



AI Data Center Needs

Raj Desai

Midwestern State University, Texas, USA

Received: 11.04.2026 | Accepted: 17.05.2026 | Published: 19.05.2026

*Corresponding Author: Raj Desai

DOI: [10.5281/zenodo.20287787](https://doi.org/10.5281/zenodo.20287787)

Abstract

Review Article

In recent years, the construction of data centers has rapidly increased due to the world's growing dependence on digital technology, with nearly every aspect of digital information relying on data centers. As more systems and people continue to rely on this technology, the construction of data centers will continue to follow and become a crucial infrastructure. Companies are now building larger and more advanced data centers to store, process, and distribute the enormous amount of digital information because this is the system that supports the modern digital world. The rapid growth of data center is primarily contributed to cloud computing, increased consumption and production of social media, need for secure digital infrastructure, and the growing demands of artificial intelligence all by companies and people alike.

Keywords: Data Centers, Artificial Intelligence, GPUs, Cooling Needs of Data Centers, Power Sources, Power Backup.

Copyright © 2026 The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0).

Introduction

Artificial intelligence, AI, continues to expand at a rapid rate, and with that expansion comes an ever-increasing demand for energy generation to support the data centers that train and help AI. AI is making machines capable of learning and performing tasks traditionally done by humans. To meet the increasing demand for power from evolving technology like data centers and AI, new power plants need to be implemented. Data centers are primarily powered by the electrical grid which includes fossil fuel plants. Increasingly, onsite generation includes natural gas, and renewables backed by diesel generators for constant power.

Sizes of Data Centers

Data centers come in three sizes. Small data centers consume up to five megawatts of power. Larger data centers consume over one hundred megawatts of power. Hyperscale data centers are set to consume over one thousand megawatts of power [1][2]. For comparison, the average household in the United States uses less than one megawatt of energy per month [3].

Construction of AI Data Centers

Modern data center construction requires temporary workers. A typical data center rests on a reinforced



concrete slab foundation. Most electrical work is placed underground. While the foundation is poured concrete, the walls are often built of prefabricated concrete panels. The workers earn above average wages and boost the local economy. Complaints from nearby residents include increased noise, traffic, and pollution. Data centers draw large amounts of power so they locate where local utilities are responsive to their demands. Many data centers use gas-turbine power plants for their electricity [4].

GPUs and CPUs & High Bandwidth Memory

A single NVIDIA GB200 rack consists of 72 GPUs (Graphics Processing Units), 36 CPUs (Central Processing Units) and 30.4 tera-bytes of memory. The new racks will require liquid cooling. The cooling distribution units (CDUs) will be connected to racks using an elaborate piping network. High bandwidth memory (HBM) is needed for providing the GPUs with the terabytes of data needed to run large language models (LLMs). There is a huge boost in demand for new data centers from giants like Amazon, Microsoft, and Google [5].

Cooling for Data Centers

Data centers need vast amounts of water for cooling. A single 1 MW data center can use over 6.6 million gallons annually. Large data centers can consume up to 5 million gallons per day, equivalent to the water use of a town populated by 10,000 to 50,000 people [6]. Only 3 percent of the earth's water is freshwater, and only 0.5 percent of all water is accessible and safe for human consumption. Data centers use water to cool their processor chips so as to avoid overheating and potential damage. A heat exchanger transfers heat from the server room to the building's cooling system. Cooling systems can account for up to 40 percent of a data center's total energy consumption, making them a major factor in overall efficiency. Apple strategically locates many of its data centers in cooler climates, which reduces the need for energy-intensive cooling systems and improves efficiency.

Power Sources for Data Centers

Solar power costs have dropped making it one of the most affordable sources of power today [7]. Solar farms under peak conditions will generate one megawatt of electricity for every five acres of land used [8]. This means that for smaller data centers twenty-five acres of land will be required to satisfy their power demands. For larger, hyperscale AI data centers that size increases dramatically, going from twenty-five all the way up to five hundred acres or more. This will make solar farms non-viable in urban areas for large scale data centers.

Modern wind generating turbines are massive. A small data center could theoretically be powered by a couple of wind turbines and a nice windy day. A larger data center will require an entire field of wind turbines, known as a wind farm. Until proper energy storage solutions can be realized to help harvest surplus energy when it is available wind power, just like solar power, will remain only partially viable for power generation.

