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Data Centers: The Critical Convergence of AI, Energy, and National Security

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In September 2024, Microsoft announced plans to power its artificial intelligence infrastructure with electricity from a reactor at the once-dormant Three Mile Island nuclear plant. This development is more than a footnote in the tech world; it signals a new era in which the rise of artificial intelligence is reshaping not only digital landscapes but also presenting new challenges to the U.S. power grid, as utilities work to meet rising electricity demands across state lines.

Although data centers have existed since the 1940s,[1] they are not all the same and have recently gained renewed attention due to the rise of artificial intelligence, which relies on specialized data centers for deployment. As of July 2025, the United States hosts more than 3,905 data centers,[2] including 156 in Georgia.[3] The rapid advancement of AI technologies such as machine learning, deep learning, and generative AI dramatically increased the demand not only for computational power but also for land space for data centers.[4] This trend is reflected in the sharp decline in the availability rate for these facilities in the U.S., which fell from 9.8% in 2020 to just 2.6% in 2024,[5] highlighting the growing pressure on the construction sector to keep up with demand.

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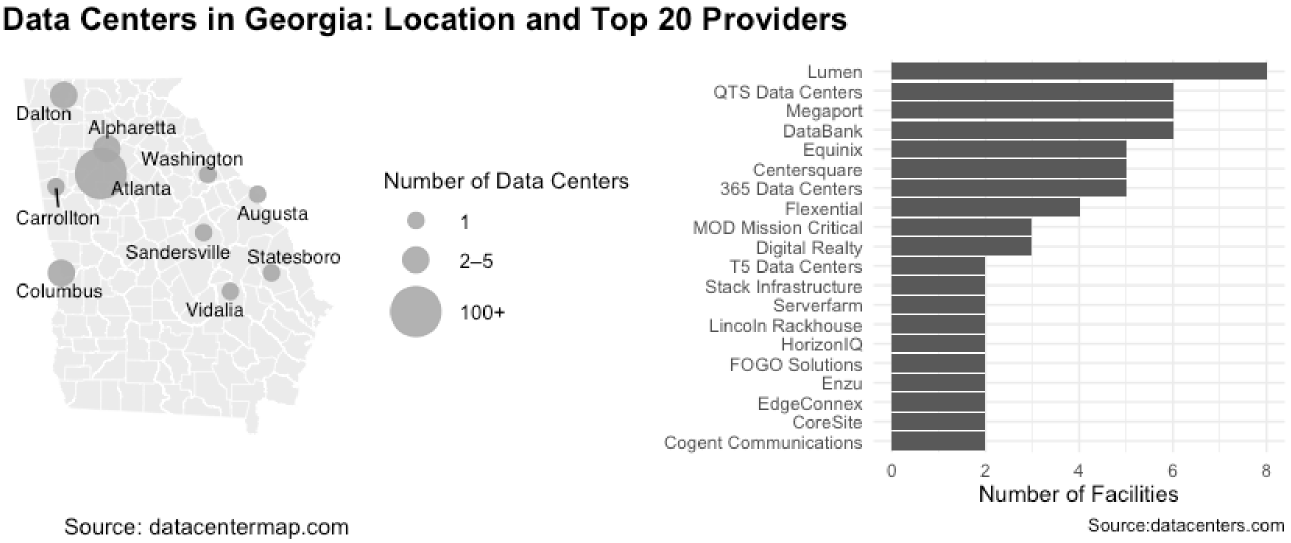

Source: datacentermap.com

Source:datacenters.com

Figure 1. Data Center Overview in Georgia

While traditional data centers typically require between 5 and 10 megawatts of power, AI facilities can exceed 100 megawatts.[6] The annual energy consumption of data center servers in the U.S. grew from about 30 terawatt-hours (TWh) in 2014 to 100 TWh in 2023, largely due to the rise of high-speed AI computers powered by advanced graphics cards rather than standard servers used for everyday tasks.[7]

From the coining of the term artificial intelligence in the 1950s to today's race to power AI with advanced energy solutions, the growth of data centers tells a story of convergence: computation, energy, and national security. Current discussions around data centers have mobilized diverse public stakeholders across the political spectrum. While some characterize them as the "new American factory" and a significant economic driver,[8] they have also been criticized for their lack of transparency regarding community benefits and operational requirements,[9] all the while the recognition of their role as the most critical infrastructure of the 21st century continues to grow.[10]

In the sections that follow, we discuss the transformative role of data centers in reshaping the U.S. energy landscape, including their physical infrastructure, emerging technological developments, and growing influence on power systems and electricity demand. In addition, we assess the advantages, challenges, and strategic considerations facing utilities, regulators, and consumers as data center demand continues to rise.

