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POLICY INITIATIVE

Powering Data Centers

What are the electricity demands of powering data centers?

Data centers are a growing industry.

Data centers support infrastructure for data processing, housing computers and servers that store and process data for online platforms, streaming, smart infrastructure, autonomous vehicles, and AI applications (Coucil of State Governments Midwest 2024). Increased demand for data from emerging technologies, such as AI, has led to rapid growth in data center workloads (Koot & Wijnhoven 2021; Masanet et al. 2020; Siddik et al 2021).

Data centers are grouped into small-scale and large-scale centers. Small-scale centers serve localized needs of small businesses, government, and larger corporations (Electric Power Research Institute (EPRI) 2024). Large-scale data centers, which include hyperscale data centers, serve operations such as multiple businesses or entire industries (EPRI 2024). In the U.S. there are currently 3,059 data centers in 50 states and D.C. (Data Center Map). In March 2024, Google selected Kansas City, MO for the location of a new data center (Butler 2024).

Research Highlights

Data centers' rapid growth is driven by an increasing demand for AI-powered applications.

By 2030, U.S. data center electricity demand is forecasted to account for 9% of the total electricity consumed, placing a burden on the electricity and water infrastructures.

New cooling technologies and power management techniques help reduce electricity consumption.

Electricity and water consumption of data centers are expected to grow.

AI models, such as ChatGPT, are significantly more energy-intensive than past data center applications, requiring up to 10 times the electricity of traditional Google searches (Goldman Sachs 2024). Data centers are projected to consume up to 9% of U.S. electricity by 2030, from an estimated 4% currently (EPRI 2024; **Figure 1**). Electricity consumption estimates depend on AI industry trends, Internet traffic, storage demand, and AI model development.

Data center energy consumption is primarily driven by IT equipment (45%), cooling systems (40%), and auxiliary components (15%) (Ahmed et al. 2021; Shehabi et al. 2016). Cooling plays a critical role in maintaining hardware performance and longevity (Koot & Wijnhoven 2021).

Data centers rely heavily on water for continuous cooling and electricity needs, raising concerns

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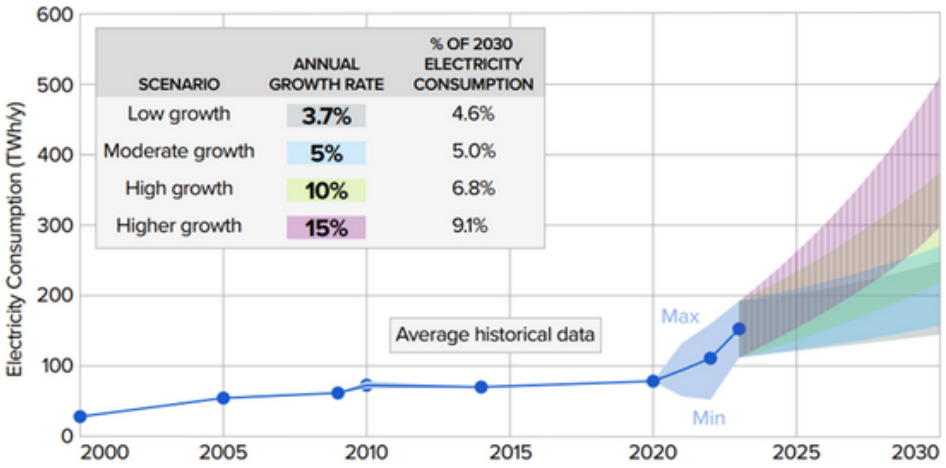

Figure 1. Projections of potential electricity consumption by U.S. data centers: 2023-2030. Projections are based on low, moderate, high, and higher growth scenarios. The blue line illustrates increase from 2000 to 2010. Between 2010 and 2020 the rate of load growth leveled off. Figure taken from EPRI (2024).

about overburdening electrical and water intrastructure, as well as land resources (Al Kez et al. 2022; Mytton 2021). Approximately 20% of U.S. data centers rely on watersheds facing moderate to high stress from drought and other factors (Siddik et al. 2021). About 16% of 122 data center operators have disclosed plans for managing water-related risks such as cutting freshwater use, water reduction goals and deadlines, and tracking their water consumption (Johnson & Molnar 2022). The European Union (EU) requires data centers to report data on energy and water use (EU 2023).

Energy-efficient practices include energy management, cooling systems, and renewable sources.

Shifting from small-scale data centers to energy-efficient hyperscale data centers has reduced infrastructure energy use (Masanet et al. 2020).

Since the average workload in many data centers is typically around 30% of peak capacity, using power management techniques to power down idle devices and ensure only necessary ones are active, minimizes energy waste and helps reduce energy consumption (Shuja et al. 2012). Keeping an inventory of server hardware and applications, and linking applications to their physical servers help identify unused servers (Department of Energy (DOE) 2017). Energy efficiency standards for IT equipment (storage, computers, servers, monitors) provide data center operators with access to IT devices that offer greater energy efficiency (DOE 2017; Masanet et al. 2020).

Virtualization is a method for managing power and resources. It allows one single physical server to run multiple virtual computers, each handling its own applications (Shuja et al. 2012).

New technologies in cooling systems can allow data centers to manage future energy demands by reducing the energy-intensive nature of traditional cooling methods. (DOE 2024; Masanet et al. 2020; National Renewable Energy Laboratory 2023). For example, immersion cooling could reduce cooling costs by up to 90% (Koot & Wijnhoven 2021).

Using renewables sources and investing in renewable-energy plants and technologies are strategies employed by hyperscale data centers to support their expansion (McKinsey & Company 2023). Renewable energy reduces reliance on power grids and eases the pressure on electricity infrastructure (EPRI 2024; Sheme et al. 2018).

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