Due to the inconsistencies of wind and solar, one obvious move is to move to small modular nuclear reactors (SMR). These reactors are clean, compact, and cost effective, providing a viable solution to the power needs. They can be assembled in a factory and transported to a data center or town to provide clean ample power. One SMR can provide more consistent power utilizing a fraction of the space required of solar farms and requiring less maintenance compared to wind farms. The main difference between SMRs and normal nuclear reactors are size, construction time, and power generation. The room required for SMRs ranges from two to five acres. SMRs are capable of generating 300 MW compared to 900 to 1700 MW from traditional reactors [9]. These reactors are designed to have an operational life of around sixty years. SMRs are the cleanest and most compact way to generate sizable quantities of power [9]. Nuclear power has the worst public relations of any electrical generation method, even though it has the highest energy density of any power source. SMRs are built with standardized modules that are shipped and assembled at the location. This approach to the construction of nuclear sites allows for faster and safer construction compared to other reactors.

The best part about the SMR is the ability to produce constant and clean energy no matter the weather, unlike other green energy solutions. The average SMR produces around 100 MW of energy which should be enough for one small city. An AI data center would only need one SMR [10]. SMRs have great fuel flexibility. This allows them to use lower enriched uranium and even nuclear recycled waste to reduce the cost of operation. This flexibility helps AI data centers get cheap, reliable power.

Power Backup

Data centers are required to be prepared for power outages. The first line of defense a data center has in case of power loss is the uninterruptible power supply (UPS). A UPS behaves similarly to both a battery and a surge protector. Modern UPS's give data centers up to half an hour to get their backup generators online and continue operations or shutdown their equipment in a safe and orderly manner. The second a power outage is detected data centers will start their backup diesel electric generators. At the same time this is happening the automatic transfer switches (ATS's) will disconnect the data center from the local power grid in order to receive power from the backup generators. With these safety measures in place most data centers are prepared to weather a power outage of up to forty-eight hours before being required to consider going offline [11] [12].

Battery energy storage is increasing rapidly in Texas. It is only second to California in battery energy storage [13]. Texas leads the nation in both dispatchable natural gas-powered electricity generation and intermittent renewable energy production. But one of the challenges Texas faces is how to align renewable generation with demand, as these intermittent power sources often go offline while demand peaks. This misalignment can lead to extreme price volatility and can make maintaining grid reliability more complex and challenging. Renewable energy also adds more volatility to the grid because the power output from these resources fluctuates.

Retired electric vehicle batteries are being repurposed for grid storage projects, extending their life span by up to 15 years before recycling. These second-life batteries are charged during periods of abundant renewable energy in Texas and then discharge electricity back to the grid when demand peaks. Some analysts question the economic viability of large-scale adoption, while others highlight environmental benefits and grid reliability [14].

Enter battery energy storage systems (BESS). When intermittent energy sources like wind and solar go offline, batteries can release stored energy and provide greater reliability and stability to the Electric Reliability Council of Texas (ERCOT) system. Batteries also can be quickly deployed to shore up grid stability in tight conditions, like when a power plant suddenly trips offline. From September 2020 to September 2024, Texas' total operational capacity of utility-scale batteries — large storage systems that plug directly into the grid or generation sources — increased more than 4,100 percent to 5,707 megawatts (MW).

Unlike traditional fossil fuel plants which can be turned up or down in response to demand energy storage will be needed for renewables [15]. One of the largest forms of energy storage is pumped hydro power. During times of excess energy production, power will be used to pump water from a lower reservoir to the higher one. When power production decreased, the water is allowed to flow back down through a turbine. The primary advantage of pumped hydro is that they can store large amounts of energy.

Geothermal energy represents a promising sustainable source of power. However, it has geographic limitations. Drawn from the earth's internal heat, geothermal energy can be harnessed for electricity generation. Unlike solar and wind energy which are intermittent, geothermal energy can provide a stable energy supply [16]. Geothermal systems, once established have low operating costs. Effective geothermal systems require access to areas with high-temperature geothermal reservoirs near the surface. Also, heat extraction cannot exceed natural replenishment, necessitating careful resource monitoring. With careful oversight, geothermal

energy can become an integral component of a balanced global energy mix.