Key Features and Classifications of Data Centers

Nearly every digital activity we perform today—whether saving a photo, streaming a movie, or shopping online—relies on infrastructure that ranges from small rooms to massive buildings, designed to house computer systems and networking equipment. Server racks are one of the core components of data centers, which are vertical structures that house all servers used for storing, processing, and delivering data. These servers require constant, reliable electricity supplied first by the local utility and backed up by on-site generators (Figure 2). A centralized power bus routes this energy to all components. To prevent overheating, the facility is equipped with cooling systems that include chillers, cooling towers, and fan coil air handling units, all of which maintain optimal operating temperatures. Water storage tanks may also be part of the cooling infrastructure. Finally, networking rooms manage the flow of data in and out of

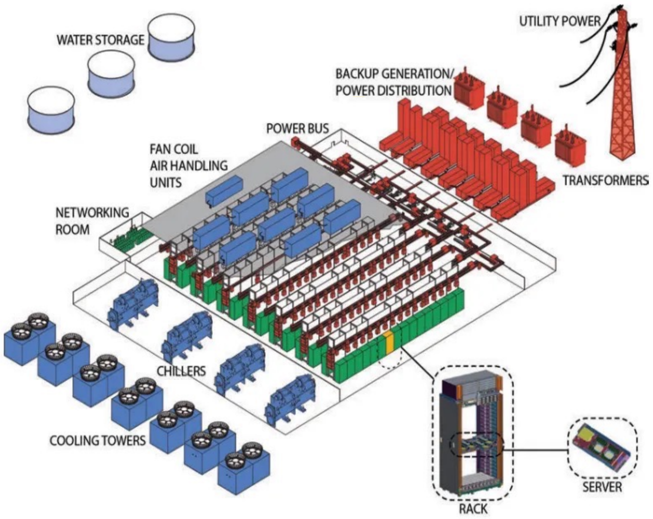

Figure 2. The Typical Components of a Large Data Centers [11]

the center, ensuring seamless connectivity across the internet.

Data centers consume significant amounts of electricity for both primary IT equipment, such as servers for processing, data storage, and networking, and secondary, non-computing infrastructure. The latter includes cooling systems, power conditioning and backup systems, such as uninterruptible power supplies, power distribution units, and generators, as well as lighting, security systems, environmental monitoring, and fire suppression systems.[12]

Predictions about data center electricity usage vary (Figure 3). In the U.S., electricity consumption by data centers have tripled since 2006, with estimates for the near future ranging from 200 TWh to 300 TWh. To put this in perspective, 145 TWh is roughly equivalent to the total electricity consumption in the state of Georgia in 2022.[13] These national trends are mirrored globally: data centers and data transmission networks account for an estimated 2-3% of total electricity consumption in the world. [14]

As to classification, data centers vary significantly in design and functionality and are often described in terms of their physical size or critical power capacity. Critical power capacity refers to the total power that can be continuously supplied to IT systems. Smaller data centers typically have a floor area of less than 5,000 square feet and a critical power capacity below 1 MW. In contrast, large data centers can support critical loads of tens of megawatts, with some exceeding 100 MW.[15] They are usually grouped into five functional categories[16] (Table 1).

Data centers that support AI operations rely on advanced architectures and rare materials to enable high-performance capabilities. In essence, running artificial intelligence applications demands specialized infrastructure capable of processing vast amounts of data. Examples of such equipment include AI chips that accelerate machine learning, deep learning models, and natural language processing capabilities, as well as solid-state drives (SSDs), which use semiconductor technology to provide fast and reliable storage critical to AI data centers.

Data Centers and AI as National Security Assets

AI infrastructure relies heavily on critical minerals and rare earth elements, such as lithium, cobalt, and

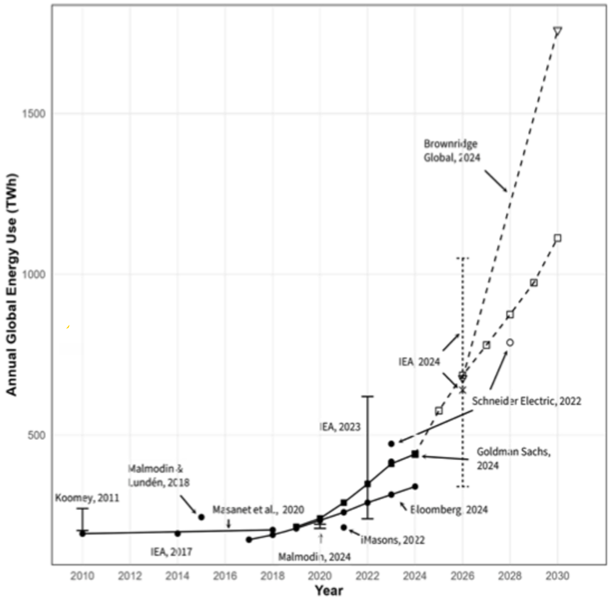

Figure 3. Academic and Industry Historical Estimates of Global Data Center Energy Use (Shehabi et al. 2024)

