equipment, software, energy generation equipment, heating or cooling systems, etc. Property: Follows eligibility for sales tax.	Generally may be renewed up to 10 yrs.; up to 20 yrs. if investment of at least $250 million.	Investment of at least $2 million in tier 1 area and at least $5 million for businesses in any other areas.	At least five qualified positions.	N/A	N/A

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
MI	Sales and use tax Property tax	Equipment, including computers, servers, routers, switches, backup generators, environmental control equipment, etc. Property tax exemption applies only to data centers in a "renaissance zone" approved in 2016.	Indefinite until sunset.	N/A	N/A	N/A	Dec. 31, 2035

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
MN	Sales and use tax	Electricity used to operate or maintain a qualified data center, enterprise information technology equipment, and software.	20 yrs. or by June 30, 2042, whichever is earlier.	New data centers: At least $30 million. Refurbished data centers: At least $50 million.	N/A	N/A	June 30, 2042
MS	Sales and use, income, and franchise taxes	Component materials, machinery, equipment, software, and electricity. Income earned by the certified business enterprise.	10 yrs.	At least $20 million.	20 new full-time jobs with minimum average salary of not less than 125% of average state wage.	N/A	N/A

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
		Capital used, invested, or employed by business enterprise for franchise tax. Value of capital used, invested, or employed.					
MO	Sales and use tax	Utilities (including energy, gas, and water), machinery, equipment, computers, and construction materials.	New facilities: 15 yrs. Existing facilities: 10 yrs.	New facilities: At least $25 million. Existing facilities: At least $5 million.	New facilities: 10 jobs. Existing facilities: 5 new jobs.	Not eligible for business recruitment tax credit.	N/A

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
NE	Sales and use tax Personal property tax	N/A	N/A	N/A	N/A	N/A	N/A
NV	Sales and use tax and property tax	No criteria for qualifying items by exempt entity.	Up to 20 yrs.	10-yr. abatement: At least $25 million. 10- to 20-yr. abatement: At least $100 million.	10-yr. abatement: At least 10 jobs. 10- to 20-yr. abatement: At least 50 jobs.	N/A	Jan. 1, 2056
NY	Sales and use tax	Machinery, equipment, other tangible personal property, and services related to data centers.	Indefinite.	N/A	N/A	N/A	N/A

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
NC	Sales and use tax	Computer software for data centers; electricity and support equipment for a "qualifying data center"; electricity and certain business property for an "eligible internet data center."	Indefinite.	For purposes of meeting the definition of a "qualifying data center": $75 million. For purposes of meeting the definition of an "eligible internet data center": $250 million.	N/A	N/A	N/A
ND	Sales and use tax	IT equipment and computer software.	Indefinite.	N/A	N/A	N/A	N/A

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
OH	Sales and use tax	Computer data center equipment used or to be used at an eligible data center.	Indefinite.	Capital investment of $100 million during at least 3 consecutive calendar yrs.	Annual payroll of at least $1.5 million or more.	N/A	N/A
OK	Sales and use tax	Machinery and equipment purchased and used by establishments primarily engaged in computer services and data processing.	Indefinite.	N/A	N/A	Establishments receiving incentive payment under Oklahoma Quality Jobs Program Act are not eligible.	N/A

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
PA	State sales and use tax (Exemption does not apply to local sales taxes.)	Computer data center equipment.	25th full calendar year after calendar year in which application for qualification filed.	At least $75 million if county population 250,000 or less and center creates 25 new jobs; or at least $100 million if county population more than 250,000 and center creates 45 new jobs.	At least 25 new jobs.	N/A	No new certifications after Dec. 31, 2032.
SC	Sales and use tax	Computers, equipment, hardware and software, and electricity.	Indefinite.	One taxpayer invests at least $50 million or one or more taxpayers invest at least $75 million.	25 people with average compensation level of 150% of per capita income of state or county.	N/A	Jan. 1, 2032

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
TN	Sales and use tax	Computers, computer networks, software, peripheral devices, and repair and installation of parts and services used in the operation of a qualified data center, including a reduced (1.5%) rate on electricity.	Indefinite.	At least $100 million during investment period.	15 jobs paying at least 150% of state's average wage.	N/A	N/A
TX	Sales and use tax	Equipment, software, and electricity.	10 yrs. if investment under $250 million; 15 yrs. if investment is $250 million or more.	At least $200 million.	20 jobs paying at or above 120% of average wage.	Data centers subject to agreement limiting the appraised value of center's property for property tax.	N/A

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
UT	Sales and use tax	Machinery and equipment.	Indefinite.	N/A	N/A	N/A	N/A
VA	Sales and use tax	Computer equipment and enabling software.	Indefinite.	At least $150 million. For distressed localities investment requirement reduced to $70 million.	50 new jobs. For distressed localities jobs requirement reduced to 10 jobs.	N/A	June 30, 2035
WA	Sales and use tax (Two separate exemptions for urban and rural data centers.)	Eligible server equipment and eligible infrastructure in rural and urban counties.	Indefinite until sunset.	N/A	Within 6 years, must show net employment increased by a minimum of the lesser of: 35 family wage employment positions, or 3 family wage employment positions	DOR may issue only 6 certificates for each type of (rural and urban) data center, and they are issued on time-filed basis.	Jan. 1, 2026. Rural data Urban data centers: July 1, 2038.

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
					for each 20,000 square feet or less of newly dedicated server space.		Rural data centers: July 1, 2048.
WI	Sales and use tax	Computer server equipment and the chassis of certain specified equipment used in the data center	Indefinite.	For building located in a county having a population greater than 100,000: $150 million; For buildings located in a county having a population greater than $50,000: $100 million; For building in a county having a population of not more than 50,000: $50 million	N/A	N/A	N/A

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
WV	Sales and use tax Personal property tax	Prewritten computer software, computers, computer hardware, servers, building materials, and tangible personal property for direct use in a qualified high-technology business or internet advertising business.[215] Property tax: Salvage value of servers directly used in a high-technology business or in an internet advertising business.	Indefinite.	N/A	N/A	N/A	N/A

State	Tax Type	Items Exempt	Qualifying Period	Investment Requirement	Job Requirement	Other Limitations	Sunset
WY	Sales and use tax	Prewritten software, computer equipment, uninterruptible power supplies, and cooling equipment.	Indefinite.	At least $5 million, plus additional $2 million in calendar year for computer equipment. Initial capital investment of $50 million, plus additional $2 million in calendar year for power supplies and cooling equipment.	N/A	N/A	N/A