Hydrogen-powered batteries have attracted interest as a cleaner, more efficient method of energy production and storage. Hydrogen systems utilize hydrogen as an external energy source that can be stored, transported, and converted into electricity as needed. Greater utilization of renewable energy sources, like wind and solar, requires efficient storage systems such as hydrogen that can store large amounts of energy for a long period with minimum loss. Because hydrogen is among the most abundant elements and only produces water vapor when converted to electricity, hydrogen batteries are considered clean and renewable for most modern applications. Disadvantages of hydrogen include hydrogen storage, which requires high pressure or specialized materials. Also, production (especially electrolysis) can be expensive. Hydrogen is flammable, and requires careful handling. Industrial applications include backup power for data centers and transportation [17]. They can store large amounts of excess power generated from solar or wind resources and release it when demand increases. The ability to balance supply and demand makes hydrogen a promising tool for stabilizing renewable-heavy grids.

Lithium batteries are not ideal candidates for large scale grid storage. Lithium batteries have very high energy density. This is good where applications where weight and small size are important, such as in smart phones or other small personal devices. However, for grid scale storage, size and weight are not nearly as important [18]. The risk of fire is also a major concern for lithium batteries.

Examples of Data Centers

Microsoft Azure's AI data centers are designed to support massive computational workloads, including large-scale machine learning, cloud-based inference, and the training of models.

Today, Azure operates more than 200 data centers worldwide, many of which are specifically optimized for AI workloads. These facilities house specialized hardware such as NVIDIA GPU's, Microsoft's

custom AI accelerators, and high-bandwidth networking systems that allow thousands of processors to work together. Azure's AI supercomputing cluster—built in partnership with OpenAI—are among the most powerful in the world and are used to train advanced models. Microsoft has also invested heavily in renewable energy, with a commitment to power all Azure data centers with 100% carbon-free energy by 2025. This sustainability focus is essential because AI workloads can consume enormous amounts of electricity. As artificial intelligence continues to grow, Azure's AI data centers will play a critical role in powering the models, applications, and innovations that shape the future of technology [19].

One of the most critical components supporting Apple's modern services, such as iCloud, Apple Music, and the App Store, is its global network of data centers. Within Apple's data centers, thousands of servers operate continuously to handle user data and applications. Because they run 24 hours a day, 7 days a week, the electrical demand is both constant and significant. As Apple's user base grows, so does the demand for computing power, which directly increases the energy requirements of these facilities. The company has committed to operating all of its data centers on 100 percent renewable energy, primarily through solar and wind power. This transition to clean energy not only reduces Apple's carbon footprint but also sets a standard for sustainability in the technology industry. In addition to efficiency improvements, Apple employs advanced load management techniques to reduce unnecessary energy consumption. By dynamically distributing workloads across servers, Apple can ensure that no single system is overburdened while others remain idle. This allows the company to turn off unused servers and reduce overall power usage. Energy storage systems also play a crucial role in Apple's data center strategy. Large-scale battery systems store excess energy generated from renewable sources and release it when demand increases. This helps stabilize the power supply and ensures consistent operation even when renewable energy production fluctuates. By combining energy storage with renewable energy, Apple enhances both reliability and sustainability [20].

AI in Medicine

AI is a tool and does not replace the doctor. The doctor still has to make the decision. Open-Evidence is a free AI medical information platform that gets its data from the New England Journal of Medicine and JAMA. It can craft patient treatment plans and edit clinical information for billing, payment, and continuity of care. AI makes changes to care plans based on new and existing research. It can increase revenue by twenty to twenty-five percent. You should still consult with legal counsel before signing any documents. It frees up time for more meaningful interactions [21].

Advantages and Disadvantages

Data centers are an emerging part of modern infrastructure and come with a few pros and cons. The benefits data centers contribute is the short-term financial gains the local community will gain from a data center. These financial gains will come from the companies buying the land and permits and whatnot for the data center as well as the influx of workers and capital from temporary workers coming to construct the data centers.

The negatives of data centers are well understood. Data centers are massive complexes that damage local environments and contribute to local weather warming effects, known as "heat islands" [22]. The facilities themselves are loud and bright and have immensely negative effects on local communities and neighborhoods.

Conclusions

Companies are now building larger and more advanced data centers to store, process, and distribute the enormous amount of digital information because this is the system that supports the modern digital world. The rapid growth of data center is primarily contributed to cloud computing, increased consumption and production of social media, need for secure digital infrastructure, and the growing demands of artificial intelligence.