Type	Ownership / Location	Key Features
Enterprise	Privately owned; on-site or off-site	Custom-built for one organization; aligned with internal apps and processes
Multi-Tenant (Colocation)	Shared facility; business-owned equipment, off-site	Provides power, cooling, and networking; Tenant not required to manage infrastructure
Hyperscale	Company-owned and operated; large-scale facilities	Built for massive storage and computing power; supports high-demand services
Edge (Micro)	Typically decentralized and near end-users	Real-time data processing; reduces latency; ideal for time-sensitive applications
Container (Modular)	Portable, pre-assembled units (often in shipping containers)	Rapid deployment; used in mobile, temporary, or emergency scenarios

Table 1. Classification of Data Centers[17]

silicon. Since these materials are critical to both data centers and some power generation technologies (e.g., wind turbines, solar PV, lithium-ion batteries)[18], ensuring access to them is essential for the reliability of technological infrastructure and energy security.

The advancement of AI and data centers increases the demand for, and geopolitical competition over, these strategic minerals. For instance, in early April 2025, China's Ministry of Commerce imposed new export controls on seven rare earth elements in response to tariffs on Chinese products introduced by President Trump. After intense negotiation, a new agreement was reached in which Beijing committed to continuing exports of rare earth elements and magnets to the U.S.[19] This episode underscores the importance of establishing a reliable and diversified supply of critical minerals. Yet, reports show that the global supply of these materials is highly concentrated in just a few regions—a precarious situation for a major commodity that is essential to modern life.[20] These are some of the reasons data centers are increasingly considered critical national security assets.

While the connection between energy and AI has been more explicitly recognized, the understanding of data centers as essential components of national and international security is still emerging. The capacity to generate reliable electricity directly influences the type of AI model a data center can support. The more sophisticated the AI model, the greater its applications and implications for global security, such as in the form of national wealth, economic competitiveness, cyber capabilities, and military technology first movers.[21] "AI takers", in contrast, adopt and diffuse these technologies from the makers.[22] Data centers are viewed as strategic assets for enabling AI development, consequently, for their potential to influence geopolitical dynamics. That includes not only the technological components of AI, from critical minerals to hardware and software, but also the recruitment, training, and education of professionals who are involved in the development and use of AI applications that matter for national power.[23] Therefore, factors such as the location, power source, and operational capabilities of data centers become a matter of national interest.

Regulating Data Centers

As much as data centers operate within a global market, key decisions about their operations, infrastructure, and contractual arrangements are often made at the local level, shaped by regulations, resource availability, and community considerations. In Georgia, an important regulatory development occurred in January 2025, when the Georgia Public Service Commission (PSC) approved a new rule targeting large-load energy customers, such as data centers. The rule, which applies to the state's investor-owned utility, Georgia Power Company, targets new facilities with energy usage exceeding 100 megawatts and requires those customers to cover the costs of power generation, transmission and distribution infrastructure associated with building their facilities.[24] The motivation for this rule was to protect current ratepayers from bearing the costs associated with new large loads.

Georgia Power projects that, over the next several years, data centers will drive a sharp increase in the state's electricity consumption—accounting for approximately 80% of new power demand.[25] To meet this rising demand, the company plans to add 9,000 megawatts of capacity by 2031. The 2025 Integrated Resource Plan (IRP) outlines Georgia Power's strategy for addressing this growth, including extending the operation of fossil fuel power plants, making significant investments in renewables and battery storage, and implementing comprehensive transmission system upgrades.[26]

Developments in Georgia are indicative of evolving debates surrounding the regulatory and infrastructural demands of data center expansion. These local dynamics reflect broader questions, such as how data centers can pose challenges to electricity market models. A recent study found that, in the U.S., vertically integrated regulated utilities are better positioned to meet this new demand growth as their integrated resource planning process facilitates the utility's commitment for interconnections and a reliable power supply.[27] The report notes that in competitive power markets, if data centers connections outpace new power supply development, the imbalance threatens grid reliability.

Infrastructure and Economic Impact

Hyperscale data centers are large construction projects, typically housing at least 5,000 servers and covering more than 10,000 square feet of physical space.[28] These facilities represent substantial capital investments and often serve as long-term anchors in the communities where they are built, with the potential to stimulate local economies through construction jobs, infrastructure upgrades, increased property tax revenue, and long-term service contracts. As an analogy, data centers are sometimes described as modern infrastructure investment on par with the Eisenhower Interstate System.[29] Signed in 1956, the Federal-Aid Highway Act launched the construction of a vast national network of highways that transformed American life. Although the system's original purpose was to connect major cities and industrial centers to enhance national defense, its domestic impact was far-reaching. The interstate highways revolutionized transportation and trade, reshaped urban planning, and accelerated suburban development. By enabling the more efficient movement of people and goods, the interstate system created new economic opportunities and laid the foundation for decades of national growth. Similarly, data centers represent large-scale infrastructure investments that extend beyond technology or real estate alone. Their presence can stimulate long-term economic development by attracting additional businesses, creating skilled jobs, and generating stable tax revenue, ultimately serving as a potential catalyst for local and regional growth.

The long-term economic impact of data centers is unknown and is an ongoing matter under examination for many states. The debate reflects ongoing uncertainty about the role of data centers in economic planning, particularly in commercial and tech hubs like Atlanta.[30] Similarly, in early 2025, Washington governor Bob Ferguson commissioned a study to evaluate the tax revenue potential, resource de mands, and potential job creation associated with data centers.[31] Washington is home to at least 87 data centers, primarily located in rural areas that often use tax breaks to reduce construction costs and defer tax revenue. In addition to economic implications, the growth of data centers has also raised environmental and resource management challenges.

Environmental and Resource Challenges

Energy and water usage have long been identified as key concerns for data center facilities, with research highlighting these issues as early as the early 2000s. These include higher energy costs for both businesses and government, increased emissions, particularly greenhouse gases, from electricity generation, and greater strain on the power grid to meet growing demand.[32] These concerns remain relevant in 2025, with water consumption emerging as a critical factor.[33] Recent research suggests that AI-driven demand could lead data centers to consume over 1 trillion gallons of fresh water globally by 2027.[34] To put this in perspective, that figure exceeds half of the United Kingdom's total annual water withdrawal. Most of this water use is tied to cooling IT equipment within the facilities. In addition to direct consumption, the indirect water footprint of data centers through the electricity generation needed to power them must also be considered. In the United States alone, data centers are estimated to consume between 60 and 95 billion liters (16–26 billion gallons) of water annually, with the majority used by hyperscale data centers and large-scale colocations. It's important to note that tracking water usage is not yet standard practice across the data center industry. Despite data centers ranking among the top ten water-consuming industries in the United States, only 51% currently monitor their water use.[35]

At the same time, as AI continues to evolve, a number of strategies have been implemented to make these facilities more energy- and water-efficient. For example, researchers developed a real-time carbon telemetry system that tracks how much carbon is emitted by the local grid while their computer vision tool is running.[36] Based on this information, the system automatically switches to a more energy-efficient version of the model, resulting in an 80 percent reduction in carbon emissions over a one- to two-day period. Another factor is the optimization of the models themselves. Large language models, widely used in AI applications, can be trained more efficiently, and with lower electricity and water consumption, when trained on specialized data for specific tasks, which may also improve performance. Another group of researchers has partnered with a tech company to test the pioneering idea of using lasers to lower power consumption and increase the efficiency of conventional air- and water-based cooling systems, as 30 to 40 percent of electricity in data centers is typically used for cooling.[37]

Conclusions

Data centers hold significant potential to drive societal development and have already transformed the ways in which we communicate, work, and access information. Nevertheless, the scale of electricity generation required to power data centers, alongside challenges related to siting, zoning, water consumption and regulation of these facilities are evolving challenges. Balancing these factors within the constraints of carbon reduction precludes a single solution. Microsoft's agreement to reactivate Unit 1 at Three Mile Island, following its retirement in 2019, illustrates some of the ongoing discussions within the industry.[38] This development underscores a renewed interest in nuclear power, recognized for its capacity to deliver reliable, firm electricity with zero onsite carbon emissions, thereby addressing two of the most critical issues confronting the power sector.

Key Takeaways

AI-Driven Expansion of Data Center Infrastructure

The growth of artificial intelligence applications is accelerating the demand for high-performance data center infrastructure, leading to revised projections in electricity consumption and requiring adaptive grid planning strategies.

Resource Intensity of Modern Data Centers

Contemporary data centers are characterized by substantial energy and water requirements—often exceeding 100 megawatts of power and millions of gallons of water per day—posing complex challenges for utility providers and municipal resource management.

Governance and Policy as Determinants of Deployment

State and local governments have considerable influence over the siting and development of data centers through regulatory instruments such as zoning laws, permitting frameworks, tax incentives, and infrastructure planning protocols.

Socioeconomic Effects at the Local Level

The establishment of data centers can yield economic benefits for host communities, including capital investment, employment opportunities, and enhancements to local tax bases and digital infrastructure.

The Strategic Value of Data Centers

Increasingly, data centers are viewed as national security assets due to their role in powering advanced AI models. Their location, energy source, and capabilities are increasingly tied to global influence and technological power.

Emerging Focus on Efficiency and Sustainability

In response to environmental concerns, data center operators are increasingly adopting advanced environmental management practices, including carbon intensity monitoring, efficient thermal management systems, water consumption monitoring, and laser for cooling computers.

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