References:

1. Thirsty Data: The Hidden Water and Energy Costs of Texas' Data Center Boom, 21, Jan, 2026, <https://harcresearch.org/news/thirsty-data-the-hidden-water-and-energy-costs-of-texas-data-center-boom/#:~:text=Data%20centers%20in%20Texas%20already,its%20residents%20during%20summer%20peak>. Accessed May 11, 2026.
2. How Much Electricity Does a Data Center Use? Complete 2025 Analysis, Solar Tech, January 1, 2026, <https://iaeimagazine.org/electrical-fundamentals/how-much-electricity-does-a-data-center-use-complete-2025-analysis/>. Accessed May 11, 2026.
3. U.S. Energy Information Administration, <https://www.eia.gov/tools/faqs/faq.php?id=97&t=3>. Accessed May 11, 2026.
4. What will it take to build the world's largest data centers, Matthew S. Smith, IEEE Spectrum, April 2026, pages 23-27.
5. AI is a memory hog, Samuel K. Moore, IEEE Spectrum, April 2026, pages 29-31.
6. Miguel Yanez-Barnuevo, June 15, 2025, "Data Centers and Water consumption" <https://www.eesi.org/articles/view/data-centers-and-water-consumption>. Accessed 13 January, 2026.
7. TerraSolEnergies, Key Milestones in the History of Solar Energy, <https://terrasolenergies.com/history-solar-power/>. Accessed May 11, 2026.
8. How Big is a Solar Project? Understanding Scale, Output, and Costs, Feb 24, 2025, <https://www.energea.com/understanding-scale-solar-projects/>. Accessed May 11, 2026.
9. Chernicoff, David. "Google and Amazon Make Major Inroads with SMRs to Bring Nuclear Energy to Data Centers." Data Center Frontier, 16 Oct. 2024, www.datacenterfrontier.com/energy/article/55235902/google-and-amazon-make-major-

[inroads-with-smrs-to-bring-nuclear-energy-to-data-centers](#)

10. U.S. Department of Energy. (2025, April 8). *Advantages and challenges of nuclear-powered data centers*. Energy.gov. <https://www.energy.gov/ne/articles/advantages-and-challenges-nuclear-powered-data-centers>
11. Emergency Power Backup for Data Centers, <https://www.primepower.com/blog/emergency-power-back-up-for-data-centers>. Accessed May 11, 2026.
12. Comparing Data Center Backup Power Systems, Christopher Tozzi, November 25, 2025. <https://www.datacenterknowledge.com/uptime/comparing-data-center-backup-power-systems>. Accessed May 11, 2026.
13. Battery energy storage in Texas, <https://comptroller.texas.gov/economy/fiscal-notes/infrastructure/2024/battery-store/>. Accessed February 3, 2026.
14. Retired EV Batteries Scored a New Gig: Bolstering Texas' Grid <https://insideclimatenews.org/news/17022026/retired-ev-batteries-bolster-texas-grid/>. Accessed on February 18, 2026.
15. NREL.gov, 1 June 2021, <https://www.nrel.gov/news/detail/program/2021/grid-scale-storage-us-storage-capacity-could-grow-five-fold-by-2050>. Accessed 21 November 2025.
16. DiPippo, Ronald. *Geothermal Power Plants: Principles, Applications, Case Studies and Environmental Impact*. 4th ed., Butterworth-Heinemann, 2016.
17. Staffell, I., & Rauen, M. (2021). Hydrogen storage for renewable energy integration. *Energy Policy*, 156, 112560. <https://doi.org/10.1016/j.enpol.2021.112560>
18. Catherine Bischofberger. "The pros and cons of batteries for energy storage." *e-tech*, 1 December 23, <https://etech.iec.ch/issue/2023-06/the-pros-and-cons-of-batteries-for-energy-storage>. Accessed 24 11 25.
19. Microsoft Azure. (2024). *Global infrastructure*. Retrieved from <https://azure.microsoft.com>. Accessed May 13, 2026.
20. Apple Data Centers: Fueling a Sustainable Revolution, Amber Jackson, May 4, 2024. <https://datacentremagazine.com/hyperscale/apple-data-centres-fuelling-a-sustainable-revolution>
21. Helping Medicine Evolve, Alisa Pierce, Texas Medicine, May/June 2026 pages 36-41.
22. Scientists have found an alarming environmental impact of vast data centers, Laura Peterson, March 30, 2026, <https://www.cnn.com/2026/03/30/climate/data-centers-are-having-an-underreported>. Accessed May 11, 2026.